الجامعة الإسلامية العالمية ماليزيا
INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA
يونيۏرسيتي إسلام انتارابڠسا مليسيا

JOURNAL OF INFORMATION SYSTEMS AND DIGITAL TECHNOLOGIES

Volume 6 Issue 2 2024

Kulliyyah of Information and Communication technology

JOURNAL OF INFORMATION SYSTEMS AND DIGITAL TECHNOLOGIES (JISDT)

Vol. 6 No. 2 (2024): December 2024

URL: https://journals.iium.edu.my/kict/index.php/jisdt/issue/view/42

Editorial Team

TABLE OF CONTENT

MAXIMIZING USABILITY OF IIUM GIGEASE: A SHORT-TERM EMPLOYMENT PLATFORM FOR IIUM STUDENTS AND NEIGHBOURING COMMUNITIES

MOHD KHAIRI MOHAMAD YUSR[1*], MADIHAH SHEIKH ABDUL AZIZ[2]

Department of Information Systems, Kulliyyah of Information and Communication Technology, International Islamic University Malaysia, Gombak, Selangor, Malaysia

**Corresponding author: Khairiyusri07@gmail.com*

ABSTRACT: Due to the rising cost of living in Malaysia, students who typically have no source of income are increasingly facing financial challenges. These challenges often compel them to make sacrifices in essential areas, such as nutrition, in order to survive throughout their study period. In response, the IIUM GIGEASE mobile application was developed as a platform to provide temporary job opportunities for students and the neighbouring communities around IIUM. The project followed the interaction design lifecycle model, which includes stages such as establishing requirements, designing alternatives, prototyping, and evaluation. This paper focuses primarily on the prototyping and evaluation phases. After identifying key features through literature review and surveys, a low-fidelity prototype was created during the designing alternatives phase. Numerous revisions were made to the prototype following user testing. The second prototype was well received, leading to the development of the high-fidelity prototype. The correct use of terminology and clear navigation design were deemed critical for the usability of the GIGEASE application. The project is expected to make a valuable contribution to IIUM and the local Gombak communities, with the potential to significantly improve community wellbeing.

KEY WORDS: *Usability Testing, Interaction Design, Mobile Interface Design, Cost of living*

1. INTRODUCTION

In the International Islamic University of Malaysia (IIUM), especially Gombak Campus, there are many clubs and societies that have been established since IIUM first establishment. As of 2021, a total of 139 student societies and clubs were registered under the Student Affair and Development Division. These societies are categorized as Kulliyyah-Based Society, Arts & Culture, Association & Solidarity, Da'wah & Spirituality, Entrepreneurship, Entrepreneurship, Humanitarian & Volunteerism, Intellectual & Knowledge, and many more (IIUM, n.d.).

Each of the clubs and societies has their own programs each semester and some of the programs include students, staff and local community. For example, each of the kulliyah based societies organized their own kulliyah based events, such as IRKHS Fest, KICT Fest, and more. In these events, many entrepreneurs from outside IIUM were invited to sell their product within the IIUM campus area. Vendors that were involved in the event would need some workers to help them handle the sale. This creates an opportunity for a temporary job for both IIUM students and local Gombak communities.

The IIUM strategic roadmap under the High-Touch Community Engagement highlights the implementation of IIUM community engagement framework, which are important in creating moderate graduates for the country and the world. Therefore, we believe the IIUM GIGEASE mobile application could be an anchor in building a strong and sustainable partnership with the surrounding Gombak community through interaction and job creation.

1.1. The Rising Cost of Living in Malaysia

According to the 2019 Household Expenditure Survey by the Department of Statistics Malaysia, the average monthly spending per household in the country amounted to RM4,033 (DOSM, 2020, as cited in RinggitPlus, 2020). This figure covers various expenses such as food, housing, transportation, education, and other categories (DOSM, 2020). The Star in 2021 reported that the average cost of living for Malaysian to have a comfortable life is around RM4,000 to RM4,500 a month for a single person. While for a family of four, it is around RM9,000 to RM9,500 a month. This figure is far too big in comparison to the minimum salary, which was set by the government at RM1,500 (MalayMail, 2022). Thus, for the lower income group, they need to sacrifice in many areas as the amount of the salaries can be said as not enough for them to provide a comfortable life for their family. Thus, most of them are finding a second source of income to make ends meet (The Edge, 2022).

For students, this is also a concern as they are usually not having any income to tackle the cost-of-living issue. Many of them are just taking a shortcut by skipping meal or just eating a single dish without vegetables (Utusan Malaysia, 2023). This practices however, will only result to nutritional deficiencies that are needed by their body which might affect their academic performances. The government also admitted these issues and provided Menu Rahmah initiative so that the students can have a proper meal (Berita Harian, 2023). However, this initiative is not enough as students still need money for their education materials, activities and others.

1.2. Gig Economy Platforms and Models

Today, the term of gig economy is more popularised with the establishment of many digital companies such as Uber, Grab, Fiverr, Upwork and more. Gig economy is a labour market where independent contractors and freelancers occupy many temporary and part-time positions rather than full-time, permanent workers (Investopedia, 2022). For the companies who are involved in the gig economy, they usually do not own any assets, as the assets are owned by their customers. For example, Uber is the largest taxi company in the world, but does not have any taxis in their assets, their ‘workers’ need to provide their own vehicle in order to work for the company.

Other than taxi and delivery services, there are other types of gig economy platforms that are available in the market today, such as Fiverr, it is a global internet marketplace for independent contractors. The platform connects freelancers with individuals or organisations who are seeking people to hire.

1.3. Gig Economy in Malaysia

Gig workers constitute a growing segment of the Malaysian labour force, offering significant potential for employment creation, production, and income generation (Harun, Ali, & Khan, 2020). The sociodemographic profile of gig economy workers in Malaysia, demonstrates high motivation and satisfaction, influenced notably by gender and age. Age and motivation together account for 59.0% of the variance in satisfaction levels (Norwani, Ismail, Nasir, Yusof, & Jamaluddin, 2022).

Despite these positive aspects, gig workers often grapple with job instability, poor job quality, and low salaries, rendering them a vulnerable population susceptible to stress (Freni-Sterrantino, & Salerno, 2021). Recognizing these challenges, there have been widespread calls for the establishment of a regulatory body for the gig economy. In line with this, the Malaysian government has committed to the creation of the Gig Economy Commission Malaysia (SEGiM) (Astro Awani, 2023). This regulatory initiative aims to address the issues faced by gig workers, ensuring fair treatment, stability, and improved working conditions within the gig economy.

1.4. Students in Gig Economy

The gig economy has a significant impact on students, offering flexibility and new opportunities, but also presents challenges such as job satisfaction and stability (Hawari, Rasyidi & Abdillah, 2023). Participation in the gig economy can also promote economic development, provide job opportunities, and support college students in starting their own businesses (Yang, Lin, Huang, Xu, & Du 2018).The digital gig economy could greatly influence Malaysian students' entrepreneurial traits. However, many students are hesitant to pursue entrepreneurship as acareer (Hamid, Kurniasari, Taib, Embong, Saheh, Azali, & Sabli, 2018). Specifically, certain aspects of the digital economy, such as the social and cultural environment and theadoption by consumers and businesses, have a significant impact on students'entrepreneurial characteristics (Hamid et al, 2018).

Perceived usefulness, social influence, and students' preparation are significant predictors of their readiness for the gig economy, with perceived usefulness being the dominant factor (Mahmud, Hamil, Ariffin, Pungot, & Hasim, 2023). Students are motivated to participate in the gig economy by the perception of its usefulness, which can lead to skilldevelopment, networking opportunities, and increased financial independence. It is crucialfor universities to update their curricula to prepare students for the gig economy and provide them with the necessary skills for future employment (Mahmud et al, 2023).

1.5. The Design of Mobile Application for Gig Communities

Mobile applications can significantly improve the efficiency and productivity of NGOs byautomating functions, reducing paperwork, and increasing interaction between members ina secure manner. A mobile application can also serve as a platform to connect NGOs withvolunteers, allowing for the communication of opportunities and enrolment based on preferences, with gamification elements to increase engagement (Goel, Agarwal,Chandwani, & Dixit, 2021).

Other than that, Pardeshi, Bhogade, Kulkarni, Shigwan, & Mashal (2016) said thatCross-platform mobile applications can enhance collaboration between NGOs and society, promoting social services, information management, and transparency in operations. Web-based platforms can serve as a hub for NGOs to register, post activities, and engage with prospective members and volunteers, using modern web technologies (Jain, Kathoke, Khobragade, & Deshpande, 2020). These applications can streamline operations, facilitate donations, and connect NGOs with volunteers and the public, ultimately supporting the NGOs' mission and expanding their impact.

In designing job marketplace application, Pavani, Pujitha, Vaishnavi, Neha and Sahithi (2022) have extracted some feature based online job portal. For job poster, they areable to be able to create a new vacancy, change the details for vacancy, search on applicant,reschedule or postpone the interview. For the job seeker, they able to view all vacancies, view the details of the job poster, view the details of the vacancy and search on vacancies. While Orrù (2020) has also list out some of the essential feature for such application, for the user, essential features include sign-up/login functionality, profile editing, resume uploading, job searches, the ability to email resumes directly, job alert notifications, and the option to save jobs for later. The recruitment panel should offer registration for recruiters, the ability to upload and post jobs or send job invitations, emailoffers to candidates, filter incoming resumes, provide payment options and membership plan management, and allow for resume downloads (Orrù, 2020).

For the design of the application, Prasetya, Ridwanto, Rahman, and Gunawan (2021) whilestudying for the impact of e-transport platforms' Gojek and Grab UI/UX design to user preference in Indonesia. They concluded that the UI/UX design is only a minor factor in determining user preference among Indonesian users. They noted that despite Gojek's more complex UI, it is more preferred by users. However, it worth to note that both Gojek and Grab SUS score is relatively close. Zahib, Effendy, and Darwiyanto (2022) while studying the lack of accessibility in the Grab application for visually impaired users. The evaluation results show that the scenario completion rate has increased, and the number of errors made when completing the scenario has also decreased.They concluded that using the UCD method can improve the usability of the application.

1.6. Application Development

Creating a usable application always involves the needs of the user; thus, understanding the user requirements and transforming them into prototypes is essential for the successful development of applications (Susanto, & Meiryani, 2019). Besides, it is crucial to understand the guidelines that are available to ensure a smooth experience for the user when using the application.

Interaction design lifecycle model methodologies are among the methodologies that allow the development of an application to adapt quickly to changing requirements. The interaction designs, for example, will improve human-computer interaction, save time for designers, and allow developers to adopt comprehensive designs for new applications (Barbosa, Chen, Cuzzocrea, Du, Kara, Liu, Sivalingam, Ślęzak, Washio, Yang, Yuan, Prates & Stephanidis, 2020). The primary aim of interaction design is to create products that facilitate users in accomplishing their goals in the most efficient manner possible. There are four basic activities in the interaction design process (Preece, Sharp, & Rogers, 2019), as explained in the next section.

1.7. Significance of The Project

There are several significances to this project, which can be view on table 1:

Table 1: the significance of the project

No.	Significances	Elaboration
1	Economic Empowerment	The project aims to address the financial challenges faced by both studentsand local B40 communities in the Gombak area. By providing opportunities fortemporary jobs and gig work through the IIUM GigEase platform, individuals can supplement their income.
2	Community Development	The project aligns with IIUM's strategic roadmap for High-Touch Community Engagement. By involving local Gombak communities on the platform, it fosters a sense of community and mutual support. It can lead tostronger social bonds and a more cohesive local environment.
3	Skills Development	The project serves as a steppingstone for local communities to familiarizethemselves with the Fourth Industrial Revolution (4IR). Through participation in gig work and using the platform, individuals can gain new skills and adapt tothe changing job market, potentially opening new career opportunities.
4	Sustainable Campus Economy	By involving outside vendors and businesses in campus events, the project also contributes to the sustainability of the campus economy. It can generate additional revenue for the university and support the local economy.

2. METHODOLOGY

In this study, the principles of Interaction Design were applied to design a user-friendly platform. Interaction design focuses on how users interact with products, particularly software applications or websites, aiming to make user interactions efficient. The interaction design process involves four basic phases: 1) establishing requirements, 2) designing alternatives, 3) prototyping, and 4) evaluating (Preece et al, 2019).

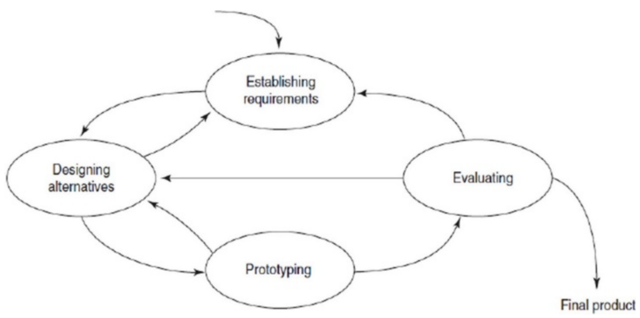


Fig. 1. Interaction Design Lifecycle Model (Rogers, Sharp, and Preece, 2019).

In the first phase, the project focused on identifying key features for the application through a literature review and a quantitative approach. These features served as the foundation for the subsequent phases. In the second phase, the design of the system's interfaces and architecture was developed, guided by the identified features. Using Adobe XD, low-fidelity prototypes were created to allow rapid iteration based on user feedback. These low-fidelity prototypes, simple and easy to modify, facilitated quick exploration of alternative designs (Preece et al., 2019).

In the third phase, wireframes and prototypes were created to visualize the platform's user interfaces (UI), focusing on layout. The initial designs used low-fidelity prototypes for rapid iteration based on user input. Then, the low-fidelity prototype was transformed into high-fidelity design prototype, providing a more realistic representation of the final product (Preece et al, 2019). The Flutter software was used to design the high-fidelity prototype, supporting multi-platform deployment with a single code base (Nwabude, 2022), aligning well with IIUM GIGEASE's multi-platform user base.

The core of this paper focuses on the prototyping process and the subsequent usability testing. After the prototypes were developed, usability testing was conducted to gather user feedback and assess the overall user experience. Based on this feedback, several improvements were made to enhance the application's usability. The next sections will detail the results of the usability testing and the analysis of user performance, highlighting key insights gained during the evaluation process.

2.1. Participant Recruitment

Participants for the usability testing were selected from the platform's target user base which is IIUM students. The Participant were recruited through convenience sampling. Convenience sampling, according to Edgar, Manz in 2017, is a method of collecting samples by selecting those that are conveniently available around a location. Through this, the researcher went to the various kulliyah common area to ask random students to participate in the research

Eleven participants were involved in evaluating both the low-fidelity and high-fidelity prototypes across three iterations. The first iteration, involving the Low-Fidelity Prototype 1, had three female participants which were found on the cafés on The Kulliyyah of Education (KOED) and Human Sciences (HS) building. The second iteration, which tested Low-Fidelity Prototype 2, included three participants—two males and one female. These participants were found on HS and the Kulliyyah of Engineering (KOE) premise area.

The final iteration tested the High-Fidelity Prototype, with five participants—three males and two females. They were found on Kulliyyah of Information and Communication Technology (KICT), HS, and Ahmad Ibrahim Kulliyyah of Laws (AIKOL) area. All participants were undergraduate students from the International Islamic University Malaysia (IIUM) Gombak campus, and apart from their education level and gender, no other demographic data were collected.

2.2. Usability Testing Procedures

Upon arrival at the testing location, participants were welcomed by the researcher, who outlined the purpose of the usability evaluation. It was emphasized that the test aimed to assess the usability of the GIGEASE platform, not to evaluate the participants themselves. Then, the researcher read the relevant tasks (Table 3). while the participants completed them one at a time, at their own pace. Participants were asked to verbalize their thoughts as they went along, while the researcher took notes.

The participants' performance is assessed based on time spent, steps taken, and questions asked. A user receives a '/' if they complete the task easily with minimal steps with or without asking for a simple hint, while an 'X' is given if they appear lost, unsure of what to do, or asking for step to complete the task.

Table 2: Post-Usability Test form (USE questionnaire).

Code	Questions
	Usefulness
Q1	It helps me to be more effective.
Q2	It helps me to be more productive.
Q3	It is useful.
Q4	It gives me more control over the activities in my life.
Q5	It makes the things I want to accomplish easier to get done.
Q6	It saves me time when I use it.
Q7	It meets my needs.
Q8	It does everything I would expect it to do.
	Ease-of-Use
Q9	It is easy to use.
Q10	It is simple to use.
Q11	It is user-friendly.
Q12	It requires the fewest steps possible to accomplish what Iwant to do with it.
Q13	It is flexible.
Q14	Using it is effortless.
Q15	I can use it without written instructions.
Q16	I did not notice any inconsistencies when I use it.
Q17	Both occasional and regular users would like it.
Q18	I can recover from mistakes quickly and easily.
Q19	I can use it successfully every time.
	Ease of Learning
Q20	I learned to use it quickly.
Q21	It is easy to learn to use it.

Q22	I quickly became skilful with it.
	Satisfaction
Q23	I am satisfied with it.
Q24	I would recommend it to a friend.
Q25	It is fun to use.
Q26	It works the way I want it to work.
Q27	It is wonderful.
Q28	I feel that I need to have it.
Q29	It is pleasant to use.

After completing all the tasks, participants were asked for opinion, and fill out the USE questionnaire (Lund, 2001) through a Google Form as show in Table 2. Finally, participants were thanked and excused.

2.3. Data Analysis

This study proposed a mobile application platform for short term employment opportunities for IIUM students called GIGEASE. The initial prototypes for the user were created and tested through a formal method of Usability Testing. The testing is conducted to identify and eliminate any usability flaws from the earliest stage of prototype design.

The participants' performance were observed while performing the tasks, their such as time spent, steps taken, questions asked, all noted for further analysis. Upon completing the tasks, the participants were asked to give their opinion regarding the prototype and answering the USE Questionnaire through google survey. The survey responses will be used to determine the score of Usability aspect of the application.

3. RESULTS AND DISCUSSION

3.1. Low fidelity Prototype 1

During the testing a total of 16 tasks were given to the participants regarding account registration, job seeking, job poster and e wallet usage. The user finds it quite problematic and often asks the interviewer for hints. The performance of the participants can be viewed at table 3.

Table 3: Tasks and user performance on low fidelity prototype 1 testing

Tasks	P1	P2	P3
Suppose you are a new user interested in using the application. Please create a new account.	/	/	/
Imagine you are a student seeking a temporary job. Please find the list of available job.	/	/	X
Apply for a job that you are interested in. Walk me through the steps you take to complete the application.	/	/	/

Suppose you want to save a job listing to review later. Find a way to bookmark or save this job. Show me how you do it.	/	X	X
You received a notification about an interview request. Please navigate to your messages and respond to the employer.	/	/	/
You want to post a temporary job opportunity. Please create a new job listing.	/	X	X
Set specific preferences for the job, such as visibility options.	/	/	X
Review a transporter job listing you previously created.	X	/	X
Hire any applicant for the job you created.	X	/	/
Imagine you have just received your payment for a job you completed. Please show me how you access your e-wallet within the application and tell me your current balance.	/	/	/
You have decided to withdraw some funds from your e-wallet to your linked bank account. Walk me through the steps to initiate this withdrawal.	/	/	/
You have just received some money and want to add it to your e-wallet. Please show me how you can add funds to your e-wallet.	/	/	/
You are planning to make a payment by scanning the QR code at the shop. Please demonstrate how you initiate and complete a payment.	/	/	/
While paying at the counter, the cashier wants to scan your e-wallet barcode, but the code is too small, please make it larger.	/	/	X
You need to transfer money to a friend who also uses the application’s e-wallet. Show me how you would perform this peer-to-peer transfer.	/	/	/
You'd like to review your transaction history to track your previous payments and transfers. Show me how you access your transaction history.	/	/	/

3.2. Participants’ Opinion

A total of three main usability issues and three suggestions were discovered from the testing.

Participants found some tasks in the application difficult due to confusing design, information overload and unclear terms for certain functions. They suggested creating separate pages for different job statuses and reducing the need for excessive navigation. Additionally, they recommended adding a new job section for university clubs to recruit new members. Despite these challenges, the study successfully captured users' attention and provided valuable insights for improving the prototypes. The suggestions received will be considered in the next refinement of the prototypes.

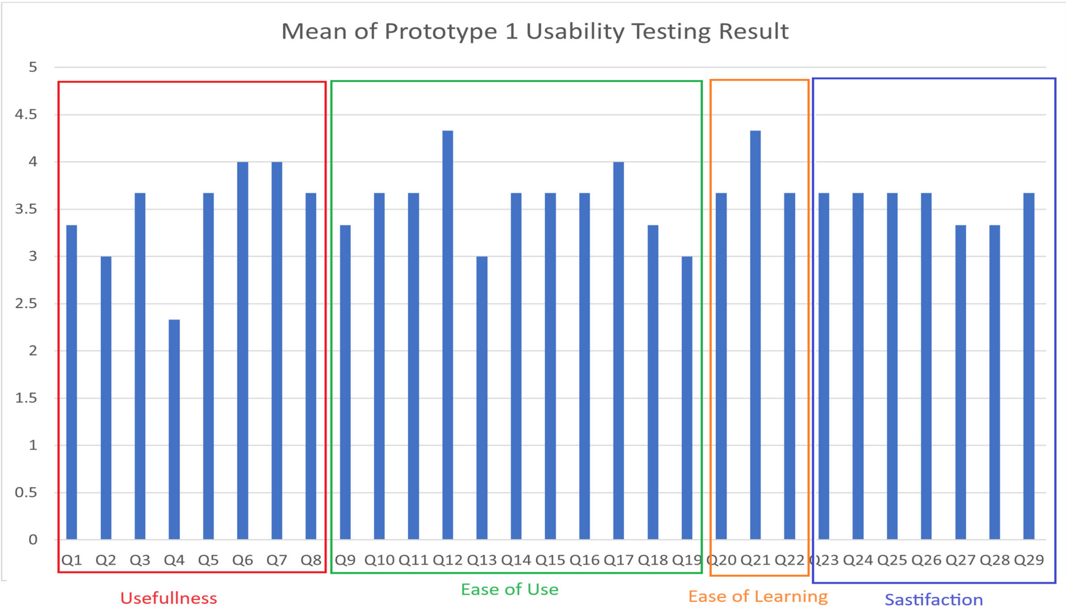


Fig. 2. Mean of Prototype 1 Usability Testing Result.

Fig 2 shows the score range for the USE Questionnaire is from 2.33 to 3.45 for usefulness, 3 to 4.33 for ease of use, 3.67 to 4.33 for ease of learning and 3.33 to 3.67 for satisfaction. Indicating further improvements should be made to the application. Detailed feedback from the participants can be viewed in fig. 3.

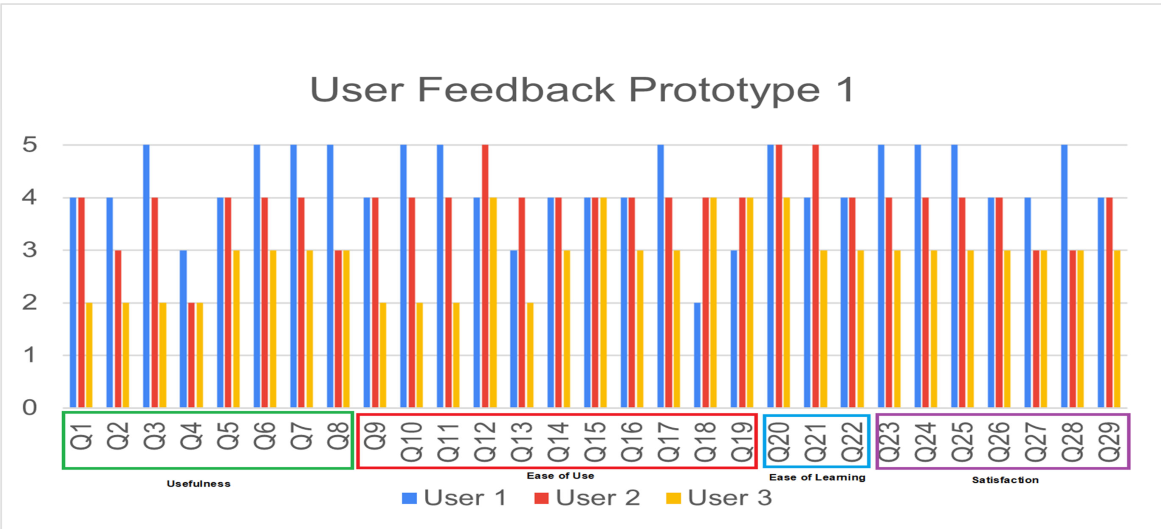
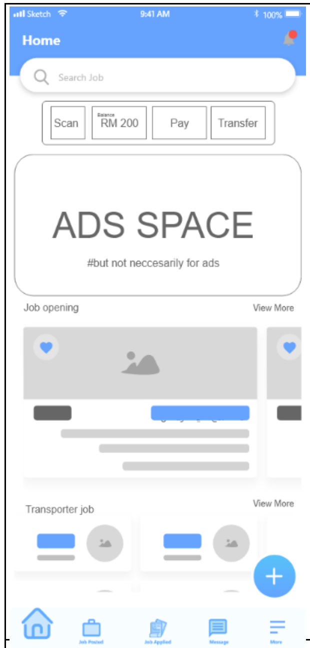
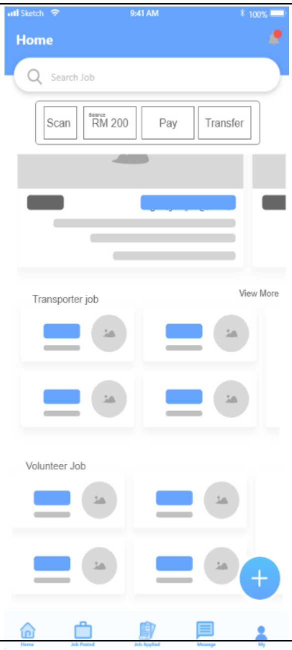
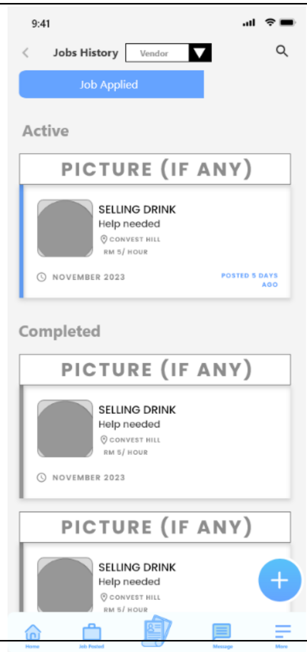
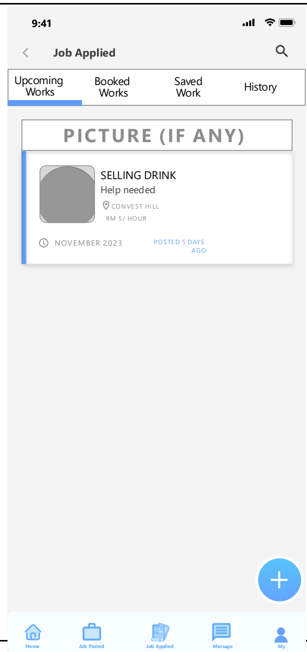
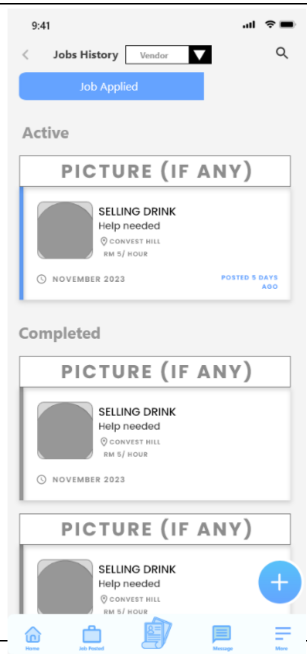
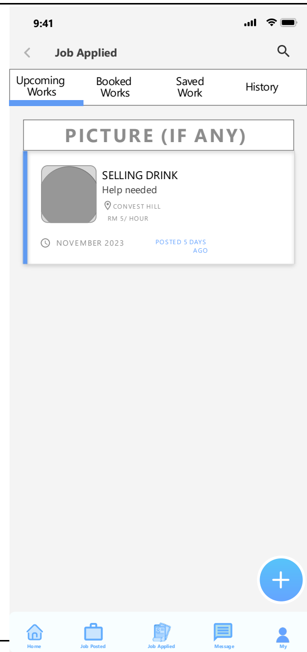
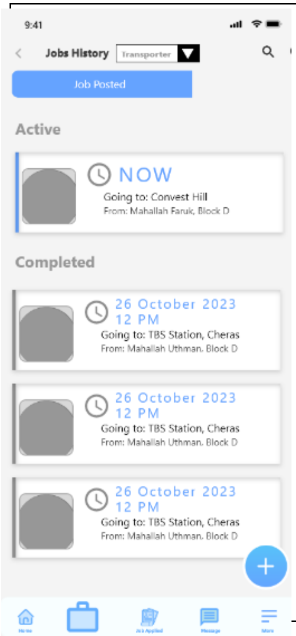


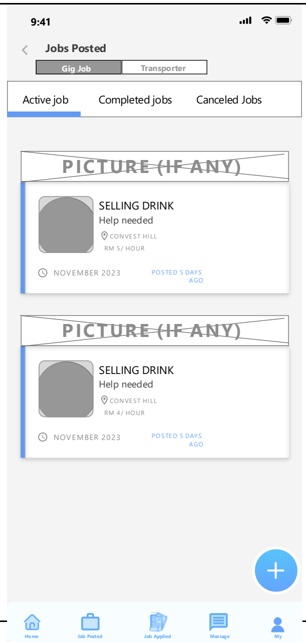
Fig. 3. User Feedback on Prototype 1.

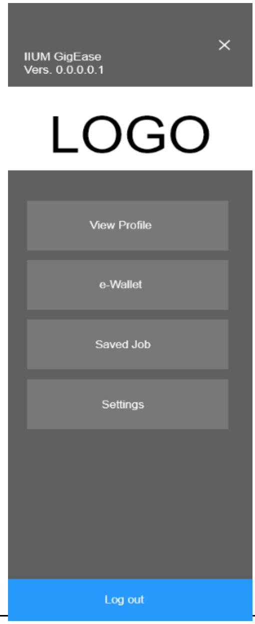
3.3. Low-fidelity Prototype 2

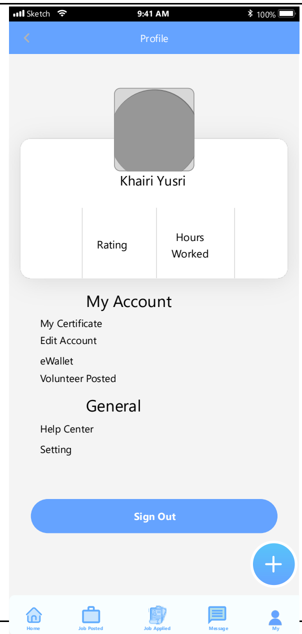
In the testing of Prototype 1, it has been discovered that some users struggled to complete some of the tasks. After refining the prototype based on the users' input, the following (fig. 4) are some examples of changes made from Prototype 1 to Prototype 2.

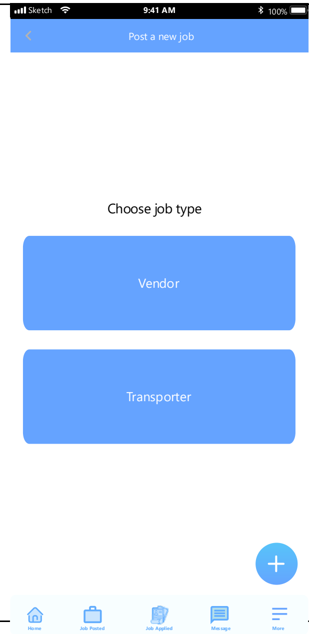
					
Prototype 1	Prototype 2	Prototype 1	Prototype 2	Prototype 1	Prototype 2
After the usability testing was finished, the participant suggested that a new section be added to give clubs opportunities to recruit their subcommittees using the application.	A new volunteer job is at the bottom of the main page.	During the testing, the user has difficulty changing the job type. The user also confuses the term ‘vendor’, which is a type of work that gives the meaning of gig job type. They also suggest making a different window for active, completed, and cancelled jobs.	Both job types will be viewed on the same screen. And the user can view the job according to its status. The term ‘gigs’ was also added to replace the previously confusing term 'vendor' that was meant as gig job type. ‘Saved work’ has been transferred here, which previously was on ‘More’.	During the testing, the user has difficulty changing the job type. The user also confuses the term ‘vendor’, which is a type of work that gives the meaning of gig job type. They also suggest making a different window for active, completed, and cancelled jobs.	Both job types will be viewed on the same screen. And the user can view the job according to its status. The term ‘gigs’ was also added to replace the previously confusing term 'vendor' that was meant as gig job type. ‘Saved work’ has been transferred here, which previously was on ‘More’.

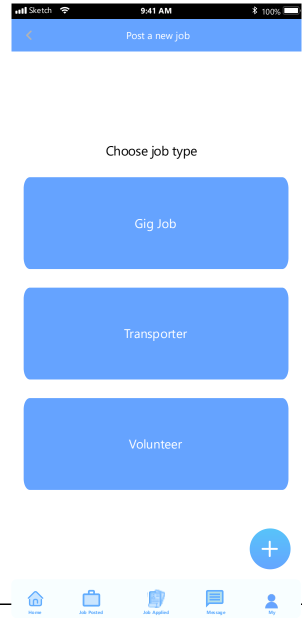












Prototype 1	Prototype 2	Prototype 1	Prototype 2	Prototype 1	Prototype 2
Similar to 'job applied', the user also has difficulty changing the job type. They also confuse the term 'vendor'. They also suggest making a different window for active, completed, and cancelled jobs.	The term 'Gigs' replaced the previously confusing term 'Vendor'. Unlike job history, which does not differentiate the view for each job type, 'Gig job' and 'Transporter', 'Job Posted' will differentiate them to avoid confusion between 'Job Applied' and 'Job Posted'. The different sections for 'active', 'completed, and 'cancel' were made.	While the user was having no problem navigating the 'More' section, one of them was suggesting replacing it with just the profile page, as it would be easier to view their account without too much navigation.	Changing the 'More' screen to 'My' screen. The rating of the user can be viewed here. They can also see how many hours they have been working. The 'Volunteer Posted' has also been put here, so that the user who is eligible to post the 'Volunteer Job' can view their applicants here.	The user is confused with the term 'Vendor', which is a type of work that has the meaning of gig job type. They asked to add a volunteer job section to the application to give clubs opportunities to recruit their subcommittees using the application.	The term 'Gigs' replaces the previously confusing term 'Vendor'. A new volunteer job option was added at the bottom of the 'Add New Job' page.

Fig. 4. The changes made from prototype 1 to prototype 2.

The tasks from the prototype 1 were presented to the participants with a few alterations to include the newly added "volunteer" job type, and only minimal hints were provided. All participants had no trouble navigating the application, indicating a high level of usability. However, one user points out one potential issueon the grid view of the job cards that might be overcrowded with information.

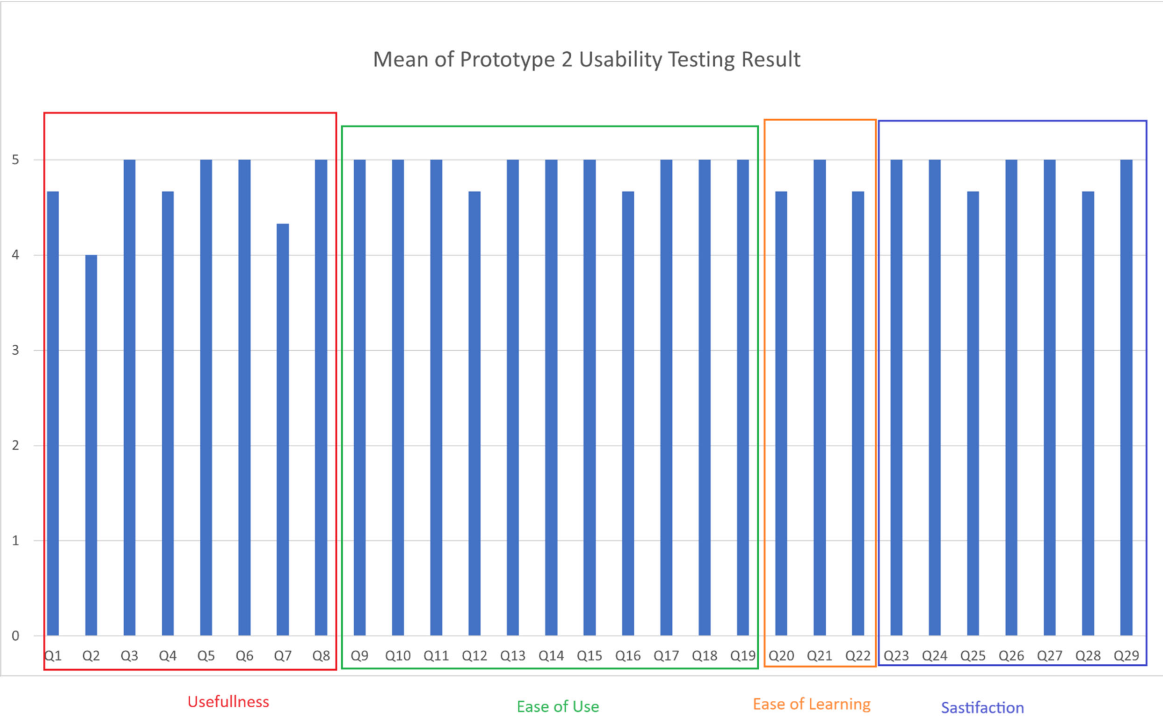


Fig. 5. Mean of Prototype 2 Usability Testing Result.

The score range for the USE Questionnaire is from 4 to 5 for usefulness, 4.67 to 5 for ease of use, 4.67 to 5 for ease of learning and 4.67 to 5 for satisfaction.

Table 4: the overall mean score for each aspect of USE (prototype 2)

Aspect	Mean Score
Usefulness	4.67
Ease of Use	4.89
Ease of Learning	4.89
Satisfaction	4.93

The overall mean scores from the USE questionnaire indicate that users rated the application highly in terms of usefulness (4.67), ease of use (4.89), ease of learning (4.89), and satisfaction (4.93). These scores suggest that the application was well-received and met or exceeded user expectations in these key areas. In the interview, one user points out one potential issue on the grid view of the job cards that might be overcrowded with information. Detailed feedback from the participants can be viewed in fig. 6.

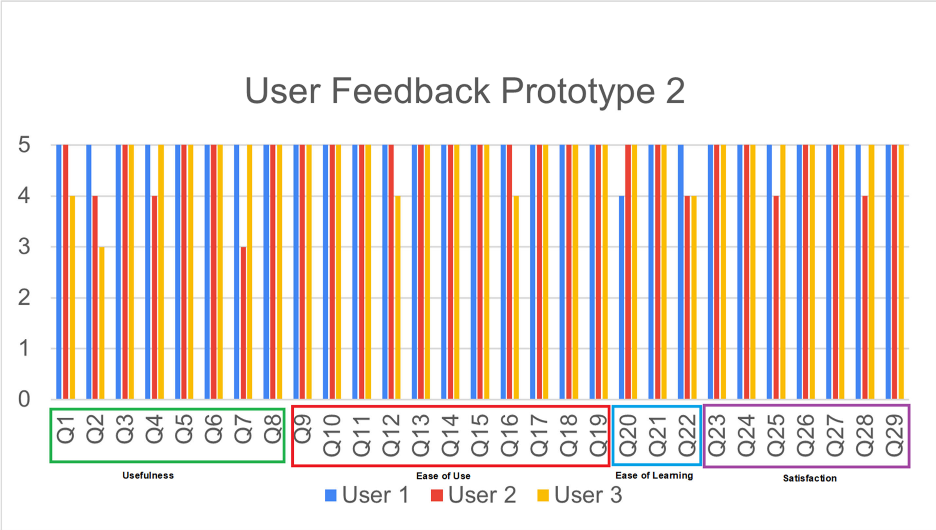
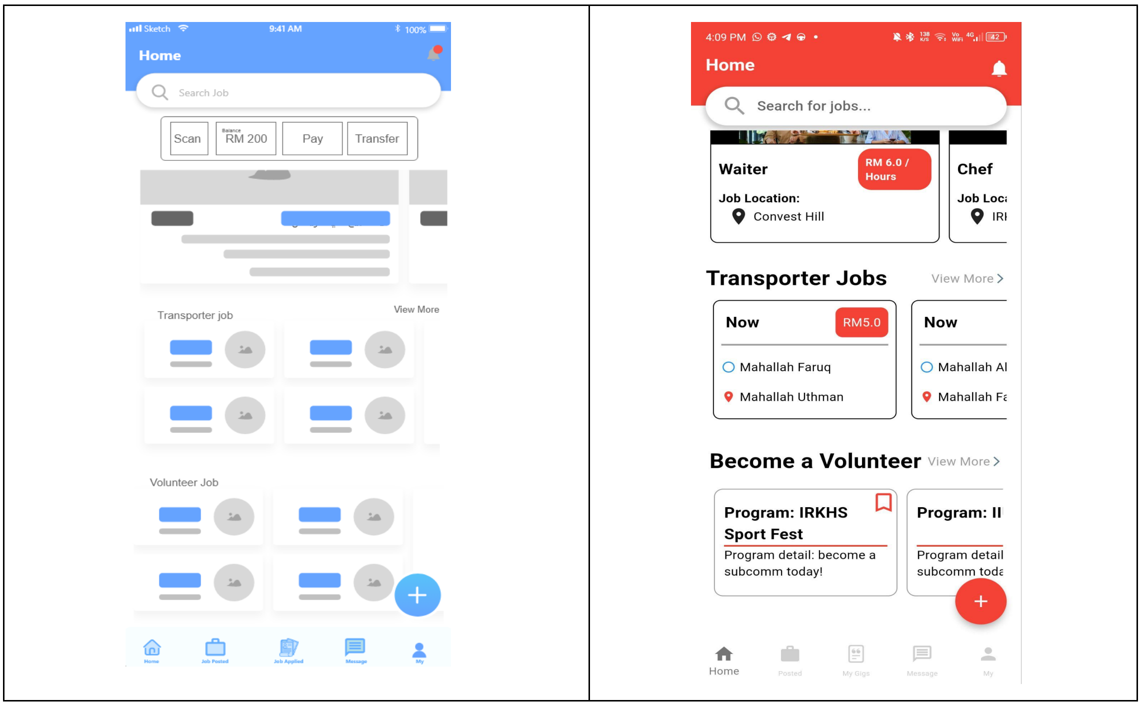


Fig. 6. User Feedback on Prototype 2.

3.4. Prototype 3 (High Fidelity Prototype)

In the Prototype 2 testing, most of the users were able to complete the tasks given with no problem. Thus, the prototype was transformed to high fidelity prototype with one alteration based on the participant suggestion. For the third prototype, the researcher has decided to include prayer time to the application to add some Islamic elemen to the application. The following (fig. 7) is the change made in prototype 3 based on prototype 2 usability test feedback.



Prototype 2	Prototype 3
The user suggests changing the grid view of the job cards for others because the job card might become too crowded with information.	The job card has been changed to only show one card per column.

Fig. 7. The changes made from prototype 2 to prototype 3.

The user suggests changing the grid view of the job cards for others because the job card might become too crowded with information. The job card has been changed to only show one card per column.

Table 5: Tasks and user performance on high fidelity prototype 3 testing

Task	R1	R2	R3	R4	R5
Create a new account as a new user	/	/	/	/	/
Find the list of available jobs as a student	/	/	/	/	/
Apply for a job and walk through the application steps	/	/	/	/	/
Bookmark or save a job listing	/	/	/	/	X
Withdraw from the job you applied for	/	/	/	/	X
Respond to an interview request notification	/	/	/	/	/
Create a new job listing for a temporary job	/	/	/	/	/
Review a previously created job listing	/	/	/	/	X
Hire an applicant for the job you created	/	/	/	/	X
Cancel a transporter job you created	/	/	/	/	/
Browse current listings in the volunteer section	/	/	/	/	/
Apply for a volunteer position and detail the submission steps	/	/	/	/	/
Respond to a message regarding a volunteer opportunity	/	/	/	/	/
Create a new volunteer listing for your society	/	/	/	/	/
Find prayer times in the app for Salah	/	/	/	/	/
Access your e-wallet and check the current balance	/	/	/	/	/
Withdraw funds from your e-wallet to your linked bank account	/	/	/	/	/
Add money to your e-wallet	/	/	/	/	/

Initiate and complete a payment by scanning a QR code	/	/	/	/	/
Make the e-wallet barcode larger for scanning	/	/	X	/	/
Perform a peer-to-peer transfer to a friend	/	/	/	/	/
Access your transaction history	/	/	/	/	/

For prototype 3, the number of participants was increased to 5 to ensure more significant results. Tasks from the previous prototype were presented with minimal alterations. Like the previous testing, almost all participants navigated the application without trouble. However, one user had trouble using the application, which indicated an area of improvement for the applications. The detailed feedback from the participants for the USE Questionnaire can be viewed in fig. 8.

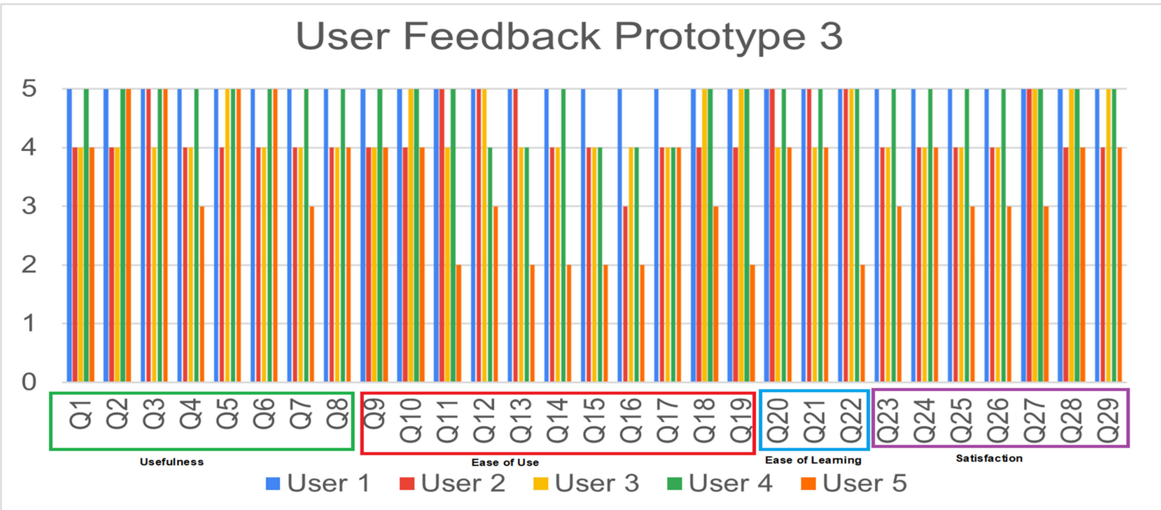


Fig. 8. User Feedback on Prototype 3.

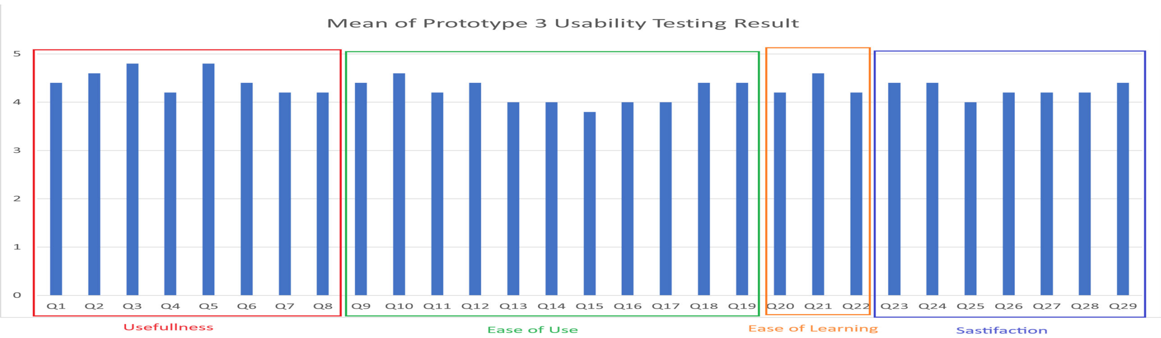


Fig. 9. Mean of Prototype Three Usability Testing Result.

Fig 9 shows the score range for the USE Questionnaire is from 4.2 to 4.8 for usefulness, 3.8 to 4.4 for ease of use, 4.2 to 4.6 for ease of learning and 4 to 4.6 for satisfaction. Indicating further improvements should be made to the application.

Table 6: the overall mean score for each aspect of USE (prototype 3)

Aspect	Mean Score
Usefulness	4.4
Ease of Use	4.4
Ease of Learning	4.4
Satisfaction	4.2

The overall mean scores from the USE questionnaire indicate that users rated the application very highly in terms of usefulness (4.4), ease of use (4.4), ease of learning (4.4), and satisfaction (4.2). These scores suggest that the application was well-received by most of the users.

3.5. Summary

The usability testing of the IIUM GigEase application across three prototypes has demonstrated significant improvements and provided valuable insights into the usability of the platform. Each iteration was carefully evaluated, and user feedback was instrumental in guiding essential modifications to enhance the application's overall usability, functionality, and design.

Table 7: Summary on each prototypes usability testing

Prototype	Participants	Key Changes	Detail
Prototype 1	3	Initial design and core functionalities.	Initial feedback indicated navigation and task completion challenges. I.e.confusing usage of term, information overload and confusing design.
Prototype 2	3	Improved navigation, added task functionalities, enhanced job listing interface, new e-wallet features.	Improved navigation and task completion. Higher satisfaction and ease of use.
Prototype 3	5	Further refinements, new features like prayer time, enhanced job card display	Positive reception with minor variability in feedback. Further areas for enhancement identified.

Table 8: Finding based on usability testing results

Key Findings	Details
Improvement Across Prototypes	Each prototype iteration showed significant improvements based on user feedback. The mean scores for all usability aspects (usefulness, ease of use, ease of learning, and satisfaction) increased progressively.
User Satisfaction	Users consistently rated the application highly, indicating a positive reception and a strong potential for meeting user needs effectively.

Areas for Enhancement	Despite high ratings, some variability in user feedback, particularly in the third prototype, suggests ongoing opportunities for refining specific features and functionalities.
Interaction Design	The iterative process underscored the importance of interaction design, with each round of testing providing crucial insights for enhancing the application.

The findings from the usability testing indicate significant improvements across the three prototypes, with progressively higher mean scores for usefulness, ease of use, ease of learning, and satisfaction. Consistently high user ratings reflect a positive reception, showing that the application effectively meets user needs. However, some variability in feedback for the third prototype suggests ongoing opportunities for refinement. Overall, the interaction design process proved essential for enhancing the application's functionality and user experience.

4. CONCLUSION

In conclusion, it appeared that the correct usage of terms and clear navigation design were most important for the GIGEASE application's usability. These factors were highlighted through user testing and feedback, indicating that further refinement in these areas is crucial for enhancing the overall user experience. The prototype 1 revealed key usability issues that were addressed in subsequent iterations, resulting in high usability scores in the next two prototypes. The development of this platform has the potential to benefit both the students and the local B40 communities in the neighbourhood of the Gombak campus. The application will address the financial issues of both targeted users.

Future work will include the full development and deployment phases. Which will also facilitate the assessment of acceptance and usage patterns among the university and neighbouring communities.

REFERENCES

Astro Awani (2023). Kerajaan setuju wujudkan Suruhanjaya Ekonomi Gig Malaysia – Zahid. Astro Awani. Retrieve From https://www.astroawani.com/berita-malaysia/kerajaan-setuju-wujudkan-suruhanjaya-ekonomi-gig-malaysia-zahid-423400.

Barbosa, S., Chen, P., Cuzzocrea, A., Du, X., Kara, O., Liu, T., Sivalingam, K., Ślęzak, D., Washio, T., Yang, X., Yuan, J., Prates, R., & Stephanidis, C. (2020). HCI International 2020 - Posters: 22nd International Conference, HCII 2020, Copenhagen, Denmark, July 19–24, 2020, Proceedings, Part I. HCI International 2020 - Posters. https://doi.org/10.1007/978-3-030-50726-8.

Berita Harian (2023). Menu Rahmah elak pelajar ikat perut. Berita Harian. https://www.bharian.com.my/berita/nasional/2023/02/1059648/menu-rahmah-elak-pelajar-ikat-perut

Edge, T. (2022). Majority of Malaysian employees have second source of income to make ends meet. The Edge. Retrieved from https://www.theedgemarkets.com/article/majority-malaysian-employees-have-second-source-income-make-ends-meet.

Freni-Sterrantino, A., & Salerno, V. (2021). A Plea for the Need to Investigate the Health Effects of Gig-Economy. Frontiers in Public Health, 9. https://doi.org/10.3389/fpubh.2021.638767.

Goel, M., Agarwal, A., Chandwani, N., & Dixit, T. (2021). Building an application framework to connect NGOs and Volunteers. 2021 International Conference on Innovative Practices in Technology and Management (ICIPTM), 1-5. https://doi.org/10.1109/iciptm52218.2021.9388342.

Hamid, N., Kurniasari, F., Taib, H., Embong, T., Saheh, N., Azali, N., & Sabli, N. (2018). A Comparative Study of Malaysian and Indonesian Students Entrepreneurial Characteristics and Career Choices Resulting from the Digital Economy. International Journal of Supply Chain Management, 7, 250- 258. https://doi.org/10.1504/IJBIS.2020.10018657.

Harun, N., Ali, N., & Khan, N. (2020). An experimental measure of Malaysia's gig workers using labour force survey1. Statistical journal of the IAOS, 36, 969-977. https://doi.org/10.3233/sji-200749.

Hawari, F., Rasyidi, E., & Abdillah, B. (2023). Measuring GIG Economy at Uin Sunan Ampel Surabaya: Typology, Characteristics, and Interests (Case Study of UIN Sunan Ampel Surabaya Students). Journal of Development Research. https://doi.org/10.28926/jdr.v7i2.350.

IIUM. (n.d). IIUM Student Organization. IIUM Student Organization. Retrieved from https://club.iium.edu.my/.

Jain, A., Kathoke, S., Khobragade, Y., & Prof, V. (2020). A Review on SEELIFE NGO Website. International Journal of Scientific Research in Computer Science, Engineering and Information Technology. https://doi.org/10.32628/cseit2063150.

Mahmud, N., Hamil, F. A., Mohd Ariffin, N. L., Mohd Pungot, S. Z., & Hasim, N. A. (2023). The Preparedness of Undergraduate Students to Take on the Gig Economy. *Information Management and Business Review, 15*(3), 399-404.

Lund, A., M. (2001). Measuring Usability with the USE Questionnaire. Research Gate. retrieved from https://www.researchgate.net/profile/Arnold-Lund/publication/230786746_Measuring_Usability_with_the_USE_Questionnaire/links/56e5a90e08ae98445c21561c/Measuring-Usability-with-the-USE-Questionnaire.pdf

Norwani, N., Ismail, Z., Nasir, N., Yusof, R., & Jamaluddin, N. (2022). The Influence of Gender, Age, Academic Level and Motivation on Satisfaction Toward Benefits Received by Gig Economy Workers in Malaysia. Archives of Business Research. https://doi.org/10.14738/abr.1012.13602.

Nwabude, o., (2022). Why You Should Use Flutter for Your Projects. Free Code Camp. Retrieve from https://www.freecodecamp.org/news/why-you-should-use-flutter/

Malay Mail. (2022, April 28). It's official: Malaysia to start RM1,500 minimum wage from May 1; firms with fewer than 5 employees exempted. https://www.malaymail.com/news/malaysia/2022/04/28/its-official-malaysia-to-start-rm1500-minimum-wage-from-may-1-firms-with-fe/2056088

Orrù, Y. (2020). Job Portal App Development: Market Overview, Features & Cost Estimations. Madappgang. https://madappgang.com/blog/job-portal-app-development-market-overview-features--cost-estimations/

Pardeshi, K., Bhogade, A., Kulkarni, R., Shigwan, T., & Mashal, K. (2016). Technology A Cross-Platform Application To Enhance Ngo And Society Collaboration.https://doi.org/10.5281/ZENODO.48827

Pavani, V., Pujitha, N. M., Vaishnavi, P. V., Neha, K., & Sahithi, D. S. (2022). Feature extraction based online job portal. In *2022 International Conference on Electronics and Renewable Systems (ICEARS)* (pp. 1676-1683).Tuticorin, India. https://doi.org/10.1109/ICEARS53579.2022.9752295

Prasetya, H. H., Ridwanto, B. B., Rahman, M. A., & Santoso Gunawan, A. A. (2021).The impact of e-transport platforms' Gojek and Grab UI/UX design to user preference in Indonesia. In *2021 1st International Conference on Computer Science and Artificial Intelligence (ICCSAI)* (pp. 167-177). Jakarta, Indonesia. doi: 10.1109/ICCSAI53272.2021.9609767

Preece, J., Sharp, H., & Rogers, Y. (2019). Interaction Design: Beyond Human-Computer Interaction (5th ed.). Wiley.

RinggitPlus. (2020, February 11). Malaysian monthly household expenditure increased in 2019 compared to 2016. https://ringgitplus.com/en/blog/household-budgeting/malaysian-monthly-household-expenditure-increased-in-2019-compared-to-2016.html

Susanto, A., & , Meiryani. (2019). System Development Method with The Prototype Method. International Journal of Scientific & Technology Research, 8, 141-144.

The Investopedia Team (2022). Gig Economy: Definition, Factors Behind It, Critique & Gig Work. INVESTOPEDIA. Retrieved from https://www.investopedia.com/terms/g/gig-economy.asp#:~:text=A%20gig%20economy%20is%20a,little%20or%20no%20job%20security.

The Star (2021). Urgency to address rising cost of living. Retrieved from https://www.thestar.com.my/business/business-news/2021/10/11/urgency-to-address-rising-cost-of-living.

Utusan Malaysia (2023). Pelajar IPT ikat perut, makan satu lauk tanpa sayur. Utusan Malaysia. https://www.utusan.com.my/gaya/2023/02/pelajar-ipt-ikat-perut-makan-satu-lauk-tanpa-sayur/

Yang, S., Lin, H., Huang, Y., Xu, G., & Du, Y. (2018). Research on the Influence of Undergraduates Participating in IGig Economyr on Their Employment and Entrepreneurship. , 970-974. https://doi.org/10.2991/ICMESD-18.2018.166

Zahib, M., Effendy, V., & Darwiyanto, E. (2022). Designing User Experience for Improving Mobile Application Accessibility Online Transport Booking for Visually-Impaired User With User-Centered Design: A Case Study of Grab. Journal of Information System Research (JOSH). Https://doi.org/10.47065/josh.v4i1.2246.

EVALUATING CRYPTOCURRENCIES THROUGH THE LENS OF ISLAMIC FINANCE BASED ON MAQASID SHARIAH

NAJHAN MUHAMAD IBRAHIM [1*], FILDZAH KARISMA PARADASA[2], FAKHRI AIZAT BIN JAFRI, MOHAMAD FAUZAN NOORDIN[3]

[123]*Department of Information Systems, Kulliyyah of Information and Communication Technology, Gombak, Selangor, Malaysia*

**Corresponding author: najhan_ibrahim@iium.edu.my*

ABSTRACT: Cryptocurrencies (digital asset) have been a growing area of interest for individuals, investors, and governments worldwide. It is a currency in a digital or virtual format, without any physical representation like traditional fiat money. This Cryptocurrency is exclusively accessible through internet-connected devices such as personal computers, laptops, cell phones, and other devices. A cryptosystem that utilizes blockchain technology offers numerous benefits, including enhanced transaction security, convenience, rapidity, and cross-border applicability. However, the circulating cryptocurrencies also have certain drawbacks, such as the absence of a regulatory body and the contentious legal status in many countries. The debate surrounding the advantages and disadvantages of cryptocurrencies has become active among professionals, including professors who have studied it from an Islamic perspective. The objective of this study is to assess the compatibility of cryptocurrencies with the principles of Islamic finance based on Maqasid Shariah. From the Islamic viewpoint, money possesses distinct attributes and prerequisites, including stability and a foundation in tangible goods. Cryptocurrency may not satisfy this requirement due to concerns regarding its classification as money from an Islamic standpoint. The research methodology employed the extant literature on cryptocurrencies. The findings indicate that Cryptocurrency exhibits significant volatility and has inherent limitations in being classified as 'money' due to its restricted supply and prevalent use for speculative purposes, which is forbidden in Islam. The research suggests that Muslims might hesitate to adopt cryptocurrencies as a medium of exchange or transaction. This factor gives rise to the anticipation that the growth of cryptocurrencies will be sluggish in Muslim nations.

KEY WORDS: *Cryptocurrency, Islamic Perspective, Digital Asset*

1. BACKGROUND & MOTIVATION

Cryptocurrencies, which are additionally referred to as digital assets, have become an innovative financial technology that is altering existing financial institutions and currencies as a result of technology's constant advancement. Currently El Salvador and the Central African Republic (CAR) have recognized cryptocurrencies as legal currency, suggesting that the country's acceptance of bitcoin as money is still relatively low. Of which, El Salvador is still the only nation that uses cryptocurrencies as accepted forms of payment in the real world. According to CoinGecko (2023). Consequently, in the majority of the nations who have legalized it, it is regarded as a digital asset.

As this newly developed kind of digital asset becomes increasingly prevalent, it is essential to evaluate the extent to which it complies with Islamic law, more especially the Maqasid Shariah. The objectives of Islamic law, or Maqasid Shariah, offer a thorough framework to analyze the moral and legal implications of various financial products, including cryptocurrency.This literature review explores the existing research on the intersection of cryptocurrency and Maqasid Shariah to understand the potential benefits and challenges from an Islamic perspective.

Currently, the cryptocurrency framework in Malaysia lacks of clear regulations and maqasid shariah, which has created huge gap and makes it difficult for businesses and investors to operate in the cryptocurrency market with certainty and security. The absence of a comprehensive cryptocurrency framework (based on maqasid shariah) has also led to concerns about the potential risks associated with Riba (Interest) and Gharar (Uncertainty): Islamic finance principles strictly prohibit the payment or receipt of interest (riba) and transactions that involve excessive uncertainty or ambiguity (gharar). The complex nature of cryptocurrencies and the potential for speculative trading may conflict with these principles, making it challenging to determine their compliance with Shariah. Also, there is no specific guideline to deal with matters on inheritance, particularly those pertaining to digital asset management. As a result, there is a significant need for the Malaysian government to establish a clear and comprehensive framework that will provide a safe and secure environment for cryptocurrency-related activities while also protecting the interests of all stakeholders involved.

1.1. Overview of Cryptocurrency

To lay the foundation for the review, it is essential to provide a comprehensive overview of cryptocurrencies. This section will delve into the technology behind cryptocurrencies, their decentralized nature, and the key features that differentiate them from traditional fiat currencies. A discussion on the rapid growth and adoption of cryptocurrencies globally will set the stage for the subsequent analysis through the lens of Maqasid Shariah. Cryptocurrency can be defined as of tokens which are intended to be used as a general or limited-purpose medium of-exchange, and which are accounted for using an often collectively-maintained digital ledger making use of cryptography to replace trust in institutions to varying extents.(Pernice et al , 2021). Most people think that Satoshi Nakamoto, the person who published the white paper on bitcoin, is the one who started cryptocurrencies, however David Chaum is the true pioneer of cryptocurrencies thanks to his idea of anonymous, bank-free digital money. Later on, he created Digicash, which needed encrypted keys to operate securely. Improving on this, Nick Szabo's 1998 Bit Gold, which resembled Bitcoin but lacked anti-double-spending measures. Finally, in 2009, Satoshi Nakamoto solved this hurdle with their Bitcoin white paper, igniting the cryptocurrency revolution.

Cryptocurrency is based on breakthrough blockchain technology, with transactions systematically recorded in a publicly distributed ledger, allowing for direct transactions between parties globally without the need for financial intermediaries. Its worth stems mostly from user trust and unique features, making it a standalone payment system in the worldwide digital financial space. The cryptocurrency industry has grown swiftly in response to rising demand, spanning a variety of forms like as Bitcoin, Litecoin, Ethereum, Solana, and Ripple, among others, illustrating the dynamic evolution and growing popularity of digital currencies. Although it was created for replacing fiat currency as a medium of exchange in the first place , it is regarded as a new class of asset called digital asset by most governments all around the world based on its inherent current valuability and importance. New things need to be analysis based on the Shariah and Maqasid Shariah to review it permissible as Islam is a religion where it is suitable for all kinds situations and places to prevent harm to the society , as the legal maxim of Shariah “Harm must be eliminated’ (N. M. Ibrahim et al, 2024).

1.2. Maqasid Shariah

This section will present an overview of the Maqasid Shariah framework, emphasizing its five primary objectives: protection of faith, life, intellect, lineage, and property. Each objective will be discussed in relation to financial transactions and economic activities, highlighting the principles that need to be considered in evaluating the permissibility of any financial instrument, including cryptocurrencies. The discussion begins by exploring the theory of Maqasid Shariah, derived from the Arabic term "maqsad," signifying objectives. Shariah, meaning religion or methodology, imposes rules by Allah through Prophet Muhammad. Various contemporary scholars offer definitions, with Allal al-Fasi emphasizing the implied objective behind legal rulings, Ahmad al-Raysuni focusing on objectives for realizing benefits, and Muhammad Saad al-Yubi emphasizing meaning, wisdom, and considerations for benefiting mankind. Maqasid Shariah aims to provide goodness and benefit to humanity in both this world and the next. Maqasid Shariah can classified based on legal texts into Maqasid ammah, the goal of preserving religion, life, intellect, lineage, and wealth; Maqasid khassah, the specific aims in matters like crime, property, and family; and Maqasid juz'iyyah, objectives in specific laws relating to particular issues. The overarching goal is to preserve order, facilitate life, establish human beings as caliphs on Earth, and promote good while curbing evil. In conclusion, Maqasid Shariah is not a product of mere human reason but is derived from a profound understanding of Islamic law.

Currently, the cryptocurrency framework in Malaysia lacks of clear regulations and This section will present an overview of the Maqasid Shariah framework, emphasizing its five primary objectives: protection of faith, life, intellect, lineage, and property. Each objective will be discussed in relation to financial transactions and economic activities, highlighting the principles that need to be considered in evaluating the permissibility of any financial instrument, including cryptocurrencies. The discussion begins by exploring the theory of Maqasid Shariah, derived from the Arabic term "maqsad," signifying objectives. Shariah, meaning religion or methodology, imposes rules by Allah through Prophet Muhammad. Various contemporary scholars offer definitions, with Allal al-Fasi emphasizing the implied objective behind legal rulings, Ahmad al-Raysuni focusing on objectives for realizing benefits, and Muhammad Saad al-Yubi emphasizing meaning, wisdom, and considerations for benefiting mankind. Maqasid Shariah aims to provide goodness and benefit to humanity in both this world and the next. Maqasid Shariah can classified based on legal texts into Maqasid ammah, the goal of preserving religion, life, intellect, lineage, and wealth; Maqasid khassah, the specific aims in matters like crime, property, and family; and Maqasid juz'iyyah, objectives in specific laws relating to particular issues. The overarching goal is to preserve order, facilitate life, establish human beings as caliphs on Earth, and promote good while curbing evil. In conclusion, Maqasid Shariah is not a product of mere human reason but is derived from a profound understanding of Islamic law.

1.3. Cryptocurrency and Maqasid Shariah Principles

The convergence of bitcoin and Maqasid Shariah principles presents a complicated and rapidly changing environment in the realm of Islamic fintech. Cryptocurrency, with its decentralised structure and dependence on blockchain technology, impacts traditional financial norms. Several key concepts emerge when analysing this technological advancement through the perspective of Maqasid Shariah, or Islamic law's goals. The most important consideration is the protection of religion (Hifz al-Din). Cryptocurrency's conformity with Islamic finance is dependent on its adherence to principles prohibiting usury (riba) and speculative features similar to gambling (maisir). Scholars examine the structure of cryptocurrencies to verify they adhere to Shariah-compliant financial procedures.

Second, the preservation of life (Hifz al-Nafs) is critical. Evaluating the risks connected with cryptocurrency investments and transactions is critical to ensuring that individuals are not subjected to unwarranted damage or speculative behaviors that jeopardize their financial security. The protection of intellect (Hifz al-Aql) entails addressing intellectual property concerns in the cryptocurrency space while also limiting the risk of fraud and scams. Transparency and ethical procedures in bitcoin transactions are required to comply with Shariah principles. The safeguarding of lineage (Hifz al-Nasl) includes family wealth management and inheritance preparation. The function of cryptocurrency in maintaining and distributing family assets in accordance with Shariah must be carefully considered.

Finally, property protection (Hifz al-Mal) involves determining the property rights and ownership concerns associated with cryptocurrency transactions. Smart contracts, as technology solutions, are being evaluated for their capacity to provide equitable and transparent financial transactions. As global recognition and use of cryptocurrencies grows, experts and practitioners should actively engage in continuing discussions to negotiate the complexities of these digital assets within the framework of Maqasid Shariah. Striking a balance between financial innovation and adherence to Islamic norms is a continuous problem that necessitates careful consideration and coordination among scholars, regulators, and the cryptocurrency community.

2. LITERATURE REVIEW

Islamic finance is a rapidly growing sector that has been embracing financial technology (fintech) to enhance its services and products. The requirements for accepting the implementation of fintech products currently under Islamic finance are based on the principles of Islamic law (shariah). These principles require that all transactions, contracts, and related activities must be free from the elements of usury (riba), gambling (maysir), and excessive uncertainty (gharar). The dealings must also be fair and just to the contractual parties and must not bear any detrimental impact on society and the environment in line with the objectives of Islamic law (maqasid Shari’ah).

Considering the Islamic viewpoint involves evaluating the extent to which anything contributes to the achievement of Maqasid al Shariah. If a practice fails to achieve the essential purposes of Islamic law, it is said to be un-Islamic. Conversely, if a practice contributes to realizing these fundamental objectives, it is considered Islamic. Shari'ah-compliance means that a financial product or activity meets the criteria of the Shari'ah. Islamic finance is guided by the principles of the Shari'ah, which are derived from the Qur'an and the Sunnah. The primary distinguishing features in implementing Shari'ah in financial structures are that transactions must be grounded on tangible assets and not include any form of interest (riba). Shari'ah principles also forbid the presence of uncertainty (Gharar), excessive uncertainty or speculation (maysir), and gambling (Qimar). Sifat and Mohamad (2018) assert that the aims of the Shari’ah are immutable and universally applicable, regardless of the increasing significance of Islamic economics and finance in the political and economic realms during the last thirty years. (Todorof 2018) suggests that implementing FinTech in Islamic banking can enhance its competitiveness and inclusivity by expanding the range of available products and services, reducing their current costs, and bridging the credit disparity prevalent in numerous Muslim nations. Nurhisam (2017) contends that the issuance of money as a medium of exchange in a country is considered a matter safeguarded by Islamic law when examined from an Islamic legal standpoint.

According to Evans (2015), Cryptocurrency could be a more suitable form of currency in Islamic banking and finance than the central bank fiat currency supported by interest. This is particularly true in cross-border trade. (Al.Zubaidi, Alsudairy, and Alzubaidi 2017) emphasize the need for additional research in digital currencies and blockchain from a Shari'ah perspective. This research is necessary to gain a deeper understanding of the topic. However, they also acknowledge the potential for introducing a digital currency that complies with Shari'ah principles once all the concerns regarding its validity have been thoroughly examined and resolved. According to (Muedini, 2018), cryptocurrencies are well-suited for Islamic finance and can offer remedies for issues related to government-regulated currencies. Digital currencies have a set supply, unlike traditional fiat currencies, eliminating uncertainty and inflation. Kameel and Meera (2018). Critically analyze the impact of Bitcoin on Islamic finance and raise doubts about its suitability as a means of exchange by Shari’ah principles. They argue that bitcoin involves elements of gambling and uncertainty, which are prohibited in Islamic banking. Oziev and Yandiev (2018) adopt an intermediate stance by delineating the role of Cryptocurrency within the financial system by assessing its impact and comparing its attributes with traditional paper money. They ultimately assert that Cryptocurrency is acceptable, albeit subject to stringent conditions.

2.1. Related works

The most related works from Wartoyo and Haerisma (2022) besides the advantages brought by cryptocurrency in modern financial systems, also arise some Sharia concerns in terms of the benefit of cryptocurrency. In current practices, people tend to treat crypto as a commodity with speculation purposes and take advantage from the movement price of cryptocurrency. In addition, cryptocurrency can potentially be used for unlawful activities. From Maqasid Shariah perspective, Wartoyo and Haerisma (2022) argue that cryptocurrency has more element of mafsadat rather than maslahah, and it is considered to fall under the element of tahsiniyat and not dharuriyyat. Similarly, Meera (2018) opined that cryptocurrency has to be backed by real commodities such as gold in order to be classified as Sharia-compliant. By doing so, cryptocurrency can promote socio economic justice and is consistent with the principle of Maqashid Shariah. Fageh and Nur Iman (2021) opined that cryptocurrency has more elements of mafsadah than maslahah despite it offered several advantages in current economic practices. In addition, Alam and Noor (2020) analyzed Sharia perspectives on Mine and non-mined cryptocurrency, stating that cryptocurrency can fulfill the element preservation of wealth (hifz al-mal) as one of the pillars of Maqasid Shariah. The arguments from scholars who allow cryptocurrency are stronger than those who do not permit crypto. This is because the arguments not permitting cryptocurrency are mostly based on external factors, while the cryptocurrency itself does not conflict with Sharia principles.

Table 1: Comprehensive Comparison Study

Authors	**Year**	**Title**	**Islamic Perspective**	**Key Finding**
Hassan, Muneeza, and Mohammed	2023	Cryptocurrencies from Islamic perspective	Cryptocurrency, Protection of wealth	- Cryptocurrencies do not possess all the characteristics of money according to Shariah principles - Scholars debate crypto classification as a medium of exchange due to concerns about volatility, intrinsic value and governance.
Khan	2022	The legality of cryptocurrency from an Islamic perspective: a research note	Cryptocurrency, Protection of wealth	Cryptocurrency does not qualify as Money in Islam: 1) Cryptocurrency is not backed by gold or silver, and it does not have any intrinsic value. 2) The price fluctuation in cryptocurrency is very high, which makes it speculative. 3) Not backed by any government and hence cannot become a legal tender. It could be used for money laundering, tax evasion, and other illegal activities because of its decentralized structure. All such activities fall under deception, which is prohibited in Islam.

Alam & Noor	2020	Mined and Non-Mined Crypto Currencies: A Critical Analysis from Shariah Perspective	Cryptocurrency, Maqasid Shariah (protection of wealth)	- Analyzing crypto currency from the *Maqasid al-Shariah* point of view, the preservation and protection of wealth is one of the fundamental objectives of Shariah (*Maqasid al-Shariah*). - Crypto currency is permissible as it does not conflict with the Shariah principles.
Wartoyo & Haerisma	(2022)	Cryptocurrency in the Perspective of Maqasid al-Shariah	Cryptocurrency, Maqasid Shariah (protection of wealth)	- Cryptocurrency has a much greater element of *mafsadah* than *maslahah*. - The benefits caused by cryptocurrencies do not reach the level of *dharuriyat* or even *hajjiyat*, but are still in the stage of *tahsiniyat*, which is legal in Islam and can be implemented but only as a complement to transactions.
Mohamed Aslam Akbar	(2022)	Towards an interpretation of cryptocurrency as a commodity from Maqasid al shari'ah perspective	Protection of Faith, Protection of Life, Protection of Intellect, Protection of Lineage	- Cryptocurrencies' anti-corruption & fair features align with Islamic values and Maqasid: the author praises crypto's decentralization and transparency as tools for promoting social justice and combating corrupt institutions. - Integration into the markets hinges on overcoming key disadvantages.
Othman Sahalan & Muhammad Adib Samsudin	2022	Cryptocurrency According to The Principles of Usul Al-Fiqh: A Critical Analysis by Mohd Daud Bakar	Usul Al-Fiqh, Views from Mohd Daud Bakar	- Cryptocurrency aligns with the Maqasid (objectives) of Islamic law in several ways, as highlighted by Mohd Daud Bakar: - The preservation of property (hifzal-mal) - More efficient and discreet method of surveillance and traceability due to its resistance to hacking
Achmad Fageh, Aldi Khusmufa Nur Iman	2021	Cryptocurrency as Investment in Commodity Futures Trading in Indonesia; Based on Maqāṣid al-Sharī'ah Approach	Cryptocurrency, Maqasid Sharia	- The use of cryptocurrency as a commodity - The weakness and challenges of cryptocurrency, which can be interpreted as Mafsadah, outnumber the benefits and prospects of cryptocurrency, which can be interpreted as Maṣlaḥah in Maqasid Shariah

Rosele et al	2022	The Concept of Wealth (māl) in the Sharīʿah and Its Relation to Digital Assets	Protection of Faith, Protection of Life, Protection of Intellect, Protection of Lineage	- The use of cryptocurrencies is arguably not fully in compliance with the principles of - Maqasid Shariah outlined in Islam considering the different fatwas of the Islamic scholars with regards to the digital currency. - that cryptocurrency (Bitcoin) meets most of the criteria and other requirements to consider as al-māl from the Sharīʿah viewpoint thus align with Maqasid.
Mohd Ma'Sum Billah	2022	Crypto-Asset. How Does Shariah Matter?	Protection of Faith, Protection of Life, Protection of Intellect, Protection of Lineage	An Islamic crypto-asset model must be entirely Shariah-compliant, not just on paper but also in practice. This means: 1) Guided by Shariah principles: The model must follow established Shariah guidelines, policies, and systems. 2) Strict Shariah oversight: A qualified board must supervise, and a Shariah audit constantly monitor all activities to ensure compliance. Ethical adherence: An advisory body provides guidance on upholding Islamic principles and divine ethics.

The objective of this paper is to explore and access cryptocurrency from the Islamic finance (Maqasid Shariah) perspective. Maqasid Shariah or objectives of Sharia is categorized into 5 pillars priority according to Al-Ghazali (Amri & Mohammed, 2019): 1) religion (al-Din), life (al-Nafs), intellect (al-Aql), progeny (al-Nasl), and wealth (al-Mal). Based on table 1, several studies related to the discussion about cryptocurrency from the Sharia point of view are found. Most studies identify cryptocurrency from the concept of wealth or property under the Maqasid Shariah perspective. There is debate among scholars about whether cryptocurrency can be accepted by Sharia as a whole. The study conducted by Hassan, Muneeza, and Mohammed (2023) and Khan (2022) shows that cryptocurrency does not qualify as money based on Sharia due to several reasons such as price volatility, regulations, and intrinsic value. The price of cryptocurrency highly fluctuates and triggering speculation may raise Sharia concerns. Unlike traditional fiat money, which is governed by Central Banks, cryptocurrency is more decentralized and not regulated by the central authority. In addition, cryptocurrency does not have intrinsic value since it is not backed by any commodity such as gold or silver. This reason also aligns with the view from Meera (2018), whereby the findings show that any cryptocurrency not backed with real assets is against Maqasid Shariah. Similarly, Rosele et al. (2022) argue that cryptocurrency does not fulfill the objective of Sharia.

From the Maqasid Shariah perspective, Wartoyo & Haerism (2022) highlighted that cryptocurrency has more elements of mafsadah rather than maslahah, and does not reach daruriyyat and hajiyyat level. This is due to the volatility and instability of cryptocurrency as a digital currency. They argued that cryptocurrency can be categorized under tahsiniyat level, considered legal in Islam, and treated as complementary over the transactions. Similar findings also found by Fageh & Nur Iman (2022) whereby from the Maqasid Shariah perspective, cryptocurrency has both advantages, which can be interpreted as maslahah, and disadvantages, which can be interpreted as mafsadah. However, the element of mafsadah is greater than Maslahah due to the high volatility and the risk of cryptocurrency being used for illegal practices. However, studies from Sahalan and Samsudin (2022) have different results. The authors argue that cryptocurrency can be accepted from the Maqasid Shariah and does not conflict with the Sharia principles. By examining the views of Sharia scholar, Mohd Daud Bakar, the study found that even the cryptocurrency is not recognized as legal currency in the country, it still can be accepted as a whole considering the preservation of property, traceable, upholds transparency as it is resistance to hacking. In line with this, Alam and Noor (2020) highlight similar points whereby cryptocurrency can fulfill the condition of money in Islam. It serves as preservation of wealth and it is permissible under Sharia principles. Moreover, the study from Billah (2022) highlights several important issues that must fulfill by crypto-asset in order to be classified as Sharia-compliant, such as: 1) follow the existing Sharia principles, policies, and systems, 2) managed and governed by Sharia board as well as Sharia audit to ensure the compliance; and 3) adhere towards Islamic principles and ethics. Akbar (2022) argued that the nature of cryptocurrency is transparent, thus it promotes justice and prevents corruption which is against Sharia principles. It is also consistent with Islamic values whereby the use of digital asset may address environmental issue, as the paper currency and coins require a lot of trees and metal; on the other hand, the element of disadvantages must be overcome, such as the high volatility.

3. METHODOLOGY

Bitcoin, Ethereum, and many other cryptocurrencies are strongly related to the financial technology (fintech) sector. These digital or virtual currencies are distributed on a public ledger (blockchain) among decentralised networks and encrypted using encryption. Cryptocurrencies may be used by criminals for illegal purposes including money laundering, financing terrorism, and many more since they are created by private businesses and are, in theory, outside the supervision of any authority (Chong, F.H.L., 2021). In Malaysia, the adoption of cryptocurrencies is still in its infancy and at a low level compared to how these currencies are received globally. The delayed adoption of cryptocurrencies by Malaysian consumers may come with a number of dangers, including "loss or theft, fraud or unauthorised usage, transaction processing issues, failure of a wallet or exchange, and poor transparency" (Unal, I.M.; Aysan, & A.F. Fintech., 2022). As a result, the government of Malaysia has developed a friendly approach to regulating cryptocurrencies. As a result, it is important to examine the strategy chosen to oversee Bitcoin and other virtual currencies (digital asset) in the nation. Since 2012 to the present has shown that the Malaysian people have not yet fully utilised the currency's enormous potential. The sluggish adoption of these cryptocurrencies may have been caused by a number of factors, the most of which were related to concerns about consumer protection and security (Nasrul, M. A, et al, 2023).

This article employs a descriptive qualitative approach, which involves conducting a literature analysis of prior publications and searching for data sources. The data collected in this study can be appropriately documented and referenced using Mendeley by established guidelines and citations. The paper examines the perspective of Islamic teachings on Cryptocurrency. This article uses descriptive qualitative, collecting specific information by conducting literature review of reports and research paper on the many aspects of cryptocurrency based on Maqasid Shariah which encompasses a comprehensive investigation of the topic, with a particular focus on gaining deeper and holistic understanding and insights. This approach requires a thorough analysis of several primary sources. It facilitates data integration by gathering information from research with comparable end measures and combining results from various methodologies. Titles, keywords, and abstracts of papers published in electronic journal databases like Scopus, Web of Science, Science Direct, ACM, Springer, and IEEE are searched as part of the ongoing research process between June 2018 and Dec 2023. Boolean operators "AND" and "OR" were utilised to create the search strategy throughout the execution phase. To find out more about Cryptocurrency (Digital Asset) Based on Maqasid Shariah was the aim of the search phrase.

4. FINDINGS AND DISCUSSION

Cryptocurrencies are a recent innovation and so, there is a need for competent Shariah scholars to deliberate on the permissibility of this innovation as, without their opinion, it would be difficult for Muslim communities to know the legal position of using them under Islamic law. Therefore, in recent years, numerous conferences and meetings of Shariah scholars have been held in different parts of the world to determine the legal position of cryptocurrencies from the Islamic perspective. From these gatherings, it is understood that determining the legal position of using cryptocurrencies from an Islamic perspective is not a matter that is simple to decide as there is a diversity of opinion among scholars in this regard. Therefore, in recent times, numerous research studies have been published on the permissibility of cryptocurrency from an Islamic perspective, elaborating on the reasons why scholars have expressed different opinions on the matter and focusing on why it is hard for them to have a uniform opinion on the matter. Hence, the objectives of this research are to review the opinions expressed by the Shariah scholars on the permissibility of cryptocurrencies and compile the issues related to it to understand its Shariah position. This paper attempts to answer an important question: What is the Shariah position of using cryptocurrencies from a Shariah perspective? It is important to answer this question as there is divergence of opinion of Shariah scholars on the permissibility of cryptocurrencies from a Shariah perspective. Most of the Shariah scholars have viewed cryptocurrency as impermissible from the Shariah perspective. Mostly on the justification that it has no intrinsic value, thus it cannot be qualified as money. Some other justifications are that it is not backed by an asset or the government, its lack of government regulation and its volatility. Moreover, the Head of the National Ulema Council of Indonesia, Asrorun Niam Sholeh, on November 11, 2021, issued a fatwa on the impermissibility of cryptocurrencies by justifying that it has elements of Gharar (uncertainty), wagering and harm. However, some few scholars hold the view that cryptocurrencies are permissible as money as they meet habits of exchange transactions besides other requirements such as maal (property), manfa'ah (usufruct), haqq (right), and dayn (liability). And even Shariah opinion on paying zakat on cryptocurrencies can also be seen around the world. So, we can see there are differing opinions.

The discussion about cryptocurrency is considered Sharia compliant and fulfills the element of Maqasid Shariah that has become debated among scholars. Cryptocurrency refers to a digital currency designed as a medium of exchange based on a cryptography system. The discussion about cryptocurrency, whether it can be identified as currency or money, is adequately addressed by Scholars. Cryptocurrency has to be not against the Sharia principle, such as no element of interest (riba), gambling (maysir), and uncertainty (gharar) (Alam and Noor, 2020). In order to be classified as currency, cryptocurrency has to satisfy the function of money, according to Islam. From the Sharia perspective, the protection of property or wealth is one (Hifz al-Mal) of the main elements in Maqasid Shariah. Therefore, it is necessary to look at cryptocurrency from the classification of money. Conceptually, the functions of money must be used as medium of exchange, as a unit of account, and store of value (Wartoyo and Haerisma, 2022). According to Khan (2022), three principles of things to be classified as money which are: 1) money can be any precious metal such as silver or gold or any commodity that has abundant supply and shelf life; 2) have intrinsic value; and 3) as a medium of exchange. Classification from Syahk Usmani (2005) whereby money from a Sharia point of view must fulfill these criteria such as: as a medium of exchange, store of value, and unit of account (Aliyu, et al. 2020).

4.1. Cryptocurrency does not align with Maqashid Shariah

Cryptocurrency works based on a decentralized system that has no authority to be involved. Since it works independently, cryptocurrency is not regulated by any central authority. The decentralized system allows cryptocurrency not to be controlled by a single authority or monopolized. From the Islamic point of view, this could raise regulatory concerns. Real money or currency is commonly regulated and maintained by the Central Banks to ensure the stability of the price. In addition, as the crypto works independently and depends only on the users and system, this may raise consumer protection issues due to the absence of regulation. Therefore, as the crypto has not been backed by any governance, the legality of cryptocurrency as money is still questionable. Some countries do not recognize cryptocurrency as a legal tender, such as Malaysia, Turkey, the United Kingdom, and India (Alam and Noor, 2020).

Cryptocurrency that is not backed by any asset and does not have intrinsic value may hinder the fulfillment of the characteristic of money in Islam. From the Sharia perspective, money must be based on physical form and can be used for economic activities as it is acceptable for everyone. It also possesses intrinsic value, on the other hand, cryptocurrency has only artificial value that of such value that is assigned by some hidden characters (Khan, 2020). Sharia scholars accept any form of money that is acceptable by the people, whether it is accepted by free will or recognized as legal tender based on law (Meera, 2018). Cryptocurrency is acceptable among users and may not be accepted by people who are still unrecognized or unfamiliar with cryptocurrency.

In addition, cryptocurrency has a risk of speculation. The cryptocurrency price is highly volatile, and people use it for speculation. Due to its unstable and high volatility, cryptocurrency cannot fulfill the function of storing value (Wartoyo and Haerisma, 2022). On the other hand, the value of money can be maintained and stored for a certain period of time. In addition, the nature of crypto is a digital asset, and it does not have a real physical form. This results in the value of cryptocurrency being unstable. Since it does not have an underlying asset (Kunaifi, Fawa'id, and Faujiah, 2022), the value of cryptocurrency tends to follow the market, and it depends on how much the trader expects the rest of the market to behave (Khan, 2022). The traders are coming to speculate and taking advantage of buying at a lower price and selling it at a higher price. It can be seen that cryptocurrency tends to be traded as a commodity through speculation. In the current practice, people tend to use crypto as a commodity to be traded rather than as a medium of exchange (Wartoyo and Haerisma, 2022). From a Sharia point of view, it is not allowed for the currency to be traded as a commodity since it is treated as a store of value (Amri and Mohammed, 2019). It is also against the principles of Sharia, where gambling and speculation are strictly prohibited in Sharia. Moreover, cryptocurrency can also be used for criminal acts due to the absence of authority bodies and government control in the systems, such as scams, cybercrime, and drug purchasing. Previously, the SilkRoad network operated as an online store on the dark web that sold various types of drugs and used bitcoin as a medium of payment (Wartoyo and Haerisma, 2022). It also could be used for financing terrorists, money laundering, and other unlawful activities. All these activities are against the Sharia values and principle.

4.2. Cryptocurrency align with Maqashid Shariah

Crypto currency as a digital asset is a another story in itself and it is considered as wealth (mal) where it has all the the criteria and other requirements to consider as al-māl from the Sharīʿah viewpoint.(Roselle et al, 2022) Additionally,Alam and Noor (2020) stated that crypto currency is permissible as it does not conflict with the Shariah principles as long as it is refer as an asset or a commodity not a currency when we see multiple countries classify it as either commodity or digital asset. Besides ,cryptocurrency aligns with the Maqasid (objectives) of Islamic law in several ways, as highlighted by Mohd Daud Bakar which is the preservation of property (hifz al-mal) and it has more efficient and discreet method of surveillance and traceability where we can identify where it comes and goes because of the blockchain technology where it is public subsequently increasing transparency. Besides , it has strong security due to its strong cryptographic system which is resistant to hacking. (Othman et al.2022).

In addition, Akbar also sees the future of cryptocurrency as a commodity or asset rather than currency and its features align with Islamic values and Maqasid where the author praises crypto's decentralization and transparency as tools for promoting social justice and combating corrupt institutions however the integration into the market need to be chiseled out .Thus it aligns with the Maqasid in the protection of wealth. Masum billah on the other hand, argued for the creation of Islamic crypto-asset model that will be entirely Shariah-compliant, not just on paper but also in practice. This means it is guided by Shariah principles by establishing Shariah guidelines, policies, and systems with strict shariah oversight where a qualified board must supervise, and a Shariah audit that will constantly monitor all activities to ensure compliance and strong ethical adherence. In conclusion , Cryptocurrency is aligned with Maqasid Shariah in the preservation of wealth as it is considered a mal , an asset or a commodity because it does not have the complete criteria for a currency.

5. CONCLUSION

This study conducts a comprehensive review of the various factors of the use of Financial Technologies such as Blockchain, Cryptocurrencies in Islamic Finance. Any innovation is welcome is Islam if it does not violate basic teachings of the Quran and Sunnah. The prospect for Islamic Fintech is bright in Islamic world and among the Muslim users of financial services as it provides opportunities for innovation and can provide financial services at affordable cost. The use of FinTech in Islamic Finance or Islamic FinTech poses a lot of challenges as well as it explores numerous opportunities. Islamic FinTech can give a boost to startups as it is transparent, accessible, and easy to use and can gain customer confidence with an ease which is very important for the startups. FinTech solutions are more cost-effective in providing financial services as compared to traditional finance and banking. Islamic FinTech will emerge as a lifeline for the Islamic Finance and Banking institution because of its cost effectiveness and the reach to the communities. Islamic FinTech can easily gain the confidence of Muslim communities as well as the non-Muslim communities primarily because of its transparency. However, along with the great opportunities comes great challenges as well, such as there is a lack good and authentic research in Islamic FinTech, lack of trained human personnel, government, and Shariah compliance trade-offs, cyberattacks and the confidence of the investors as Islamic FinTech is still in its infancy. Regulatory framework is another important area for Islamic FinTech which must be regularized and overcome its flaws. As Islamic FinTech is still in its inception, there are several regulatory challenges such as the regulatory framework is still evolving and conflicts with some of the existing regulations. The regulatory bodies should use relaxed, liberal, and principle-based approaches in regulating the Fintech organization. As far as the Blockchain technology in Islamic FinTech is concerned, it gives a more secure and innovative way of doing business. The transactions under Blockchain are more transparent and visible to all the users. Also, Smart contracts can be a useful mechanism in all financial transactions and the monitoring and regulation process can be reduced to mere writing a smart contract. The Cryptocurrency has been a revelation and Muslim countries seriously need to have more research and must find ways to develop and a cryptocurrency fully compatible with the sharia principle. As of now no Muslim country allows cryptocurrency for legal transactions.

Based on the discussion, cryptocurrency currently still raises debate among scholars and the argument of crypto whether it is acceptable from Sharia or not. Previous studies found that crypto may not be accepted as currency because it does not fulfill the characteristics of money in Islam. The lack of intrinsic value, store of value, high volatility, and not regulated by central authorities may hinder the fulfillment of cryptocurrency to comply with Sharia. Therefore, cryptocurrency cannot be accepted as a legal tender according to Sharia principles. On the other hand, cryptocurrency could also be seen as a commodity or wealth, as it fulfills the requirements of wealth, according to Sharia. The features of cryptocurrency align with Maqasid Shariah, where it promotes social justice and prevents any corruption activities as it is transparent and decentralized. Therefore, cryptocurrency that is treated as currency does not align with Maqasid Shariah, however, cryptocurrency that is treated as a commodity or wealth is aligned with Maqasid Shariah in the preservation of wealth.

REFERENCES

Chong, F.H.L. (2021), "Enhancing trust through digital Islamic finance and blockchain technology", Qualitative Research in Financial Markets, Vol. 13 No. 3, pp. 328-341. https://doi.org/10.1108/QRFM-05-2020-0076

Unal, I.M.; Aysan, A.F. Fintech (2022), Digitalization, and Blockchain in Islamic Finance: Retrospective Investigation. FinTech 2022, 1, 388-398. https://doi.org/10.3390/fintech1040029

Rafique, M. O., Abdullah, A. S. C., Fatoni, M. A. W., & Lubis, A. (2023). Hiyal (Legal Stratagems) in Islamic Finance: Systematic Literature Review. International Journal of Professional Business Review, 8(6), e01752. https://doi.org/10.26668/businessreview/2023.v8i6.1752

Al-hussaini abulfath ibrahim saleh, a. a. ibrahim, m. f. noordin, h. m. mohadis, (2020). islamic approach toward purification of transaction with cryptocurrency. journal of theoretical and applied information technology

Prayudya, Daffa Rizqi and Al-Ayubi, Solahuddin (2023), Islamic Central Bank Digital Currency (CBDC) Design (June 27, 2023). Al-Infaq: Jurnal Ekonomi Islam, Available at SSRN: https://ssrn.com/abstract=4511582

Albalawee N and Al Fahoum AS (2023). Islamic legal perspectives on digital currencies and how they apply to Jordanian legislation [version 2; peer review: 2 approved]. F1000Research 2023, 12:97 (https://doi.org/10.12688/f1000research.128767.2)

Meera, A. K. M. (2018). Cryptocurrencies from islamic perspectives: The case of bitcoin. Buletin Ekonomi Moneter Dan Perbankan, 20(4), 475-492.

N. M. Ibrahim, M. Abu Bakar, S. S. Abdul Rahman and M. Amrullah DRS Nasrul, "Cryptocurrency as Digital Asset According to the Principles of Usul Al-fiqh: a Critical Analysis by Mohd Daud Bakar," 2024 3rd International Conference on Creative Communication and Innovative Technology (ICCIT), Tangerang, Indonesia, 2024, pp. 1-6, doi: 10.1109/ICCIT62134.2024.10701114.

Alam, S., & Noor, H. (2020). Mined and Non-Mined Crypto Currencies: A Critical Analysis from Shariah Perspective. In International Journal of Innovative Science and Research Technology (Vol. 5, Issue 3).

Aliyu, A., Abu Bakar, K., Matsuda, G., J Darwish, T. S., Hanan Abdullah, A., Samad Ismail, A., Zahilah Raja Mohd Radzi, R., Fadhil Yusof, A., Murtadha Mohamad, M., Yazid Idris, M., Ismail, Z., & Che Yaacob, A. (2019). Review of Some Existing Shariah-Compliant Cryptocurrency.

Amri, M. C. el, & Mohammed, M. O. (2019). The Analysis of Cryptocurrency Based on Maqasid al-Shari'ah. In Halal Cryptocurrency Management (pp. 119–131). Springer International Publishing. https://doi.org/10.1007/978-3-030-10749-9_8

Fageh, A., & Iman, A. K. N. (2021). Cryptocurrency as Investment in Commodity Futures Trading in Indonesia; Based on Maqasid al-Sharia Approach. JURNAL HUKUM ISLAM, 19(2), 175–192. https://doi.org/10.28918/jhi.v19i2.3723

Hassan, M. K., Muneeza, A., & Mohamed, I. (2023). Cryptocurrencies from Islamic perspective. Journal of Islamic Accounting and Business Research. https://doi.org/10.1108/JIABR-09-2022-0238

Khan, S. N. (2023). The legality of cryptocurrency from an Islamic perspective: a research note. In Journal of Islamic Accounting and Business Research (Vol. 14, Issue 2, pp. 289–294). Emerald Publishing. https://doi.org/10.1108/JIABR-02-2022-0041

Kunaifi, A., Fawa'id, W., & Faujiah, A. (2022). OPEN ACCESS Cryptocurrency and the Future of the World Currency ARTICLE INFO ABSTRACT. Islamic Research, 5(1), 2022. https://doi.org/10.47076/ir.v5i1.136

Meera, A. K. M. (2018). CRYPTOCURRENCIES FROM ISLAMIC PERSPECTIVES: THE CASE OF BITCOIN. Buletin Ekonomi Moneter Dan Perbankan, 20(4), 475–492. https://doi.org/10.21098/bemp.v20i4.902

Rosele, M. I., Muneem, A., Che Seman, A. bin, Abdullah, L. B. H., Binti Abdul Rahman, N. N., Sukor, M. E. B. A., & Ali, A. K. bin. (2022). The Concept of Wealth (māl) in the Sharīʿah and Its Relation to Digital Assets. SAGE Open, 12(2). https://doi.org/10.1177/21582440221102424

Othman. S., Samsudin, M. A. (2023). Cryptocurrency According to The Principles of Usul Al-Fiqh: A Critical Analysis by Mohd Daud Bakar. Islamiyyat, 45(1), 37–46. https://doi.org/10.17576/islamiyyat-2023-4501-04

Wartoyo, W., & Haerisma, A. S. (2022). Cryptocurrency in The Perspective of Maqasid Al-Shariah. Afkaruna: Indonesian Interdisciplinary Journal of Islamic Studies, 18(1). https://doi.org/10.18196/afkaruna.v18i1.14164

Abbasi, Ghazanfar Ali, Lee Yin Tiew, Jinquan Tang, Yen Nee Goh, and Ramayah Thurasamy. 2021. "The Adoption of Cryptocurrency as a Disruptive Force: Deep Learning-Based Dual Stage Structural Equation Modelling and Artificial Neural Network Analysis." PLoS ONE 16(3 March 2021):1–26. https://doi: 10.1371/journal.pone.0247582.

Abubakar, Yusuf Sani, Ahmad Faosiy Ogunbado, and Mpawenimana Abdallah Saidi. 2018. "Bitcoin and Its Legality from Shariah Point of View." SEISENSE Journal of Management 1(4):13–21. https://doi: 10.33215/sjom.v1i4.32.

Al-Amri, Redhwan, Shuhd Al-Shami, Hussein Mohammed Esmail Abualrejal, Mohammed A. Al-Sharafi, and Tareq Khaled Yahya Alormuza. 2021a. "Role of Shariah Compliance on Cryptocurrency Acceptance among Malaysians: An Empirical Study." International Conference on Intelligent Technology, System and Service for Internet of Everything, ITSS-IoE 2021 (May 2022):1–7. https://doi: 10.1109/ITSS-IoE53029.2021.9615291.

Al-Amri, Redhwan, Nur Haryani Zakaria, Adib Habbal, and Suhaidi Hassan. 2019. "Cryptocurrency Adoption: Current Stage, Opportunities, and Open Challenges." International Journal of Advanced Computer Research 9(44):293–307. https://doi: 10.19101/ijacr.pid43..

Hanif, M. (2020). "Developing a Fair Currency System." ISRA International Journal of Islamic Finance 12(3):325–45. https://doi: 10.1108/IJIF-02-2019-0024.

Rabbani, M. R., Shahnawaz Khan, & Eleftherios I. Thalassinos. (2020). "FinTech, Blockchain, and Islamic Finance: An Extensive Literature Review." International Journal of Economics and Business Administration 8(2):65–86. https://doi: 10.35808/ijeba/444.

Mustafa Raza Rabbani. (2022). "FinTech, Blockchain, and Islamic Finance: An Extensive Literature Review." International Journal of Computing and Digital Systems. http://dx.doi.org/10.12785/ijcds/130147.

Nasrul, M. A. D., Shah, N. A. M. A., Ibrahim, N. M., & Manaf, Z. I. A. (2023). Overview Of Digital Asset and Its Process Under the Inheritance Management. International Journal of Business and Technology Management, 5(S5), 199-208.

MODELLING AND FORECASTING THE INTERNET AND MOBILE SUBSCRIBERS IN BANGLADESH: A TIME SERIES SEASONAL ARIMA APPROACH

ABU SAYEED MD. RIPON ROUF[1], MD. RASHIDUL HASAN[2*], MD. SAJADUL ISLAM SARKER[3]

[1]*Department of Statistics, Jagannath University, Dhaka- 1100, Bangladesh*
[2]*Department of Public Health, Leading University, Sylhet- 3112, Bangladesh*
[3]*Department of Tourism and Hospitality Management, Leading University, Sylhet- 3112, Bangladesh*

**Corresponding Author: rashidulhasan067@gmail.com*

ABSTRACT: The internet and mobile devices are considered the backbone of today's world. A country can only be called a digital country when it becomes an e-state and all of its activities are carried out over the internet. The main objective of this study is to build the best seasonal ARIMA model to forecast the internet and mobile users in Bangladesh. This study takes into account monthly data from the Bangladesh Telecommunication Regulatory Commission (BTRC) from January 2012 to December 2021. This study also used data from January 2022 to December 2022 to validate the model. The Box-Jenkins approach was applied to build the model as well as to forecast the internet and mobile subscribers. The findings show that SARIMA (1, 1, 1) (1, 0, 0)12 and SARIMA (1, 1, 0) (1, 0, 0)12 are the best models to forecast the internet and mobile subscribers, respectively, in terms of the lowest AIC, AIC_C, and BIC value. The value was forecasted with a 95% confidence interval using the best-fitted models for both internet and mobile subscribers. The original and forecasted series were compared, and the findings reveal that the selected models provide satisfactory results. The proposed models may help policymakers forecast accurately and know the future trends of internet and mobile users in Bangladesh.

KEY WORDS: *Seasonal ARIMA Model, Internet, Mobile, Forecast, Bangladesh*

1. INTRODUCTION

The internet and mobile technology played a vital role in forming digital Bangladesh. In Bangladesh, four mobile phone operators are in operation, such as Grameen Phone Limited, Robi Axiata Limited, Banglalink Digital Communications Limited, and Teletalk Bangladesh Limited (BTRC, n. d.). These operators are currently selling not only voice calls but also many sorts of mobile entertainment or content such as SMS, MMS, welcome tune, miscall alert service, cell Bazar, job search, and so on. Bangladesh Telecommunications Company Limited (BTCL) has been a Public Switched Telephone Network (PSTN) operator in Bangladesh since its inception. The ultimate goal of PSTN services is to improve voice and data communication services so that people can benefit from them. There are numerous Internet Service Providers (ISPs) companies that provide internet connections and services to individuals and companies. ISPs may provide software packages, such as browsers, e-mail accounts, and a personal website or home page, in addition to internet connectivity. Effective forecasting of internet and mobile users indicates a country's progress toward digitization.

Time series forecasting is a crucial forecasting area in which historical data of the same variable is gathered and analyzed to develop a model that describes the underlying relationship. The model is then utilized to forecast the future time series (Zhang, 2003). There have been several methods for forecasting time series data. One of the most widely used models in time series forecasting over the past three decades is the ARIMA, which was provided by Box and Jenkins. Due to its forecasting capacity and deeper information on time-related changes, the Box-Jenkins seasonal ARIMA (SARIMA) model offers various advantages over other models, especially over exponential smoothing and neural networks (Mishra and Desai, 2005). The ARIMA model takes into consideration the serial correlation, which is the most significant feature of time series data. This model also includes a systematic search for an appropriate model at each stage (Chatfield, 1996; Zhang, 2003). The SARIMA family of models also has the benefit of having a small number of model parameters needed to explain time series that exhibit non-stationarity within and between seasons. McKerchar and Dellur (1974), Cline (1981), Govindaswamy (1991), and Yurekli et al. (2005) all discussed the applications of these models. The Box-Jenkins methodology, according to Dizon (2007), is particularly well suited for the development of models with strong seasonal behavior.

This is the first study in Bangladesh to forecast the number of internet and mobile subscribers using the seasonal ARIMA model. Consequently, there is not enough literature available in this context to the best of our knowledge. This study is intended to fill this literature gap. However, several studies have been conducted to analyze trends and forecast the behavior of time series data in the telecommunications sector. For instance, Karunarathna et al. (2018) identified the modeling trend in the Sri Lankan telecommunication sector and also found an accurate mechanism for predicting demand for internet and cellular phone connections. Zamil and Hossen (2012) discussed the present condition of the telecommunications sector of Bangladesh, identified the major challenges faced by the operators, and attempted to determine the prospects of the sector. The Box-Jenkins approach has been used in this study to develop a seasonal ARIMA model of monthly internet and mobile subscriber data. The development of an appropriate forecasting model will aid in forecasting the number of internet and mobile users. The forecasted data series also expresses the probable future trend. Thus, to track Bangladesh's digital advancement, it is essential to forecast internet and mobile users. Hence the study's main objective is to identify the best SARIMA model to forecast the internet and mobile users in Bangladesh. The main contribution of this research is to accurately forecast the internet and mobile users in Bangladesh and to know its future trends.

The general structure of this paper is as follows: The first section provides an introduction. Materials and methods are presented in Section 2 and include the data source, time series decomposition, Box-Jenkins methodology, ARIMA, and SARIMA models. The statistical software and packages utilized, the results, and the discussions are represented in sections 3 and 4, respectively. Finally, the study's conclusion is presented in Section 5.

2. MATERIALS AND METHODS

2.1. Data Source

The study took into account monthly data from the website www.btrc.gov.bd of the Bangladesh Telecommunication Regulatory Commission. The data consists of the number of internet subscribers (Mobile Internet, ISP+PSTN) and mobile subscribers (GP, Robi, Banglalink, Teletalk) covering 120 months from January 2012 to December 2021.

2.2. Decomposition of Time Series

The decomposition of time series is applied to describe the trend and seasonal pattern in time series data (Ray et al., 2021). When measurements are taken daily, weekly, or monthly, the frequency of measurements will be high, while quarterly or yearly observations will be low. According to Dagum (2010), the four variations have traditionally been assumed to be mutually independent of one another and specified using an additive decomposition model: $Y_t = T_t + S_t + C_t + R_t$, where Y_t denotes the observed data series, T_t the long-term trend, S_t the seasonal components, C_t the cyclic components, and R_t the random or irregular components.

2.3. Box-Jenkins Approach

The ARIMA model, also known as the Box–Jenkins approach, is applied to univariate time series modeling (Box and Jenkins, 1976). For estimating a good ARIMA model, at least 50 observations are required, and a seasonal time series requires a reasonably large sample size (Pankratz, 1983). The ARIMA model is particularly well suited to short-term forecasting as well as forecasting seasonally augmented data series (Ray and Bhattacharyya, 2020). The steps for the Box–Jenkins approach are identification, estimation, diagnostic checking, and forecasting. Before constructing the Box-Jenkins technique, it is essential to examine the stationarity of the time series and any major seasonality that needs to be modeled. In this work, several well-known statistical tests, including the Augmented Dickey-Fuller (1979) test and the Phillips-Perron (1988) test, were employed to examine the stationarity of time series data. In the identification step, the model's order was estimated using the ACF and PACF functions. The parameter estimation procedure was performed by the maximum likelihood method after the model's order had been determined. The best model has been chosen using model selection criteria such as Akaike's information criteria (Akaike, 1974), Akaike's information corrected criteria (Akaike, 1974), and Bayesian information criteria (Schwarz, 1978). The standardized residuals plot, ACF plot of residuals, and normal curve over the histogram of residuals were used to perform diagnostic checking. Additionally, the Ljung-Box test (Ljung and Box, 1978) was employed to test the autocorrelation among residuals. In this case, the null hypothesis is H_0 : $\rho_1 = \rho_2 = \cdots \cdots = \rho_k = 0$ that is the autocorrelation among the residuals is zero is tested with the Ljung-Box statistic $Q^* = n(n+2)\sum_{k=1}^{m}(n-k)^{-1}\,\rho_k^2 \sim \chi^2_{(m)}$, where *n* is the number of observations used to estimate the model, ρ_k is the sample autocorrelation at lag *k*, and m is the number of lags being tested. If Q^* is significantly large from zero, the residuals of the fitted model are said to be autocorrelated. The accuracy of the selected model was measured using the mean absolute percentage error (MAPE). The MAPE is perhaps the most commonly used indicator of forecasting accuracy (Armstrong and Collopy, 1992; Goodwin and Lawton, 1999; Ren and Glasure, 2009). MAPE is defined by the following formula: $MAPE = \frac{1}{n}\sum_{t=1}^{n}\left|\frac{\hat{y}_t - y_t}{y_t}\right| \times 100$, where *n* is the number of observations, y_t is the observed value at time *t*, and $\hat{y}_t$ is the predicted value by the model for time *t*. Finally, the forecasted and actual values were compared to check the validity of the chosen model (Ray et al., 2016).

2.4. Autoregressive Integrated Moving Average (ARIMA) Model

Most of the real-time series are typically non-stationary because of their increasing and declining trends; follow integrated (Ray et al., 2021). Considering a time series of data Y_t, the ARMA model is an instrument for understanding and potentially predicting future values of data. The model is divided into two sections: an autoregressive (AR) component and a moving average (MA) component (Mishra et al., 2021). The model is usually known as ARIMA (*p*, *d*, *q*) model, where *p* is the AR term, *d* is the difference, and *q* is the MA term. The model can be generated as follows:

Let, a time series Y_t is said to follow an autoregressive moving average of order *p* and *q* denoted by ARMA (*p*, *q*) if $Y_t = \mu + \phi_1 Y_{t-1} + \cdots\cdots + \phi_p Y_{t-p} - \varepsilon_t - \theta_1 \varepsilon_{t-1} - \cdots\cdots - \theta_q \varepsilon_{t-q}$ (1)

Where, $\varepsilon_t \sim WN(0,\ \sigma^2)$, $\phi's$ and $\theta's$ are constants such that (1) is both stationary and invertible. Suppose (1) is put as $\phi_p(B)Y_t = \theta_q(B)\varepsilon_t$, where *B* is the backshift operator. $\phi_p(B) = 1 - \phi_1 B - \phi_2 B^2 - \cdots\cdots - \phi_p B^p$ (The order *p* of AR term) $\theta_q(B) = 1 - \theta_1 B - \theta_2 B^2 - \cdots\cdots - \theta_q B^q$ (The order *q* of MA term) and $B^k Y_t = Y_{t-k}$

Let the *d*th difference of Y_t be denoted by $\nabla^d Y_t$ where $\nabla = 1 - B$. A replacement of Y_t in (1) by $\nabla^d Y_t$ yields an ARIMA model of orders *p*, *d*, and *q* denoted by ARIMA (*p*, *d*, *q*) in Y_t . If *d* = 0 then ARIMA (*p*, *d*, *q*) = ARIMA (*p*, *q*).

2.5. Seasonal Autoregressive Integrated Moving Average (SARIMA) Model

The SARIMA model is commonly referred to as the seasonal ARIMA model where the time series follows the seasonal consequence. The model is built with the seasonal behavior of the series in consciousness. The overall multiplicative SARIMA model can be written as SARIMA (*p*, *d*, *q*) (*P*, *D*, *Q*)$_S$ (Afrifa-Yamoah et al., 2016).

Mathematically, $\phi_p(B)\Phi_P(B^S)(1-B)^d(1-B^S)^D(Y_t - \mu) = \theta_q(B)\Theta_Q(B^S)\varepsilon_t$

$\phi_p(B) = 1 - \phi_1 B - \phi_2 B^2 - \cdots\cdots - \phi_p B^p$ (The order *p* of AR term)

$\theta_q(B) = 1 - \theta_1 B - \theta_2 B^2 - \cdots\cdots - \theta_q B^q$ (The order *q* of MA term)

$\Phi_P(B^S) = 1 - \Phi_1 B^S - \Phi_2 B^{2S} - \cdots\cdots - \Phi_P B^{PS}$ (The order *P* of seasonal AR term)

$\Theta_Q(B^S) = 1 - \Theta_1 B^S - \Theta_2 B^{2S} - \cdots\cdots - \Theta_Q B^{QS}$ (The order Q of seasonal MA term) and $\varepsilon_t \sim WN(0,\ \sigma^2)$, the difference *d* is a positive integer, *s* is an integer greater than one. It is to be noted that $\mu = 0$, if *d* > 0 or *D* > 0

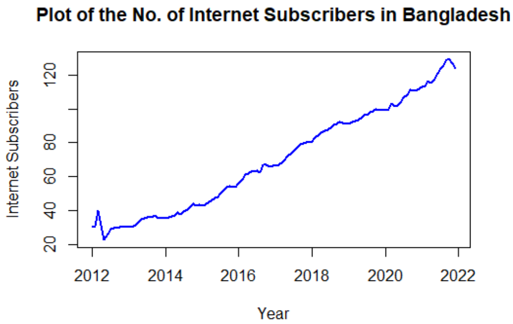
3. STATISTICAL SOFTWARE AND PACKAGES USED

The analysis of this study was carried out entirely using the open-source statistical programming software R Studio (version 3. 5. 3) for Windows. TSA, forecast, MASS, and tseries are some of the library packages used for analysis.

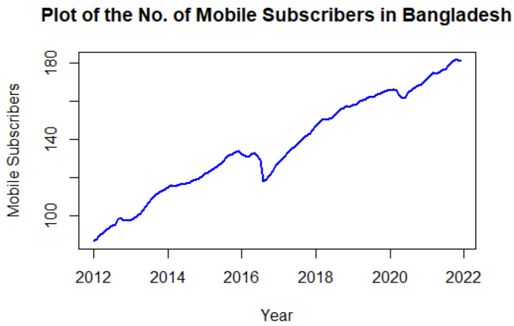
4. RESULTS AND DISCUSSIONS

4.1. Plot of the Original Time Series

In this section, the plot of the original internet and mobile subscriber's data has been depicted.



(a)



(b)

Fig. 1. Time series plot of the number of internet and mobile subscribers.

Fig. 1(a) and 1(b) show the graphical representation of the number of internet and mobile subscribers (in millions) from January 2012 to December 2021 in Bangladesh. It is obvious from Fig. 1 that the number of internet and mobile subscribers fluctuated over the study period. That is there is an indication of a trend and seasonality in both time series.

4.2. Decomposition of the Original Time Series

In this section, time series of internet and mobile subscribers' data have been decomposed to find the trend and seasonality. Time series decomposition revealed that the series has been broken down into its trend, seasonal, and random components.

Fig. 2(a) and 2(b) depict the observed time series (top), the trend component (second from top), the seasonal component (third from top), and the random component (bottom) of the internet and mobile subscriber series. The trend component for both the internet and mobile subscribers' data shows an upward trend over the period, although the irregular character of the mobile subscribers' series for the years 2016 to 2017 may be of interest. Again, the seasonal component of the data series for both internet and mobile subscribers shows an up-and-down pattern over time. The upward and downward trend of the observed time series provides evidence of seasonality in the data series. Thus from Fig. 2(a) and 2(b) both the internet and mobile subscriber, data have a seasonal effect, with the usual upward and downward pattern occurring yearly throughout the study time. This means that seasonal factors influenced the internet and mobile subscriber's data series each year. Since there is both trend and seasonality in the internet and mobile subscribers data series, apply a seasonal difference (month = 12) of order $D = 1$ for both data series and re-evaluate the trend (PennState, n. d.).

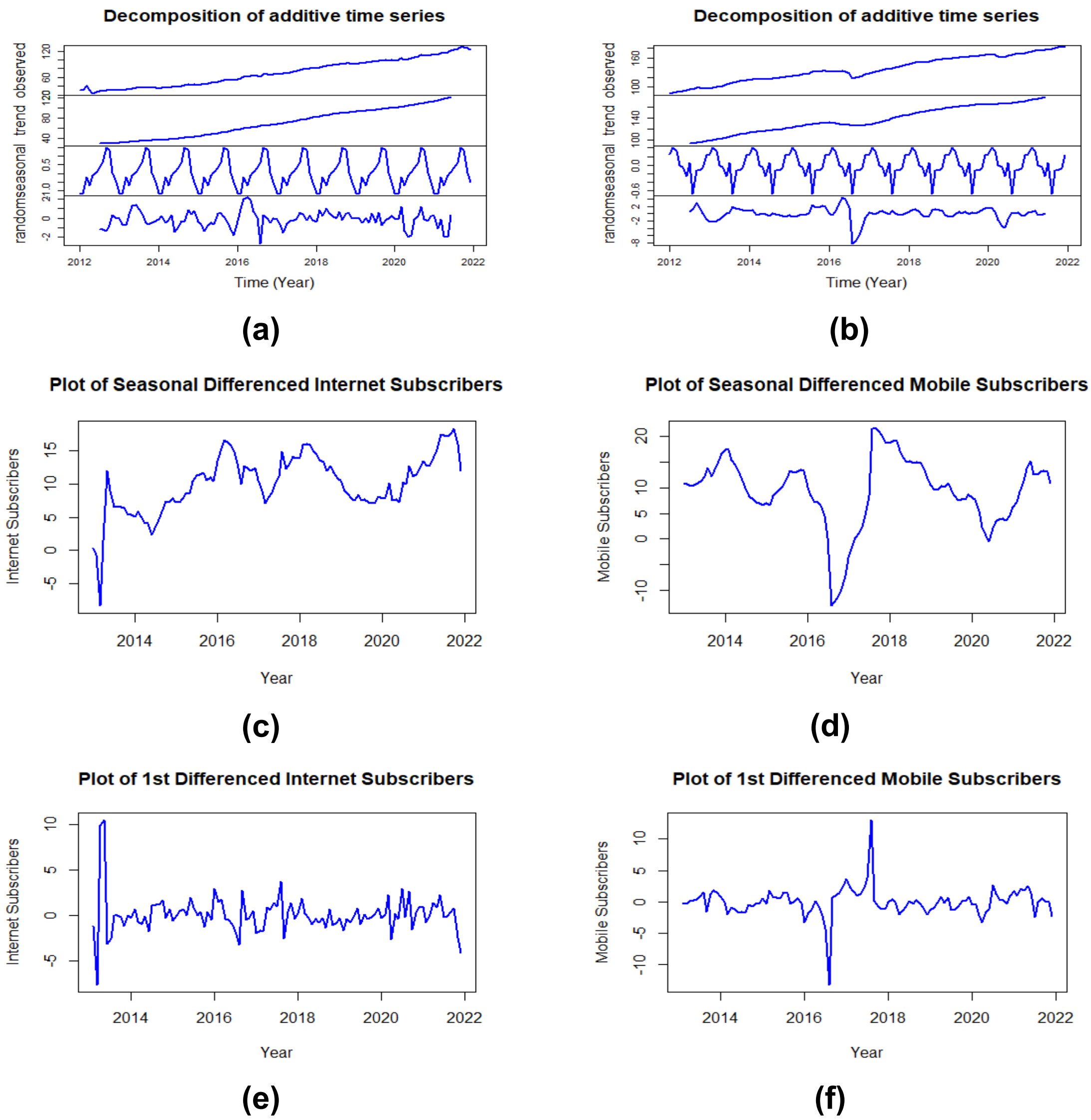


Fig. 2. Decomposition of additive internet and mobile subscriber series.

Fig. 2(c) and 2(d) show that the seasonal differenced internet and mobile subscribers' data series have an upward trend. To remove the trend component that is to make the series stationary we take the non-seasonal difference of order $d = 1$ for both internet and mobile subscribers' data series. Fig. 2(e) and 2(f) show that the first differenced internet and mobile subscriber time series have no significant trend pattern. This is an indication of stationary behavior. Moreover, we apply the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests to ensure stationarity.

4.3. Stationary Test

Data must be checked for stationarity before being used in time series modelling. Under this test, the statistical hypothesis is:

H_0: The series has a unit root.

H_1: The series does not have a unit root; that is, the data series is stationary.

Table 1: ADF and PP tests for first-differenced internet and mobile subscriber's time series

Time series	Tests	Calculated value	Truncation lag parameter	p-value	Comment
Internet	ADF	-5.1725	4	0.01	Stationary
Subscriber	PP	-84.673	4	0.01	Stationary
Mobile	ADF	-3.7927	4	0.02	Stationary
Subscriber	PP	-63.537	4	0.01	Stationary

The p-value of the first differenced internet and mobile subscriber series is lower than the significance level of 0.05 indicating that both the data series are stationary.

4.4. Identification of Model

To detect non-seasonal and seasonal AR and MA terms, inspect the ACF and PACF of first-differenced internet and mobile subscriber data.

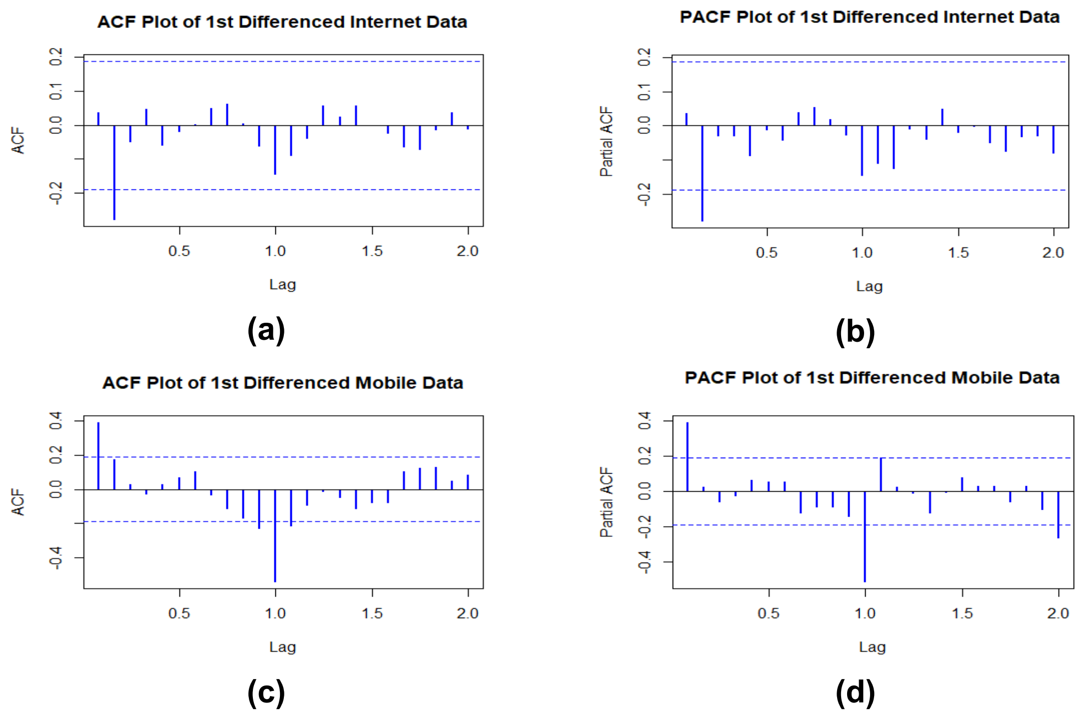


Fig. 3. ACF and PACF plot of first-differenced internet and mobile subscribers.

Non-seasonal AR and MA: To identify the non-seasonal terms, look into the early lags (1, 2, 3, and so on). For internet subscriber data, the PACF shows (Fig. 3(b)) a significant negative spike at lag 2 and then nothing else. So, a non-seasonal AR of order p = 1 could be an important component of the model for the internet series. Also, for internet subscriber data, the ACF shows (Fig. 3(a)) a significant negative spike at lag 2 and then nothing else. Hence, a non-seasonal MA of order q = 1 could be an important component of the model for the internet series (PennState, n. d.). Again, the PACF for mobile subscriber data shows (Fig. 3(d)) a significant positive spike at lag 1 and then nothing until around lag 12. As a result, a non-seasonal AR of order p = 1 could be an important element of the model for the mobile data series. In addition, the ACF for mobile subscriber data shows (Fig. 3(c)) a significant positive spike at lag 1 and then nothing until around lag 11. Hence, a non-seasonal MA of order q = 1 could be an important element of the model for mobile data series (PennState, n. d.).

Seasonal AR and MA: Examine the patterns across multiples of S = 12 lags. For seasonal parameters, we are looking at what's going on around lags 12, 24, and so on. There is no significant spike in PACF for internet subscriber data at lags 12 and 24 (Fig. 3(b)). So, a seasonal AR of order P = 0 could be useful in the model for the internet series. There is no significant spike in ACF for internet subscriber data at lags 12 and 24 (Fig. 3(a)). Hence, a seasonal MA of order Q = 0 could be useful in the model for the internet series (PennState, n. d.). At lags 12 and 24, there is a significant negative spike in PACF for mobile subscriber data (Fig. 3(d)). As a result, a seasonal AR of order P = 2 could be useful in the model for the mobile data series. There is a significant negative spike at lag 12 in ACF for mobile subscriber data (Fig. 3(c)), and then nothing else. Hence, a seasonal moving average of order Q = 1 could be useful in the model for mobile data series (PennState, n. d.). Based on several seasonal and non-seasonal AR and MA terms the appropriate model for internet subscriber data is ARIMA (1, 1, 1) (0, 1, 0)12 and mobile subscriber data is ARIMA (1, 1, 1) (2, 1, 1)12. Now all possible tentative seasonal ARIMA models with the appropriate combination of seasonal and non-seasonal AR and MA terms and their summary statistics are listed in the following table.

Table 2: Seasonal ARIMA models for internet and mobile subscriber data and their goodness of fit test

Time series	Models	Goodness of fit		
		AIC	AICC	BIC
Internet subscriber	ARIMA (1, 1, 1) (0, 1, 0)12 with drift	-324.18	-323.95	-316.16
	ARIMA (1, 1, 1) (1, 0, 0)12 with drift	-381.00	-380.64	-369.88
	ARIMA (1, 1, 0) (1, 0, 0)12 with drift	-363.21	-363.00	-354.88
	ARIMA (0, 1, 1) (0, 0, 1)12 with drift	-366.96	-366.75	-358.62
	ARIMA (0, 1, 0) (1, 0, 0)12 with drift	-365.03	-364.93	-359.47
	ARIMA (0, 1, 0) (2, 0, 0)12 with drift	-363.19	-362.99	-354.86
	ARIMA (0, 1, 0) (1, 0, 1)12 with drift	-364.55	-364.34	-356.21
	ARIMA (0, 1, 0) (0, 0, 1)12 with drift	-364.85	-364.75	-359.3
	ARIMA (0, 1, 0) (2, 0, 1)12 with drift	-362.56	-362.21	-351.44
	ARIMA (0, 1, 1) (1, 0, 0)12 with drift	-366.27	-366.06	-357.93
Mobile subscriber	ARIMA (1, 1, 1) (2, 1, 1)12 with drift	-618.27	-617.43	-602.24
	ARIMA (1, 0, 1) (2, 0, 1)12 with drift	-715.34	-714.81	-701.44
	ARIMA (1, 1, 1) (2, 1, 0)12 with drift	-603.5	-602.91	-590.14
	ARIMA (0, 1, 1) (2, 1, 0)12 with drift	-603.17	-602.78	-592.48
	ARIMA (1, 1, 0) (1, 1, 1)12 with drift	-622.27	-621.88	-611.58
	ARIMA (2, 1, 2) (1, 0, 1)12 with drift	-712.68	-711.67	-693.22
	ARIMA (1, 1, 0) (1, 0, 0)12 with drift	-718.65	-718.44	-710.32
	ARIMA (0, 1, 1) (0, 0, 1)12 with drift	-708.55	-708.34	-700.21
	ARIMA (1, 1, 0) (0, 0, 1)12 with drift	-718.65	-718.44	-710.31
	ARIMA (1, 1, 0) (1, 0, 1)12 with drift	-717.27	-716.92	-706.15
	ARIMA (0, 1, 0) (1, 0, 0)12 with drift	-687.75	-687.65	-682.19
	ARIMA (0, 1, 0) (0, 0, 1)12 with drift	-687.45	-687.35	-681.89

AIC: Akaike Information Criterion; AIC_C: Akaike Information Correction Criterion; BIC: Bayesian Information Criterion

The best seasonal ARIMA model is selected based on the lowest AIC, AIC_C, and BIC values. According to these model selection criteria, seasonal ARIMA (1, 1, 1) $(1, 0, 0)_{12}$ is the best model to forecast the internet subscribers in Bangladesh with the lowest AIC= -381.00, AIC_C = -380.64, and BIC= -369.88. Also, seasonal ARIMA (1, 1, 0) $(1, 0, 0)_{12}$ is the best model to forecast the mobile subscribers in Bangladesh with the lowest AIC= -718.65, AIC_C = -718.44, and BIC= -710.32.

4.5. Parameter Estimation and Diagnostic Test of Models

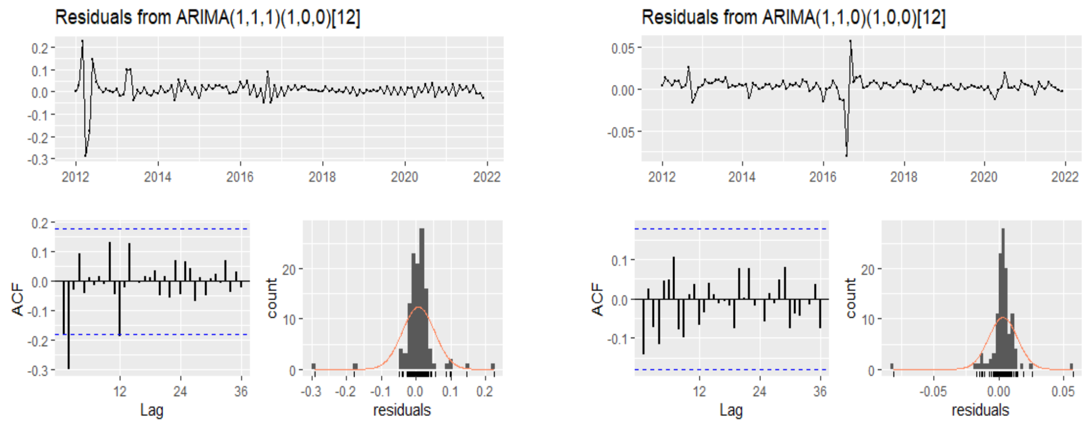
The estimated parameters, standard error, and Ljung–Box Q statistic for best-fitted models are presented in Table 3.

Table 3: Parameter of models and Ljung-Box test

Models	Parameter estimation			Ljung-Box Q test		
	Parameters	EV	SE	Lag used	Statistics	p-value
ARIMA (1, 1, 1) $(1 ,0, 0)_{12}$	*p*	-0.479	0.117	24	28.500	0.127
	q	0.867	0.063			
	P	0.253	0.158			
ARIMA (1, 1, 0) $(1, 0, 0)_{12}$	*p*	0.505	0.081	24	12.978	0.934
	P	-0.025	0.095			

EV: Estimated Value; SE: Standard Error of Parameter

From Table 3, the p-value ensures that the null hypothesis of all autocorrelation coefficients equal to zero at various lags is accepted for the best-fitted models.



(a) **(b)**

Fig. 4. ACF and residual plot of best-fitted models.

The residual plot of the best-fitted seasonal ARIMA models shown in Fig. 4(a) and 4(b) indicates that the standard errors are roughly constant in their mean and variance over time, though there appears to be some higher variance near the beginning of the internet subscriber series and towards the middle of mobile subscriber series. Furthermore, the ACF of the residual of the best-fitted models shows the different autocorrelation coefficients at different lags within the 95% confidence interval, except for lag 2 of the internet subscriber series, confirming the data “good fit” to the selected models. Finally, the residuals of the best-fitted models are normally distributed, according to the histogram of residuals. However, to investigate the adequacy of the fitted models, forecasting criteria values were presented in the following table.

Table 4: Forecasting criteria value of the fitted models

Models	Forecasting Criteria			
	RMSE	MAE	MAPE	MASE
ARIMA (1, 1, 1) $(1, 0, 0)_{12}$	2.063	1.415	2.501	0.138
ARIMA (1, 1, 0) $(1, 0, 0)_{12}$	1.410	0.839	0.656	0.081

MAPE: Mean Absolute Percentage Error

The MAPE is 2.501 for model ARIMA (1, 1, 1) $(1, 0, 0)_{12}$ and it is 0.656 for model ARIMA (1, 1, 0) $(1, 0, 0)_{12}$ which is less than 10, indicates that the fitted models are highly accurate (Lewis, 1982). Therefore, these models can be applied to accurately forecast the internet and mobile subscribers in Bangladesh.

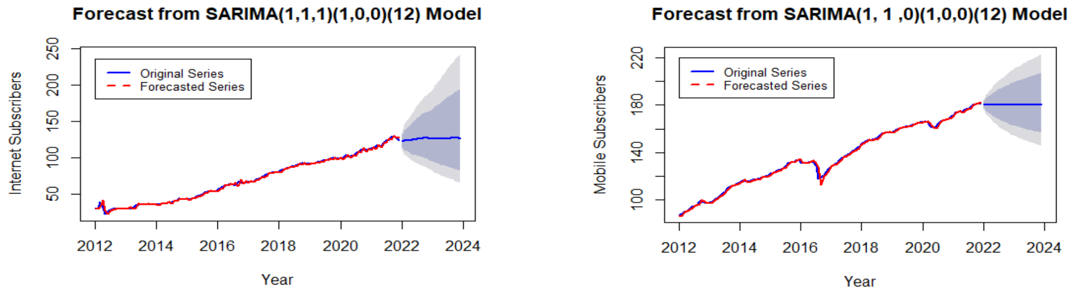
4.6.Forecasting

Forecasting is done for both internet and mobile subscribers after the best-fitted time series models have been developed. Here, the data of the first ten years covering 120 months (January 2012 to December 2021) were used to build models, while the remaining one year covering 12 months (January 2022 to December 2022) was used to ensure the validity of the model.

Table 5: Forecast value of the number of internet and mobile subscribers in Bangladesh

Year	Month	SARIMA (1, 1, 1) $(1, 0, 0)_{12}$			SARIMA (1, 1, 0) $(1, 0, 0)_{12}$		
		Forecast value	Actual value	95% CI	Forecast value	Actual value	95% CI
2022	Jan.	122.79	121.87	(111.87,134.79)	180.74	180.78	(176.68,184.90)
	Feb.	123.40	122.79	(105.21, 144.72)	180.59	181.54	(173.31,188.17)
	Mar.	124.04	124.89	(102.08, 150.73)	180.49	182.92	(170.42,191.16)
	Apr.	123.99	124.20	(98.61, 155.90)	180.48	183.38	(167.99,193.89)
	May	124.43	125.52	(96.24, 160.88)	180.43	184.23	(165.83,196.31)
	June	125.43	126.21	(94.53, 166.43)	180.39	184.45	(163.93,198.51)
	July	126.14	127.55	(92.87, 171.33)	180.38	184.05	(162.23,200.55)
	Aug.	126.59	127.26	(91.19, 175.74)	180.33	183.58	(160.67,202.41)
	Sept.	127.43	126.31	(89.93, 180.56)	180.29	181.43	(159.22,204.14)
	Oct.	127.53	126.18	(88.28, 184.23)	180.26	181.67	(157.89,205.80)
	Nov.	126.88	125.02	(86.23, 186.68)	180.26	180.87	(156.68,207.39)
	Dec.	126.17	124.42	(84.26, 188.92)	180.27	180.20	(155.54,208.93)
2023	Jan.	125.90	---------	(82.09, 193.09)	180.28	---------	(154.49,210.37)
	Feb.	126.06	---------	(80.11, 198.37)	180.28	---------	(153.50,211.74)
	Mar.	126.22	---------	(78.39, 203.24)	180.28	---------	(152.56,213.05)
	Apr.	126.21	---------	(76.64, 207.84)	180.28	---------	(151.66,214.32)
	May	126.32	---------	(75.10, 212.49)	180.28	---------	(150.79,215.55)
	June	126.58	---------	(73.72, 217.34)	180.29	---------	(149.96,216.75)
	July	126.76	---------	(72.39, 221.99)	180.29	---------	(149.15,217.92)
	Aug.	126.88	---------	(71.08, 226.47)	180.29	---------	(148.38,219.06)
	Sept.	127.09	---------	(69.89, 231.07)	180.29	---------	(147.63,220.18)
	Oct.	127.11	---------	(68.67, 235.30)	180.29	---------	(146.90,221.27)
	Nov.	126.95	---------	(67.40, 239.12)	180.29	---------	(146.19,222.35)
	Dec.	126.77	---------	(66.17, 242.86)	180.29	---------	(145.49,223.40)

CI: Confidence Interval



(a) **(b)**

Fig. 5. Forecast from the best-fitted SARIMA model.

From Table 5, the best models predict an increase in the number of internet and mobile subscribers in Bangladesh during the period January 2022 to December 2023. Moreover, the forecast and actual values of the internet and mobile subscriber series from January 2022 to December 2022 lie between the 95% confidence interval. Fig. 5 shows that the forecasted series of internet and mobile subscribers (red color) differed by a small amount from the original series of internet and mobile subscribers (dark blue color), indicating that the fitted model for the number of internet and mobile subscribers is functioning properly. Therefore, the estimated internet and mobile subscribers are a much more accurate representation of the actual internet and mobile subscribers in Bangladesh.

5. CONCLUSION

This study is intended to identify the best SARIMA model to forecast the internet and mobile users in Bangladesh. The model was constructed and the forecast was made using the Box-Jenkins technique in this study. The findings of this study conclude that SARIMA (1, 1, 1) $(1, 0, 0)_{12}$ and SARIMA (1, 1, 0) $(1, 0, 0)_{12}$ are the best modes to forecast the internet and mobile subscribers, respectively, in Bangladesh. The graphical evaluation of the observed and forecasted series shows a slight difference, indicating that the fitted model performs well in forecasting. Both models also predict that there will be an increase in internet and mobile subscribers during the period of prediction. This study may help predict the internet and mobile subscribers by using the estimated models. Hence, policymakers may find this research beneficial.

ACKNOWLEDGMENT

The authors sincerely appreciate the reviewers' insightful comments and suggestions for the manuscript.

REFERENCES

Afrifa-Yamoah, E., Saeed, B., & Karim, A. (2016). Sarima modelling and forecasting of monthly rainfall in the Brong Ahafo region of Ghana. World Environment, 6(1), 1–9. http://dx.doi.org/10.5923/j.env.20160601.01

Akaike, H. (1974). A new look at the statistical model identification. IEEE Transaction on Automatic Control, 19(6), 716–723. https://link.springer.com/chapter/10.1007/978-1-4612-1694-0_16

Armstrong, J. S., & Collopy, F. (1992). Error measures for generalizing about forecasting methods: Empirical comparisons. International Journal of Forecasting, 8(1), 69-80. https://doi.org/10.1016/0169-2070(92)90008-W

Bangladesh Telecommunication Regulatory Commission. (n. d.). Mobile Subscribers. https://btrc.gov.bd

Bangladesh Telecommunication Regulatory Commission. (n. d.). PSTN Services. https://btrc.gov.bd

Box, G. E. P., & Jenkins, G. M. (1976). Time series analysis: Forecasting and control. Holden Day, San Francisco. http://dx.doi.org/10.1111/jtsa.12194

Chatfield, C. (1996). The analysis of time series: An introduction with R, 283. Chapman and Hall, New York. https://doi.org/10.4324/9780203491683

Cline, T. B. (1981). Selecting seasonal stream flow models. Water Resources Research, 17(4), 975–984. https://doi.org/10.1029/WR017i004p00975

Dagum, E. B. (2010). Time series modeling and decomposition. Statistica, 70(4), 433–457. http://dx.doi.org/10.6092/issn.1973-2201/3597

Dickey, D. A., & Fuller, W. A. (1979). Distribution of the estimators for autoregressive time series with a unit root. Journal of the American Statistical Association, 74(366), 427–431. http://dx.doi.org/10.2307/2286348

Dizon, C. Q. (2007). ARMA modeling of a stochastic process appropriate for the Angat reservoir. Philippine Engineering Journal, 28(1), 1-20. https://journals.upd.edu.ph/index.php/pej/article/download/2211/2108

Goodwin, P., & Lawton, R. (1999). On the asymmetry of the symmetric MAPE. International Journal of Forecasting, 15(4), 405-408. https://doi.org/10.1016/S0169-2070(99)00007-2

Govindaswamy, R. (1991). Univariate Box-Jenkins forecasts of water discharge in Missouri river. Water Resource Development, 7(3), 168–177. http://dx.doi.org/10.1080/07900629108722509

Karunarathna, K. A. N. K., Brindha, S., & Paramadevan, P. (2018). Modeling trend in telecommunication in Sri Lanka: A case study on internet and cellular connections. International Journal of Statistics and Probability, 7(4), 32- 42. http://dx.doi.org/10.5539/ijsp.v7n4p32

Lewis, C. D. (1982). Industrial and Business forecasting methods. Journal of Forecasting, 2(2), 194-196. https://doi.org/10.1002/for.3980020210

Ljung, G. M., & Box. G. E. P. (1978). On a measure of lack of fit in time series models. Biometrika, 65(2), 297–303. https://doi.org/10.1093/biomet/65.2.297

McKerchar, A. I., & Dellur, J. W. (1974). Application of seasonal parametric linear stochastic models to monthly flow data. Water Resources Research, 10(2), 246–255. http://dx.doi.org/10.1029/WR010i002p00246

Mishra, A. K., & Desai, V. R. (2005). Drought forecasting using stochastic models. Stochastic Environmental Research and Risk Assessment, 326-339. https://www.researchgate.net/publication/226230747

Mishra, P., Matuka, A., Abotaleb, M. S. A., Weerasinghe, W. P. M. C. N, Karakaya, K., & Das, S. S. (2021). Modeling and forecasting of milk production in the SAARC countries and China. Modeling Earth Systems and Environment, 947-959. https://doi.org/10.1007/s40808-021-01138-z

Pankratz, A. (1983). Forecasting with univariate Box-Jenkins models: concepts and cases. Wiley Series in Probability and Mathematical Statistics, USA. http://dx.doi.org/10.1002/9780470316566.refs

PennState. (n. d.). Applied Time Series Analysis. https://online.stat.psu.edu/stat510/lesson/4/4.1

Phillips, P. C. B., & Perron, P. (1988). Testing for a unit root in time series regression. Biometrika, 75(2), 335–346. https://doi.org/10.1093/biomet/75.2.335

Ray, S., & Bhattacharyya, B. (2020). Statistical modeling and forecasting of ARIMA and ARIMAX models for food grains production and net availability of India. Journal of Experimental Biology and Agricultural Sciences, 8(3), 296–309. http://dx.doi.org/10.18006/2020.8(3).296.309

Ray, S., Bhattacharyya, B., & Pal, S. (2016). Statistical modeling and forecasting of food grain in effects on public distribution system: An application of ARIMA model. Indian Journal of Economics and Development, 12(4), 739–744. http://dx.doi.org/10.5958/2322-0430.2016.00199.2

Ray, S., Das, S. S., Mishra, P., & Al Khatib, A. M. G. (2021). Time series SARIMA modelling and forecasting of monthly rainfall and temperature in the South Asian countries. Earth Systems and Environment, 531-546. https://doi.org/10.1007/s41748-021-00205-w

Ren, L., & Glasure, Y. (2009). Applicability of the revised mean absolute percentage errors (MAPE) approach to some popular normal and nonnormal independent time series. International Advances in Economic Research, 15(4), 409-420. https://doi.org/10.1007/s11294-009-9233-8

Schwarz, G. (1978). Estimating the dimension of a model. The Annals of Statistics, 6(2), 461–464. https://doi.org/10.1214/aos/1176344136

Yurekli, K., Kurunc, A., & Ozturk, F. (2005). Application of linear stochastic models to monthly flow data of Kelkit stream. Ecological Modelling, 183(1), 67–75. https://www.researchgate.net/publication/223244028

Zamil, M. F., & Hossen, M. M. (2012). Problems and prospects of telecommunication sector of Bangladesh. A critical review. New Media and Mass Communication, 16-25. https://api.semanticscholar.org/CorpusID:166558832

Zhang, G. P. (2003).Time series forecasting using a hybrid ARIMA and neural network model.Neurocomputing,159–175. http://dx.doi.org/10.1016/S0925-2312(01)00702-0

IIUMINKIND PROJECT BUSINESS MODEL: CROWDFUNDING FOR ENHANCING THE WELLBEING OF B40 COMMUNITIES AND NURTURING B40-PRENEURS

NURALYA MEDINA BINTI MOHAMMAD NIZAM[1*], NIK SHAMEERA AZFAREEHA BINTI NIK SHAMLAN[2], NOR AZREEN BINTI ASARI[3], SYAZA NUR SABRINA BINTI MOHAMAD FAEZAL[4], ABDUL RAHMAN AHMAD DAHLAN[5]

[1,2,3,5]Kuliyyah of Information and Communication Technology International Islamic University Malaysia, Kuala Lumpur, Malaysia
[4]Kuliyyah of Economics and Management Sciences International Islamic University Malaysia, Kuala Lumpur, Malaysia

**Corresponding author: medinamohdnizam@gmail.com*

ABSTRACT: This conceptual paper outlines an approach for increasing community well-being by adapting the crowfunding IIUMinKind project business model offered, aiming to tackle a wide array of societal issues such as poverty, homelessness, mental health, and addressing the special needs of the low income B40 population. With an eye towards enhancing various facets of the society, such as unemployed, community centres & network of mosques, the disabled, single mothers, and orphanages, the approach seeks to collect public funds and redistribute them to these establishments, ensuring transparency and impactful outcomes in donation utilization. Additionally, the approach aims to empower individuals in these needy communities by providing opportunities for reskilling and upskilling, thereby fostering entrepreneurship, jobs and wealth creation, and economic growth. Reaching out to and engaging underprivileged or isolated individuals and groups, who frequently face unstable finances, limited access to quality medical care, difficulty finding steady work, housing insecurity, and limited resources for education and skill development, are among the challenges of this endeavor. The effort, which encourages accountability, transparency, and impactful outcomes in fund usage, seeks to meet societal demands and getting community support. Thus, creating social cohesion and economic growth towards the betterment of human life and civilisation. This paper seeks to lay a solid basis for long-term outcomes and impacts by leveraging on business modelling tools like the Value Proposition Design Canvas (VPC), Business Model Canvas (BMC), and Business Environmental Map (EM). Surveys are used to collect data on situations, understanding, and knowledge, allowing for ongoing modification of the model to suit the changing needs of stakeholders. Hence, this paper offers the IIUMinKind project business model aims to pave the way towards the betterment of B40 quality of life by leveraging on trusted digital platforms for fund/donation collection and distribution in supporting impactful societal initiatives.

KEY WORDS: *Digital Platforms Business Model, Societal Quality of Life, Donation, Impactful Societal Initiatives, B40 Entrepreneur*

1. INTRODUCTION

The digital world is rising as the world evolves causing many changes especially in the betterment in human's life. The Internet is accessible to everyone hence, a lot of things have been digitalised including the method of donations to encourage people to keep donating to the needy. The changes of the donation process has significantly expanded the donation sector's scope and provided them with more opportunities to interact with donors. According to Sung et al., (2020), by providing related information, the online donation system enables donors to see how their donations are used or distributed to donees. Donors can donate at fingertips due to the development of mobile-apps that are designed to make donations quicker and more convenient than ever before.

The existing online donation platforms such as GoFundMe, KickStarter, and Indiegogo offer both benefits and challenges for donors and donees. Although they differ slightly from one another, all these online donation platforms operate similarly. With only a few clicks, online donation platforms enable donors to support anyone and allow them to track the distribution of their giving, which is a huge advantage. However, there are drawbacks as well, such as the possibility of fake campaigns and issues about the use of donations. Moving on to the donees' perspectives, online donation platforms give them immediate access to a huge population of potential donors and allow them to collect donations for a variety of needs. However, due to the huge amount of people asking for donations on these platforms, this leads to some donees not being able to achieve their KPI in receiving the donations. Despite this, there are still flaws in the online donation platforms that must be fixed to enhance the donation experience for everyone involved. Thus, a major issue is the adaption of high platform charges, which have a big influence on the amount of money that eventually reaches the donees, leading to affecting the success of the donation process.

This paper introduces IIUMinKind project business model with a digital and mobile app-based platform for donations & funding of impactful initiatives in assisting organizations, including NGOs, in their efforts to create values and support communities in need. To promote generosity, IIUMinKind provides a comprehensive channel that accepts donations, both locally and globally. For this reason, it is essential to promote community engagement (CE) initiatives to ensure the effectiveness and success of this project. In addition, as stated in the IIUM Roadmap 2023 - 2024, to achieve High Touch CE and Global Relevance & Citizenship, it is crucial to build strong CE and partnerships between IIUM and the local and global communities. This will therefore lead to easier distribution of donations to various community organizations, among which are mosques, orphanages, and homes for the disabled and elderly. By focusing on the B40 demographic, also referred to as the poor or underprivileged, IIUMinKind can ensure the needs and goals of the people it aims to nurture as digital entrepreneurs can be achieved.

2. OBJECTIVES

This project is proposed in an attempt to help those in need, especially from the low income B40 groups in Malaysia. In line with several United Nations' Sustainable

Development Goals (SDGs) namely SDG1 - No Poverty, SDG2 - Zero Hunger, SDG4 - Quality Education, and SDG8 - Decent Work and Economic Growth, this paper aims to offer a conceptual project business model that include the following:

a. To build an intuitive and user-friendly digital platform and mobile application that allows individuals to donate various items conveniently.
b. To provide educational resources and free teaching sessions through the platform to empower low-income families, students, and individuals with disabilities to acquire new skills and improve their livelihoods.
c. To collaborate with mosques, elderly, orphanages, and other community organizations to identify and address the specific needs of beneficiaries and ensure the effective distribution of donated items.
d. To foster a culture of giving, community engagement, and social responsibility among individuals, businesses, and organizations through the platform's initiatives and outreach efforts.
e. To empower vendors, especially Micro, Small, and Medium Enterprise entrepreneurs from the B40 group, by providing them with a platform to showcase and sell their products, locally and globally.

3. METHODOLOGY

This paper employs the design thinking methodology to formulate a conceptual IIUMinKind project business model aimed at assisting both local and global communities. To gain a comprehensive understanding of the challenges faced by various customer segments (CS) – donors, donees & B40 entrepreneurs - a literature review is conducted. Additionally, surveys are administered to assess the well-being of IIUM students and external communities, including community centers and the B40 group. These surveys also gather feedback on the proposed digital platform/app, which facilitates donations of goods or monetary contributions and the sales of goods by communities. Leveraging on business modeling tools such as the Business Model Canvas (BMC) (Osterwalder & Pigneur, 2010) and Value Proposition Design Canvas (VPC) (Osterwalder et al., 2014), a conceptual project business model is developed embedded with a digital platform in facilitating donations collection and distribution for funding of impactful societal initiatives. The initial BMC is validated through surveys distributed to key partners, ensuring their endorsement of the application's potential utility. Meanwhile, the initial VPC is validated through surveys with various customer segments (CS), ensuring the validated business model is well-aligned with the identified problems and effectively addresses the needs of the target communities.

4. LITERATURE REVIEW

4.1. Benchmark of Business Model

4.1.1. GoFundMe (https://www.gofundme.com/)

GoFundMe is a crowdfunding platform founded in 2010 by Brad Damphousse and Andrew Ballester. Its original purpose was to help people raise money for private causes, including emergency medical bills or college expenditures. With time, the platform gained attraction and grew to become one of the biggest crowdfunding websites in the world. People can use GoFundMe to raise money for small businesses, charitable organizations, and other purposes in addition to personal causes. See Fig. 1.

One factor in GoFundMe's success is its reputation for being easy to use and user-friendly. Making a campaign website, sharing personal narratives, and receiving contributions are all made possible for users. The site provides campaign organizers with a wide range of tools and information to aid them in meeting their funding targets.

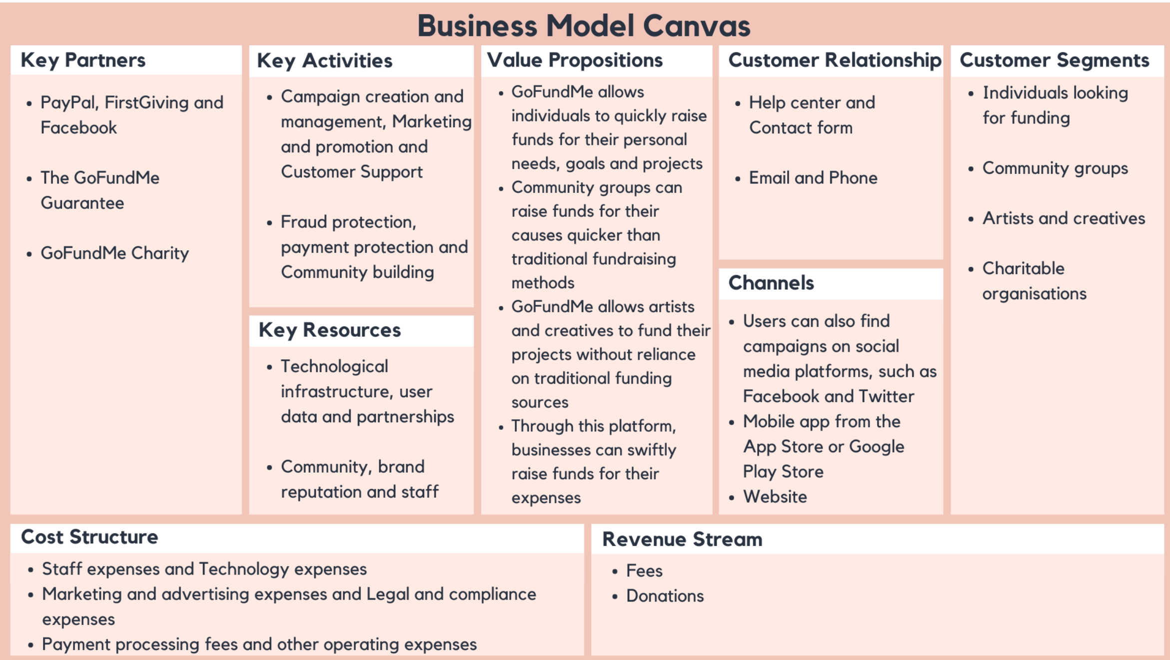


Fig. 1. GoFundMe Business Model

4.1.2. **KickStarter (https://www.kickstarter.com/)**

Kickstarter is a worldwide website that facilitates the funding of creative projects by consumers. It was developed to link musicians, designers, filmmakers, and artists with possible backers who may enable them to realize their creative visions.

Kickstarter has developed and expanded over time. A new category called "Design and Technology" was added to the platform in 2014 with the sole goal of assisting hardware projects. This category rose to dominance on the website quite rapidly. It has aided in financing several creative products.

Kickstarter has become one of the most favored and successful crowdfunding sites worldwide. The site had raised over $5 billion for over 200,000 projects as of 2021. Kickstarter has aided in the development of numerous creative projects, ranging from films and music albums to innovative gadgets and social concerns. See Fig. 2.

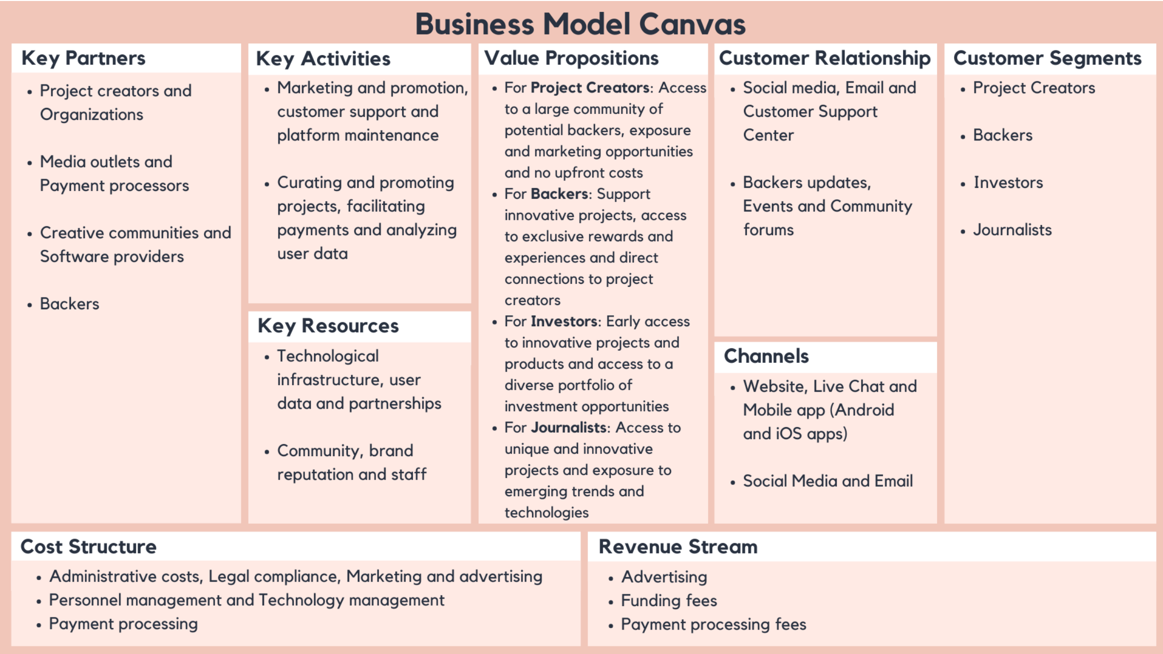


Fig. 2. KickStarter Business Model

4.1.3. Indiegogo (http://www.indiegogo.com/)

Through the crowdfunding website Indiegogo, people and organizations may raise money for a range of initiatives, causes, and projects. Indiegogo, which was established in 2008 by Danae Ringelmann, Slava Rubin, and Eric Schell, has grown to become one of the top sites for crowdfunding. The platform uses a rewards-based crowdfunding approach, in which campaign backers get benefits or incentives in return for their financial contributions. Indiegogo is a user-friendly platform for utilizing campaign creation and management. It enables campaign creators to share their stories, set fundraising targets, and motivate backers with incentives, social issues, entrepreneurship, and more, which are addressed through campaigns on Indiegogo. With the help of Indiegogo, entrepreneurs, artists, activists, and inventors may now more easily obtain funding and acknowledge their ideas. See Fig. 3.

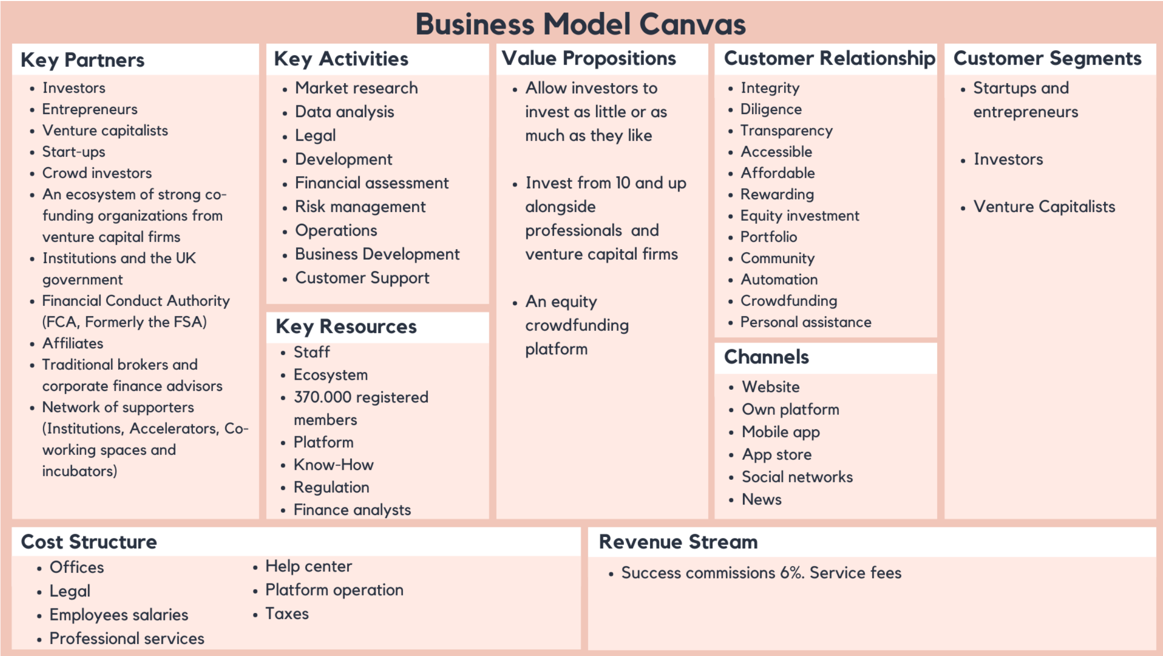


Fig. 3. Indiegogo business model

4.2. 4IR on Donation Platform

According to Zhang et al., (2020), as the Internet continues to change our life, donation practices are also being adapted to the evolving technology, making conventional fundraising methods almost obsolete. Online platforms offer flexibility by allowing donors to make donations whenever they want, eliminating the needs of physical giving. The Fourth Industrial Revolution, or 4IR, is the term used in Malaysia to describe the adoption of cutting-edge technology such as artificial intelligence (AI), the Internet of Things (IoT), and robotics. The implementation of 4IR technologies in donation platforms has completely changed the process of making and managing donation. Through the analysis of donor behavior and preferences by AI algorithms, platforms can boost donor interaction and customize donations.

Moreover, the government has sped up the nation's digital transformation by launching MyDigital. The MyDigital, which highlights the value of technological advancement and integration across all sectors, offers Malaysia a strategic framework to lead the country into the digital era. Malaysia characterizes the digital economy as "economic and social activities that involve the production and use of digital technology by individuals, businesses and government," based on research, analysis, and consensus among key players in the public and private sectors. The digital economy, then, is the result of the 4IR due to the fact that digital technology has been widely used. New digital economies are developing as a result of the fundamental changes that 4IR technologies are bringing about in several industries, including how businesses function and engage with their clients. Using 4IR technologies in the context of online contribution platforms is one way that digital innovation promotes change and boosts Malaysia's digital economy. This does not only bring the donation process up to date, but they are also promoting societal benefit, transparency, and trust in the digital era by securely and openly managing giving donations.

4.3. Aspects that Lead to Donation Giving

According to the research by Noor et al. (2016), age, income, and education have been found to have an impact on the features of charitable donating behaviour in Malaysia. Thus, individuals' preferences towards making donations are determined by the combination of their demographic characteristics with socio-economic backgrounds, real-life experiences, and personal views on certain things. The combination of these factors shows the needs of a variety of donation practices and the encouragement to make donations within the diverse community in Malaysia.

Aside from demographic characteristics, a study by Geng et al. (2022) found that donors' satisfaction and well-being influence their desire to donate. Although to some, the issue of transparency may not directly affect the donors' decision to donate, however, it has a major effect on the environment that promotes giving as a whole. When the donors and the donation or nonprofit organizations have developed a high level of trust, thus, this may lead to a stronger connection between them, as the donors place a high confidence and trust in the organization's responsibility and honesty. However, it is crucial to note that the honesty felt by the donors might change from time-to-time especially when there are questions about the entire organization's operation or perhaps, mismanagement inside the organizations.

4.4. Online Donation Platform

According to Brunker (2016), most donations are made via a variety of payment methods, such as checks, credit cards, digital wallets (also known as e-wallets), and cash. With these donation options, donors can donate to any donation or nonprofit organizations with ease, meeting a range of preferences. Financial donations are, in fact, still a popular way, especially for in-person donation events. Thus, by accepting a variety of donation methods in terms of financial, the nonprofit organizations can improve their fundraising strategies, which will ultimately lead to more support, leading to a huge success in their charitable initiatives.

In Malaysia, the Muslim community prefers making direct or face-to-face donations either to the collection boxes or to the receivers. This shows that traditional approaches to donation requests are preferred over modern approaches that make use of technology (Awang et al., 2015). In addition, the Muslim community in Malaysia keeps to cultural and religious norms that place a high value on interpersonal relationships. Thus, this illustrates a preference for traditional practices of giving, even in the face of the wide range of technologically enabled platforms, such as mobile-app and the use of Internet platforms.

4.5. Having Confidence in Donating to Nonprofit Organizations

Trustworthiness is the foundation of acts of trust, such as donations (Wiencierz et al., 2015). The attitudes and actions of donors in charitable engagements are greatly impacted by trust. When donors have confidence in an organization, they are more willing to contribute their resources to the organizations (Sung et al., 2020). As mentioned, trust acts as a foundation upon which strong relationships between donors and donation organizations are built. Thus, by prioritizing trust-building efforts, charity giving can help to strengthen connections with donors, which may lead to greater charitable engagements.

In addition, transparency is also essential for establishing trust and dependability among the receivers, and donors in the nonprofit organizations. To accomplish their goals and attract more donations, the nonprofit organizations significantly depend on the trust of the general public. Thus, the nonprofit organizations must show great responsibility by being open and honest about how they operate, and handling financial management. Likewise, information should be identified in a timely manner (Sung et al., 2020). This gives donors confidence that their money will be spent wisely and morally.

5. INITIAL BUSINESS MODEL (BM) – USING BMC & VPC

5.1. Initial Business Model Canvas (BMC)

Based on Literature Review conducted above, the initial BM of IIUMinKind using the BMC framework is created (see Fig. 4)

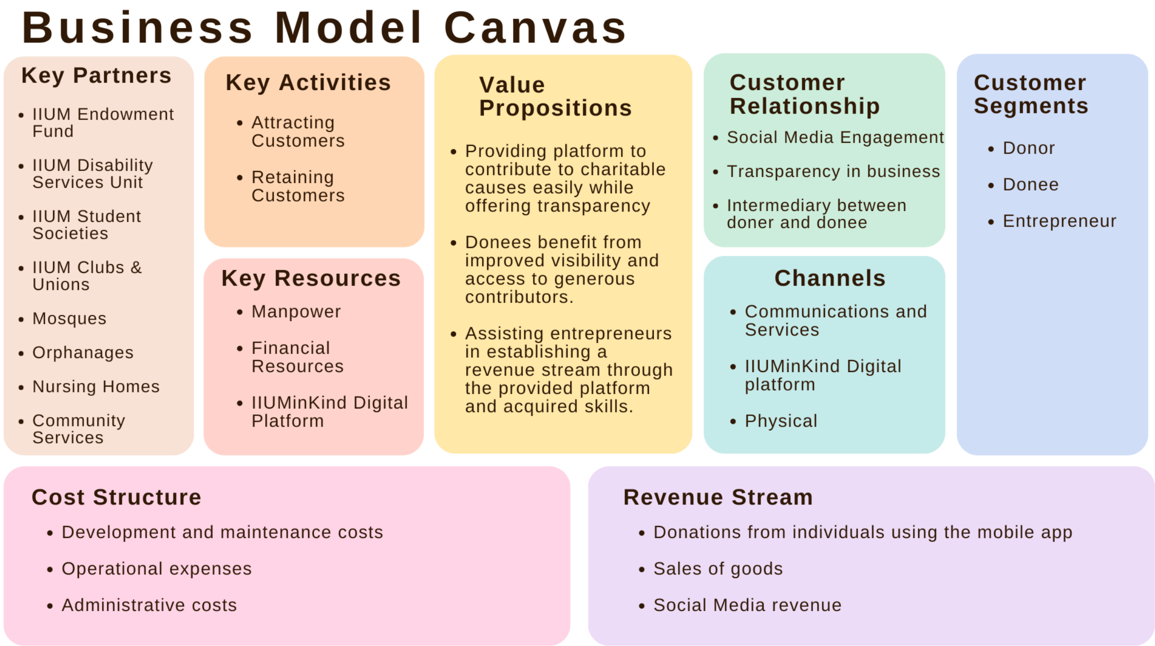


Fig. 4. Initial Business Model Canvas (BMC)

5.2. Initial Value Proposition Canvas (VPC)

Table 1 : Value Proposition Canvas

Customer Segment	Value Map	Customer Profile
Donor	Products and Services 1. User-Friendly mobile apps 2. Secure payment gateway 3. Access to charitable organizations and causes Gain Creators 1. Visualization of success stories in the tangible impact of donations 2. Customized recommendations based on donors preferences. 3. Social media sharing features to share donation activities Pain Relievers 1. Assurance of trust and credibility towards charitable organizations 2. Streamlined donation processes 3. Privacy of data and security measures for safety of donors' personal information.	Pains 1. Time-consuming donation processes 2. doubtful of the credibility of donation platforms 3. lack of transparency of the donations cashflow. Gains 1. Build trust in the accountability of the apps 2. Convenience to donate through a user-friendly app. 3. Can discover and support variety of causes Job-to-do 1. Search for reputable charitable organizations or causes to support 2. Create impacts through donations 3. Ensure transparency in donations to see if it is Uzen effectively

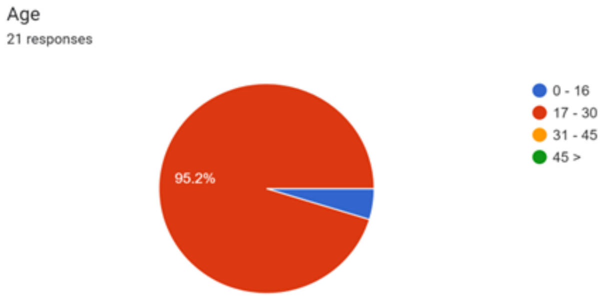
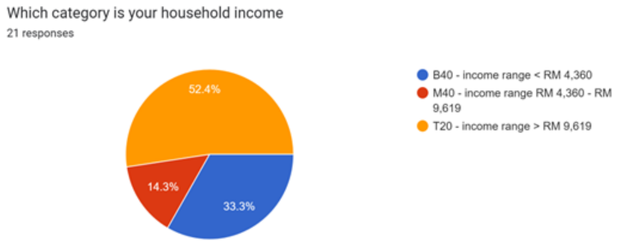
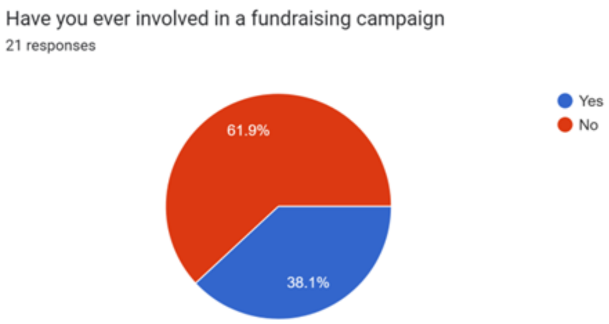
Donee	Products and Services 1. Community workshops and training programs. 2. Educational resources and tutoring services 3. Childcare and support services for single parents. Gain Creators 1. Tailored skill-building programs lead to employment opportunities. 2. Networking opportunities with potential employers and mentors. 3. Community events and social activities promote inclusion and belonging. Pain Relievers 1. Accessible and affordable mental health support services. 2. Flexible scheduling for community programs to accommodate diverse needs. 3. Holistic support services addressing housing and food insecurity issues.	Pains 1. Limited funding for programs and services. 2. Difficulty in reaching and engaging underprivileged community members. 3. Lack of resources for skill-building and educational programs. Gains 1. Increased funding for programs and services. 2. Enhanced community engagement and participation. 3. Access to resources for skill-building and educational programs. Job-to-do 1. Securing funding for community programs and services. 2. Engaging and supporting underprivileged communities. 3. Providing resources for skill-building and educational programs.

Entrepreneur	Products and Services 1. Provision of essential items, such as food packages, clothing, and hygiene products, through the platform. 2. Financial assistance programs can help alleviate financial issues. 3. Facilitate community engagement and support networks to help connect them with resources, services, and opportunities. Gain Creators 1. More access to opportunities since the apps will help small business owners build their brand. 2. It helps to create more sales due to the sales of goods in the apps. 3. Ease them to get financial assistance and distribution of essential goods. Pain Relievers 1. Offer access to essential items by requesting donations from other parties through the apps. 2. Relief in financial hardship and resources. 3. Facilitate peer support groups or mentorship programs connecting people in need with mentors that can provide guidance and encouragement.	Pains 1. Unstable finances and the incapacity to pay for necessities. 2. Difficulty locating steady work or possibilities to generate cash at a living salary. 3. Difficulties getting resources for education and skill development, especially for kids and young adults from low-income households. Gains 1. Improved capacity to meet fundamental requirements and stability in terms of finances. 2. Possibilities for socioeconomic growth and upward mobility. 3. Support and aid from governmental bodies, non-governmental groups, and neighborhood associations to meet their requirements and worries. Job-to-do 1. Providing necessities, including food and medical care, with limited financial resources. 2. Having access to chances for skill development and inexpensive education for both professional and personal growth. 3. Obtaining chances for income-generating work or steady employment in order to sustain their family and themselves.

6. CONDUCT VALIDATION OF INITIAL BM & KEY FINDINGS

6.1. Online Survey

An online survey using a Google Form has been conducted to validate IIUMinKind's initial business model canvas. To validate the business model canvas, a total of 14 questions were created and responses were received to assist in enhancing some areas. As a result, this survey was able to achieve a number of 21 respondents, and the summary of the responses is as follows:

Responses	Elaboration
 Fig. 5. Question 1	The first question asked about the age group of the respondents followed by asking their current status, whether they are part of the IIUM community or not. As shown in Fig. 5, 95.2% of the respondents are aged between 17-30, and also majority of them are students where they are part of the IIUM community.
 Fig. 6. Question 3	Moving on to the third question, the question asked about the household income of the respondents with the aim of knowing their income group. Based on Fig. 6, the majority of the respondents or 52.4% of the respondents are coming from the T20 group. Next, 33.3% of respondents are the B40 people known as the poor, and the remaining 14.3% are from the M40 group.
 Fig. 7. Question 4	Next, the online survey continues with a question asking about the respondents' involvement in a fundraising campaign. From Fig. 7, 61.9% of the respondents had never taken part in a fundraising campaign before. On the other hand, as many as 8 or 38.1% of the respondents have experience on a fundraising campaign.

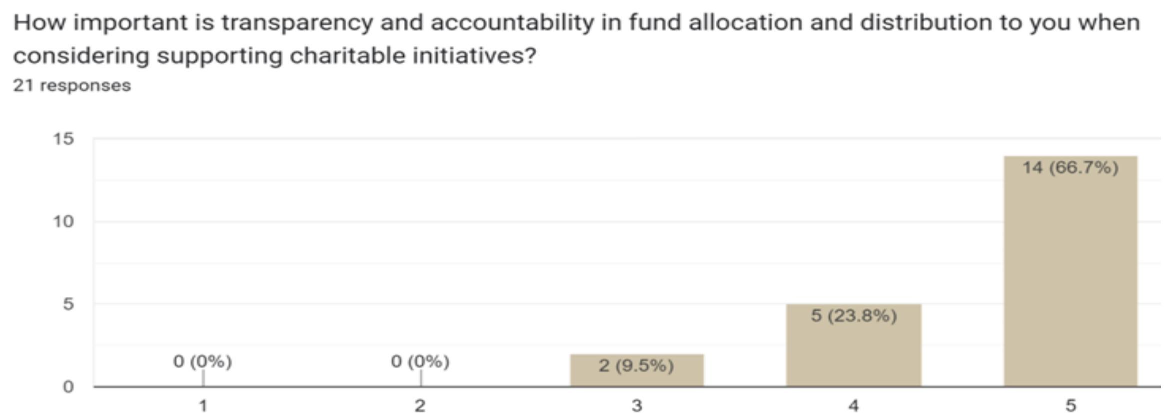


Fig. 8. Question 5

The following question asked about respondents' opinions on how important transparency and accountability in the distribution of funds is when considering charitable initiatives. As shown in Fig. 8, on a scale from 1 to 5 with 5 being extremely important, 14 of the respondents agreed that it is extremely important to promote transparency and accountability in the distribution of funds. Meanwhile, a total of 5 respondents chose scale number 4, and another 2 respondents chose scale number 3.

In addition, the online survey also asked about the respondents' awareness of the societal challenges faced by the community. Based on the responses given, it is an undeniable fact that the majority, or a total of 20 respondents are aware of the societal challenges while one respondent thinks otherwise.

Moreover, there is also a question asking about how familiar are the respondents on the B40 people socio economic issues. As a result, 52.4% or equivalent to 11 respondents are somewhat familiar with the issues, while another 10 of the respondents are very familiar with the issues.

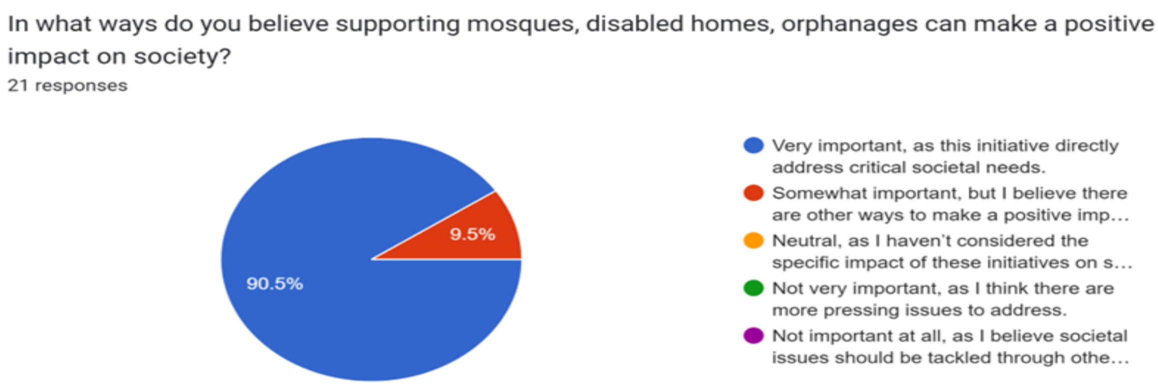


Fig. 9. Question 8

Furthermore, in this question where they were asked in what ways did they believe supporting mosques, disabled homes, and orphanages can make a positive impact on society, the survey showed that 90.5% of respondents agree with the statements in the question (Fig. 9). They believe that this initiative directly addresses a critical community need. The remaining respondents consider it quite important but believe there are other ways to have a positive impact as well. Overall, the majority of respondents are aware of the importance of supporting these institutions in contributing to the well-being of society, especially in addressing urgent social needs.

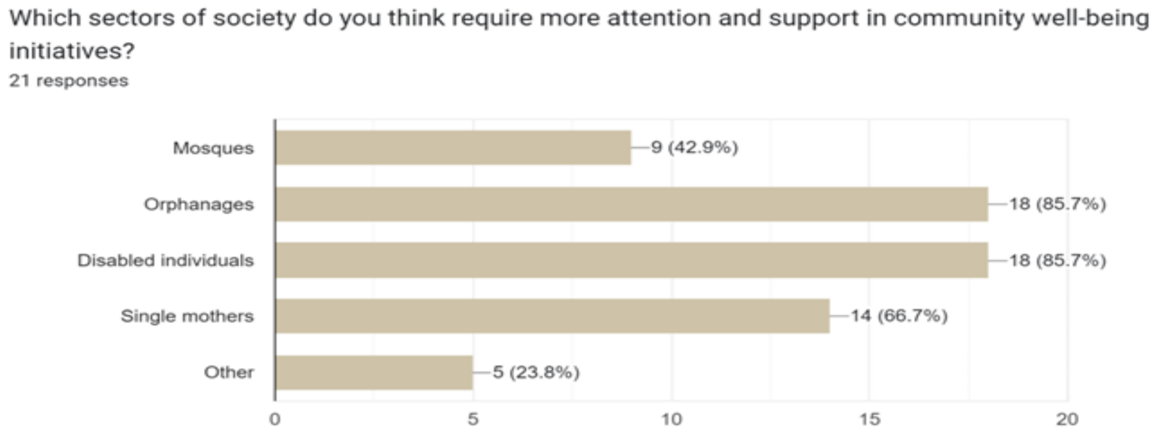


Fig. 10. Question 9

The following question asked about in which sectors of society need more attention and support in community well-being initiatives. From Fig. 10, it can be seen that orphanages and disabled individuals are tied with a total of 18 respondents. Moving on next are single mothers with a total of 14 respondents, coming on third are mosques with a total of 9 respondents. Lastly, 5 respondents think that other societies deserve more attention and support in community well-being initiatives.

On question number 10, the online survey continues with a question asking about the opinion of the respondents on whether the crowdfunding platform can assist deserving groups like the B40, Asnaf, disabled people, and single mothers. As a result, all respondents agreed that a crowdfunding platform may cater to the people in need.

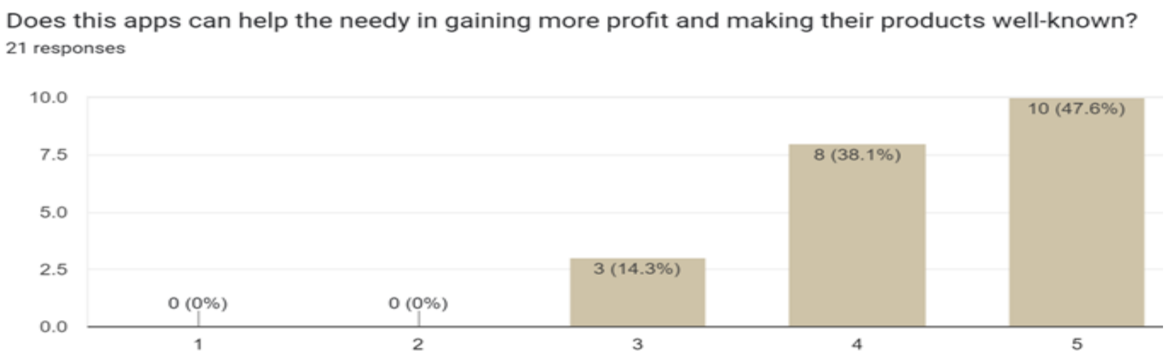


Fig. 11. Question 11

Next, the respondents were asked about how this app can help the needy in gaining more profits and making their products well-known. Based on the Fig. 11, on a scale from 1 to 5 with 5 being totally agree, 10 respondents totally agree that this platform is beneficial to the needy. 8 of the respondents chose the scale number 4 which equivalent to agree, and another 3 of the respondents chose the scale number 3 which is equivalent to neutral.

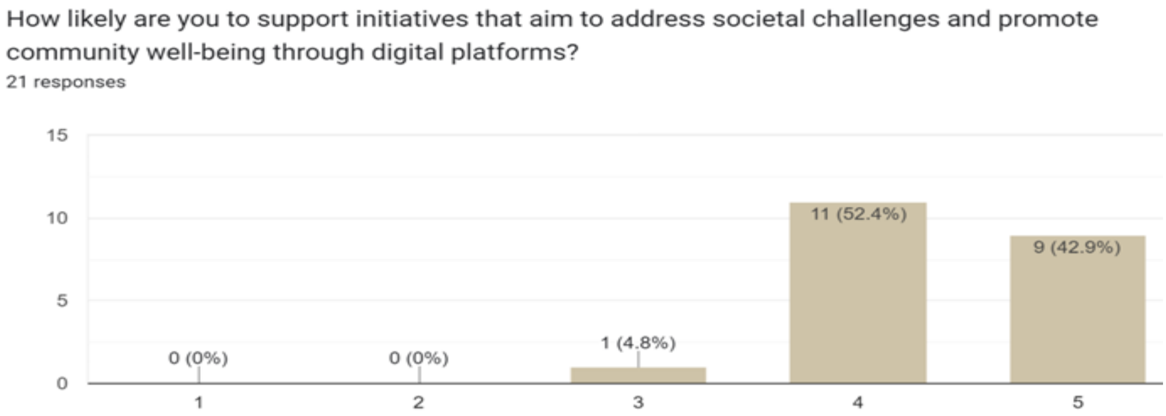


Fig. 12. Question 12

Moving on to question number 12, the respondents were asked about how likely they are willing to support the initiatives with the aim to address societal challenges and promote community well-being through digital platforms. From Fig. 12, on a scale from 1 to 5 with 5 as very likely, 11 of the respondents chose the scale number 4 or known as likely to support. Next, 9 of the respondents chose the scale number 5 which they are very likely to support and lastly, one respondent chose the scale number 3 or known as neutral.

Next, the question asked about how willing are the respondents to contribute to the effort of redistributing the funds, as the result of the reskilling and upskilling programs, enabling the people in need to become financially independent. Based on the survey, all of the respondents gave their full support in supporting the needy to become financially independent or entrepreneurs.

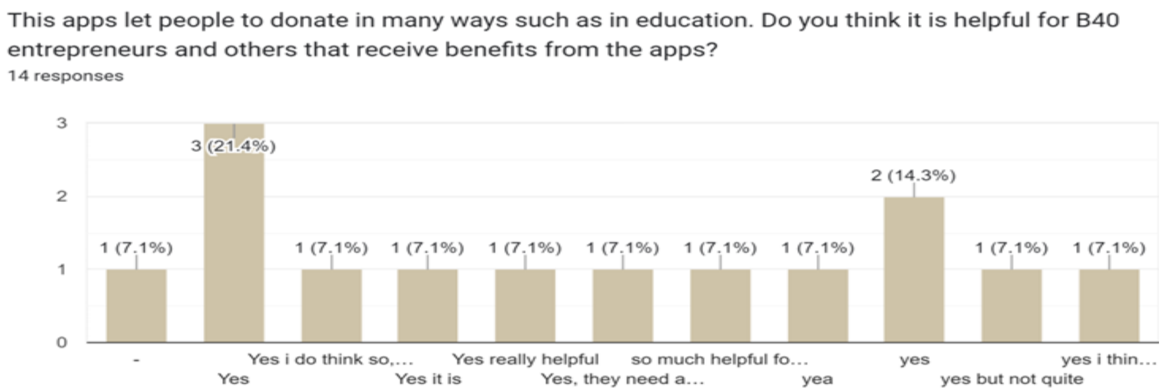


Fig. 13. Question 14

The last question from this survey is an open-ended question where it is not required for respondents to answer. See Fig. 13. Thus only 14 responses were collected out of 21 in total. In this question, they have been asked their opinion on whether this app is helpful for B40 entrepreneurs as well as others who receive benefits from the apps. Although the answers given were varied, the majority showed unanimous agreement with the statement which stated that the app is contributive for many groups of the community.

7. VALIDATED BUSINESS MODEL (BM) – BMC FRAMEWORK

7.1. Validated Business Model (BM)

Based on the online survey findings, the validated business model using the BMC framework for IIUMinKind is shown in Fig. 14 below:

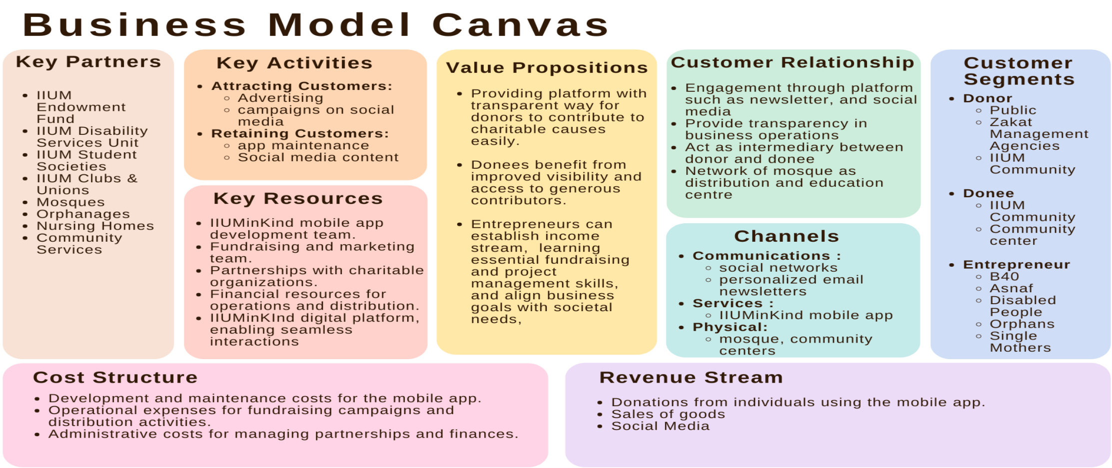


Fig. 14. Validated Business Model Canvas (BMC)

a) Customer Segments

The customer segments that are involved are donors, donees, and B40 entrepreneurs. The online application platform allows donors to make seamless contributions through fundraising campaigns and partnerships with charity organizations, assuring transparency and ease of donating. The app's outreach and engagement techniques assist the general public by encouraging community involvement and awareness. Zakat management agencies benefit from the platform's efficiency in distributing Zakat funds and reaching a larger audience for meaningful activities. Within the IIUM community, both donors and entrepreneurs find a welcoming atmosphere for collaboration and help, utilizing resources and networks to mutual benefit. Donors provide aid and support to the IIUM community and community centers, which address a variety of needs and improve general well-being. The app connects entrepreneurs in the category of those in need, like the B40, asnaf, disabled, orphans, and single mothers, with donors and resources to help their ventures become entrepreneurs and livelihoods, providing chances for empowerment and economic progress.

b) Value Proposition

Our platform provides a transparent way for donors to contribute to charitable causes easily, guaranteeing that their contributions have a real influence on society by helping mosques, old people's homes, orphanages, single mothers and food distribution efforts. Donees benefit from improved visibility and access to generous contributors, allowing for long-term development and success in their projects. B40 entrepreneurs can establish a consistent income stream through the platform, learning essential fundraising and project management skills, and aligning their business goals with the societal needs, resulting in purposeful companies that positively impact the society and nation.

c) Channels

A variety of approaches to communication and service delivery has been made, leveraging social media to successfully involve stakeholders by using the huge reach of social networks to communicate information about charitable activities, encourage community involvement, and amplify its voice across several platforms. In addition, the program uses personalized email newsletters to keep stakeholders informed about events and fundraising efforts. A dedicated IIUMinKind mobile app complements these marketing efforts by serving as the primary interface for consumers to access and interact with the charitable platform. The app includes features such as payment processing, real-time information on fundraising efforts, and chances to discover and support other causes. IIUMinKind app will also apply MyMosqueNet2Cloud Collaborative System, which implements Leavitt's model and will make Change Management (CM) more effective (Hamid et al, 2013). Not to mention our physical strategy, which includes mosques, community centers, and other venues where we hope to hold fundraisers.

d) Customer Relationships

IIUMinKind encourages strong and transparent consumer interactions across different channels including newsletters and social media, by giving regular updates, success stories, and chances for interaction to keep stakeholders informed and interested. IIUMinKind emphasizes transparency in business operations especially in fund allocation to build trust and confidence in the stakeholders. Furthermore, by acting as an intermediary between contributors and beneficiaries, the initiative fosters meaningful connections and guarantees that donations are directed toward effective causes, boosting both donors' and receivers' senses of purpose and fulfillment. Moreover, the network of mosques is part of the distribution and education center to improve social welfare. Utilizing the Mosque Network to transform the Mosque into a hub for education, zakat distribution and collection and other value-added services for the local population (Nasution et al., 2015). At the same time, it can enliven the mosque when people keep using the mosque as the center.

e) Key Activities

IIUMinKind's key activities revolve around customers by attracting and retaining them. To attract customers, the effort relies on advertising and running campaigns on social media platforms, using targeted messaging and compelling content to create knowledge about its charity platform and drive new users. Concurrently, in order to keep existing customers, the initiative invests in app maintenance to ensure smooth functionality and user experience, as well as rapid resolution of any technical difficulties to preserve user happiness and loyalty. Furthermore, the program continuously generates and distributes interesting social media content, adding value to its audience, encouraging community involvement, and reinforcing its brand presence to encourage continued use and support. This strategic way is to create long-term relationships with existing users, while attracting new ones.

f) Key Resources

Key resources are assets that are vital to run business and deliver value propositions to the customers. IIUMinKind key resources are mobile app development teams that are responsible to develop and maintain mobile apps to ensure it is always up-to-date. Fundraising and marketing team is to attract more users and donors to use the platform. We also do partnerships with charitable organizations to leverage network and expertise. Having sufficient financial resources is vital to cover business operations and distribution funds to beneficiaries. Lastly, the IIUMinKind's digital platform encompasses mobile apps that enable seamless interactions between users and facilitates efficient operations.

g) Key Partners

Key partners are external organizations and entities that collaborate with businesses to facilitate the execution of value propositions and improve business operations. IIUMinKind has partnered with several IIUM entities, including the IIUM Endowment Fund, Disability Services Unit, Student Societies, Clubs and Unions, and IIUM Alumni chapters. Additionally, we collaborate with external organizations such as mosques, orphanages, nursing homes, community services, government and private companies to expand the reach of our apps to a wider target audience.

h) Cost Structure

Cost structure refers to the expenses incurred during the operation of the business, and it plays a crucial role in determining the success and sustainability of the business. For IIUMinKind, the costs involved include development and maintenance costs for the mobile apps, operational expenses for fundraising campaigns and distribution activities. Administrative costs are incurred to manage business operations especially in partnerships and finances.

i) Revenue Streams

Revenue streams are the income generated from customer segments. IIUMinKind obtains revenue from the donations from individuals that use the mobile app and sales of goods by the entrepreneurs through the apps. Based on this, a few percentages will be taken to maintain and update the digital platform/app. Also, social media that are mainly used for advertising and promotions purposes to attract more users to use the apps.

7.2. Environmental Map (EM)

According to Tristancho, C.(2023), conditions that aren't directly under the project team's or project management office's control are known as project environmental factors that are included in EM. They need to be managed because this could affect the outcomes of the project. These factors have the potential to impact project outcomes in both positive and negative ways while being outside the control of the project team and the organization that started the project. The range of these elements is further expanded because they can arise both inside and outside of the organization that is starting the project. There are numerous things to consider, including the following:

7.2.1. Market Forces

a. Market size and growth:

Market size and growth refers to the measurement and assessment of the current size of the charitable giving market in Malaysia, as well as the anticipated growth of this market over time. The charitable giving market in Malaysia is experiencing significant growth, particularly in the area of digital and event-based fundraising. In correlation with that, IIUMinKind initiative, which aims to offer an easy-to-use mobile application and digital donation platform, finds great relevance in this trend. According to a OneCause survey in 2023, six out of ten NGOs obtained more than 21% of their annual budget from events and online fundraising. This realization highlights IIUMinKind’s ability to profit from the growing use of digital fundraising approaches. From this analysis, it can be seen that IIUMinKind was able to deal with the complex environment of charitable giving, optimize strategies, and maximize its impact on society.

b. Target audience:

Analysis of target audiences in the context of market forces enables IIUMinKind to create focused strategies and campaigns that appeal to potential donors and recipients, optimize outreach and engagement, and eventually result in positive community impact. The primary target audience for IIUMinKind includes low–income families, students, and individuals with disabilities. These groups often face barriers to accessing resources. Digital tools and platforms can help in accurately identifying and engaging these groups by utilizing donation-based crowdfunding platforms as offered by IIUMinKind. According to Kamarudin et al.(2023), social support and community quality are vital in influencing donation behaviors. By fostering a supportive online community, IIUMinKind can enhance trust and encourage donations, which are essential for sustaining the initiatives.

7.2.2. Key Trends

a. Digital transformation:

With the help of digital transformation, IIUMinKind is able to use innovations and technological advancements to improve fundraising, reach a wider audience, and have a greater impact on societal issues including homelessness, poverty, and many more. The initiative could capitalize on new opportunities, adjust to the changing digital landscape, and promote good community change by adopting digital transformation as a major trend. According to data provided by the Malaysian Communication and Multimedia Commission (MCMC), a survey stated that internet users of the total Malaysian population have increased from 76.9% in 2016 to 87.4% in 2018 (MCMC, 2018). Thus, it can be simply put that digital donation platforms will reach wider opportunities and advantages compared to traditional approaches.

b. Sustainable practices:

Incorporating sustainable practices into IIUMinKind's operations aligns to promote community well-being and address societal challenges in a responsible and ethical manner. This app can maximize its good impact and help create a more resilient and sustainable future for everyone by placing a high priority on social responsibility, transparency, and community involvement.

7.2.3. Industry Forces

a. Technological advancements:

Technological advancements offer IIUMinKind the chance to give a better presence on the internet later, expedite its fundraising procedures, and increase the amount of support it provides to underprivileged communities. IIUMinKind may efficiently use technology to accomplish its goals by keeping up with emerging trends and using creative solutions. The increasing usage of mobile payment solutions such as e-wallets and blockchain based donations are beneficial for IIUMinKind to offer safe and convenient donation options to users.

7.2.4. Macroeconomic Forces

a. Government policies:

Government policies play a significant role in shaping the operating environment for organizations like IIUMinKind. The government frequently offers tax deductions to promote charitable giving and aid nonprofit organizations. Tax discounts or credits may be among several incentives available to both individuals and organizations who make donations to qualified nonprofits. Comprehending and utilizing these inducements can help IIUMinKind in drawing donors and optimizing fundraising endeavors.

7.3. Strategy Canvas

A strategy canvas that compares the IIUMinKind business model canvas with the other existing companies, such as Kickstarter, Indiegogo, and GoFundMe, has been created to gain a better understanding of the model. The key features that distinguish these donation platforms from one another are displayed on this canvas. Based on Fig. 15, the interface, transaction fees, platform accessibility, promotion it provides, and branding are the main elements that are being analyzed.

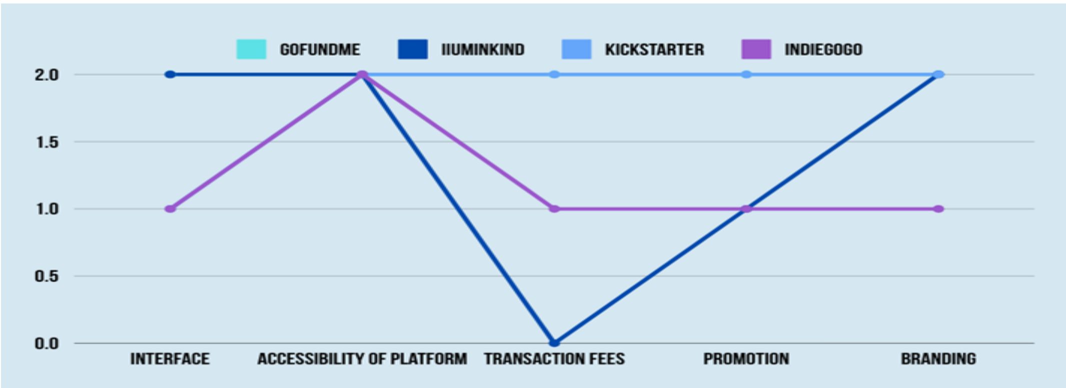


Fig. 15. Strategy canvas between three benchmark companies

7.4. Low Fidelity prototype apps

Fig. 16, 17, 18, 19 illustrates the low fidelity prototype apps that were developed in the initial stages of the design process. These prototypes allow quick iterations and user testing of the basic functionalities and layout of the application.

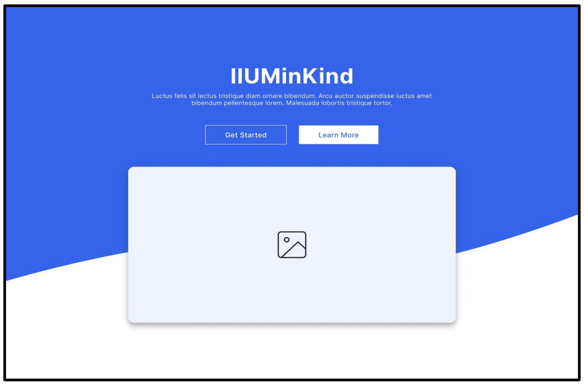


Fig. 16. Low fidelity prototype for the home screen of the IIUMinKind web application

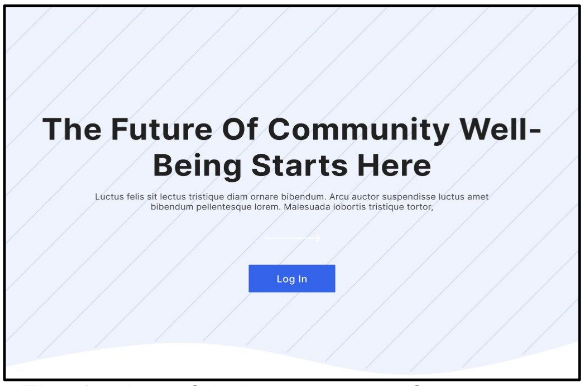


Fig. 17. Low fidelity prototype for the login screen of the IIUMinKind web application.

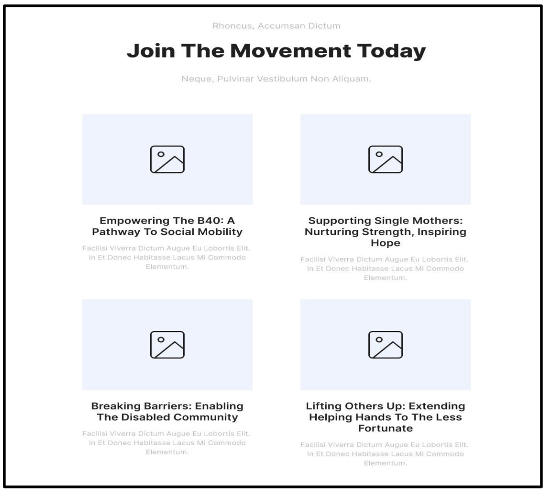


Fig. 18. Low fidelity prototype for a page in the IIUMinKind web application to list out types of donations.

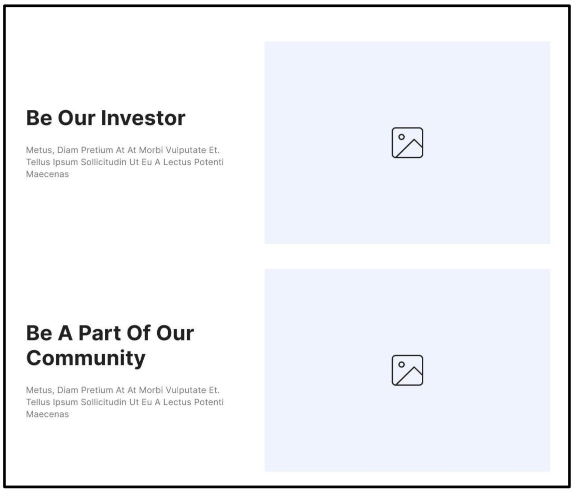


Fig. 19. Low fidelity prototype for a page in the IIUMinKind web application to choose their role in the web application.

8.CONCLUSION AND FUTURE WORKS

In conclusion, IIUMinKind serves as a light of empathy and generosity on the IIUM community as well as the larger community. This platform allows people and organizations to show their empathy and help those in need by providing a user-friendly interface. This platform, with its creative approach to donations, supports businesses and poor communities by promoting economic growth and skill-building programs in addition to average donation platforms. Its commitment to promoting trust, transparency, and engagement is what makes this platform unique and exclusive. This platform redefines the boundaries of donations by putting these principles first, making it more than just a place for donations. IIUMinKind's humane and inclusive approach is paving the way for a society where generosity is unrestricted, everyone is welcome to help one another. Every donation made through IIUMinKind turns into a step towards a more promising and just future for everybody.

Future works for IIUMinKind include the development of a comprehensive project plan for the implementation of its digital platform and mobile app. This project plan will outline the key steps involved in the platform's development, from the beginning till the end. An extensive need for assessment to determine the specific requirements of users, as well as to make sure it is in line with the most recent technology, will be one of the project plan's main tasks. Therefore, working together with developers and designers to produce a user-friendly, innovative, and up-to-date interface is essential. Furthermore, this platform will concentrate on implementing important features and functionality, such as community engagement, skill-building programs, and donation tracking. The long-term success of this platform will also depend on the adoption of monitoring the platform usage, gathering feedback, and analyzing its relevancy and impact on the community.

REFERENCES

Awang, S. A., Borhan, J. T., Mohamad, M. T., & Muhammad, F. (2015). Exploring the patterns and antecedents of charitable giving among Muslim community in Malaysia. Online Journal of Research in Islamic Studies, 2(2), 46-58 https://ejournal.um.edu.my/index.php/RIS/article/view/9950.

Brunker, M. (2016, September 8). Study Finds Payment Method Matters When Donating to Charity. https://publicpolicy.paypal-corp.com/news/study-finds-payment-method-matters-when-donatingcharity.

Economic Planning Unit, Prime Minister's Department. (2021). Malaysia Digital Economy Blueprint. https://www.ekonomi.gov.my/sites/default/files/2021-02/malaysia-digital-economy-blueprint.pdf

Economic Planning Unit, Prime Minister's Department. (2021). National Fourth Industrial Revolution (4IR) Policy. https://www.ekonomi.gov.my/sites/default/files/2021-07/National-4IR-Policy.pdf

Geng, Y., Chen, Y., Huang, C., Tan, Y., Zhang, C. (2022, January 7). Volunteering, Charitable Donation, and Psychological Well-Being of College Students in China. https://doi.org/10.3389%2Ffpsyg.2021.790528

Hamid, H., Khairuddin, N. D., Al-amodi, Y., Dahlan, A. R. A., & Osman, R. A. (2013). MyMosqueNet2Cloud Collaborative System: A network of mosques towards eradicating poverty in Malaysia. American Academic & Scholarly Research Journal Vol. 5, No. 5, July 2013

Intention to Donate Money via Social Network Site: Perspective from a Developing Country. (2021). Jurnal Pengurusan, 61(1), 1–15. https://doi.org/10.17576/pengurusan-2021-61-07

Kamarudin, M. K., Mohamad Norzilan, N. I., Mustaffa, F. N. A., Khidzir, M., Alma'amun, S., Nor Muhamad, N. H., Abu-Hussin, M. F., Noor Zainan, N. I., Abdullah, A. H., & Samat-Darawi, A. B. (2023). Why Do Donors Donate? A Study on Donation-Based Crowdfunding in Malaysia. Sustainability, 15(5), 4301. https://doi.org/10.3390/su15054301

Madhukar, A. (n.d.). 4 Effective Platforms To Fund Social Causes In Malaysia. Jireh's Hope. https://www.jirehshope.com/posts/2436/platforms-fundraising-campaigns

Mohd Azhar, N. I. B., Mat Rejab, M. (2023, November 30) View of i-Care: A Web-Based Online Goods Donation Management System. *https://publisher.uthm.edu.my/periodicals/index.php/aitcs/article/view/12146/4346*.

Nasution, A. I., Dahlan, A. R. A., Husaini, M. I., & Ahmed. M. H. (2015). Developing Islamic City through Network-of-Mosque (NoM). *Journal of Social and Development Sciences*, *6*(2), 37–45.

Noor, A. H., Isa, N. A., Irpan, H. M., Bahrom, H., Salleh, A. M., & Ridzuan, A. R. (2016). Does performance and transparency matter to individual donors' giving in Malaysia? *Contemporary Issues and Development in the Global Halal Industry*, 3–12. https://doi.org/10.1007/978-981-10-1452-9_1

OneCause® | Fundraising Solutions | Creator of BidPal Mobile Bidding. (n.d.). OneCause. https://www.onecause.com/

Osterwalder, A., Pigneur, Y., Bernarda, G., Smith, A. (2014). Value Proposition Design: How to Create Products and Services Customers Want. John Wiley & Sons.

Osterwalder, A., & Pigneur, Y. (2010). Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers. Wiley.

Pereira, D. (2023a, April 14). *GoFundMe business model - how does gofundme* digital *work and make money?*. Business Model Analyst. https://businessmodelanalyst.com/gofundme-business-model/

Pereira, D. (2023c, May 22). *Kickstarter business model - how Kickstarter makes work money?*. Business Model Analyst. https://businessmodelanalyst.com/kickstarter-business-model/

Sirisawat, S., Chatjuthamard, P., Kiattisin, S., & Treepongkaruna, S. (2022). The future of digital donation crowdfunding. PLOS ONE, 17(11), e0275898. https://doi.org/10.1371/journal.pone.0275898

Sung, J. H., Bock, G. W., Kim, H. M. (2020, June 6). The Effect of the Online Donation System on Donation Behavior. https://web.archive.org/web/20220908043004id_/https://aisel.aisnet.org/cgi/viewcontent.cgi?article=1160&context=pacis2020

Vizologi. (n.d.). *Indiegogo business model canvas*. System on Donation Behavior. https://vizologi.com/business-strategy-canvas/indiegogo-business-model-canvas/

Wiencierz, C., Pöppel, K., & Röttger, U. (2015, April 3). Where Does My Money Go? How Online Comments on a Donation Campaign Influence the Perceived Trustworthiness of a Nonprofit Organization. https://doi.org/10.1080/1553118x.2015.1008634

Zhang, Y., Tan, C. D., Sun, J., & Yang, Z. (2020, November 1). *Why do people patronize donation-based crowdfunding platforms? An activity perspective of critical success factors*. Computers in Human Behavior. https://doi.org/10.1016/j.chb.2020.106470

A CONCEPTUAL CLEANCARE DIGITAL PLATFORM BUSINESS MODEL: ENHANCING THE WELL-BEING AND NURTURING LOW-INCOME B40 COMMUNITIES AS CLEANCARE-PRENEURS IN THE GOMBAK COMMUNITY

PUTERI NOOR FARHANA BINTI MEGAT MOHD SUHAIMI[1*], PUTERI SABRINA RAYSA BINTI RAMLAN[2], NUR SYAHIRAH BINTI AHMAD YUSOF[3], NAAFILAH HUDAA BINTI MUHAMMAD SHAKIR[4], ABDUL RAHMAN BIN AHMAD DAHLAN[5]

[1,2,3,4,5]*Department of Information Systems, Kulliyyah of Information and Communication Technology, International Islamic University Malaysia,*

Kuala Lumpur, Malaysia

**Corresponding author: farhana.mms@live.iium.edu.my*

ABSTRACT: This paper is to offer a conceptual platform business model of laundry and cleaning services, called CleanCare, embedded with a digital platform/app. The value proposition of CleanCare is to help improving the quality of life that meets the expectation and needs of the Gombak community by providing a comprehensive digital platform laundry and *sertu* cleaning business model. The business model provides services like efficient pickup, *sertu* and careful washing method, professional folding and delivery service to the front of customers' homes; aligned with the United Nations' Sustainable Development Goals; SDG 3 - Good Health and Well-being, SDG 8 - Decent Work and Economic Growth, and SDG 9 - Industry, Innovation and Infrastructure. In addition to save the houseowners time and effort, this service maintains the highest standards of hygiene and cleanliness by streamlining the laundry process that align with SDG 3 for reducing the Gombak communities from the risk of being infected to dangerous bacteria and germs from dirty clothes. The paper adapts the design thinking methodology, which includes empathizing, defining, ideating, prototyping, and testing processes. CleanCare business model is designed, tested, and established as a multi-sided platform business by first understanding the job-to-do, essential gains, and extreme pains faced by the various customer segments (CS) – cleaning service seekers, cleaning service providers, B40-preneurs and donors. In formulating business model options as a possible solution that is relevant to the various CS, business modelling tools like the Value Proposition Design Canvas (VPC), Business Model Canvas (BMC), and Business Environmental Map (EM) are used in the ideation, designing, and testing of the initial/prototype business model, and finally establishing the CleanCare business model. Hence, this paper offers the CleanCare business model aims to pave the way towards the betterment of Gombak community quality of life by leveraging on trusted digital platforms for laundry and *sertu* cleaning services.

KEY WORDS: *Laundry and Sertu Cleaning Services, Multi Sided Platform Business Model, Societal Wellbeing, B40-preneurs, SDG*

1. INTRODUCTION

Families and students in the bustling town of Gombak Selangor, struggle to balance their demanding schedules and academic obligations. Taking care of the home, striking a balance between work/study-family-leisure, and guaranteeing work/academic achievement sometimes leave little time for personal wellbeing. This is particularly true in the B40 region, where the issues are compounded by budgetary limits. In their never-ending quest to fulfil their responsibilities, employees and students frequently compromise their health and wellbeing. A system that may reduce these stresses and open doors for the community to live a more sustainable and balanced existence is desperately needed.

Due to time restrictions, families in Gombak frequently find it difficult to juggle the responsibilities of employment, childcare, and domestic tasks (Lisa Guirguis, 2003).The family's general well-being depends on keeping the house tidy and orderly, yet busy schedules often make this difficult. Services like CleanCare, which provide professional house cleaning and laundry services, are aware of these difficulties and seek to simplify things.

Families have a major obligation to provide a safe, comfortable, and happy home environment that fosters family unity. Families may spend more time resting, spending time together, and participating in meaningful activities by hiring help for cleaning and washing duties. Services like CleanCare are designed to improve peace of mind and strengthen family ties in addition to providing a clean atmosphere (Morrow, 2023).

Students at Gombak struggle with rigorous academic schedules and frequently do not have enough time to take care of household responsibilities (Lisa Guirguis, 2003).Taking care of laundry and housekeeping responsibilities can frequently be neglected when balancing personal obligations, part-time work, and schooling. Services like CleanCare come in to offer helpful support, allowing students to concentrate on their education and personal development.

Services like CleanCare serve not just families and kids directly but also the larger community, especially the workforce in the B40 region. Services that are dedicated to fostering economic empowerment and social inclusion via the recruitment of people from under represented backgrounds and the provision of solid work opportunities. Services aim to improve their quality of life and make a constructive contribution to the growth of the community by offering fair salaries and skill development activities.

Hence, CleanCare business model aims to transform Gombak community's household management by utilizing digital-based innovation and encouraging community engagement. Our strategy promotes holistic well-being and strengthens community ties by addressing the many requirements of families, workers, and students while emphasizing balanced quality of life. CleanCare innovative approach to household management is not only simplifing daily routines but also creates meaningful community engagement with the Gombak community. By reimagining household tasks as opportunities for empowerment and social impact, CleanCare empower individuals and families to thrive and achieve their goals while contributing to a more balanced and harmonious society (Zhang Y, 2023).

2. OBJECTIVES

The main objective of this paper is to develop a conceptual multi-sided business model including digital platform/application that offers and provides services as pain relievers and gain creators including:

a. To deliver dependable and effective laundry and *sertu* cleaning services that are relevant and meeting customer expectations.
b. To provide a convenient door-to-door options service to make life easier for the Gombak community.
c. To generate job opportunities for the B40 Gombak community by supporting local businesses and service providers.
d. To provide a trusted and scalable digital-based platform/app for laundry and *sertu* cleaning services seekers and providers.

3. METHODOLOGY

This study has adapted the Design Thinking Approach of Tim Brown from the Interaction Design Foundation. Design Thinking is significant because it integrates the needs of people, the potential of technology, and the prerequisites for business success in a human-centered manner by using the designer's toolset (Kurek et al., 2023). The five stages of design thinking are empathy, define, ideate, prototype, and test. The first stage is to develop empathy, which involves reading articles and news to understand current events and behavioral patterns in people. It implies seeing and interacting with targeted customer segments like B40 communities to get a psychological and emotional understanding of them. In this stage, the designer aims to put aside preconceptions and acquire accurate user insights. To operate a more relevant business, online questionnaire surveys are also utilized in this stage to gather extra data and gain a deeper understanding of human thought processes. Based on what we've learned from earlier stages, the defining step is where we define the problem that individuals have. All findings from the empathy phase are gathered to have a clear problem statement. The ideate stage is utilized to provide solutions in order to deal with this problem. Different kinds of solutions are created from brainstorming to mind mapping to identify the most effective one for the difficulties at hand. Once the answers to satisfy people's wants have been found, the prototype is created. This prototype is a scaled-down version of the product to make sure the best one meets the target audiences' expectations for the business developed. In the last phase, testing, the prototype is tested to get input and gauge user satisfaction. It is also to identify any issues that arise throughout the testing procedure so that they may be fixed right away. Additionally, benchmarking is carried out through the search for comparable business practices that have historically existed in the industry. This ensures that, by modifying the currently accessible business model, our company satisfies the high requirements and is similar to other existing enterprises. By examining these benchmark companies, our company utilized modeling tools such as the initial business model canvas and value proposition canvas. Then, these tools are later validated with various customer segments like the B40 community to establish a validated business model with its value proposition.

4. BUSINESS MODELLING TOOLS

a. Business Model Canvas (BMC)

BMC is a strategic management tool that facilitates more efficient planning, visualization, and definition of our company. The current version of BMC consists of nine components, according to Osterwalder and Pigneur (2010): customer segment, value proposition, channel, customer relationship, revenue stream, cost structure, key activities, key resources, and key partner.

b. Value Proposition Canvas (VPC)

Osterwalder et al. employ VPC as a tool to identify the demands of our client group and determine the solution that will be provided to them (Osterwalder et al., 2014). The value map and the customer profile are the two components that make up the VPC, they continued. Each of the two blocks consists of three segments: the customer profile comprises job-to-do, extreme gain, and pain; the value map contains items and services, gain creators, and pain relievers. We are better equipped to comprehend client needs and offer pertinent solutions thanks to VPC.

c. *Strategy Canvas (SC)*

The strategy canvas is a tool from Blue Ocean Strategy that helps businesses analyze and compare their competitive positioning in a visual way. It enables companies to map out important competitive factors like pricing, product features, and customer experience on a graph, in comparison to the current industry landscape (Osterwalder & Pigneur, 2010).

d. Environment Map (EM)

The external circumstances and elements that surround and affect an organization's success, operations, and decision-making are referred to as the business environment. These variables are divided into four major categories: market forces, industry forces, key trends, and macroeconomic forces. Comprehending the company environment is imperative for organizations to adjust, prosper, and make knowledgeable choices in a swiftly evolving terrain. (Osterwalder & Pigneur, 2010).

5. LITERATURE REVIEW

5.1. Laundry & Cleaning Services

The laundry and cleaning services sector is undergoing major changes in the Digital/4IR age as a result of evolving customer expectations, technology breakthroughs, and environmental concerns. This study of the literature looks at a number of topics related to this industry, such as consumer behavior, company strategies, legislation, opportunities, and problems as well as market trends.

Research on the laundry and cleaning services industry in Malaysia, particularly in the Klang Valley and Gombak region (Zaini, 2021), shows that due to hectic schedules, the rise in families with two working parents, and an increased emphasis on convenience and cleanliness, urban households are depending more and more on professional laundry and cleaning services. In crowded places like the Klang Valley, where people place a high value on time-saving solutions that guarantee their houses are hygienic, this tendency is especially apparent.

Because of urbanisation, the rise in families with two working parents, and people's general need for convenience, there is an increasing demand for cleaning and laundry services. From conventional launderettes to tech-driven startups, the sector provides a variety of services to meet specialised needs like as eco-friendly choices and on-demand scheduling.

The way that consumers behave has a significant impact on the services that the sector provides. When selecting laundry and cleaning services, customers give priority to factors including sustainability, affordability, quality, and convenience. Maintaining a positive and devoted clientele requires clear communication, personalised experiences, and trust-building.

The delivery of services has evolved due to technology; automation, smartphone applications, and smart gadgets have increased operational efficiency and enhanced consumer satisfaction. The convenience of scheduling, tracking, and customisation offered by mobile applications appeals to today's tech-savvy, contemporary customers. The sector uses a variety of business strategies, including as on-demand services. These adjust to consumer tastes and market movements provide consistent income and build enduring bonds.

Being ecologically conscious and adhering to regulations are crucial for companies operating in this industry. Adhering to health, safety, and environmental regulations fosters consumer trust. To lessen their influence on the environment, many businesses are implementing eco-friendly procedures, such as using energy-efficient equipment and biodegradable detergents.

In conclusion, to satisfy the demands of contemporary consumers, the laundry and cleaning services sector is undergoing fast change in the Digital/4IR age. Businesses may expand responsibly and adjust to changes in the market by embracing technology, sustainability, and flexible business models. Success in an ever-changing business requires an understanding of market trends and client preferences.

5.2. Multi-Sided Platform Business

Various sectors have been significantly changed by the coming up of business model with multiple faces which include the cleaning and the household maintenance sectors. These models connect two different clients considering homeowners who need cleaning services and at the same time workers who look for extra income in the cleaning and maintenance industry. This review of literature focuses on the key points and consequences of multi-sided platform models in this context.

The model of a platform with multiple edges is characterized by network effects, which means that as more users join, the worth of the platform goes up. Hagiu and Wright (2014) studied the significance of the platform in economics and its relationship to creating competitive advantages that last. For one, CleanCare uses network effects to ensure a better quality of services, among other things attracting different types of clients but also creates jobs for individuals within the cleaning industry.

However, the use of digital technology has completely changed the way users interact with multi-sided platforms. Studies by Chen et al. (2020) have investigated how digital platforms improve customer engagement, personalized services, and operational efficiency. CleanCare's easy-to-use website and digital platform allow for easy booking, real-time tracking, and customized services, leading to higher customer satisfaction and employee productivity.

Complex regulatory environments require multi-sided platforms to comply with labor laws, data privacy regulations, and industry standards. A 2021 study by Zhang and Liu examines the obstacles and tactics for meeting regulatory requirements in platform businesses. CleanCare's proactive stance on regulatory compliance, such as following labor laws and data protection protocols, builds trust and reduces legal liabilities.

5.3. Islamic Values and Hygiene Practices

CleanCare highlights Islamic principles by considering specific criteria that are in line with Islamic teachings on cleanliness, stewardship, and communal welfare. Spiritual, mental, and bodily purity are valued and encouraged in Islam. The importance of hygiene including *sertu* cleaning is made evident in both the verses of the Holy Quran and the hadith of Prophet Muhammad. The Prophet Muhammad said that cleanliness is an essential aspect of faith, emphasizing the importance of cleanliness in both the physical and spiritual domains. Abu Malik Al-Ash`ari (may Allah be pleased with him) reports that Islam places a great emphasis on cleanliness as an essential aspect of faith. Keeping one's body and spirit clean not only encourages heart purity but also helps overall wellness. As a Muslims, we need to make sure our body is clean every time to do the obligations of Allah such as Salah. CleanCare plans to provide laundry and *sertu* cleaning service that focuses on maintaining the highest levels of hygiene to help customers keep their clothes clean and fresh.

According to the Holy Quran, "You are the best nation produced [as an example] for mankind. You enjoin what is right and forbid what is wrong and believe in Allah. If only the People of the Scripture had believed, it would have been better for them. Among them are believers, but most of them are defiantly disobedient." (Quran 3:110). The road to strength and health is clean. Islam aspires to a robust and healthy Muslim society that can comprehend, apply, and disseminate Allah's teachings throughout the world. CleanCare also highlights with the Islamic idea of stewardship, or Khilafah, which how important of take care of environment that the servant should protecting the environment by applying eco-friendly method. Additionally, CleanCare promotes community welfare by helping residents to reduce the stress of laundry chores, freeing them up to concentrate more on their family commitments, religious obligations, and community involvement. Thus, the washing and cleaning service not only satisfies the practical needs of the Gombak community but also adheres to Islamic values and teachings by combining Islamic ideals of cleanliness, stewardship, and communal welfare.

5.4. Benchmark of Business Model

5.4.1. dobiQueen (https://www.dobiqueen.my/laundry-pick-up)

dobiQueen is both a self-service and laundry pickup service in Malaysia but the difference between our businesses is that CleanCare does not limit customers to a specific time to book a service as it is subject to availability of our workers. For dobiQueen, the last pickup time should be by 12.30 p.m. to receive the completed laundry on the same day before 6 p.m. As for CleanCare, it depends on the availability of workers since the laundry facilities are open 24 x 7.

5.4.2. CleanSolution (https://journals.iium.edu.my/kict/index.php/jisdt/article/view/424/255)

CleanSolution provides housekeeping and sertu cleaning services (Shariffudin et al., 2023). See Fig. 1. The company intended to help the B40 community to gain extra income from new job opportunities while enhancing their skills in cleaning services which CleanCare plans to offer as one of its value propositions. The only difference is that CleanCare provide laundry pickup and drop-off services. This project will offer a wider variety of services to the workers. B40 communities can also work outside office hours after 12 a.m. since most laundry facilities are open 24 hours a day. It also provides them with a choice of upskilling their skills doing laundry activities rather than cleaning activities.

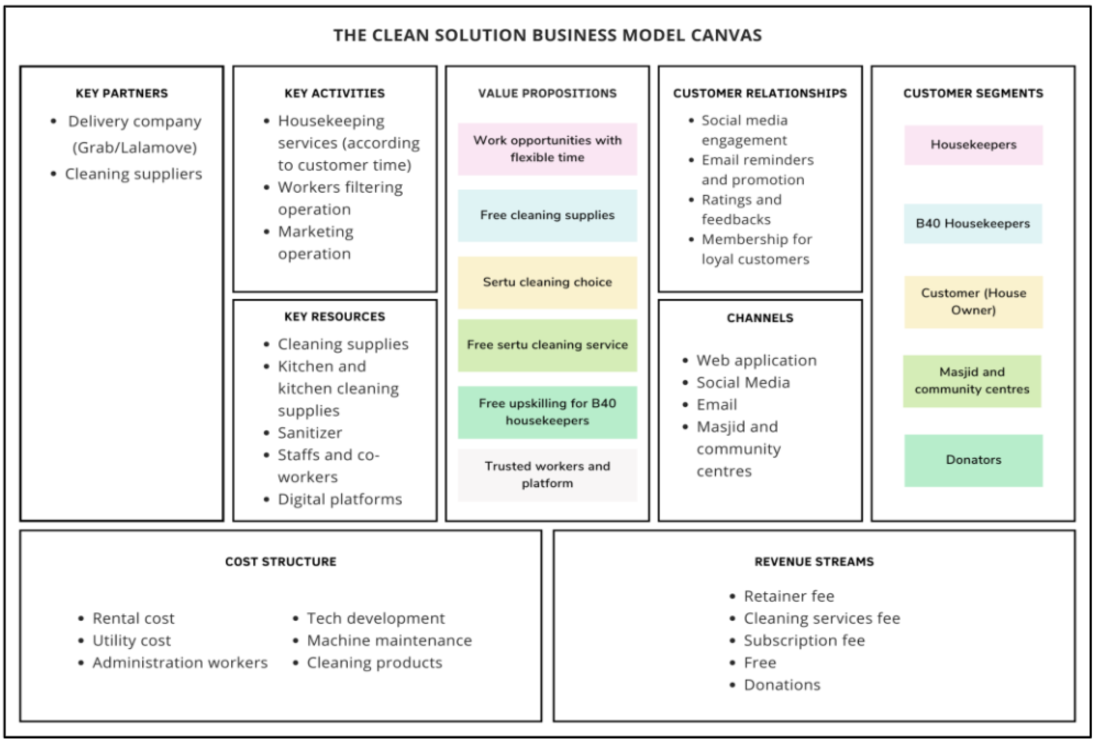


Fig.1. BMC Clean Solution

5.4.3. V Clean Laundry (https://vcleanlaundry.com/)

V Clean Laundry provides a variety of services including on-site cleaning, wet wash and folding. See Fig. 2 Their practices might vary in one area, which is the way they hire their staff. V Clean Laundry uses its vendor relationships programme to hire staff. In the meanwhile, B40 members are encouraged by CleanCare services to expand their income and develop their abilities, which will enable them to advance in their careers.

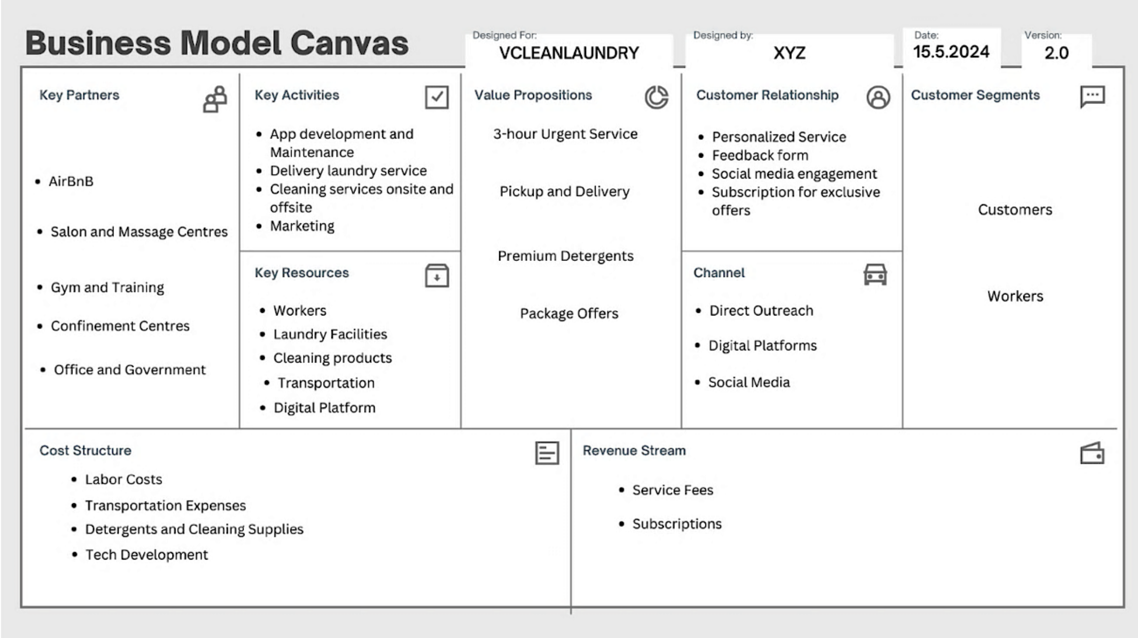


Fig. 2. BMC V Clean Laundry

5.4.4. Hamper App (https://www.hamperapp.com/)

Hamper App is a dry cleaning and laundry delivery service located in the United States of America - see Fig. 3. What differentiate them apart from other companies in Malaysia in this field is that they offer customers to track the process of their orders. Whether the laundry is in the washer, or a driver is on the way, everything is updated in the app. This real-time update feature is what CleanCare aims to include to ensure customer satisfaction and trust in our service.

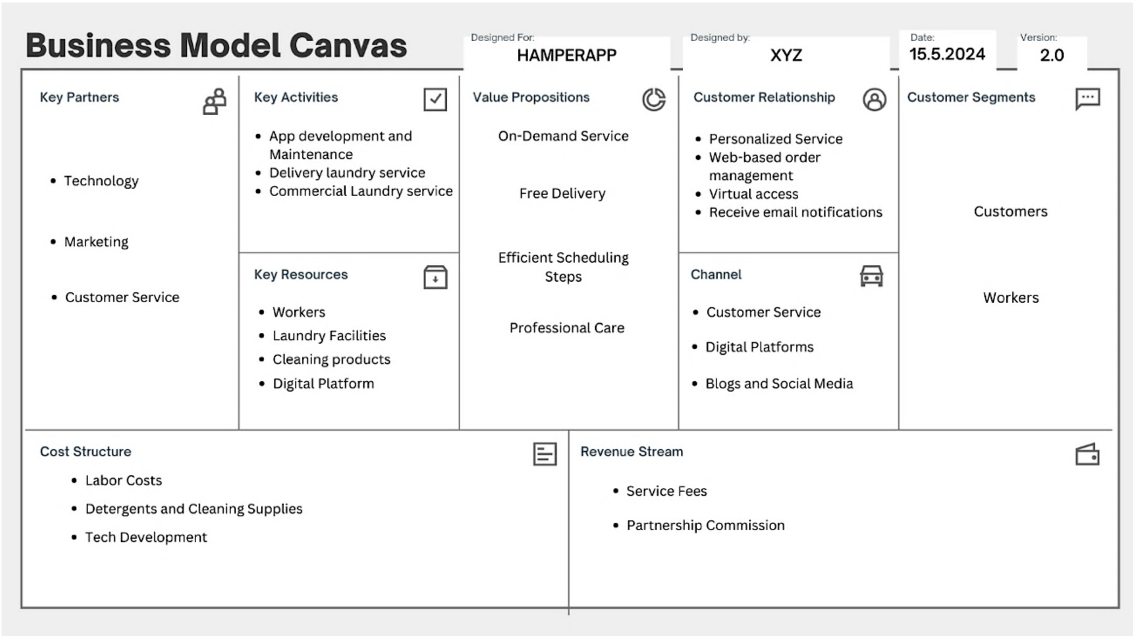


Fig. 3. BMC Hamper App

6. INITIAL BUSINESS MODEL (BM) – USING BMC & VPC

Based on the insights gleaned from the literature review, an initial business model canvas (BMC) has been devised for the proposed multi-sided business platform, which is CleanCare, as shown in Fig. 4.

6.1. Business Model Canvas (BMC)

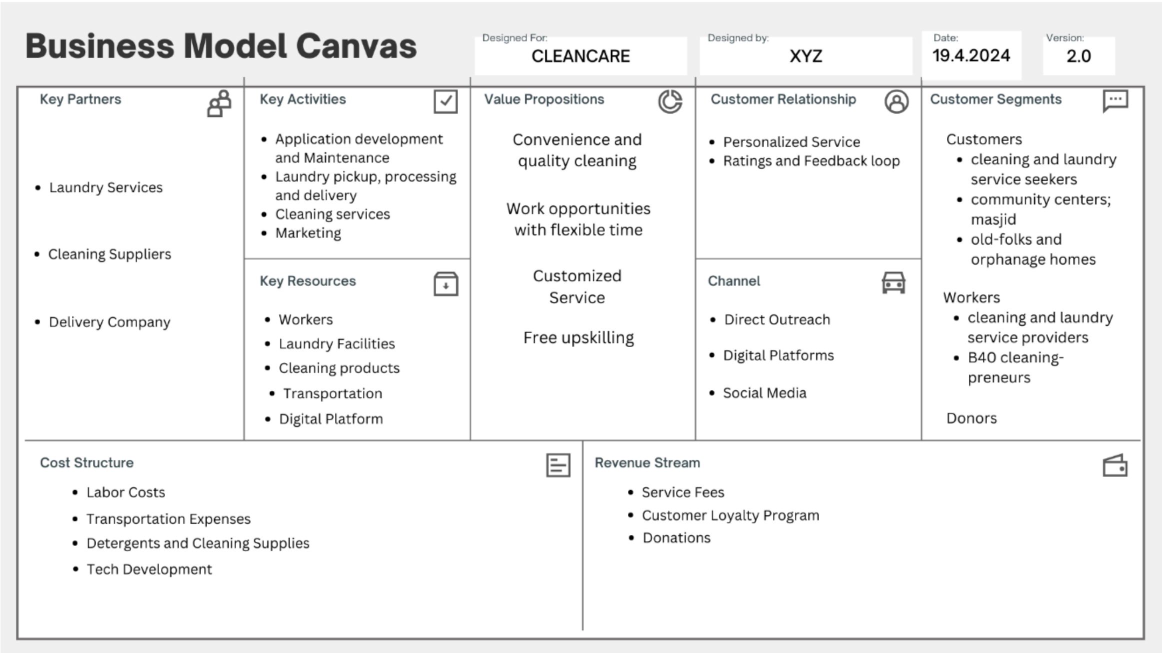


Fig. 4. Initial CleanCare Business Model Canvas (BMC)

6.2. Value Proposition Canvas (VPC)

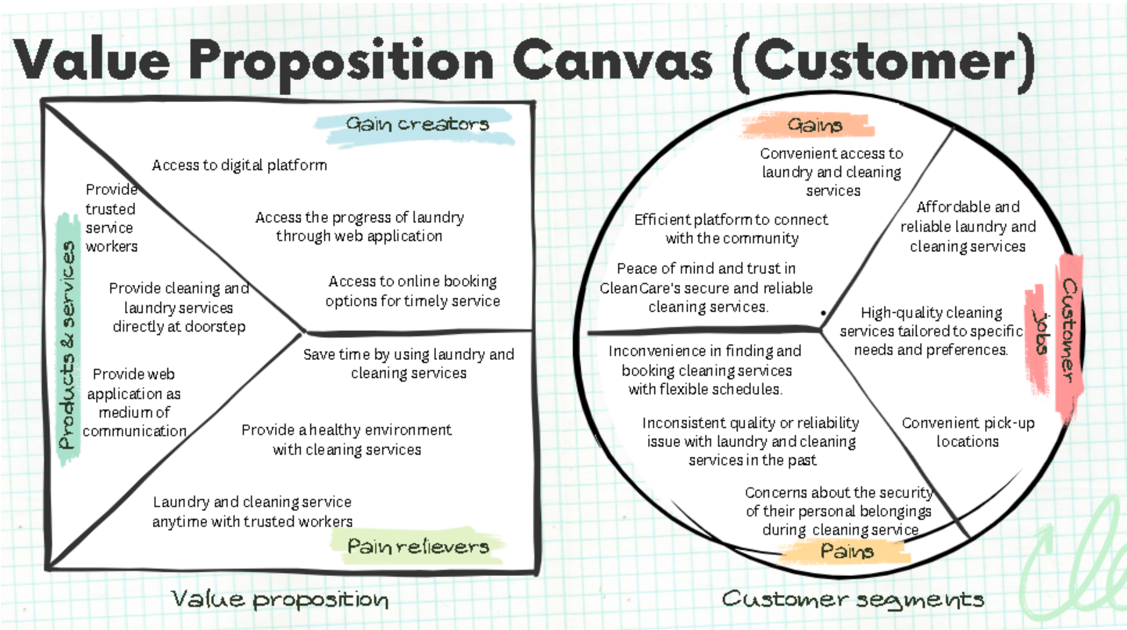


Fig. 5. Value Proposition Canvas for Customer

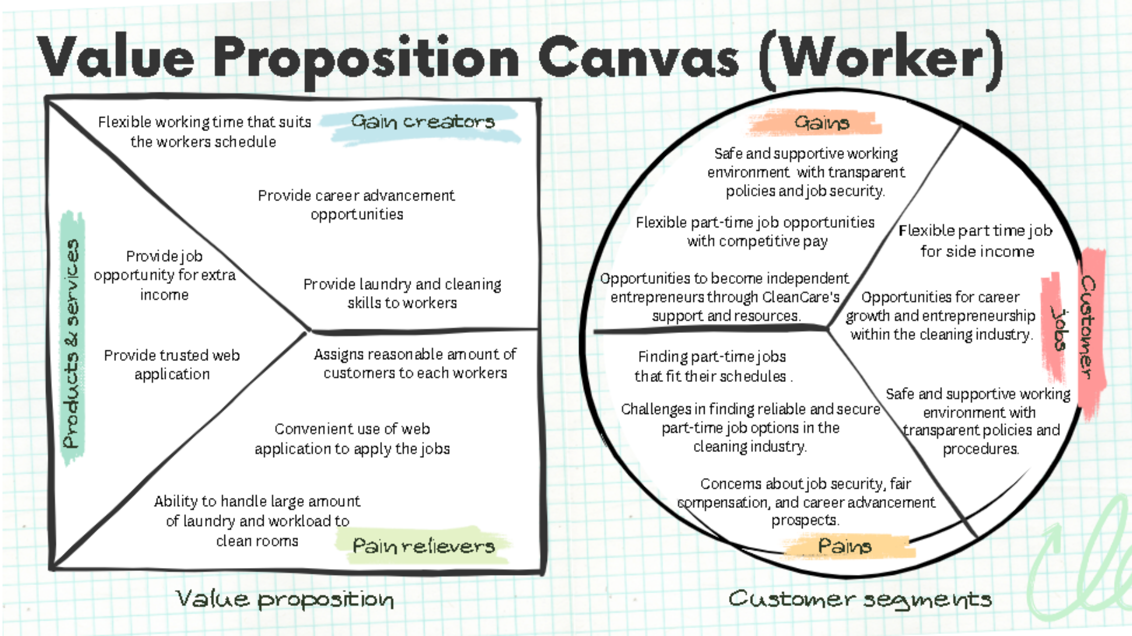


Fig. 6.Value Proposition Canvas for Workers

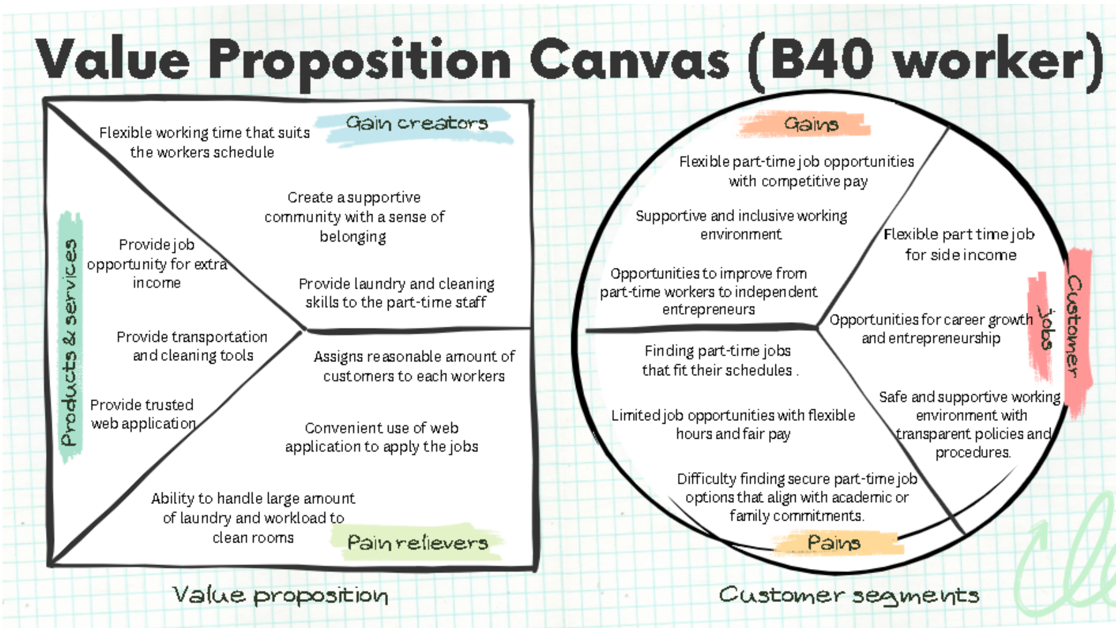


Fig. 7. Value Proposition Canvas for B40 worker

7. CONDUCT VALIDATION OF INITIAL BM & KEY FINDINGS

In order to validate the CleanCare business model, a survey had been done involving 30 residents of Gombak dominated by 56.7% of cleaning service seekers, cleaning service providers, B40 community, and donors. Below is the analysis of the data collected from the online survey presented in the following diagrams.

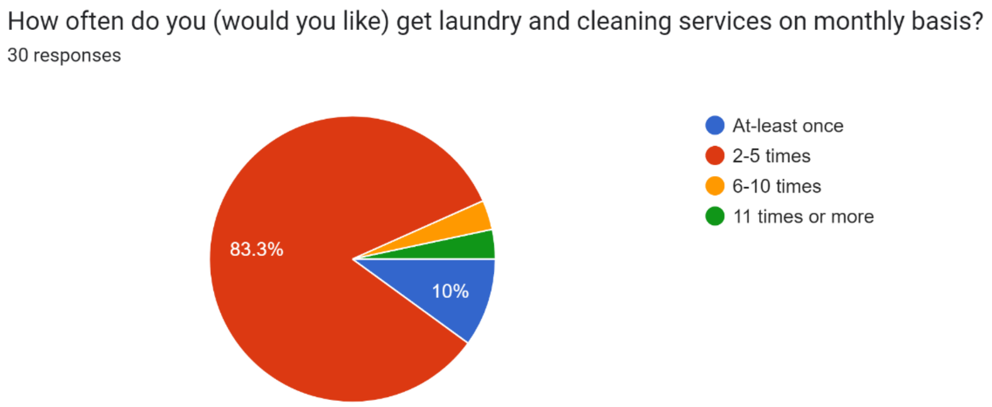


Fig. 8. Pie Chart of frequent usage laundry and cleaning service

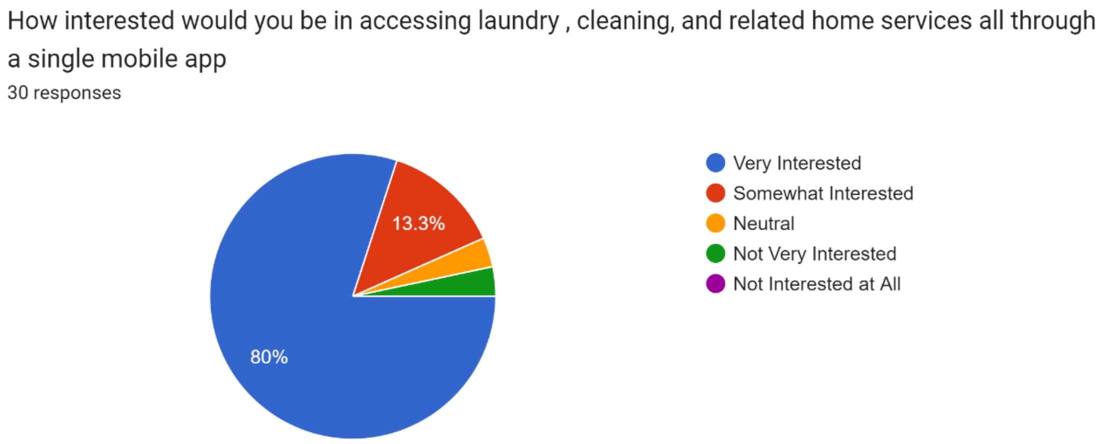


Fig. 9. Pie chart of respondents interested in accessing services through a single mobile application

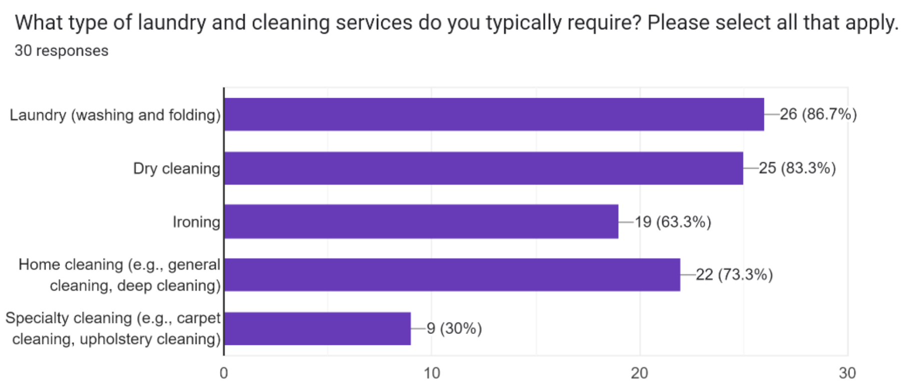


Fig. 10. Type of laundry and cleaning services offers

Fig. 8 highlighted the significant demand for cleaning and laundry services among Gombak residents, with 83.3% of the respondents using these services 2 to 5 times a month, and 10% using them at least once. This shows a persistent demand in the neighborhood. Similarly, Fig. 9 and Fig. 10 show a strong preference for simplified convenience, with 80% of residents of Gombak expressing interest in using a single mobile application to access such services. Also, from this survey, it is interesting to see that 26 respondents agreed that laundry services that include washing and folding are essential. Furthermore, out of the respondents, 25 are in favor of dry-cleaning services, and 22 are in favor of adding home cleaning services to the laundry and cleaning service offers.

Although our methodology sample is small with only 30 respondents, the survey additionally discusses the socio-economic impacts of these services, 56.7% were students, and they recognized that these services had the potential to empower people, especially those in the B40 category. Amazingly, respondents stress the contribution of cleaning and laundry services to employment growth. Furthermore, the survey indicates a change in the delivery of services towards digital channels, with most respondents favoring mobile applications instead of websites and phone calls. Furthermore, 73.3% of the respondents are currently se home cleaning and laundry service that they found through online platform. Lastly, respondents prioritize price, convenience, and cleaning quality in order of importance when choosing a laundry and cleaning service. These characteristics stand out as crucial determinants of consumer decisions, underscoring the significance of providing excellent customer service and satisfaction.

8. VALIDATED BUSINESS MODEL (BM) – BMC FRAMEWORK

8.1.Validated Business Model

After conducting the validation process, the validated CleanCare Business Model is shown in Fig. 11 below.

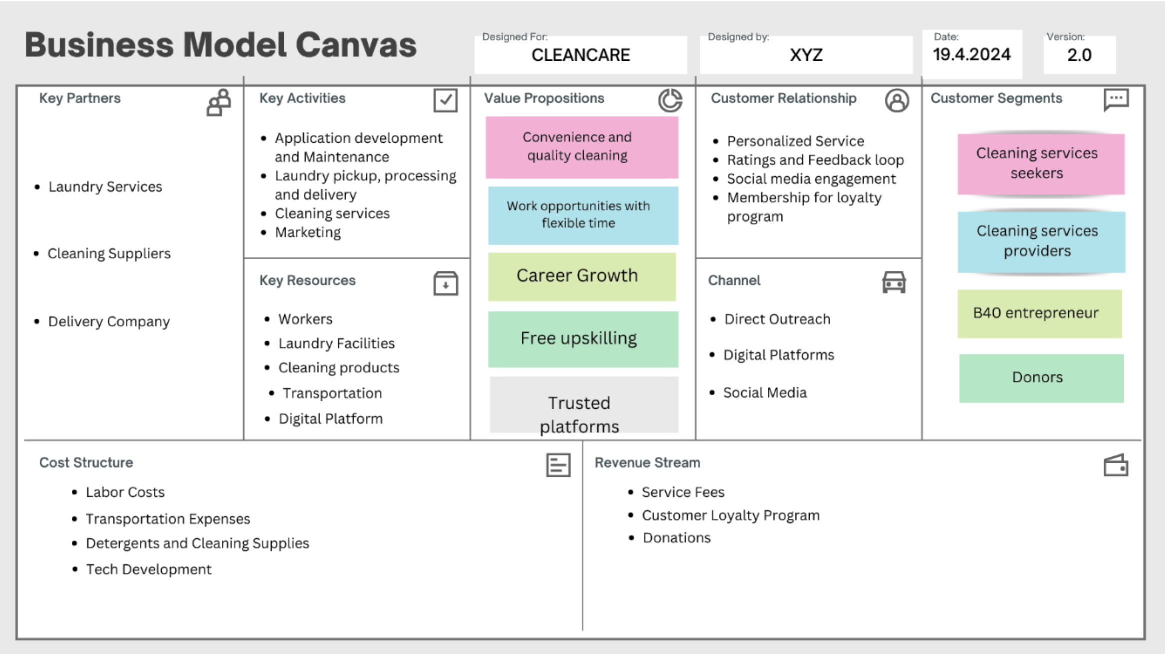


Fig. 11. Validated CleanCare Business Model Canvas

8.1.1. Customer Segment (CS)

CleanCare targets multiple CS: cleaning service seekers including families, students, busy professionals, B40, and community centres like masjid, old folks

& orphanage homes in the Gombak area who seek convenient and high-quality laundry and *sertu* cleaning services. For cleaning service providers, CleanCare provides a digital platform for wider market outreach. Additionally, CleanCare provides employment opportunities for individuals who become cleaning service providers and B40 community as cleaning-preneurs, offering flexible work arrangements that cater to their needs and circumstances. For donors – organizations (government and private) and individuals interested in supporting impactful social initiatives and community development through donations and sponsorships to CleanCare.

8.1.2. Value Proposition (VP)

CleanCare's value proposition is centered around delivering customized services that are relevant and meet specific customer preferences, ensuring convenience, and maintaining high standards of *sertu* cleaning quality. For customers and service seekers, CleanCare offers time-saving solutions that allow them to focus on other aspects of their lives. For cleaning service providers, the VP includes bigger market outreach. Workers benefit from flexible work opportunities and upskilling programs, enhancing their employment prospects and economic well-being. Donors can support CleanCare's social mission while contributing to B40 career growth and development.

8.1.3. Channels (CH)

CleanCare utilizes various channels to reach its target audience and stakeholders. Direct outreach involves community engagement and partnerships via network of masjid (Dahlan et al., 2021; Hamid et al., 2013) to connect with potential customers and workers. CleanCare digital platforms, including a mobile app and website, streamline service bookings, facilitate customer feedback, and manage worker operations efficiently. Social media platforms such as Facebook, Instagram, and LinkedIn are leveraged for marketing campaigns, customer engagement, and brand promotion.

8.1.4. Customer Relationship (CR)

CleanCare prioritizes building personalized relationships with its customers by offering tailored services that address specific needs and preferences. The business actively seeks and responds to customer feedback, fostering a feedback loop that drives continuous improvement in service quality and customer satisfaction. This personalized approach via digital and physical platforms enhances customer loyalty and retention, contributing to the long-term success of CleanCare.

8.1.5. Revenue Streams (RS)

CleanCare generates revenue primarily through service fees charged to laundry and cleaning service seekers, commission from laundry and cleaning service providers. Additionally, the business may implement a customer loyalty program offering discounts or benefits to repeat customers to drive retention and increase revenue. Furthermore, CleanCare can generate revenue through donations contributed by supporters interested in social impactful and community development initiatives.

8.1.6. Key Resources (KR)

Key resources for CleanCare include skilled workers from the B40 community who perform laundry and cleaning services, operational facilities equipped with laundry facilities and cleaning supplies, transportation infrastructure for efficient service delivery, and a robust digital platform for managing bookings, payments, and customer interactions. These resources collectively enable CleanCare to deliver reliable and high-quality services to its customers.

8.1.7. Key Activities (KA)

CleanCare's key activities include ongoing digital platform/app development and maintenance to optimize user experience, efficient execution of laundry pickup, processing, and delivery services, professional cleaning activities tailored to customer requirements, and strategic marketing initiatives to attract and retain customers. These activities are essential for delivering value and maintaining operational efficiency within the business.

8.1.8. Key Partners (KP)

CleanCare collaborates with laundry services providers for processing customer orders, cleaning suppliers for sourcing high-quality cleaning products and equipment, and delivery companies for timely and reliable transportation of laundry and cleaning materials. These strategic partnerships enable CleanCare to optimize its operations and enhance service quality for its customers. Another KP are organizations like government agencies e.g. *Jabatan Kebajikan Masyarakat* (JKM), NGOs and masjid, and private companies.

8.1.9.Cost Structure (CS)

CleanCare's cost structure encompasses labor costs for paying workers, transportation expenses related to vehicle maintenance and fuel, procurement costs for detergents and cleaning supplies, and investments in tech development for app development, maintenance, and digital platform management. These costs are carefully managed to ensure profitability while delivering value relevant to the various customers segments.

8.2. Business Environmental Map (EM)

8.2.1. Market Forces

As stated by The Brainy Insights (2024), in its report titled 'Online Laundry Services Market Size by Service (Laundry Care, Dry Clean, and Duvet Clean), By Application (Residential, and Commercial), Regions, Global Industry Analysis, Share, Growth, Trends, and Forecast 2023 to 2032', from 2023 to 2032, the online laundry services market is expected to develop at a compound annual growth rate (CAGR) of 18.2%. The market was valued at USD 22.41 billion in 2022. At its foundation, an online laundry service is a digital marketplace that facilitates the outsourcing of tasks associated with doing laundry. This innovative concept has gained significant traction in recent years and offers societal advantages beyond communication.

8.2.2.Industry Forces

There are other companies that provide cleaning and laundry services. Therefore, to set itself apart from the competition, CleanCare offers its customer segment an additional benefit by prioritizing B40 Gombak communities as workers to those who may seek extra income.

8.2.3. Key Trends

The growing need for contactless services is one of the most recent significant industry developments in the online laundry services sector. Services that provide pickup and delivery alternatives without needing clients to interact with the workers are growing in popularity since the COVID-19 outbreak. Advanced technologies like machine learning, artificial intelligence, and mobile applications are being embraced by a lot of laundry and cleaning businesses to manage inventory, automate procedures, and offer personalised services. Real-time order status updates and improved customer communication are two further uses for these systems (SkyQuest, 2024). The emphasis on sustainability and environmental friendliness is also another key trend in the market. Reducing water use and utilising eco-friendly washing products are two examples of the green practices that many laundry and cleaning firms are adopting. This is a reaction to customers' increased interest in lowering their carbon impact and understanding of environmental concerns.

8.2.4. Macroeconomic Forces

Considering that CleanCare offers a service in great demand, it has potential to develop in the future (The Brainy Insights, 2024). Additionally, it may raise the B40's quality of living by giving them training to eventually run their own cleaning and laundry business and by giving them work opportunities. CleanCare will need to be carefully maintained, nevertheless, as inflation increased in February 2024 by 1.8% to 132.1 (Ministry of Economy, 2024). To avoid being negatively influenced by inflation, which will eventually affect other prices as well as the cost of laundry and cleaning service equipment, some actions must be taken.

8.3. Strategy Canvas

The strategy canvas (see Fig. 12) compare CleanCare and its competitors i.e. Clean Solution and DobiQueen in the housekeeping services industry. CleanCare differentiate itself by focusing on important factors like transparent pricing that ensures customers & service seekers know what they are paying. Next, CleanCare is committed to high quality services that we will always filter the workers based on our selection process as well from our rating and feedback features. CleanCare promotes job opportunities to a wider community, which limits its recruitment to individuals with a maintenance background. CleanCare's main focus is on creating a user-friendly online platform that is easy to access for both customer segment and potential workers. This platform acts as the main way for the business to communicate, leading to smooth interactions and prompt services.

CleanCare is dedicated to empowering B40 workers, improving their cleaning abilities, and encouraging entrepreneurship, benefiting both the workers and the company. By including customer service metrics like ratings and testimonials, CleanCare builds a stronger relationship with its customers, fostering trust and loyalty. In addition, CleanCare takes a strategic marketing approach by using online channels and digital platforms to reach a broader audience without spending much.

This approach not only increases brand awareness but also supports CleanCare's goal of making top-notch housekeeping services accessible to everyone in the country. Overall, CleanCare's thorough strategy aims to raise the bar for housekeeping services, establishing a stronger and more influential presence in the Malaysian market.

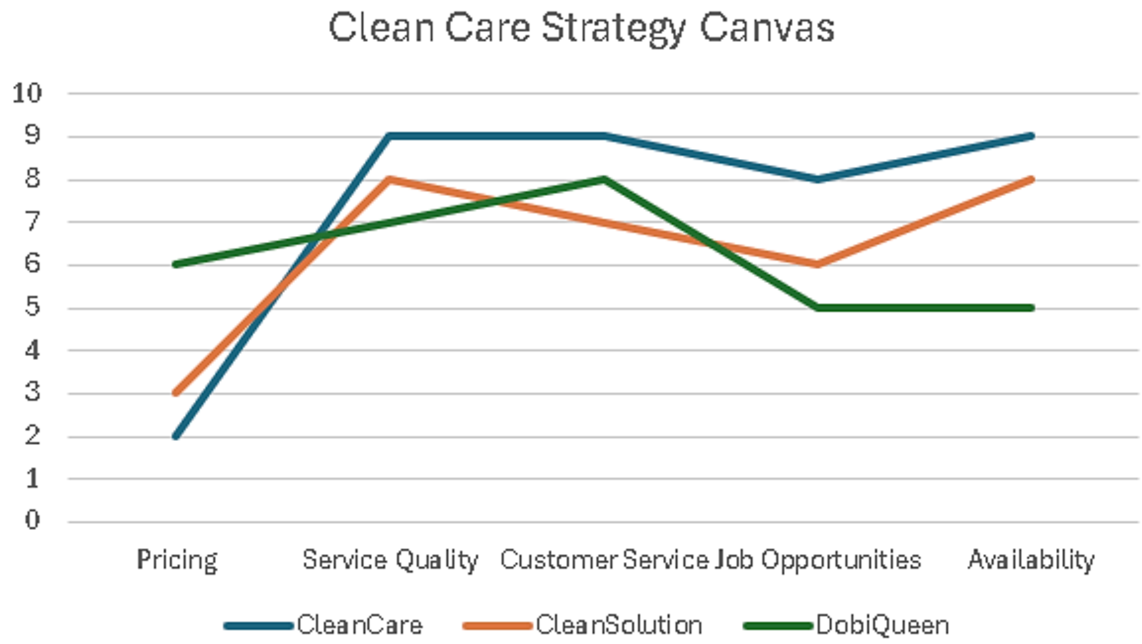


Fig. 12. CleanCare Strategy Canvas

8.4.Low Fidelity Prototype Apps

Fig. 13. CleanCare Website Homepage

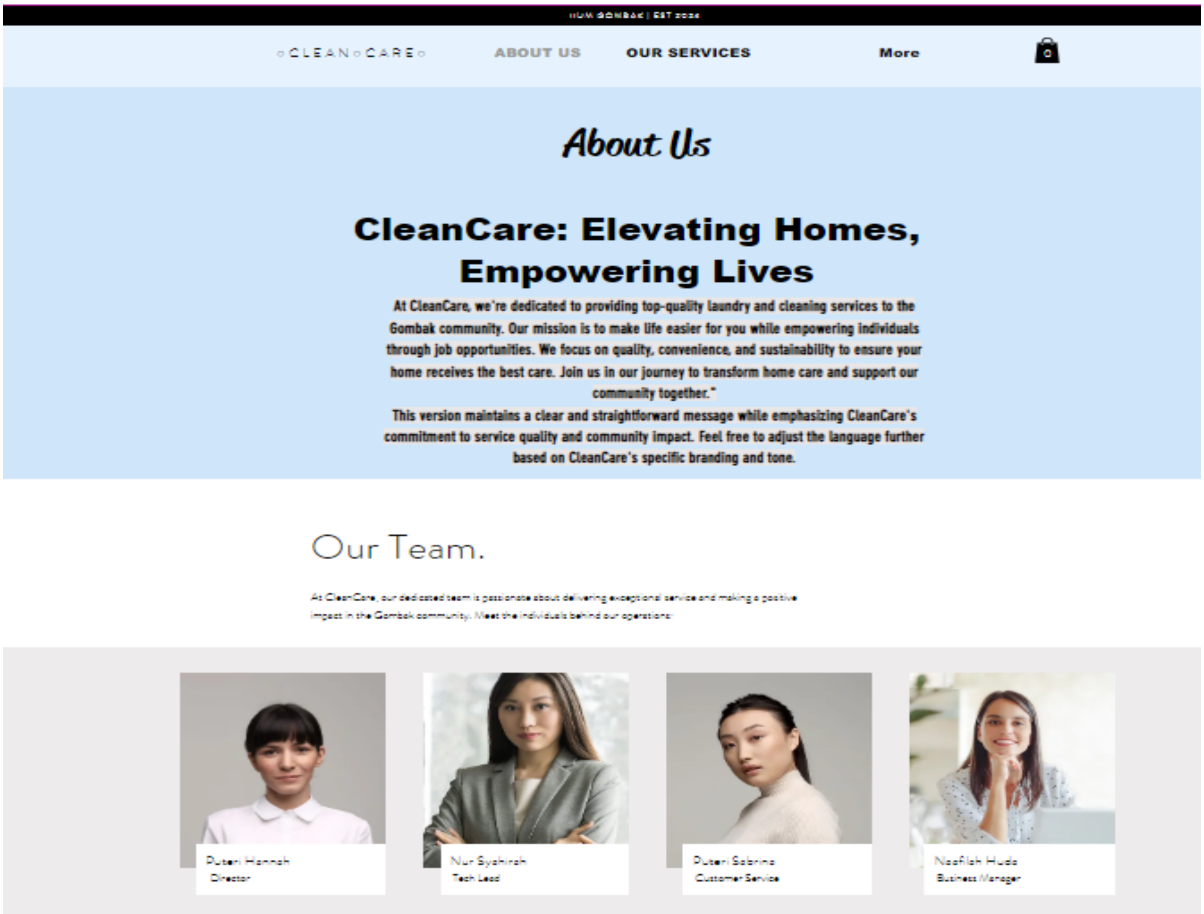


Fig. 14. CleanCare Website About Us Page

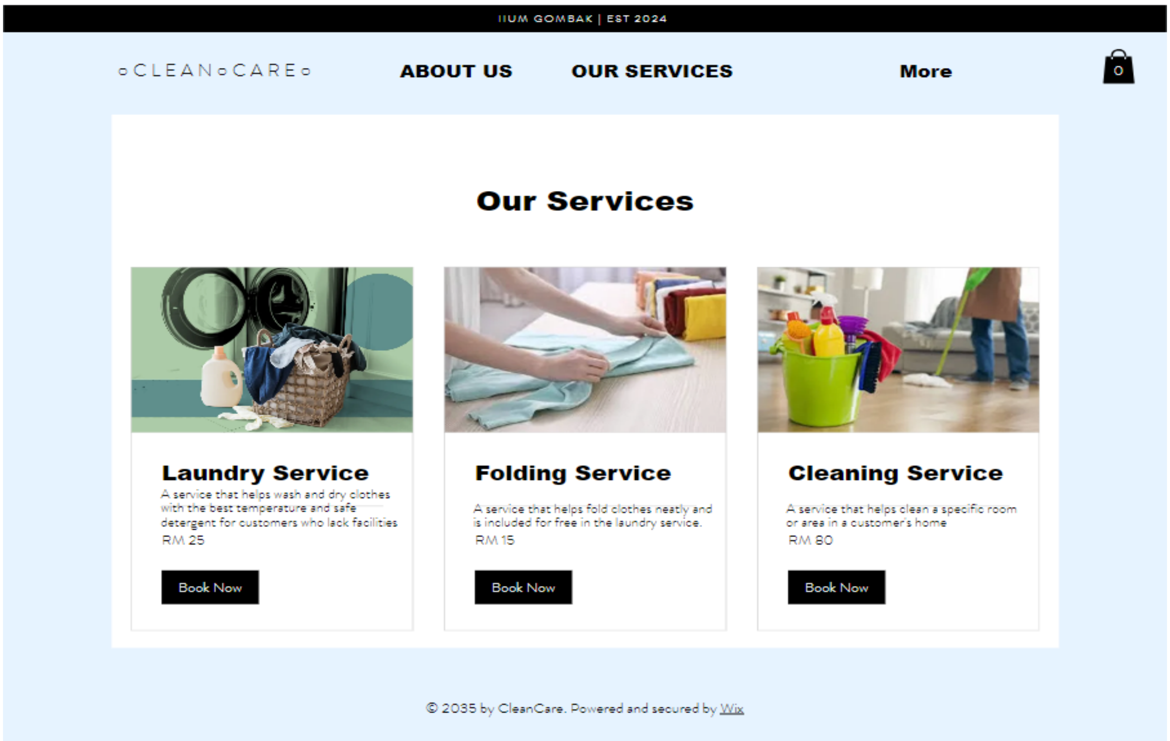


Fig. 15. CleanCare Website Services Page

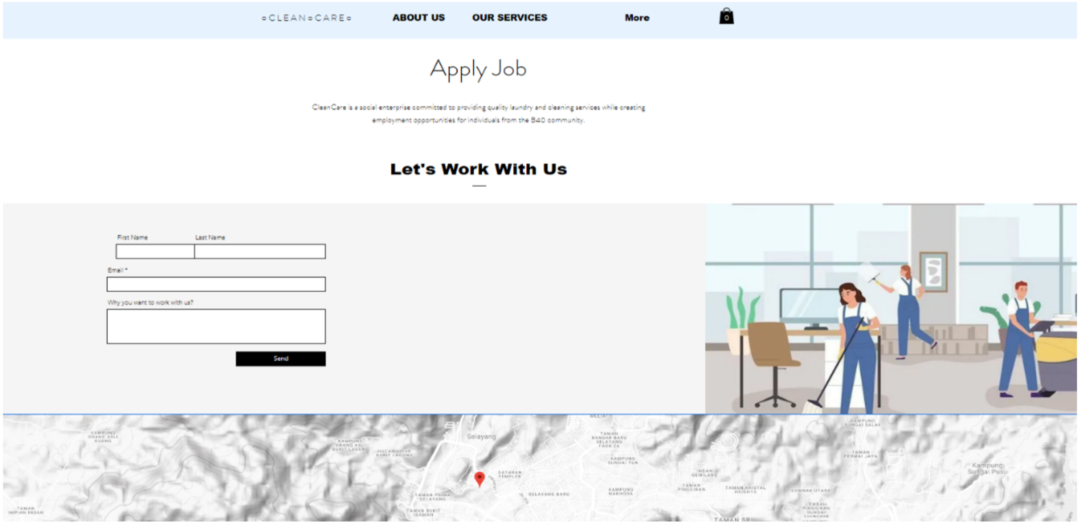


Fig. 16.CleanCare Website Apply Job Page

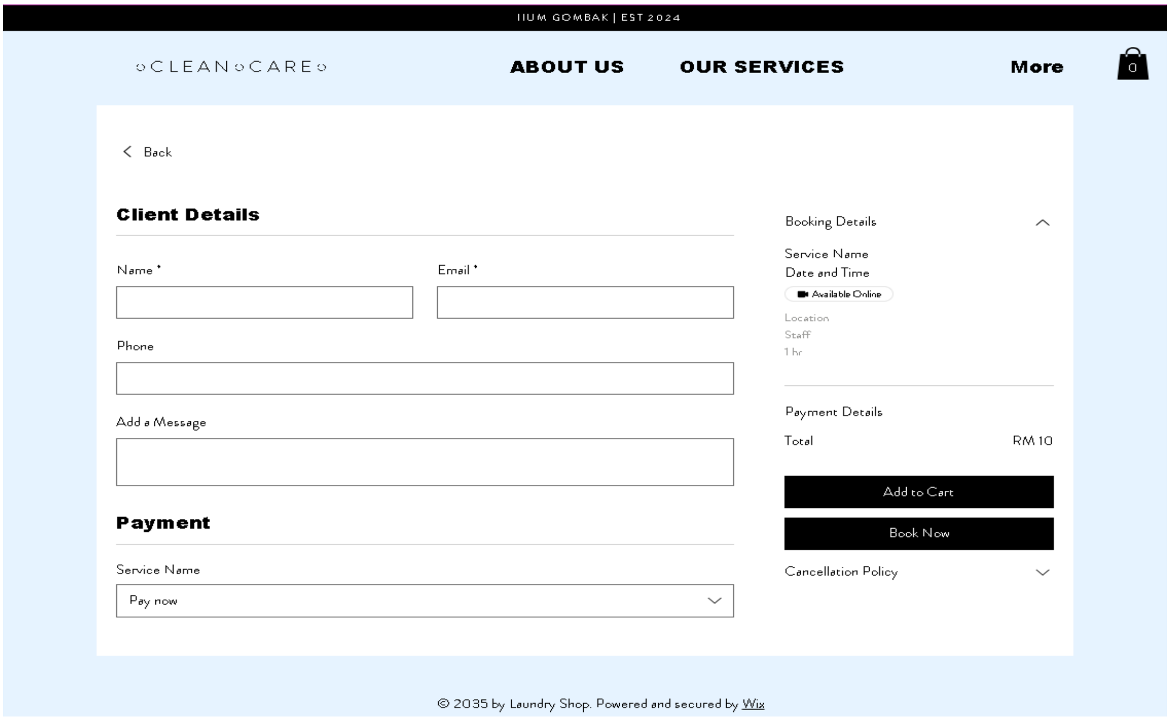


Fig. 17. CleanCare Website Book Appointment Page

9. CONCLUSION AND FUTURE WORKS

In conclusion, this conceptual CleanCare business model aims to address several key challenges faced by the Gombak community including the lack of affordable and convenient laundry and *sertu* cleaning services, security concerns during providing services, and limited job opportunities with flexible schedules and competitive pay. The extreme pains experienced by customers and workers, such as limited availability of the services and the concern about security of their personal belongings, are addressed by the pain relievers features of CleanCare. CleanCare products and services act as gain creators by providing convenient, reliable, and high-quality services while serving as pain relievers through transparent pricing, flexible scheduling, and enhanced communication channels.

To further refine and elaborate on CleanCare' conceptual business model, the development of a comprehensive business plan is essential. This plan will serve as a roadmap for implementation with detailed strategies and value propositions, financial projections, key partners, and operational procedures. Additionally, regular reviews and updates of the conceptual business model are crucial to ensure its alignment with evolving technological advancements, market trends, and customers demand. CleanCare may also consider introducing services like dry cleaning, cloth repair, and selling preloved clothes to customers. CleanCare goal is to become the top choice of laundry and *sertu* cleaning service around the local Gombak communities and globally.

REFERENCES

Arippudin, A. (2022). LAUNDRY SERVICE BUSINESS MANAGEMENT. *Neo Journal of economy and social humanities*, 1(1), pp.9–16. doi:https://doi.org/10.56403/nejesh.v1i1.3.

Dahlan, A. R. A., Ibrahim, I., Ahmad H. Osman, R., Mhd. Sarif, S., Jaapar, G., Man, S., Abdul Razak, D., Mohd Ali, N. Z., Abdul Aziz, N., Mohamad Ali, N. A., Mahri, N., Ismail, A. R., Abdul Kadir, A. F., Mansor, H., Mohd Nor, R. (2021). Freemium Multi-Sided Platform Business Model: Mosque Kitchen as A Source of Free Food, Employment and Empowerment of B40s Food-Preneurs. Journal of Information Systems and Digital Technologies, 3(2), 1–10.

Goodrich, M. (2022, March 28). How laundry delivery service is changing for the better. The Folde. https://www.thefolde.com/how-laundry-delivery-expectations-are-changing/

Hamid, H., Khairuddin, N. D., Al-amodi, Y., Dahlan, A. R. A., & Osman, R. A. (2013). MyMosqueNet2Cloud Collaborative System: A network of mosques towards eradicating poverty in Malaysia. American Academic & Scholarly Research Journal Vol. 5, No. 5, July 2013

House Cleaning Services Morrow GA. (2023). Retrieved from https://mycleaningangel.com/services/house-cleaning/morrow-ga/

Kurek, J., Brandli, L. L., Leite Frandoloso, M. A., Lange Salvia, A., & Mazutti, J. (2023). Sustainable Business Models Innovation and Design Thinking: A bibliometric analysis and systematic review of literature. Sustainability, 15(2), 988. https://doi.org/10.3390/su15020988

Mohammed, M. (n.d.-a). Exploring the impact of social media on customer engagement. EXPLORING THE IMPACT OF SOCIAL MEDIA ON CUSTOMER ENGAGEMENT. https://www.researchgate.net/publication/348252717_EXPLORING_THE_IMPACT_OF_SOCIAL_MEDIA_ON_CUSTOMER_ENGAGEMENT

Online Laundry Services Market Scope, Demand, Forecast | The Brainy Insights. (n.d.). Www.thebrainyinsights.com. Retrieved 2024, from https://www.thebrainyinsights.com/report/online-laundry-services-market-13934

Online Laundry Services Market Size, Share, Growth Analysis, By Service, Application - Industry Forecast 2023-2030. (n.d.). Www.skyquestt.com.

Retrieved from https://www.skyquestt.com/report/online-laundry-services-market#:~:text=Key%20trends%20in%20the%20global

Osterwalder, A., Pigneur, Y., Bernarda, G., Smith, A. (2014). Value Proposition Design: How to Create Products and Services Customers Want. John Wiley & Sons.

Osterwalder, A., & Pigneur, Y. (2010). Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers. Wiley.

Shariffudin, N. S. A., Sayuti, W. M. A. W. A., Kamil, N. F. M., Babatat, Z. A. Y., & Dahlan, A. R. A. (2023). A Conceptual CleanSolution Business Model: Empowering Low-Income B40 Communities as Entrepreneurs Through Housekeeping and Sertu Cleaning Services. *Journal of Information Systems and Digital Technologies*, *5*(2), 121–141. https://doi.org/10.31436/jisdt.v5i2.424

Team, T. M. V. (2020, July 12). 6 QURANIC VERSES AND HADITH ON CLEANLINESS - TMV. https://themuslimvibe.com/faith-islam/6-quranic-verses-and-hadith-on-cleanliness

The Brainy Insights (2024). Online Laundry Services Market Size by Service (Laundry Care, Dry Clean, and Duvet Clean), By Application (Residential, and Commercial), Regions, Global Industry Analysis, Share, Growth, Trends, and Forecast 2023 to 2032. https://www.thebrainyinsights.com/report/online-laundry-services-market-13934

Zhang, Y., & Gong, S. (2023, March 20). *A recent regulatory storm in China: Theoretical interpretation and applicability - Asian review of Political Economy*. SpringerLink. https://link.springer.com/article/10.1007/s44216-023-00011-3

10 HADITHS ON HEALTH AND HYGIENE. (2019, December 27). About Islam. https://aboutislam.net/shariah/hadith/hadith-collections/10-hadiths-on-health-and-hygiene/

A CONCEPTUAL THRIFTYMEALS BUSINESS MODEL: ENHANCE FOOD SECURITY AND REDUCE FOOD WASTE

NABILAH HAKIM HAZRI[1*], WAN NUR FARAH[2], NURUL IZZATY MUHAMMAD ARIS[3], NORA ALISSA ISMAIL[4], ABDUL RAHMAN AHMAD DAHLAN[5]

[1,2,3,4,5]Department of Information System, [4]Department of Computer Science, Kulliyyah of Information and Communication Technology, International Islamic University Malaysia Gombak, Malaysia

**Corresponding author: nabilahhakim01@gmail.com*

ABSTRACT: This paper introduces ThriftyMeals, a digital platform business model that is reshaping the way people consume food while actively contributing to Sustainable Development Goal (SDG) 12 - Responsible Consumption and Production. ThriftyMeals objective is to address the critical issues of food waste and affordability while aligning with SDG 12's objectives. At its core, ThriftyMeals provides a digital platform designed to reduce food waste by making surplus food available to consumers at reduced prices. The methodology used in this paper is Design Thinking, utilising modeling tools namely the Business Model Canvas (BMC), Value Proposition Canvas (VPC), Business Environmental Map (EM), and Strategy Canvas (SC) to guide the process of designing, testing, and establishing a vadlidated ThriftyMeals business model. This paper collects using surveys and analyzes data from the various customer segments like restuarants and consumers. ThriftyMeals operates with a unique framework that transforms the traditional approach to food sourcing and distribution. At the same time, emphasizing the significance of ThriftyMeals towards achieving global sustainability goals, particularly SDG 12, which advocates for a more responsible and sustainable approach to consumption and production. ThriftyMeals stands as an innovative solution, aligning with the imperative of SDG 12, while reimagining food consumption and waste reduction on a local and global scale.

KEY WORDS: *Surplus Food, Food Waste Reduction, Food Security, Digital Business Model, Re-skilling, Sustainable Development Goals*

1. INTRODUCTION

In a world where food waste is a growing problem (Chirsanova, 2021), "ThriftyMeals" brings fresh hope and a new way of thinking. This business idea is not about making money but it's about solving a global grand challenge issue which is food waste. To strike a balance between environmental friendliness, resource conservation, and responsible eating, ThriftyMeals is revolutionizing the way in which the community handles food.

ThriftyMeals is more than just a business concept, it is a whole new way of doing things. Its main mission is clear, which is to reduce food waste in supermarkets and restaurants. At a time when food waste is causing serious problems for the environment and people, ThriftyMeals steps up to make a difference. This paper aims to uncover what makes ThriftyMeals so special, from why it matters so much to how it works.

The core idea behind ThriftyMeals is simple yet powerful that is to take food that might get thrown away, make it affordable, and share it with the needy and low income B40 community. This is not just about saving money but it's about saving the planet too. In fact, ThriftyMeals is aligns with Sustainable Development Goal (SDG) 12, which is all about being wise in what we produce and consume. By delving into ThriftyMeals, one can ascertain its inner workings and comprehend its critical significance. It is not just a business idea, but it is a way to change how one handles food and make it affordable and better for everyone.

2. BACKGROUND, CHALLENGES, AND OPPORTUNITIES

Food waste is a severe problem in Malaysia, with restaurants playing a significant role. According to Ng et al. (2021), Malaysians produced 33,000 tons of solid waste daily, with municipal solid waste accounting for the majority at 64%. This waste composition includes food waste, which is a major contributor. This problem stems from the country's rich culinary culture, which creates a considerable quantity of food waste. Malaysia's rich and diversified cuisine pushes food enterprises such as restaurants, cafés, and street sellers to make ample servings and a vast range of meals to appeal to the different preferences of both residents and visitors. However, this frequently leads to overproduction and surplus, resulting in significant food waste. Inefficient food management practices, insufficient storage facilities, and a lack of understanding of the environmental and economic effects of food waste have exacerbated the problem.

Recent studies illuminate food businesses' multifaceted food waste management challenges. The lack of standardized food waste measurement and reporting methods makes it hard to evaluate and compare waste reduction efforts (Muth et al., 2019). Food products are perishable, making inventory management difficult. Balancing supply and demand reduce waste. Consumers discard imperfect but edible produce due to aesthetics, resulting in significant production waste (Hingston & Noseworthy, 2020). Standardized metrics for consistent measurement, cutting-edge technologies for inventory tracking and demand forecasting, and targeted consumer education campaigns to change food aesthetics perceptions are solutions to these challenges. However, a lack of platforms that help these food establishments and methods to help the B40 community with this platform still poses a challenge. Therefore, a new solution is required to overcome these challenges.

3. OBJECTIVES

The main objective of this paper is to create a conceptual business model called ThriftyMeals that focuses on reducing the amount of food excess and food waste created by food establishments. This can be facilitated by introducing an online platform for food establishments to donate or to sell their surplus food items at a reduced-price. Which allows consumers to buy food at a lower price. Thus, reducing food waste. ThriftyMeals will serve as a digital platform which facilitates consumers and business owners for food sponsoring for the B40 community.

4. METHODOLOGY

This paper will adapt the Design Thinking (DT) Methodology. According to Kurek et al. (2023), DT has a purpose in creating creative ideas that are relevant for the users to find solutions that can give a good impact in the future. The DT methodology focuses on a human-centered approach to design and solve problems in five stages. The first stage empathizes with the customers by understanding their perspectives and listing out their needs. The second stage is to define the problems and extreme pains of the customers that need to be solved. The third stage is to ideate as many business models options, embedded with digital platform/app, as possible solutions for the identified problems. Next is the fourth stage where the business model prototype is created in the form of an initial business model, using Business Model Canvas (BMC) framework, embedded with a low-fidelity digital platform/app. The last stage is to test the prototype by getting feedback from the target customer segments (CS) in order to establish the validated business model. Then, the processes will be repeated to implement the feedback given by the target CS. The modeling tools used in this paper are the BMC which is used to capture the nine blocks of the business, the Value Proposition Canvas (VPC) which is used to determine the value the service needs to provide to the customers, the Environmental Map (EM) which is used to figure out external factors that will influence the business and the Strategy Canvas (SC) (Osterwalder & Pigneur, 2010; Osterwalder et al., 2010). The process for establishing the validated business model is done by conducting surveys targeted at the CS of the initial business model. The findings of the survey are then reviewed, and the validated business model in the form of BMC is established. To further validate the conceptual business model, the Strategy Canvas is used to compare the values, relevancy, and performances of ThriftyMeals against other similar businesses.

5. LITERATURE REVIEW

5.1. Food Waste Among Stores in Malaysia

Food waste is a major global problem, and Malaysia is no exception. The retail sector is a significant contributor to food waste in Malaysia, accounting for about 20% of total food waste in the country (Jaafar et al., 2020). There are a number of causes of food waste in the retail sector in Malaysia. One of the main causes is overstocking. Retailers often overstock their shelves to ensure that they have enough products to meet customer demand. However, this practice can lead to unsold, expired, or spoiled food items. Another major cause of food waste in the retail sector is aesthetics. Retailers often discard food items that have blemishes or are not aesthetically please , even if they are still safe to eat. This is because consumers are more likely to purchase food items that are visually appealing. The consequences of food waste can be various in terms of environment, economy, and society. Economically, food waste incurs substatial financial losses for the retail sector (Horoś & Ruppenthal, 2021). Stores suffer not only from the cost of purchasing excess inventory but also from disposal and handling expenses. Efforts to reduce food waste in Malaysian stores encompass various strategies and initiatives. Collaborations with food banks and NGOs have emerged as a viable solution to distribute surplus food to the needy (Spring & Biddulph, 2020).

5.2. Selling Surplus Food as Business in the Digital Economy

Selling surplus food as a business is a new model that aims to reduce food waste and create a more sustainable food system (Yang et al., 2022). Surplus food can be redistributed from businesses to charities, benefiting both retailers and consumers (Davies, 2018). By diverting culled fresh fruits and vegetables from grocery stores, this surplus food can be processed for donation or for new commercial enterprises, generating revenue and supporting community-based enterprises (O'Donnell et al., 2015). Furthermore, it is also stated by Ciulli et al. (2019) that digital platform organizations can also act as 'circularity brokers' that can foster waste recovery in food supply chains. Overtime, digital multi-sided platform adapted to achieve long-term economic viability while minimizing food waste, thereby contributing to social and environmental sustainability (Principato et al., 2023). Moreover, commercial surpluses of food that would have otherwise been wasted can be repurposed, creating new food markets and benefiting the environment (Giles, 2020). The Italian food supply chain has also explored the management of surplus food throughout different stages and sectors, contributing to the sustainable management of the food supply chain (Garrone et al., 2012). Overall, selling surplus food as a business and digital business can help reduce food waste, support communities, and create new economic opportunities .

5.3. Benchmarking of exisiting ThriftyMeals Business Models

5.3.1. ResQ Club

ResQ Club is a Finnish company connecting sustainable restaurants, cafes and grocery stores with consumers that appreciate eating affordable quality food through a digital service (Mesiranta et al., 2020). The application provided by the Finnish company allows restaurants to sell their unsold lunch meals to consumers at a lower price. Restaurants and consumers which are their main customers, can download the application for free and register themselves. Registered restaurants will have the capability to effortlessly list their available meals along with their designated prices. On the consumer side, diners can conveniently peruse the meal options that align with their preferences and complete secure payments directly within the app. By today, tens of thousands of active buyers and thousands of sustainable food business are registered on the platform (ResQ Club, n.d.-h). ResQ Club's mission is to foster waste-free societies, with the initial objective being the eradication of food waste within European restaurants by the year 2030 (Mesiranta et al., 2020). ResQ Club's revenue model relies on earning commissions from each meal sold through its app, making the company reliant on the presence of restaurant food waste. Additionally, the company's day-to-day operations have depended on external financial support, including backing from public investors like Business Finland and private angel investors.

5.3.2. Too Good To Go!

"Too Good To Go" is a popular mobile application that addresses the global issue of food waste, while providing a practical solution for consumers and businesses alike. See Fig. 1. The application was developed with the mission to reduce food waste by connecting consumers with local restaurants, bakeries, grocery stores, and other food establishments that have surplus food they can no longer sell. Through Too Good To Go, users can browse listings of these businesses, which offer 'Magic Bags' or similar deals at a significantly discounted price. The products are reserved by the customer when Too Good To Go confirms their order with a reservation confirmation. The customer has the possibility to filter the results in the application in consideration of the availability of products to reserve, of the pickup hour, or of the nature of products contained in “magic bags” (Mathisen & Johansen, 2022). These bags contain unsold but perfectly edible food, and users can purchase them through the application, thereby rescuing food that would otherwise end up in the trash. This concept not only helps consumers access affordable and delicious meals but also contributes to a more sustainable and environmentally friendly food system. As such, the stores may be able to reduce food waste and also have a small income from the surplus sales. The stores may post their food surplus in the app with a reduced price and with a defined time frame in which customers may bid for and collect the items. (Mathisen & Johansen, 2022).

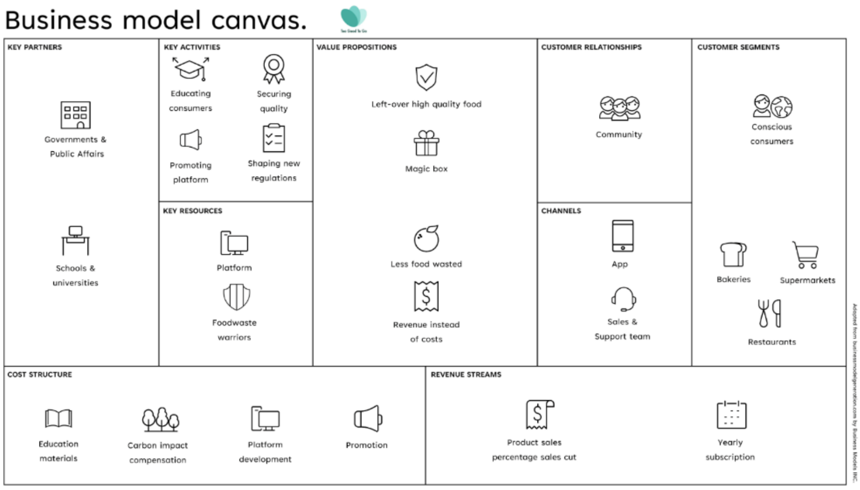


Fig. 1. Business Model Canvas for Too Good To Go!

5.3.3. Olio

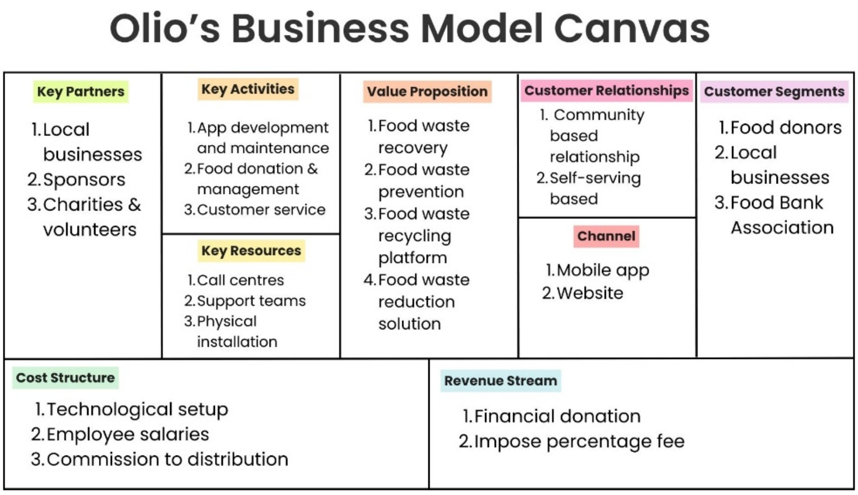


Fig. 2. Business Model Canvas for Olio

Olio is a mobile application that facilitates local sharing by enabling users to redistribute their unwanted possessions to nearby individuals. Fig. 2 shows that Olio is a platform that allows individuals to repurpose their unused possessions, such as food, clothing, books, and toys, contributing to reducing waste and promoting sustainability efforts. Olio lets users exchange goods without monetary transactions through the acts of giving and receiving, lending and borrowing, or engaging in the purchase and sale of previously owned products. Individuals derive value from sharing their food resources without incurring waste while also benefiting from acquiring complementary commodities. On the other hand, businesses can utilise the consumer network to effectively manage their surplus food for a fixed cost, as opposed to the fees imposed by conventional trash management companies (Ronteau et al., 2023).

In contrast to the food-sharing application Too Good To Go, the connections facilitated by OLIO are entirely free. OLIO generates its money through its commercial operations, and its platform allows for both business-to-consumer (B2C) and consumer-to-consumer (C2C) exchanges (Ronteau et al., 2023). Olio generated revenue initially by imposing charges on larger enterprises for the services rendered through their Food Waste Heroes Programme. Additionally, Olio has established supplementary sources of income. One is offering additional app features in exchange for a minor subscription fee. Furthermore, the Olio app has included ads (Olio, 2023).

5.3.4. HelloFresh

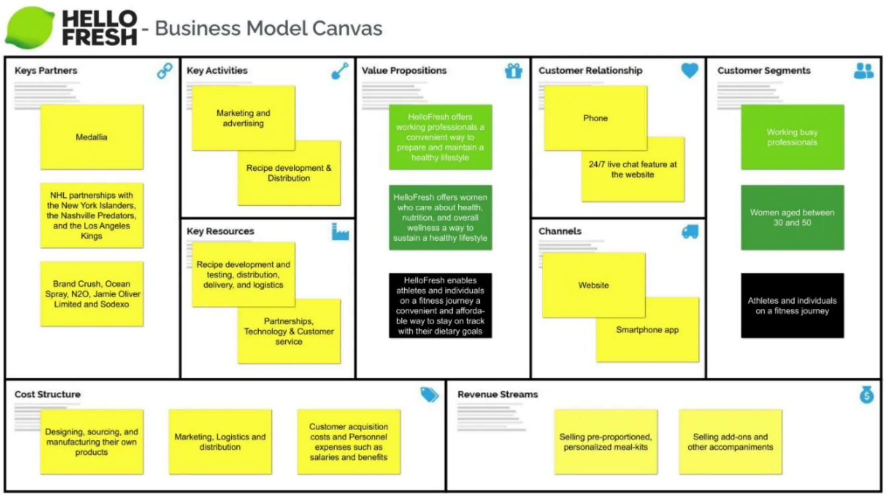


Fig. 3. Business Model Canvas for HelloFresh

HelloFresh is a company based in Berlin, Germany that trades healthy meal-kits. Fig. 3 shows the business model canvas for HelloFresh. The company focuses on working busy professionals, women aged between 30 and 50, and athletes or individuals on a fitness journey as their customer segment. The value propositions of the company are firstly to prepare meals that are convenient and healthy for working busy professionals. Secondly, it is to offer health-conscious women a way to sustain a healthy lifestyle and lastly, to enable people on a fitness journey a way to track their dietary goals. The channels they use to communicate with their customers are through their website and smartphone application. They improve their customer relationships by phone and a 24/7 live chat feature that is available on their website. The key activities of the business are recipe development and distribution along with marketing and advertising said recipes. Next is the key resources needed to complete the key activities which are the delivery and logistics of the recipe development and maintaining the relationship of the company with their partners and customers. Moving on to the key partners of the company are Medallia, a company that specialises in customer experience and uses IT to improve it, various National Hockey League (NHL) partnerships, and other companies that can improve the user experience on their online platform. Next is the cost structure where designing, sourcing, manufacturing, marketing, logistics, and distribution are the costs incurred for their products along with customer acquisition costs and employee salaries and bonuses. Lastly HelloFresh generates revenue through subscription based selling of pre-proportioned personalised meal kits and by selling additional customisations.

6. INITIAL BUSINESS MODEL (BM) - USING BMC & VPC

The initial business model is derived from the literature reviewed from the previous section. It is also based on assumptions made for each segment in the Business Model Canvas (BMC), Fig. 4, and Value Proposition Canvas (VPC), Fig. 5 to Fig. 8.

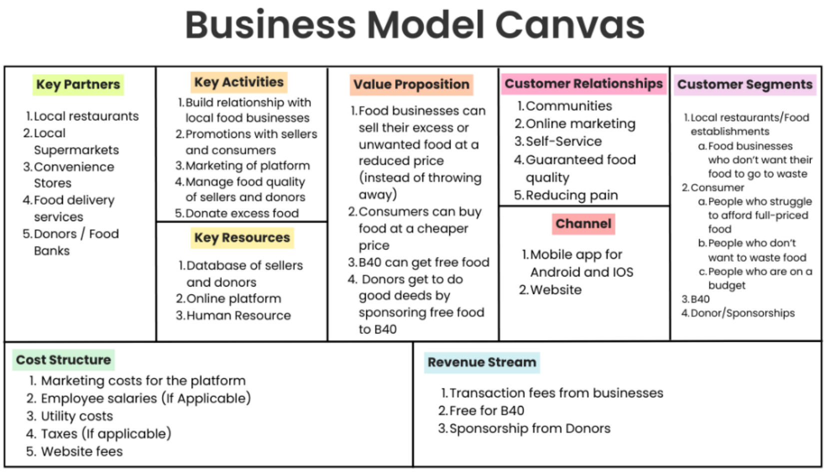
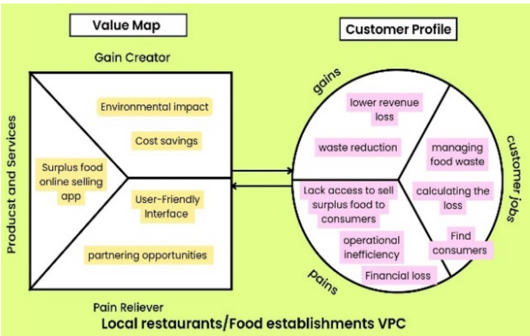


Fig. 4. Business Model Canvas for ThriftyMeals



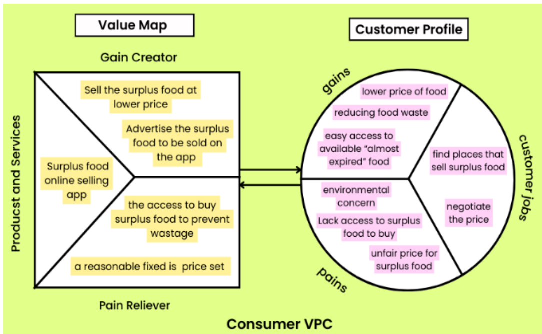
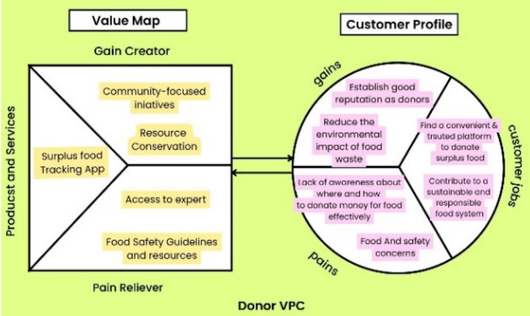


Fig. 5. Value Proposition Canvas for Sellers & Fig. 6. Value Proposition Canvas for Consumers



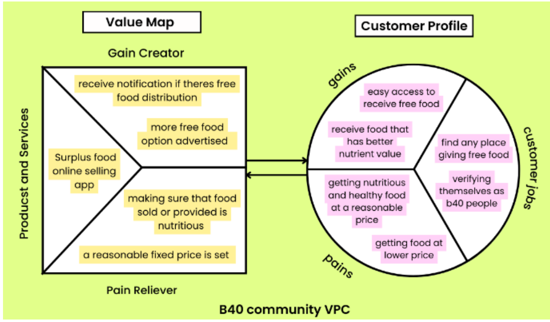


Fig. 7. Value Proposition Canvas for Donors & Fig. 8. Value Proposition Canvas for B40 Community

7. CONDUCT VALIDATION OF INITIAL BM & KEY FINDINGS

To achieve a thorough validation of the initial business model, researchers opted for a meticulous approach, conducting four distinct surveys tailored to specific customer segments: consumers, local supermarkets/restaurants, the B40 community, and donors. This strategic decision aimed to delve deep into the unique experiences, needs, and challenges of each customer group, seeking a comprehensive understanding of their daily lives as it relates to the proposed business model. The surveys were conducted using an online survey platform where the customers could participate anytime they want within the survey distribution period.

7.1. Consumers survey

In the consumer survey, a series of 6 questions were structured in the survey form. A total of 16 responses received which are categorized in 4 different ages of groups which were identified in the first question.

To gauge consumer perceptions of the business model's validity, the next five survey questions are designed to assess their concerns about daily food waste in supermarkets and restaurants. The survey's introductory question delves into this issue, revealing that 12 out of 16 participants express their concern about food waste. This finding highlights the significance of food waste as a social issue that demands attention and action. The third survey question assesses the participant’s frequency of seeking out establishments that offer surplus food at reduced prices. The rating scale ranges from 1, indicating no effort to find surplus food, to 5, indicating a strong inclination to actively locate such establishments. As illustrated in Fig. 9, the majority of participants actively seek out surplus food retailers, suggesting a growing awareness and acceptance of this sustainable practice.

Fig. 9. Survey Result – Frequency of Seeking Out Surplus Food

To understand consumer's pain regarding the food waste issue, a survey question was designed to assess their frustration level of not being able to access surplus food retailers. The rating scale from 1, indicating no frustration involved, to 5, indicating a very frustrating situation for them. The survey as shown in Fig. 10 reveals that the majority of respondents (63%) experience some level of frustration when they are unable to access or locate stores offering surplus/stale food items for purchase. This suggests that there is a significant unmet demand for surplus food in the community, and that there is room for improvement in the availability and accessibility of these items.

Fig. 10. Survey Result – Frustration Level of Inability to Access Surplus Food

To assess the perceived importance of developing a platform or service aimed at reducing food waste in restaurants and supermarkets, we asked participants to rate their assessment of the proposed solution's potential benefits. As displayed on Fig. 11, the survey results show that the overwhelming majority of respondents (94%) found the platform or service to be beneficial, with 50% rating it as "very beneficial." This suggests that the platform or service is meeting a real need in the community and is providing significant value to users.

Fig. 11. Survey Result – The Degree of Benefit of Having a Platform that Sells Surplus Food

The final survey question explored participants' willingness to purchase surplus food at reduced prices. The insights gained reveal that the majority of respondents (56.3%) are more inclined to purchase food if it was offered at a reduced price due to nearing expiration. This suggests that there is a significant opportunity for businesses to reduce food waste and generate additional revenue by offering discounts on food that is approaching its expiration date. The results also show that a significant portion of respondents (43.8%) are "maybe" inclined to purchase food at a reduced price due to nearing expiration. This suggests that some consumers may need to be persuaded of the benefits of purchasing near-expiration food, such as its affordability and safety.

7.2. Local Restaurants/Supermarkets Survey

In the survey for local food businesses, a series of 8 questions were asked to understand the types of food businesses that may need the online platform while assessing the average amount of surplus food generated by the respondents, the main reasons for the food surplus, the types of food commonly found in the surplus, and the way the respondents deal with the surplus food with the challenges faced by them to manage it. The survey received 5 responses from the target respondents.

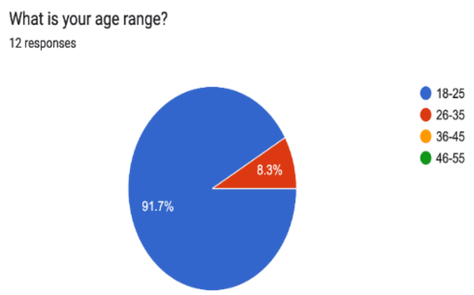
In the first question, the types of food businesses vary from a restaurant, catering service, a bakery, and online businesses. From there comes the second question to determine the average amount of surplus food generated. The catering service generated the highest among all the other businesses with an average surplus amount of food of more than 100 kg whereas 3 food businesses with the lowest average surplus amount of food of less than 10 kg. The other respondent, a restaurant owner, had an average surplus amount of food between 10 – 50 kg.

Next, the third and fourth questions analyze the main reasons for the surplus food generated by the respondents and the most common food items in surplus. As expected, most respondents had overproduction as the main reason for the surplus food whereas the other respondents had unsold food and returns from customers as the main cause for the surplus. The common food items in surplus are perishables and prepared meals which had 2 respondents each and the bakery owner had baked items as the common surplus.

The next section inquired about the ways in which the respondents handled the surplus food and their challenges. 1 out of 5 respondents freeze the leftover food whereas 1 respondent donates the food, and the other 3 respondents can't keep the food. This reveals that 2 of the respondents have a strategy in reducing the surplus food and unsurprisingly, the respondents with no strategy had generated more surplus food than the ones with a strategy. However, only 1 of the respondents donates the surplus food by communicating with a student society whereas the others do not donate due to the SOP of their business, employee mishandling the storage of food, and the unpredictability of customer flow.

7.3. B40 Survey

The B40 survey encompasses seven inquiries focusing on diverse aspects. It explores respondents' age range, their familiarity with various food programs or services, motivations that drive their choices, top priorities when accessing food resources, the challenges they encounter, their current utilization of surplus food, and their interest in a wide array of surplus food options. These questions delve into the multifaceted landscape of respondents' attitudes and experiences concerning food, aiming to gain comprehensive insights into their needs, preferences, and perspectives within this domain.



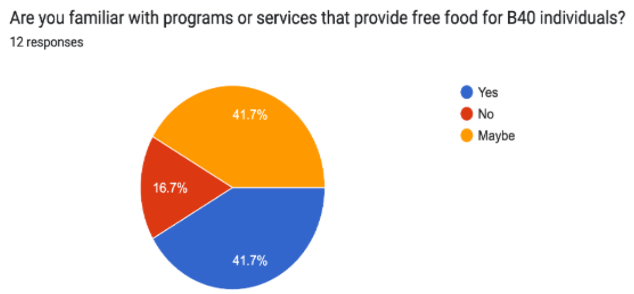


Fig. 12. & 13. Survey Result – Age Range and Familiarity with food programs or services for B40 Individuals.

Fig. 12 shows the B40 demographic reveals interesting insights about the age range of the respondents. The majority, constituting 91.7%, falls within the largest age group with age 18-25 years old, depicted by the blue section of the pie chart. The second largest group, represented by the red section, accounts for 8.3% of the responses with age 26-35 years old. While Fig. 13 shows the familiarity with food programs or services for B40 individuals which indicates the level of respondents have with programs or services that provide food for B40 individuals. Most respondents answered "Yes", indicating they are familiar with such programs or services.

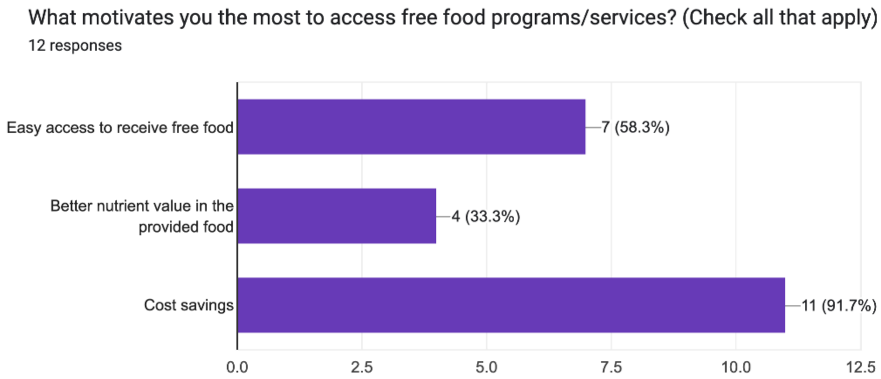


Fig. 14. Survey Result – Motivations of respondents when accessing free food programs/services

In Fig. 14, insightful data reveals the motivations driving respondents' engagement with free food programs or services. Notably, an overwhelming 58.3% of respondents are motivated by the ease of accessing these provisions, signifying its paramount importance. Following closely, 33.3% express a keen interest in the superior nutritional value offered by these programs or services, indicating a significant consideration for health benefits. Conversely, cost savings emerge with the least impact, garnering a response rate of 91.05%. While acknowledged as a factor, it evidently holds less sway compared to the accessibility and nutritional quality of the available food options, as perceived by the respondents.

Fig. 15. and 16 survey Result – Respondents' priorities when accessing food programs/services and current state of usage of surplus food selling platforms

Fig. 15 illustrates the significance of nutrient value as perceived by respondents engaged with these programs or services. The pie chart underscores a striking consensus, with 86.7% of participants deeming it "Very Important," and an additional 25% regarding it as "Important." Notably, none of the respondents indicated a neutral stance or deemed nutrient value as "Not Very Important" or "Not Important at All." This unanimous perspective underscores the critical role that the nutritional content of food holds within these programs or services, showcasing its paramount importance among the participants surveyed.

Fig. 16 presents the utilization status of surplus food selling platforms among respondents which is 36.4% have engaged with these platforms, possibly due to convenience and eco-consciousness while 45.5% haven't, likely due to limited awareness or trust issues and 18.2% are open to future use, highlighting growth potential if barriers are addressed. This data underscores the need for strategies like awareness campaigns and enhanced user experiences to convert potential users, indicating avenues for platform expansion and increased user engagement.

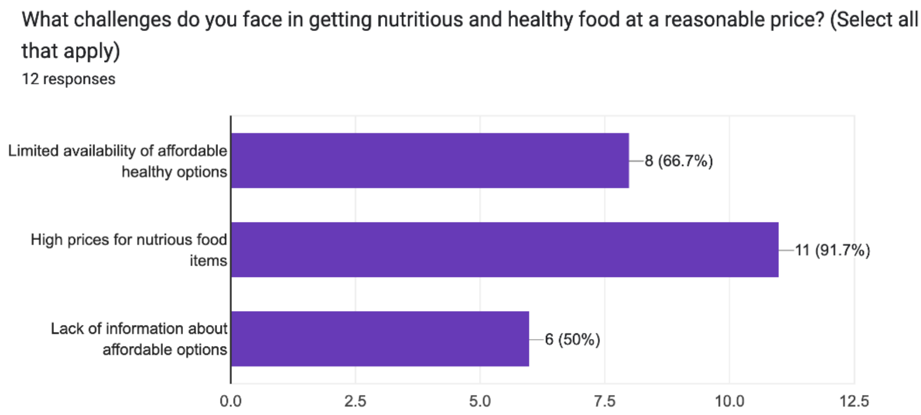


Fig. 17. Survey Result – Multifaceted challenges people face when trying to access nutritious and healthy food at a reasonable price.

Fig. 17 outlines challenges in accessing affordable, nutritious food which around 66.7% face limited availability or distribution issues, indicating accessibility hurdles due to location and distribution networks. Cost is a significant concern, although the exact percentage isn't specified, reflecting financial barriers to healthy options. Furthermore, the lack of information about healthy food options signifies a need for better education and dissemination of such knowledge. This data emphasizes the multifaceted nature of food security, urging comprehensive solutions that address accessibility, affordability, and knowledge gaps in healthy eating for individuals facing these challenges.

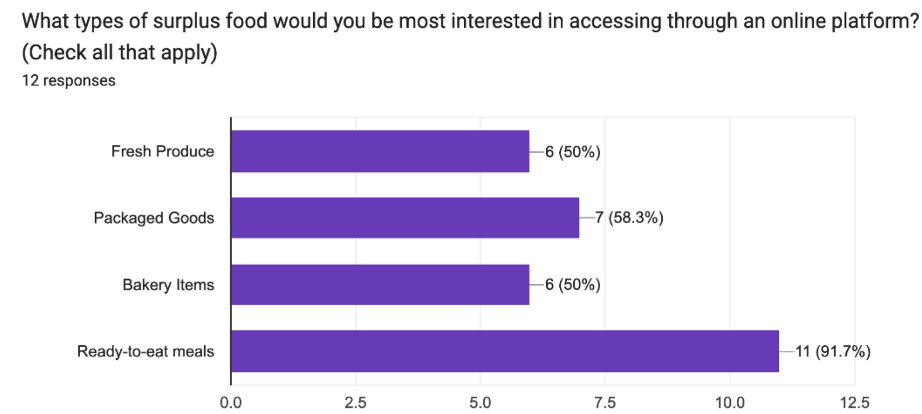


Fig. 18. Survey Result – Broad interest in a variety of surplus food types

Fig. 18 displays the types of surplus food people are most keen on accessing through online platforms. Fresh Produce and Bakery Items each capture 50%

interest, indicating a desire for healthy options and cost-effective choices. Packaged Goods draw attention from over 58.3% of respondents, suggesting an inclination toward longer shelf-life essentials. Surprisingly, Ready-to-eat meals are the least favored at 91.7%, potentially due to concerns regarding freshness, taste preferences, or dietary restrictions. These insights offer guidance for online platforms to align their offerings with consumer preferences while also signaling an opportunity to educate users about the benefits and safety of surplus ready-to-eat meals, potentially increasing their appeal.

7.4. Donor Survey

In the donor survey, the survey form included nine questions. The questions were split into six sections: demographics, awareness and interest, motivations, incentives and benefits, communication preferences, and closing comments.

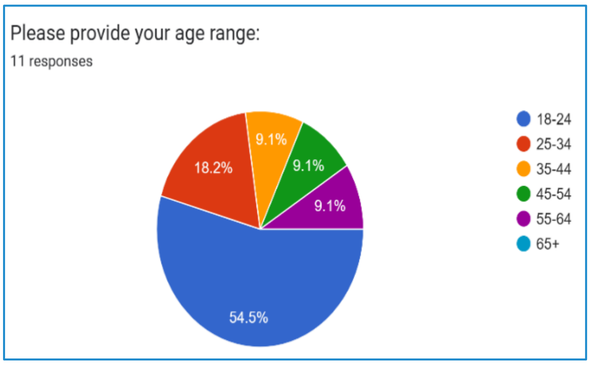


Fig. 19. Survey Result – Age range of donors

The first section is demographic, where we learn about our potential donors' age group and employment status. As indicated in Fig. 19, eleven replies were received and classified into five different age groups identified in the first question. The second survey question asked about the current employment status of the potential donors. According to the statistics, 63.6% are employed, 27.3% are students, and 9.1% are housewives. As a result, the majority of them are employed and hence more likely to be able to donate.

The second section discusses the donors' awareness and interest in platforms that allow food donations and their desire to support a business that aims to reduce food waste. Question three demonstrates that 81.8% of donors are not aware of platforms that allow them to donate food. This is because more well-known platforms are currently required. As a result of question four, all potential donors would want to support our business's initiative to reduce food waste.

The third section examines what motivates donors to give. Question five asks donors why they want to support a startup that sells surplus food at a discount. The top three responses were reduced food waste at 90.9%, environmental sustainability at 81.8%, and ethical consumption at 81.8%. This outcome validates our customer gains in reducing the environmental impact of food waste. Question six asks donors how important it is to support a cause they believe in. Most potential donors felt they needed to support the causes they believed in. This finding suggests that it is critical to consider the donors' values as being similar to the business' values to ensure satisfaction for both parties.

The fourth section investigates the incentives and benefits that potential donors would find appealing. Question seven asks what incentives or benefits they would receive from donating to ThriftyMeals. According to the findings, most respondents (81.8%) wanted to know how their contribution impacted the B40 group. Similarly, they want to be recognized on the business platform. The donors would be pleased to be involved and contributing to the community after seeing the positive change resulting from their contribution.

The fifth question is regarding the potential donors' communication preferences. 81.8% of them prefer social media updates. This result is because social media is the most convenient and common method of receiving updates.

Finally, the final section welcomes potential donors' comments or suggestions about ThriftyMeals' food waste reduction initiatives. There were three comments regarding the quality of stale food. This is a reasonable concern, and ThriftyMeals intends to establish food safety guidelines and SOP to ensure that the food remains safe to eat despite being stored for so long. One commenter suggested repackaging the food to make it more appealing to buy, which is a crucial point to consider. Another potential donor suggested allowing customers to pay for food for others when making purchases on the platform.

8. VALIDATED CONCEPTUAL BUSINESS MODEL

8.1. Validated Conceptual Business Model

Following our validation surveys on the initial business model, we learned that our clients are generally satisfied with the business model and that changes were made when necessary. As a result, Fig. 20 depicts the validated business model canvas for ThriftyMeals.

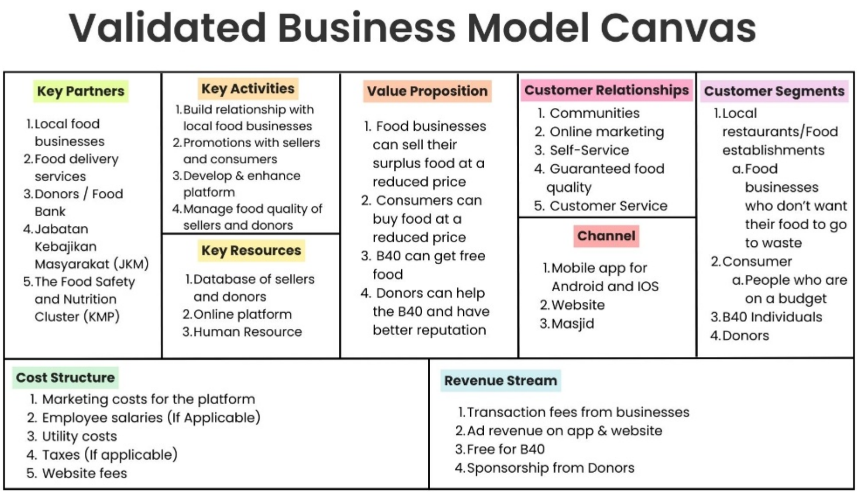


Fig. 20. The validated business model canvas of ThriftyMeals.

The BMC's nine blocks, which are explained below, represent the overall picture of the ThriftyMeals business, components, and procedures.

8.1.1. Customer Segments (CS)

The Customer Segments in this study are the groups of people or organizations we hope to reach or help with this platform. These are the local food businesses that do not want their food to go to waste, consumers looking to cut costs on food, low-income B40 individuals who do not have the money to purchase food, and donors who support "Reduce Food Waste" cause and assist the needy B40.

8.1.2. Value Proposition (VP)

A value proposition is a service or feature offered to suit the needs and wants of certain customer segments. The values provided to each customer type are as follows:

a. **Local restaurants/Food establishments**: ThriftyMeals is a surplus food sales platform that enables food businesses to sell their surplus food at a reduced price instead of throwing it away. Our platform allows food businesses to create listings for surplus food items and offer them to consumers at a discounted price. This not only helps to reduce food waste but also reduces the business' financial loss and operational inefficiency.

b. **Consumers**: As consumers, they can purchase quality food at a reduced price. Consumers can browse through the listings and purchase the food items they want for personal consumption or donation purposes. By doing so, consumers can save money on their food expenses while contributing to reducing food waste. ThriftyMeals aims to create a win-win situation for food businesses and consumers by promoting sustainability in the food industry.

c. **Low-income Individuals (B40)**: On ThriftyMeals, low-income individuals (B40) can also benefit from our platform by receiving free food donations from donors. Our platform makes donated food items available for low-income individuals to claim. To receive free food donations, low-income individuals must sign up for an account on ThriftyMeals and provide proof of their B40 status. Once their account is verified, they can browse the listings of donated food items and claim the items they need.

d. **Donors**: Donors can sponsor free food to B40 individuals on ThriftyMeals and gain a better reputation. By donating money to purchase food items for low-income individuals, donors can contribute to the reduction of food waste and help alleviate food insecurity among those in need. This aligns with the 12th Sustainable Development Goals (SDGs) goal, which is responsible consumption and production. ThriftyMeals aims to create a platform that promotes responsible consumption and production while benefiting the community.

8.1.3. Channels (CH)

Channels explain how we want to reach out to and engage with potential and new customers to provide the value proposition. ThriftyMeals will communicate with its customer groups via its website and mobile application. Customers may also contact us through our Facebook, Twitter, and Instagram social media pages. ThriftyMeals also uses the Masjid as a place for B40 individuals to collect their free food (Nasution et al., 2015; Dahlan et al., 2021).

8.1.4. Customer Relationships (CR)

ThriftyMeals is a platform that focuses on building relationships with current customer segments to provide them with the best possible experience. The platform aims to build a community of like-minded individuals who care about reducing food waste and alleviating food insecurity. ThriftyMeals uses online marketing channels such as social media, email marketing, and search engine optimization to attract new customers and retain existing ones. The platform also offers a self-service feature, allowing customers to create listings, purchase food items, and claim free food donations. The platform guarantees the quality of food items sold to ensure customer satisfaction. Lastly, ThriftyMeals provides excellent customer support through various channels e.g. email, phone, social media, and Mosques (Hamid et al., 2013; Dahlan et al., 2021) to address any issues or concerns.

8.1.5. Revenue Stream (RS)

ThriftyMeals will generate income via transaction fees from food businesses' sales on the platform, ad revenues on its mobile app and website, and donor sponsorship. In the case of B40 individuals, it will be free.

8.1.6. Key Resources

The most critical assets necessary to make the ThriftyMeals business model succeed are the Key Resources. Our significant resources include a seller and donor database, digital platforms like our mobile application and website, and a competent business team which are the co-founders of ThriftyMeals.

8.1.7. Key Activities

Building partnerships with local food businesses, promotions to sellers and customers, develop & enhance ThriftyMeals' digital platform, and regulating the food quality of sellers and donors are the key activities necessary to make the ThriftyMeals business model function.

8.1.8. Key Partners (KP)

Our business partners are our key partners. Local food businesses, food delivery services, donors, food banks, masjids, Jabatan Kebajikan Masyarakat (JKM), and The Food Safety and Nutrition Cluster (KMP) are among them. Local food businesses will sell their unsold food on our platform. Food delivery services will assist us in delivering purchased food from our platform to the customers. Donors and food banks will assist us in providing funds for the food donations to the B40 individuals. We will cooperate with masjids in local areas to setup a station for B40 individuals to collect the free food donated by the generous donors. Government agency such JKM will assist us with providing a list of B40 individuals and KMP will assist us in making guidelines for ThriftyMeals' Food Safety Guidelines.

8.1.9. Cost Structure

ThriftyMeals' operating costs include the website's utility expenditures, mobile app technological infrastructure, and website and mobile app maintenance. Marketing expenses are required to make ThriftyMeals prominent to customers. Employee salaries are also included in the cost structure. Finally, if applicable, we include the expense of paying taxes in our cost structure.

8.2. Low Fidelity ThriftyMeals Prototype

Fig. 21. Low Fidelity Prototype of ThriftyMeals Mobile App

The Fig. 21 above displays the low fidelity prototype of ThriftyMeals mobile app. Consumers and food retailers each have dedicated main screens tailored to their specific needs. Upon logging in, consumers are presented with an interactive map showcasing food retailers selling surplus food in their vicinity. The map streamlines the process of locating and selecting the desired surplus food items. The consumer menu screen provides an effortless browsing and ordering experience, enabling seamless navigation through the available surplus food options. The consumer can easily browse and order surplus food items on the consumer menu screen. In contrast, food retailers benefit from a dedicated main screen that empowers them to post and manage their surplus food offerings with ease. The notification screen keeps retailers informed of incoming food orders, allowing them to prepare the surplus food for pick-up in a timely manner. The app's simple design and intuitive navigation make it an effective tool for tackling food waste and promoting sustainable practices.

8.3. Business Environmental Map

8.3.1. Key Trends

ThriftyMeals should be aware of three key businesses that could impact business. Firstly, increasing awareness of food waste. Going forward, a more environment-conscious population will likely embrace the cause because it will reduce carbon emissions and facilitate cost savings by not throwing away as much as spoiled food (Alterman, 2021). This awareness is driving consumers and businesses to seek solutions that can help to reduce food waste. Secondly, the rise of technology in food management. Technology is playing a crucial role in reducing food waste. For instance, applications that connect consumers with restaurants that have surplus food are becoming increasingly popular. A less scientific, but certainly practical innovation, is startup Too Good to Go's food waste-reduction marketplace, which currently operates across several European countries (Alterman, 2021). Thirdly, government regulations and incentives: Governments around the world are implementing regulations and offering incentives to reduce food waste. These could range from penalties for wasting food to tax benefits for businesses that donate surplus food. Staying abreast of these regulations and leveraging the incentives could be advantageous for ThriftyMeals. In achieving more integrated waste management solutions, the Government had further extended the tax incentive for Green Technology through the Budget 2014. This was done to further strengthen the development of green technology (Shahril, 2020).

8.3.2. Market Forces

Consumer demand is one of market forces of ThriftyMeals. On one side of the exchange, restaurants, grocery stores and other food businesses contribute surplus food items. On the other side, consumers can purchase food right before it becomes unsellable. As a result, businesses generate revenue from surplus food, customers can buy food at low prices, and the transactions reduce food waste (Alterman, 2021). Next, regulatory pressure also market forces of ThriftyMeals. The loss of the food itself is bad enough, but the secondary effects are alarming as well: the water consumption linked to food loss and waste amounts to approximately one-fourth of the world's freshwater supply. Greenhouse-gas (GHG) emissions from food loss and waste constitute 8 percent of the global total, or at least four times those of the aviation industry (Borens, 2022).

8.3.3. Macroeconomic Forces

There are two macroeconomic forces for ThriftyMeals. Firstly, are economic incentives. Reducing food waste can lead to significant cost savings for businesses. This not only improves their bottom line but also contributes to their sustainability goals by reducing their scope 3 emission footprint. Research shows that retailers could reduce their cost of goods sold (COGS) by 3 to 6 percent, and manufacturers by 5 to 10 percent (Borens, 2022). This is a clear demonstration of how economic incentives can align with environmental sustainability. Next, the global food crisis. The global food crisis is indeed highlighting the importance of reducing food waste. Solutions like ThriftyMeals are becoming increasingly relevant and are likely to influence both economic policies and consumer behavior. We chose tomatoes because 50 million to 75 million tons of them are lost upstream every year—more than any other fruit or vegetable (Borens, 2022). With 50 million to 75 million tons of tomatoes lost upstream every year, it's clear that there's a significant opportunity for waste reduction. The lessons learned from addressing waste in the tomato supply chain can indeed be extrapolated to other fresh-produce categories.

8.3.4. Industry Forces

In the food industry, specifically within the realm of sustainable food consumption and waste reduction, the key factors of industry forces are consumer preferences, quality and variety. The shifting food preferences of consumers toward ready-to-eat food products owing to the busy lifestyles of working individuals as well as the hectic work schedules of college students is likely to fuel market growth based. Consumer preferences for packaged meals are constantly changing as people are looking for higher-quality ingredients, more variety, and speedier delivery. This has boosted the popularity of ready-to-eat takeaways and same-day delivery. The rising pressure upon brands to offer products that are better for the environment continues to shift the overall concept of packaged food boxes toward more plant-based or vegan ingredients and the use of sustainable packaging with less plastic and waste (FMI, 2023).

8.4. Strategy Canvas

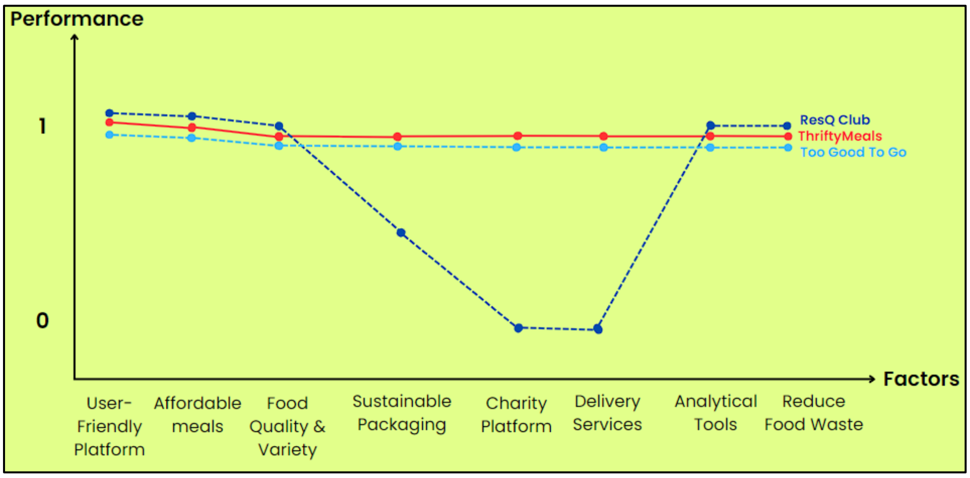


Fig. 22. Strategy Canvas for ThriftyMeals against ResQ Club

The strategy canvas helps compare ThriftyMeals' strategies and values captured with other similar businesses. See Fig. 22. The important key factors that need to be compared in the online platform for ThriftyMeals are the user interface design and user experience in navigating the platform as it will be the main source of interaction between the business and its customers. If the online platform is not as user-friendly as other platforms, then customers will not use it and recommend the platform to their friends. The online platform will have user authentication for the B40 customers, food establishments, and normal customers or donors. This implementation will allow separate user views on the platform where sellers have an additional page where they can use analytical tools to review their performance and an option to pay for their shop to be advertised in the platform.

The next key factor is the quality and variety of the food sources available on the platform. ThriftyMeals will need to build relationships with food establishments or convenience stores, to ensure that customers are able to choose healthy food options. Furthermore, the business will partner with delivery services such as FoodPanda etc. and clarify the locations available with surplus food. Customers can also choose to pick up their food to remove the delivery cost. The meals that are ordered will be packed in an eco-friendly container to attract customers that are concerned about the environment.

Another key factor is the price of the meals. The meals will be sold at a reduced price which will attract thrifty customers. In addition, donors that donate to the platform can see their contributions to the community through the platform. The donations made through the platform will allow B40 customers to verify their status and receive free food from the funds donated. The platform will implement a review section in each seller's platform so that customers can engage with the sellers and provide feedback that can further improve the sellers' products and services.

Lastly, the blue ocean strategy for the business leverages on the fact that there are few competitors that sells the same type of products as ThriftyMeals in Malaysia. Similar businesses in Malaysia include Pasar Grub and Graze Market. However, these businesses currently focus on the excess of fresh produce. Thus, ThriftyMeals allows access to affordable meals that can be donated while also reducing potential food wastage.

9. CONCLUSION

The vast amount of food waste generated daily at restaurants and supermarkets poses a significant environmental and social challenge. In response to this pressing issue, ThriftyMeals emerges as a conceptual business model dedicated to minimizing food waste and combating hunger. By establishing a platform that connects food retailers and consumers, ThriftyMeals facilitates the seamless exchange of surplus food, reducing the volume of food destined for landfills. Furthermore, ThriftyMeals extends its reach to alleviate hunger by channeling excess food donations to individuals and communities in need, for example the B40 community. Through its dual focus on environmental sustainability and social responsibility, ThriftyMeals presents a promising solution to tackling the multifaceted problem of food waste and hunger.

To further refine and elaborate on ThriftyMeals' conceptual business model, the development of a comprehensive business plan is essential. This plan will serve as a roadmap for implementation, outlining detailed strategies, financial projections, and operational procedures. Additionally, regular reviews and updates of the conceptual business model are crucial to ensure its alignment with evolving technological advancements and market trends. Expanding the customer segment to have B40 community's contribution instead of just receiving the free surplus food presents a compelling opportunity for ThriftyMeals to not only address food insecurity but also empower this underserved group. By providing B40 individuals with opportunities to contribute to the business, ThriftyMeals can foster a sense of ownership, self-reliance, and economic empowerment within this community.

REFERENCES

Alterman, R. (2021, January 15). *How the Food Industry Is Tackling Food Waste in 2021*. The Food Institute. https://foodinstitute.com/focus/how-the-food-industry-is-tackling-food-waste-in-2021/

Borens, Moira, et al. "Reducing Food Loss: What Grocery Retailers and Manufacturers Can Do." *McKinsey & Company*, 7 Sept. 2022, www.mckinsey.com/industries/consumer-packaged-goods/our-insights/reducing-food-loss-what-grocery-retailers-and-manufacturers-can-do.

Chirsanova, A., & Calcatiniuc, D. (2021). THE IMPACT OF FOOD WASTE AND WAYS TO MINIMIZE IT. *Journal of Social Sciences*. https://doi.org/10.52326/JSS.UTM.2021.4(1).15.

Ciulli, F., Kolk, A., & Boe-Lillegraven, S. (2019). Circularity Brokers: Digital Platform Organizations and Waste Recovery in Food Supply Chains. Journal of Business Ethics, 1-33. https://doi.org/10.1007/S10551-019-04160-5.

Dahlan, A. R. A., Ibrahim, I., Ahmad H. Osman, R., Mhd. Sarif, S., Jaapar, G., Man, S., Abdul Razak, D., Mohd Ali, N. Z., Abdul Aziz, N., Mohamad Ali, N. A., Mahri, N., Ismail, A. R., Abdul Kadir, A. F., Mansor, H., Mohd Nor, R. (2021). Freemium Multi-Sided Platform Business Model: Mosque Kitchen as A Source of Free Food, Employment and Empowerment of B40s Food-Preneurs. Journal of Information Systems and Digital Technologies, 3(2), 1–10.

David, Boarder, Giles. (2020). After Market: Capital, surplus, and the social afterlives of food waste. Routledge Handbook of Food Waste, 23-36. https://doi.org/10.4324/9780429462795

Davies, A. R. (2018). Redistributing Surplus Food. Mobilities, Mobility Justice and Social Justice, 250–262. https://doi.org/10.4324/9780815377047-17

Garrone, P., Melacini, M., Peergo, A., & Pollo, M. (2012). Food waste reduction: Empirical findings from the Italian Food Supply Chain. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.2109587

Hamid, H., Khairuddin, N. D., Al-amodi, Y., Dahlan, A. R. A., & Osman, R. A. (2013). MyMosqueNet2Cloud Collaborative System: A network of mosques towards eradicating poverty in Malaysia. American Academic & Scholarly Research Journal Vol. 5, No. 5, July 2013

Hingston, S. T., & Noseworthy, T. J. (2020). On the epidemic of food waste: Idealized prototypes and the aversion to misshapen fruits and vegetables. *Food Quality and Preference*, *86*, 103999. https://doi.org/10.1016/j.foodqual.2020.103999

Horoś, I. K., & Ruppenthal, T. (2021). Avoidance of food waste from a grocery retail store owner's perspective. Sustainability, 13(2), 550. https://doi.org/10.3390/su13020550

Jaafar, R., Narzeri, S., & Samsuddin, M. (2020). A Journey of Mutiara Food Bank "Awareness of Food Wastage" Interactive Documentary. Journal of Engineering and Applied Sciences, 15, 1267-1272. https://doi.org/10.36478/jeasci.2020.1267.1272.

Kurek, J., Brandli, L. L., Leite Frandoloso, M. A., Lange Salvia, A., & Mazutti, J. (2023). Sustainable Business Models Innovation and Design Thinking: A bibliometric analysis and systematic review of literature. Sustainability, 15(2), 988. https://doi.org/10.3390/su15020988

Mathisen, T. F., & Johansen, F. R. (2022). The Impact of Smartphone Apps Designed to Reduce Food Waste on Improving Healthy Eating, Financial Expenses and Personal Food Waste: Crossover Pilot Intervention Trial Studying Students' User Experiences. JMIR Formative Research, 6(9), e38520. https://doi.org/10.2196/38520

Mesiranta, N., Heikkinen, A., & Mattila, M. (2020). Platform-based sustainable business models: Reducing Food Waste in food services. International Journal of Entrepreneurship and Innovation Management, 24(4/5), 249. https://doi.org/10.1504/ijeim.2020.10028425

Muth, M. K., Birney, C., Cuéllar, A., Finn, S. M., Freeman, M., Galloway, J. N., Gee, I., Gephart, J., Jones, K., Low, L., Meyer, E., Read, Q., Smith, T., Weitz, K., & Zoubek, S. (2019). A systems approach to assessing environmental and economic effects of food loss and waste interventions in the United States. *Science of The Total Environment*, *685*, 1240–1254. https://doi.org/10.1016/j.scitotenv.2019.06.230

Nasution, A. I., Dahlan, A. R. A., Husaini, M. I., & Ahmed. M. H. (2015). Developing Islamic City through Network-of-Mosque (NoM). Journal of Social and Development Sciences, 6(2), 37–45.

Ng, C G., Yusoff, S., Zaman, N S B K., & Siewhui, C. (2021, March 8). Assessment on the Quality and Environmental Impacts of Composting at Institutional Community using Life Cycle Assessment Approach. https://scite.ai/reports/10.15244/pjoes/124115

O'Donnell, T. H., Deutsch, J., Yungmann, C., Zeitz, A., & Katz, S. H. (2015). New sustainable market opportunities for surplus food: A food system-sensitive & methodology (FSSM). Food and Nutrition Sciences, 06(10), 883–892. https://doi.org/10.4236/fns.2015.610093

Olio. (2023). How does olio make money? https://help.olioapp.com/article/82-how-are-you-making-money

Osterwalder, A., Pigneur, Y., Bernarda, G., Smith, A. (2014). Value Proposition Design: How to Create Products and Services Customers Want. John Wiley & Sons.

Osterwalder, A., & Pigneur, Y. (2010). Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers. Wiley.

Pereira, D. (2023, August 7). HelloFresh Business Model. Business Model Analyst. https://businessmodelanalyst.com/hellofresh-business-model/

Principato, L., Trevisan, C., Formentini, M., Secondi, L., Comis, C., & Pratesi, C. A. (2023). The Influence of Sustainability and Digitalisation on Business Model Innovation: The case of a multi-sided platform for food surplus redistribution. Industrial Marketing Management, 115, 156–171. https://doi.org/10.1016/j.indmarman.2023.09.001

ResQ Club. (n.d.). The road to zero. Retrieved November 6, 2023, from https://www.resq-club.com/zero

Ronteau, S., Muzellec, L., Saxena, D. & Trabucchi, D. (2023). A The OLIO Case Study: A Social Enterprise App Tackling the "Chicken and Egg" Paradox. In Digital Business Models: The New Value Creation and Capture Mechanisms of the 21st Century (pp. 143-150). Berlin, Boston: De Gruyter. https://doi.org/10.1515/9783110762556-011

Shahril. "Sustainable Waste Management in Malaysia : Opportunities and Challenges - MIDA | Malaysian Investment Development Authority." *MIDA | Malaysian Investment Development Authority*, 8 Dec. 2020, www.mida.gov.my/sustainable-waste-management-in-malaysia-opportunities-and-challenges.

Spring, C., & Biddulph, R. (2020). Capturing Waste or Capturing Innovation? Comparing Self-Organising Potentials of Surplus Food Redistribution Initiatives to Prevent Food Waste. Sustainability, 12, 4252. https://doi.org/10.3390/su12104252.

Yang, C., Chen, X., Sun, J., Wei, W., Miao, W., & Gu, C. (2022). Could surplus food in blind box form increase consumers' purchase intention? Agriculture, 12(6), 864. https://doi.org/10.3390/agriculture12060864

A SYSTEMATIC LITERATURE REVIEW ON THE APPLICATION OF ARTIFICIAL INTELLIGENCE IN ENHANCING CARE FOR KIDNEY DISEASES PATIENTS

MD SAIDUR RAHMAN[1], NOR SAADAH MD NOR[1*]

[12] *Kulliyyah of Information and Communication Technology, IIUM Gombak Campus, International Islamic University Malaysia, Gombak, Malaysia*

**Corresponding author: norsaadahnor@iium.edu.my*

ABSTRACT: Chronic Kidney Disease (CKD) is a very long-term condition whereby the kidneys, over time, progressively lose some of their core functionality, resulting in waste accumulation within the body. It may progress silently, with manifestations in advanced stages, and can result in kidney failure that may necessitate dialysis or transplantation. It requires early detection for management. Artificial Intelligence (AI) has emerged as a transformative tool in the management of CKD, enabling more precise diagnosis, treatment optimization, and long-term care. The other way round, AI is a limb of Computer Science dedicated to developing systems that do what a human does intelligently. AI in healthcare has opened several breakthroughs in health care, especially in the management of CKD. Recent development related to AI, including machine learning, natural language processing, and predictive analytics, has gradually integrated all the stages in CKD care, from early diagnosis to treatment optimization, considering the significantly improved diagnostic accuracy and better patient outcomes. AI algorithms use huge datasets ranging from biomarkers to medical imaging in the early diagnosis of kidney dysfunction and provide timely interventions, facilities, and initiation of tailored treatment plans that improve patient outcomes and reduce healthcare costs. AI-based systems enhance decision support for clinicians, improving the management of dialysis and post-transplant care by predicting complications and providing real-time insights. Even with the possible advantages accruing from them, data fragmentation, quality issues, and ethical concerns over patient privacy and decision-making processes continue to be a problem. This review highlights the ongoing challenges related to AI model generalizability across diverse patient populations and the need for more transparent and standardized validation processes. Strong data management is required in this, with due adherence to ethical guidelines, so that AI makes its way into kidney care in a way that's fair and secure. Addressing these challenges requires cross-disciplinary collaboration between AI researchers, nephrologists, and policymakers to ensure safe and equitable integration of AI in clinical practice. The objective of the research is to systematically evaluate AI technology in CKD from a patient-centered perspective of care improvement for patients with CKD. Fourteen studies published from 2018 to 2024 were reviewed in the systematic review to learn how AI technology was incorporated to improve care for CKD patients. These studies demonstrate the increasing role of AI in identifying biomarkers, predicting disease progression, and personalizing treatment protocols. In addition, most of the research those were reviewed was published in Science Directory, IEEE Xplore and Emerald Insights database and done by university students for improvement in the care of CKD patients using AI. The findings from this review suggest that while progress has been made, there is still a need for more rigorous validation and real-world evidence to fully realize the potential of AI in CKD management.

KEY WORDS: *Artificial Intelligence, Kidney Diseases, CKD, Healthcare*

1. INTRODUCTION

AI-based systems offer better decision support for clinicians, thereby improving dialysis management and post-transplant care through complication predictions and real-time insights. These technologies also enhance early-stage diagnosis and long-term patient management, especially in CKD.

AI will continue rapidly to change the face of healthcare and, similarly, will be doing so for chronic kidney diseases. Recent literature depicts how AI is improving diagnostic precision, personalizing therapy, and facilitating better patient outcomes in nephrology.

Díez-Sanmartín et al. (2021) identified the impact of AI and big data on treatments for end-stage renal disease; according to these authors, such technologies optimize effective analytics in patient management. In this line, Ho et al. (2024) add that up taking trends of AI and machine learning are revolutionizing kidney care by way of predictive analytics along with a decision support system.

Integration of AI with omics data has taken research on kidney diseases to the next level. Grobe et al. (2023) and Zhou et al. (2023) review how this integration of AI with omics approaches improves diagnostic precision and personalization of treatment. Grobe et al. (2023) focus more on the synergy of omics and AI, while Zhou et al. (2023) focus more on multi-omics integration, providing deeper insight into disease mechanisms.

It also extends to very specific conditions, such as kidney stones. Kianian et al. (2024) illustrate the use of AI-driven, patient-targeted health information in the management of kidney stone disease. Such specific applications are put into a broader perspective by works like Sawhney et al. (2023), who review various models of AI for early CKD prediction and evaluation.

The future of AI in kidney health looks bright. Nadkarni and Kotanko present, for 2022, and Elsevier BV, for 2024, the ever-evolving role of AI-from predicting survival rates in advanced CKD, as discussed by Dharmarathne et al. in 2024, to improving the diagnostic precision with explainable AI.

Early prediction remains a focus of prime importance. Pareek et al. (2023) used convolutional neural networks to predict CKD at an early stage. Savitha et al. (2022) presented a comprehensive review of machine learning algorithms for the diagnosis of CKD. Further, Khade et al. (2021) and Sameena and Rajashekaran (2023) presented the advancement and comparative effectiveness regarding the usage of different AI techniques in the early-stage prediction of CKD.

The final contribution is by Hegde and Mundada (2022), who introduce hybrid generative regression-based deep intelligence and present state-of-the-art AI methods for the risk prediction of chronic diseases. These contributions enable us to show that AI can bring about essential improvements in kidney disease management and patient care.

The following systematic review addresses 10 research questions based on 14 key studies that examine very important features of AI applications in CKD care. The research questions (RQ) guiding this review include:

RQ-1. How has artificial intelligence (AI) and big data influenced the treatment of end-stage kidney disease?

RQ-2. What are the current trends in artificial intelligence and machine learning in the management of kidney care?

RQ-3. How do omics technologies combined with artificial intelligence contribute to understanding kidney diseases?

RQ-4. What is the role of AI in providing patient-targeted health information for kidney stone disease?

RQ-5. How does the integration of AI and multi-omics approaches improve the management of kidney diseases?

RQ-6. What are the strengths and weaknesses of different AI models used for early prediction and evaluation of chronic kidney disease (CKD)?

RQ-7. What does the future hold for AI and machine learning in the field of kidney health and disease?

RQ-8. How can AI be applied to predict survival in patients with stage 4-5 chronic kidney disease (CKD)?

RQ-9. What are the advantages of using a machine learning-based interface with explainable AI for diagnosing chronic kidney disease (CKD)?

RQ-10. How effective are convolutional neural networks (CNNs) in predicting early-stage chronic kidney disease?

This systematic review provides a comprehensive assessment of how AI technologies are shaping kidney care, as well as identifying critical gaps and opportunities for further research. By addressing these research questions, this study shows significant value in informing the potential of AI to address specific challenges in CKD care, from early diagnosis to personalized treatment.

2. LITERATURE REVIEW

Artificial Intelligence has grown to become the cornerstone in chronic kidney disease management. The use of AI in health, especially in nephrology, brings immense advancement in early diagnosis, personalized treatments, and predictive analytics. This review summarizes some of the recent research on AI applications in the management of kidney diseases and further develops key recent advances and future directions.

2.1. Impact of AI and Big Data on End-Stage Kidney Disease

Díez-Sanmartín et al. (2021) give an overview of how the approach in the treatment of end-stage kidney disease has been changing with AI and vast data. The study by the authors further reveals that these AI technologies are creating capabilities for vast volumes of data processing in pattern identification and finding trends that might be difficult to perceive through other means. It leverages predictive analytics with real-time data integration and opens up new frontiers for personalized treatments, optimized management strategies, and better clinical outcomes. If anything, it epitomizes AI's role in dealing with complex patient data and enabling personalized intervention.

2.2. Emerging Trends in AI and Machine Learning for Kidney Care

Ho et al. (2024) review current trends in AI and machine learning applications in kidney care. The authors highlighted that deep learning and reinforcement learning are considered some of the AI algorithms that advance predictive model development for the progression of CKD and treatments. The rapid growth in AI capabilities in Nephrology will in turn allow for much more precise risk stratification, earlier diagnosis, and personalized treatment plans as reviewed by this paper (Ho et al., 2024).

2.3. Integration of AI with Omics Data

So far, the integration of AI with omics data has taken kidney disease research to a new dimension. Grobe et al. (2023) review how omics technologies in combination with AI provide deeper insights into the molecular mechanisms of kidney diseases. AI models analyze complicated biological data and point out biomarkers and pathways associated with CKD that might help improve diagnostic accuracy and offer personalized treatment strategies. Zhou et al. (2023) further extend this to discuss multi-omics integration, extending the knowledge of kidney diseases by integrated analysis of multi-types of data into holistic models that enable improved interventions.

2.4. AI Applications in Specific Kidney Conditions

Kianian et al. (2024) have targeted the application of AI in the management of kidney stone disease. Indeed, their study proves that AI-driven health information systems are able to provide personalized advice and treatment recommendations for patients as individuals. Therefore, this approach elevates the level of adherence by a patient with prescribed treatment and the recurrence rate of kidney stones by providing recommendations in relation to one's condition and way of life. Kianian et al. (2024) further illustrate how AI applies in relation to specific kidney conditions.

2.5. Comparative Evaluation of AI Models for CKD Prediction

Sawhney et al. (2023) have presented a comparative review of AI models with respect to early prediction and assessment in CKD. The said article employed different kinds of AI algorithms for predicting the progression of CKD and its outcomes in patients, such as machine learning and deep learning models. This comparison would thereby give an idea of the relative strengths and weaknesses of each model; therefore, this comparison ensures meaningful insights are derived for its practical applicability and effectiveness in clinical settings. According to Sawhney et al. (2023), this is indeed an important comparison analysis that will help in decision-making regarding the selection of appropriate AI tools for the early detection of CKD.

2.6. Future Prospects and Explainable AI

While discussing the future directions of AI in kidney health, Nadkarni and Kotanko (2022) and Xue et al. (2022) present several emergent technologies of AI that may further revolutionize the management in KD through diagnostic accuracy and personalization of treatment. According to Xue et al. (2022), explainable AI will help bring interpretability to the output of models, so necessary for clinical adoption. Explainable AI should bring insight into the decision-making process and build confidence with healthcare providers and patients (Nadkarni & Kotanko, 2022; Xue et al., 2022). The authors add to this discourse by narrowing down to ML-based interfaces with explainable AI towards CKD diagnosis emphasizing model transparency and user trust (Dharmarathne et al., 2024).

2.7. Early Detection and Predictive Modeling

The overall effectiveness in managing CKD is in early detection. Prediction on early detection of CKD using CNNs was done by Pareek et al. (2023) and demonstrated how the advanced AI technique enhances predictive accuracy for further intervention. The merit of CNN lies in its subtlety through medical imaging and other sources to aid diagnosis and treatment in their very nascent stage. A survey of machine learning algorithms used in the early detection and management of CKD was done by Savitha et al. in 2022.

2.8. Comparative and Advanced AI Techniques

Sameena and Rajashekaran (2023) published a review on the recent advancement in AI application to kidney disease with particular emphasis on state-of-the-art techniques and their clinical relevance. They have explored new AI approaches that include hybrid models and ensemble methods for improved predictive accuracy and personalized treatment. Recently, a comparative study of multiple AI techniques in early CKD prediction was described by Khade et al. (2021) in terms of performance and applicability to various clinical scenarios. More recently, AI advancements in predicting the risk of chronic diseases have been introduced by Hegde and Mundada (2022), which include hybrid generative regression-based deep intelligence. Their studies show the new methodologies in AI innovations are transforming and there lies a hope for better outcomes on chronic diseases. Conclusion: The studies by Hegde and Mundada (2022), Khadeet al. (2021), and Sameena and Rajashekaran (2023) are some of these research works.

As identified from the reviewed literature, AI facilitates revolutionary deep management of kidney disease through enhanced diagnostic capability, personalized treatment, and early detection. In the case of nephrology, several important paradigms to improve care are related to the further integration of AI with omics data, advanced development of predictive models, and focusing on explainable AI. These advances determine possible contributions of AI to address complexity in kidney diseases and improve outcomes among patients through innovative and effective health care solutions.

3. METHODS

The method of Systematic Literature Review (SLR) involves an organized process through which the comprehensively and unbiasedly evaluates research evidence. An SLR starts with the definition of a clear research question, followed by the development of a detailed protocol indicating the scope of the review. It goes further to define inclusion and exclusion criteria, describes the search strategies, methods for data extraction, and quality assessment. The researcher then identifies the sources of data and formulates a search strategy that involves certain keywords and Boolean operators in retrieving these studies from databases like Science Direct, IEEE Xplore and Emerald Insight. For instance, the succeeding step involves screening of titles, abstracts, and full texts in order to select those studies that meet the inclusion criteria. Following that, quality assessment determines the risk of bias and methodological rigor for studies that may be included using the Cochrane Risk of Bias Tool among other tools by Sterne et al. (2019). Data will be systematically extracted from each study based on pre-specified information as described in Bero (2020). Synthesis and analysis: After extraction, the data is synthesized and analyzed, where findings are summarized qualitatively or quantitatively, which might involve meta-analysis if appropriate (Munn et al., 2018). Then, the review is reported according to PRISMA to allow for transparency and reproducibility (Page et al., 2021).

Formulation of the research questions is an integral part of the SLR process because it sets at the outset the frames of reference of the research. Fig. 1 shows the six stages of the review methodology that were applied in this study. Fig. 1 highlights the process of merging a search strategy that emphasizes developing preliminary research. Even if this process is completed, it remains to create a method for determining the search terms, criteria and the initial it is to be correlated with such research as the SLR.

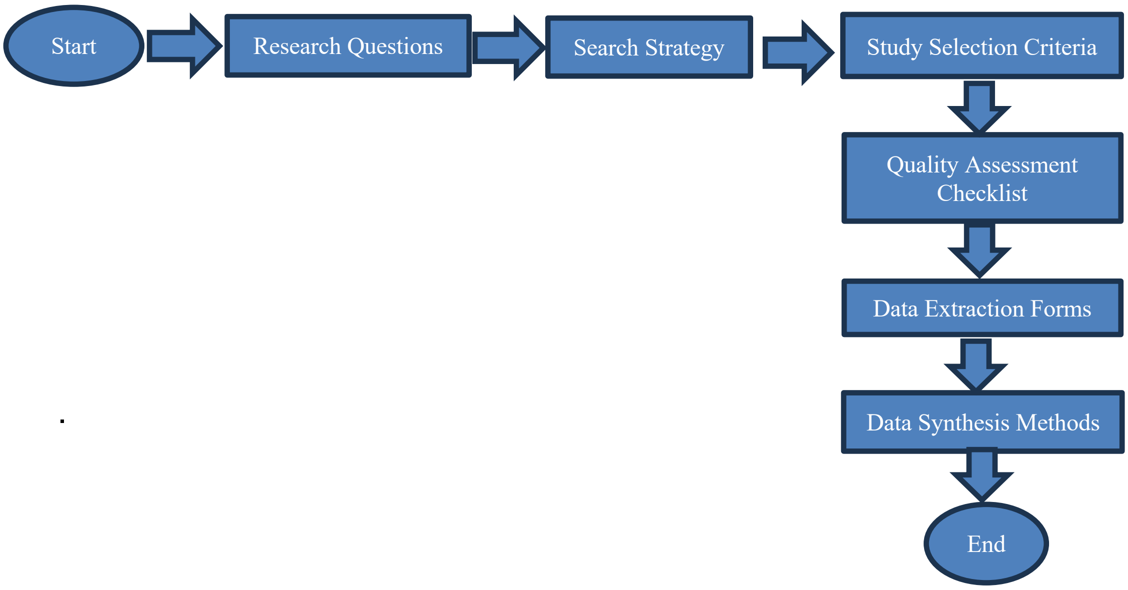


Fig. 1. Protocol review stages.

3.1. Inclusion and Exclusion Criteria

The articles that meet the inclusion and exclusion criteria listed in Table 1 will be analyzed for the review research.

3.2. Data Sources and Search Strategies

The search for articles to be considered in this systematic review began on 6 August 2024. The "ScienceDirect, IEEE Xplore, and Emerald" databases were employed to conduct a comprehensive search of published research to compile the research articles for inclusion in this systematic review. The search terms utilized to find pertinent publications were predicated on the keywords in Table 2. Because keywords provide the foundation for accessibility to pertinent publications, proper keyword selection is critical for the selection of articles for inclusion in the systematic review (Costa & Monteiro, 2016). The search findings acquired using the already mentioned keywords provided.

Table 1: Inclusion and exclusion criteria

Inclusion Criteria	Exclusion Criteria
Must involve AI in kidney disease care	Article on AI application but not in kidney disease care
Must involve research framework	Articles without research framework
Must be written in English language	Articles published in languages other than English
Must be published between 2018 and 2024	

Table 2: Keyword search

Keyword search
"Application" & "Artificial Intelligence" & "Healthcare" & "kidney" & "CKD" "Diseases" "Patients"

Table 3: Final search results across the databases

No	Database	Count
1	ScienceDirect	748
2	IEEE Xplore	45
3	Emerald Insight	11
Total		804

The study involved accessibility to 804 articles (see Table 3). Despite retrieving numerous articles from three different databases, only 14 articles evaluating the inclusion and exclusion criteria were selected, and as well as due to time constraints.

3.3. Quality Assessment

After filtration, as shown in Table 4 below, seven items of the quality assessment checklist were used to further ascertain the quality of the research articles eligible for analysis. Quality assessment is as important as inclusion and exclusion criteria (Al-Emran et al., 2018). The quality assessment checklist is presented in Table 4.

Table 4: Quality assessment checklist

No.	Assessment Items
1.	Are the research aims clearly specified?
2.	Was the study designed to achieve these aims?
3.	Are the techniques considered by the study clearly specified?
4.	Is the research model reported?
5.	Are the data collection methods adequately detailed?
6.	Is the study context/discipline clearly specified?
7.	Do the results add to the literature?

The checklist was a modification of the recommendations from Kitchenham and Charters (2007); moreover, it was not intended to critically review any of the projects by the researchers. The questions were then scored on the basis of the standard three-point scale for scoring the questions: 1 point allocated to 'Yes', 0 points allocated to 'No', and 0.5 points allocated to 'Partially.' Any research could therefore receive from 0 to 7 points. The high general score from the research means that the research will be in a better position to answer the research questions. The quality assessment results of all the research are shown in Table 5, showing that all 14 studies met the quality assessment criteria, hence acceptable and competent for further analysis.

Table 5: Quality Assessment Results

Review	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Total	Percentage
LR-1	1	1	1	0.5	1	1	1	6.5	93
LR-2	1	1	1	0.5	1	1	1	6.5	93
LR-3	1	1	1	0.5	1	1	1	6.5	93
LR-4	1	1	1	0.5	1	1	1	6.5	93
LR-5	1	1	1	0.5	1	1	1	6.5	93
LR-6	1	1	1	1	1	1	1	7	100
LR-7	1	1	0.5	0.5	0.5	1	1	5.5	79
LR-8	1	1	1	1	1	1	1	7	100
LR-9	1	1	1	1	0.5	1	1	6.5	93
LR-10	1	1	1	1	1	1	1	7	100
LR-11	1	1	1	1	1	1	1	7	100
LR-12	1	1	0.5	0.5	0.5	1	1	5.5	79
LR-13	1	1	1	1	1	1	1	7	100
LR-14	1	1	1	1	1	1	1	7	100

3.4. Data Coding and Analysis

The following characteristics of research methodology reliability were coded: (a) year of publication, (b) primary research area in AI in kidney disease care, (c) research methodology (example, interview, survey, experiment, etc.), (d) education level (University), (e) region, and (f) database (ScienceDirect, IEEE Xplore, Emerald Insight).

4. RESULT AND DISCUSSION

Answers to 10 research questions are provided based on 14 research topics published between 2018 and 2024 worldwide. Here are the 10 research questions with their answers.

RQ-1. How has artificial intelligence (AI) and big data influenced the treatment of end-stage kidney disease?

AI and big data have revolutionized the management of ESKD, allowing for more personalized and accurate care. For example, AI algorithms utilizing huge amounts of data from patient demographics, medical histories, and treatment outcomes provide disease and treatment protocol predictions. Machine learning algorithms, for example, look at the trends in data on patients so that complications-for instance, cardiovascular events or infections-can be predicted and appropriate interventions made. This is data-driven and can enhance the accuracy of predictions but also helps in the personalization of treatments according to individual needs for better patient outcomes. In addition, big data analytics allows for the identification of trends and patterns that will guide new treatment strategies and updates in clinical guidelines toward better management of ESKD (Díez-Sanmartín et al., 2021; Nadkarni & Kotanko, 2022).

RQ-2. What are the current trends in artificial intelligence and machine learning in the management of kidney care?

The role of AI and ML is that these emerging trends in kidney care management are a reflection of the move towards more advanced and insightful data-driven approaches. One of the big trends, predictive modeling, drives AI algorithms to analyze large volumes of historical patient data to forecast the progression of kidney diseases and the likely outcomes of various treatment options. With this type of risk profiling provided, health professionals are able to institute treatment measures well in advance, hence more personalized. The emphasis also goes out on personalized medicine, where AI is supporting personalization of treatment through the aggregation of genetic information, lifestyle, and clinical data. Automating routine tasks, such as interpreting laboratory results and medical image interpretation, is becoming even more frequent, making diagnosis considerably more efficient and effective. Put together, these trends amount to more precise and effective kidney care from the stage of early diagnosis to ongoing management (Ho et al., 2023; Sawhney et al., 2023).

RQ-3. How do omics technologies combined with artificial intelligence contribute to understanding kidney diseases?

Integration of omics technologies with AI therefore provides overall framework toward the understanding of kidney diseases at the molecular levels. Omics technologies include genomics, proteomics, and metabolomics; those techniques responsible for the generation of massive volumes of data on genes, proteins, and metabolites related to both kidney function and pathology. AI algorithms interpret complicated data to bring into view the relationships and patterns in the datasets that cannot decipher by traditional methods of analysis. This synergy promotes accordingly the discovery of novel biomarkers for early diagnosis and monitoring of diseases, and clarification of the pathophysiological mechanisms underlying diseases. Coupled with that, AI-driven insights from omics data will further allow the development of targeted therapies and personalized methods of treatment, moving forward the field of the management of kidney diseases and improving the outcomes (Grobe et al., 2023; Zhou et al., 2023).

RQ-4. What is the role of AI in providing patient-targeted health information for kidney stone disease?

The integration of artificial intelligence has immense potential in optimizing patient-targeted health information related to the disease of kidney stones. It estimates the risk of nephrolithiasis formation in a patient by using his or her individual data, such as medical history, lifestyle factors, and genetic predispositions. These AI-powered tools proactively provide personalized advice regarding dietary changes, hydration strategies, and lifestyle modification for the prevention of stones. Other additional functions of AI-powered platforms are personalized education and reminders for patients in adherence to better preventive measures for managing their conditions. This personalized approach further enhances not only patient engagement but also, in general, lifts the bar on the quality of disease management strategies (Kianian et al., 2024; Sameena et al., 2023).

RQ-5. How does the integration of AI and multi-omics approaches improve the management of kidney diseases?

AI integrated with multi-omics approaches allows a much more sophisticated and subtle view of the disease process in kidney diseases. Multi-omics technologies produce complete data on a variety of biological layers: genomic, proteomic, and metabolomic data. AI algorithms integrate diverse datasets that analyze and identify disease-specific biomarkers and pathways for more accurate diagnostics and prognostics. This holistic view enables treatment plans tailored according to the molecular signature of the individual, thus making the interventions at a focused and powerful standpoint. By combining AI with multi-omics, improvement in disease management is established apart from accelerating the process for discovering new therapeutic targets and strategies (Grobe et al., 2023; Zhou et al., 2023).

RQ-6. What are the strengths and weaknesses of different AI models used for early prediction and evaluation of chronic kidney disease (CKD)?

Different strengths and weaknesses are developed in different AI models regarding early prediction and evaluation of CKD. For instance, some of the key strengths of several AI models, such as deep learning and ensemble methods, are that these models can handle big and complex data; thus, they tend to perform better in terms of predictive accuracy. These models can catch small patterns and correlations which may not be depicted by traditional analytic methods. However, one of the most important weaknesses is overfitting, whereby models will perform well while being trained but cannot generalize well onto new or unseen datasets. Also, the nature of some AI models makes them so complex that a good interpretation is not warranted, which may be the limiting factor in its clinical application. Besides, the quality of the data feeding AI algorithms is crucial; poor or biased data will lead to suboptimal performance. These challenges need to be resolved in ensuring the effectiveness and reliability of AI in CKD management. This will be quite necessary according to Dharmarathne et al. (2024), Khade et al. (2021), and Sawhney et al. (2023).

RQ-7. What does the future hold for AI and machine learning (ML) in the field of kidney health and disease?

The future of AI and ML in kidney health and disease seems bright, with continuous innovation and enhancement in patient care. Some of the emerging trends include the development of sophisticated predictive models that integrate diverse data sources, including electronic health records, genomics, and real-time monitoring data to comprehensively provide a big picture on kidney health. Wearable technology will, in due course of time, provide monitoring in real time and continued feedback on renal function to highlight early warning signals of problems. Gravitation of explainable AI toward more transparency and interpretability of the AI models will help mainstream such systems into clinical practice. Personalized medicine will be an application of AI, in which treatment will be customized for the individual patient profile, thus offering effective and selective therapies. These are the developments that are about to revolutionize the management of renal disease, hence assuring better outcomes and an improved quality of life for patients. This is a view by Dharmarathne et al. (2024), Nadkarni and Kotanko (2022), and Pareek et al. (2023).

RQ-8. How can AI be applied to predict survival in patients with stage 4-5 chronic kidney disease (CKD)?

Advanced analytics of data with stratification of risks using artificial intelligence can considerably enhance the prognosis of survival among patients with grade 4-5 CKD. AI models, utilizing an extensive range of patient data that includes clinical measurements, laboratory results, and treatment outcomes, have provided estimates on the survival probabilities. These models find all key risk factors associated with adverse outcomes and provide a risk score to further guide the prioritization of patients for care and treatment. AI-driven prognosis tools support high-risk patients by providing valuable insights in the management, offering tailored interventions toward better decision-making. This AI application improves the accuracy of the survival prediction, which enables better resource allocations and personalized care strategies (Nadkarni & Kotanko, 2022; Xue et al., 2022).

RQ-9. What are the advantages of using a machine learning-based interface with explainable AI for diagnosing chronic kidney disease (CKD)?

Such an interface for the diagnosis of CKD using machine learning with explainable AI confers several advantages. Explainable AI gives good transparency to clear insights into the complex decision-making process of AI models. This will allow the clinicians to gain insight into, and thus believe in, the recommendation of the system. This is better accepted and integrated into clinical practice. Furthermore, with explainable AI, clinicians are able to integrate such insights from the AI with their clinical knowledge for more informed decision-making. Integration enhances the entire process of diagnosis through broad clinical decisions. Because of this interpretation challenge, explainable AI models help health professionals by making it easy for them to adopt and rely on AI systems for the accurate and efficient diagnosis of CKD (Dharmarathne et al., 2024; Savitha et al., 2022).

RQ-10. How effective are convolutional neural networks (CNNs) in predicting early-stage chronic kidney disease?

In fact, the CNNs have done an excellent job in the early-stage prediction of CKD and form a paradigm for application in analyzing medical imaging data. Needless to say, CNNs are befitting to detect minute patterns and abnormalities in images like kidney scans or histopathological slides that indicate early-stage CKD. The fact that they are able to process and interpret even complex visual data enhances the possibility of the detection of early signs of the disease, which may not even be clearly visible to the human naked eye. The CNNs automate this diagnosis process, hence making it efficient and accurate. It helps improve diagnostic precision, early intervention, and better management of the disease in the case of early-stage CKD prediction using CNNs (Khade et al., 2021; Pareek et al., 2023; Sameena et al., 2023).

These 10 research questions review the several aspects of AI in kidney disease management. First is that AI and big data have impacted ESKD treatment by offering personalized medicine through predictive modeling and trend analysis. Second, current trends of AI and machine learning in kidney care focus on predictive modeling, personalized treatment based on genetic and clinical data, and automating routine tasks to increase diagnostic efficiency. Third, the integration of AI with omics technologies-genomics, proteomics, metabolomics-has gone further in enhancing our understanding of the pathophysiology of renal diseases through biomarker identification, hence providing a comprehensive explanation for the mechanisms of the disease that ultimately allow for personalized therapies. Fourth, AI plays a huge role in the management of kidney stones through providing patient-specific recommendations regarding prevention based on the risk factors pertinent to the particular patient. Fifth, AI together with multi-omics approaches creates much better diagnostics and treatment due to analysis of various biological data layers. Sixth, although AI models developed for early prediction of chronic kidney disease show high predictive accuracy, several challenges are revealed concerning overfitting and limited interpretability. Seventh, the future for AI in kidney health is bright, inclusive of real-time monitoring with wearable technologies and more sophisticated predictive models. Eighth, AI has proved resilient in predicting the survival of patients with advanced CKD by analyzing comprehensive patient data to estimate risk and guide treatment. Ninth, integrating machine learning using Explainable AI into diagnosis raises transparency and clinician trust in AI-driven recommendations concerning CKD diagnosis. Finally, CNNs have great potential in the early-stage prediction of CKD, while the analysis of medical imaging data provides early detection both accurately and efficiently. To conclude, AI and machine learning are two major contributors to the development of kidney diseases for more personalized care, efficient, and accurate diagnosis, though challenges regarding data quality and model interpretability remain.

5. DISCUSSION

Artificial Intelligence in Kidney Disease Management represents the biggest leap forward in nephrology and is expected to ensure an improvement in diagnostics, treatment, and care given to patients. It has been reported in recent literature how AI and big data analytics created innovative steps for the treatment of end-stage kidney disease because of more personalized and effective management plans made possible with it. Machine learning algorithms, to this date, enable foresight into the course of a disease and optimization of therapeutic interventions for the particular needs of each patient, which may allow the improvement of overall outcomes in a patient. AI techniques, combined with omics data such as genomics and proteomics, have considerably further improved knowledge on kidney diseases at the molecular level by identifying novel biomarkers and targeted therapies. AI applications have indeed also been found adaptable to the management of some kidney conditions, such as kidney stones, whereby personalized recommendations have improved treatment outcomes. Comparisons made in various studies on different AI models for prediction CKD have indicated a significant improvement in model performance and clinical applicability, but further refinement will be required to overcome several limitations. Explanation: The development of explainable AI systems is highly crucial to bring about more transparency and build trust in the decisions made through AI, hence their wide application in clinical practice. This view is supported by the works of Dharmarathne et al. (2024) and Nadkarni and Kotanko et al. (2022).

6. FUTURE WORK

The future research on AI for kidney disease management should be directed to a number of key areas with a view to further enhancing its effectiveness and integration into clinical practice. It is, therefore, necessary that comprehensive models of AI are developed in the light of multi-modal data sources, namely, electronic health records, imaging, and genetic information, which would enhance diagnostic and personalized treatment accuracy. It is also important to consider the implementation and validation of AI tools in real-world settings. Various studies would be required to test the performance of the models across heterogeneous patient panels and health systems to guarantee their generalizability and usability. Ethical and regulatory considerations should be considered in using AI technologies responsibly, so that privacy, security, and ethics can be respected in the data. In addition, understanding and improving patient and provider acceptance of the AI technologies is going to be critical to successful integration. A process in which research is focused on factors that influence trust and engagement with the AI tools. Finally, the investigation and development of new techniques for AI, including hybrid and ensemble models, can further catalyze advances in predictive performance and patient care through novel solutions for a range of complex healthcare challenges. Ongoing investment in these areas will be important to maximize the full potential of AI in nephrology and improving patient outcomes.

Furthermore, interdisciplinary collaboration among researchers in AI, healthcare providers, and clinicians cannot be replaced in further validation and practical implementation of AI models in a wide range of healthcare settings. The research should focus not only on the technical improvement of AI but also on the smooth integration of AI technologies into the workflow of healthcare. This will involve very close collaboration with clinicians to tailor the AI systems to their needs and enable smooth adaptation of the AI tools in current day-to-day practices, ensuring that the tools meet both patient outcomes and healthcare workflows.

7. CONCLUSION

AI integration into kidney diseases has shown great promise in the revolution of handling such diseases. Artificial intelligence technologies, through the effort of machine learning and big data analytics, have greatly prepared new pathways toward better diagnosis, personalized treatment, and overall disease management. The integration of AI with omics data has illuminated the molecular mechanism of kidney diseases, thereby leading to the identification of biomarkers and target therapies. Different artificial intelligence applications have been found to be helpful in identifying certain specific conditions of the kidneys, such as kidney stones, by recommending tailored health information and treatment options for patients (Grobe et al. 2023; Zhou et al., 2023). Therefore, various comparisons of AI models pointed out their strengths regarding predictive accuracy and clinical applicability but also as continuous refinement and validation. In this respect, future emphasis needs to be given to the enhancement of AI models by comprehensive data integration, meeting the ethical and regulatory challenges, and ensuring better acceptance by patients and providers. Translating research into bedside clinical applications with newer AI techniques will be imperative in order to realize full benefits of AI in nephrology. Further transformation of kidney disease management is thus achievable with AI and affords new opportunities for improving patient care in the future and furthering the science behind nephrology.

There is a further need for interdisciplinary research and collaboration in nephrology, data science, ethics, and healthcare management to fill the gaps in knowledge, assure real-world applicability, and respond to challenges in AI implementation. These collaborations will be very important in refining the AI tools for usability by clinicians, besides optimizing them for diverse healthcare settings. With AI becoming more and more advanced, efforts within these disciplines should be combined harmoniously in an effort to translate research findings into smooth clinical practice and maximize the full potential of AI in managing kidney diseases.

REFERENCES

Al-Emran, M., Mezhuyev, V., Kamaludin, A., & Shaalan, K. (2018). The impact of knowledge management processes on information systems: A systematic review. *International Journal of Information Management, 43,* 173-187.

Bero, L. A. (2020). Improving the quality of systematic reviews in public health: Introduction to the series. *American Journal of Public Health 110*(11), 1601-1602.

Costa, V., & Monteiro, S. (2016). Key knowledge management processes for innovation: A systematic literature review. *VINE Journal of Information and Knowledge Management Systems, 46*(3), 386-410.

Dharmarathne, G., Bogahawaththa, M., McAfee, M., Rathnayake, U., & Meddage, D. P. P. (2024). On the diagnosis of chronic kidney disease using a machine learning-based interface with explainable artificial intelligence. *Intelligent Systems with Applications*, 22, 200397.

Díez-Sanmartín, C., Sarasa-Cabezuelo, A. A. (2021). The impact of artificial intelligence and big data on end-stage kidney disease treatments. *Expert Systems with Applications, 180, 115076.*

Grobe, N., Scheiber, J., Zhang, H., Garbe, C., & Wang, X. (2023). Omics and artificial intelligence in kidney diseases. *Advances in Kidney Disease and Health, 30*(1), 47-52.

Hegde, S. K., & Mundada, M. R. (2022). Hybrid generative regression-based deep intelligence to predict the risk of chronic disease. *International Journal of Intelligent Computing and Cybernetics, 15*(1), 144-164.

Ho, Y.-S., Fülöp, T., Krisanapan, P., Soliman, K. M., Cheungpasitporn, W. (2024). Artificial intelligence and machine learning trends in kidney care. *American Journal of the Medical Sciences, 367*(5), 281-295.

Khade, A. A., Vidhate, A. V., & Vidhate, D. (2021). A comparative analysis of applied ai techniques for an early prediction of chronic kidney disease. *2021 2nd International Conference on Smart Electronics and Communication (ICOSEC),* 1386-1392.

Kianian, R., Carter, M., Finkelshtein, I., Eleswarapu, S. V., & Kachroo, N. (2024). Application of artificial intelligence to patient-targeted health information on kidney stone disease. *Journal of Renal Nutrition, 34*(2), 170-176.

Kitchenham, B., & Charters, S. M. (2007). *Guidelines for performing Systematic Literature Reviews in Software Engineering Version 2.3* (EBSE Technical Report EBSE-2007-01). Retrieved from https://www.researchgate.net/publication/258968007

Munn, Z., Stern, C., Aromataris, E., Lockwood, C., & Jordan, Z. (2018). What kind of systematic review should I conduct?. A proposed typology and guidance for systematic reviewers in the medical and health sciences. *BMC Medical Research Methodology, 18*(1), 5.

Nadkarni, G. N., & Kotanko, P. (2022). The future of artificial intelligence and machine learning in kidney health and disease. *Advances in Chronic Kidney Disease, 29*(5), 425-426.

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., … Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ (Clinical Research ed.), 372*, n71.

Pareek, N. K., Soni, D., & Degadwala, S. (2023). Early-stage chronic kidney disease prediction using convolution neural network. *2023 2nd International Conference on Applied Artificial Intelligence and Computing (ICAAIC),* 16-20.

Sameena, V. A., Rajashekaran, R. (2023). Neoteric furtherance of artificial intelligence in kidney disease – a purview. *2023 Annual International Conference on Emerging Research Areas: International Conference on Intelligent Systems (AICERA/ICIS), pp.* 1-5.

Savitha, S., Rajiv Kannan, A., & Logeswaran, K. (2022). A comprehensive analysis of machine learning algorithms in diagnosis of chronic kidney disease. *2022 13th International Conference on Computing Communication and Networking Technologies (ICCCNT),* 1-5.

Sawhney, R., Malik, A., Sharma, S., & Narayan, V. (2023). A comparative assessment of artificial intelligence models used for early prediction and evaluation of chronic kidney disease. *Decision Analytics Journal, 6,* 100169.

Sterne, J. A. C., Savović, J., Page, M. J., Elbers, R. G., Blencowe, N. S., Boutron, I., … Higgins, J. P. T. (2019). RoB 2: A revised tool for assessing risk of bias in randomised trials. *BMJ (Clinical Research ed.), 366*, l4898.

Xue, H., Rutkowski, M.P., Clausen, D., Walsh, D., Wintner, M., Kathuria, H., … Kaiser Permanente Innovation Lab. (2022). 173 Application of artificial intelligence to predict survival in patients with Chronic Kidney Disease (CKD) Stage 4-5. *American Journal of Kidney Diseases*, 79(4), 53.

Zhou, X. J., Zhong, X. H., & Duan, L. X. (2023). Integration of artificial intelligence and multi-omics in kidney diseases. *Fundamental Research, 3*(1), 126-148.

APPENDIX

Article Id	Author	Year	Country	Database
RT-1	Díez-Sanmartín et al.	2021	Spain	Science Direct
RT-2	Ho et al.	2024	USA	Science Direct
RT-3	Grobe et al.	2023	Germany	Science Direct
RT-4	Kianian et al.	2024	USA	Science Direct
RT-5	Zhou et al.	2023	Chaina	Science Direct
RT-6	Sawhney et al.	2023	India	Science Direct
RT-7	Nadkarni and Kotanko	2022	USA	Science Direct
RT-8	Xue et al.	2022	USA	Science Direct
RT-9	Dharmarathne et al.	2024	Australia	Science Direct
RT-10	Pareek et al.	2023	India	IEEE
RT-11	Savitha et al.	2022	India	IEEE
RT-12	Sameena et al.	2023	India	IEEE
RT-13	Khade et al.	2021	India	IEEE
RT-14	Hegde and Mundada	2022		Emerald Insight

MYKIDNEY APPLICATION: OPTIMIZING M-HEALTHCARE FOR ENHANCED CHRONIC KIDNEY DISEASE SELF-CARE MANAGEMENT - A RESEARCH STUDY

RAMIYA BALARAMAN[1], AHGALYA SUBBIAH[1*]

[1]*Faculty of Information Science and Engineering, Management and Science University Section 13, 40100 Shah Alam, Selangor, Malaysia*

**Corresponding author: ahgalya_subbiah@msu.edu.my*

ABSTRACT: Chronic Kidney Disease (CKD) poses a significant global health challenge due to deficiencies in patient engagement, leading to disease progression and increased strain on healthcare systems. In chronic kidney disease, insufficient patient engagement in self-management behaviors, such as adhering to dietary restrictions and medications, increases the risk of complications and burdens the healthcare system, underscoring the need for effective strategies to encourage active participation. This project aims to address these challenges by developing the "My-Kidney" mobile health application, designed to empower CKD patients through comprehensive self-management tools and crucial health information. Utilizing an Agile methodology, the development process focuses on iterative feedback and rapid prototyping to ensure user-centric design and functionality. Qualitative research methods are employed to explore patient health management strategies and preferences, informing the application features and usability. By promoting active patient participation in self-care practices and providing tailored support, the "My-Kidney" app aims to improve health outcomes and reduce healthcare burdens. Through technological innovation and patient-centered care, this initiative seeks to catalyze a paradigm shift in CKD management, offering personalized and empowered healthcare delivery for patients worldwide.

KEY WORDS: *Chronic Kidney Disease (CKD),Mobile Health Application, Remote Monitoring, Patient Engagement, Disease Management*

1. INTRODUCTION

Chronic kidney disease (CKD) represents a significant global health challenge, characterized by a spectrum of renal impairments leading to a gradual decline in kidney function (Webster et al., 2017). With its prevalence rapidly escalating, CKD affects millions worldwide, exerting substantial burdens on healthcare systems and individual well-being (Deng et al., 2021). Despite advancements in medical understanding and treatment modalities, CKD remains a leading cause of morbidity and mortality, necessitating comprehensive strategies for prevention, management, and patient engagement (P. K. T. Li et al., 2020). Human Kidney or known also as renal care is a crucial aspect of maintaining a healthy lifestyle. Fig. 1 demonstrates a healthy renal and poorly maintained renal.

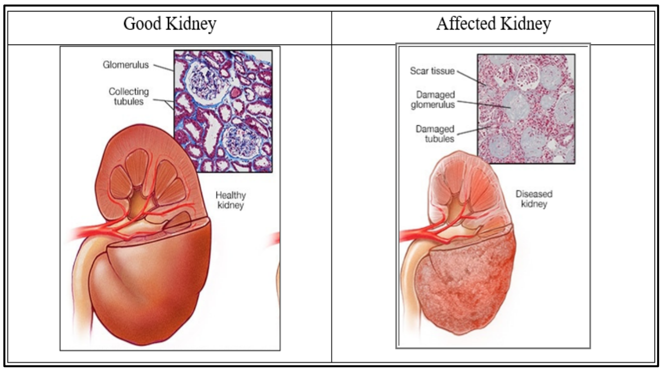


Fig. 1. Renal Overview

A brief overview of normal kidney function serves as a strong basis for understanding chronic renal disease. The kidneys' principal function is to eliminate waste and excess water from the circulation, releasing urine as a byproduct. A good passage from the nephron to the urethra is vital. A clean passage from the nephron to the urethra is required, and each kidney has 700,000 to 1 million filtering units or nephrons. CKD is caused by problems that gradually limit the number or function of nephrons. When the kidneys function properly, they maintain the body's fluids and chemicals in balance. Any imbalance might cause signs of kidney disease. Swelling, notably around the feet and ankles, may manifest in some CKD cases before other symptoms emerge. Even in advanced stages of kidney failure, individuals may continue to produce a seemingly normal amount of urine, though it lacks sufficient waste product elimination. While CKD is typically thought to be a slowly progressing illness, the rate of advancement varies between individuals and is determined by factors such as the underlying cause of CKD, overall health, genetics, and the efficacy of medical treatments. Early detection, lifestyle changes, and timely medical intervention are critical to effectively manage the condition and prevent or delay its progression to more severe stages. Regular monitoring and prompt intervention are vital in managing CKD and mitigating its associated symptoms and complications.

CKD's multifaceted nature encompasses various physiological abnormalities, including compromised renal function and declining Glomerular Filtration Rates (GFR) (Deng et al., 2021). Its impact reverberates across demographics and geographies, with South Asia notably bearing a high prevalence. Notably, CKD's insidious progression underscores its status as a silent epidemic, often evading detection until advanced stages. Risk factors such as diabetes, hypertension, and cardiovascular disease contribute significantly to CKD's pathogenesis, amplifying its global health footprint (Chen et al., 2019; Ghelichi-Ghojogh et al., 2022). Furthermore, one of the key challenges in managing CKD is the limited access that patients have to essential educational materials and monitoring tools. A critical issue is the inconsistency in information availability, which often leaves patients struggling to find comprehensive and up-to-date educational resources.

A significant challenge within the CKD patient population is the insufficient awareness and understanding of their condition, which impairs their ability to effectively self-manage it. Many CKD patients lack knowledge about the causes, progression, and potential consequences of their disease, leading to difficulties in making informed decisions regarding self-management. This knowledge gap often results in non-adherence to prescribed treatment regimens, as patients may not fully grasp the rationale behind dietary restrictions, medications, and lifestyle changes. Moreover, inadequate disease understanding can lead to delayed or missed diagnoses, as patients may underestimate or overlook CKD symptoms.

Addressing the complexities of CKD management necessitates a nuanced understanding of the challenges impeding effective care delivery (Schrauben et al., 2021). Foremost among these challenges is the inadequate engagement of patients in self-management behaviors, including medication adherence and dietary compliance. Such lapses not only exacerbate CKD progression but also strain healthcare resources (Liu et al., 2014). Moreover, insufficient monitoring and management of comorbidities like diabetes and hypertension further compound CKD's trajectory, underscoring the need for integrated care approaches.

2. REVIEW OF LITERATURE

Chronic Kidney Disease (CKD) is a complex health issue characterized by gradual kidney function loss. The severity of CKD is often evaluated using the estimated glomerular filtration rate (eGFR) from serum creatinine concentration. Early identification of CKD stages is crucial, as complications and end-stage renal disease progression are more common in severe cases. CKD poses significant challenges for patients, affecting their daily lives and requiring diligent care management to mitigate risks and improve outcomes. CKD profoundly affects patients' daily lives, with symptoms ranging from fatigue and weakness to complications such as hypertension, anemia, and bone disease. According to a study published in the Journal of Renal Nutrition, CKD patients often experience reduced quality of life due to physical symptoms and psychological distress associated with the disease (Russell et al., 2022). Furthermore, CKD imposes dietary restrictions and lifestyle modifications, leading to challenges in meal planning, social interactions, and overall well-being.

Apparently, failure to manage CKD effectively can result in serious complications, including cardiovascular disease, kidney failure, and premature death. Research published in the American Journal of Kidney Diseases highlighted the heightened risk of cardiovascular events among CKD patients, emphasizing the need for comprehensive care management to address modifiable risk factors such as hypertension, diabetes, and dyslipidemia (Schrauben et al., 2021). Managing CKD requires a multifaceted approach, including medication adherence, dietary modifications, regular exercise, and close monitoring of kidney function and associated comorbidities. Medical mobile apps offer promising tools for empowering patients to take control of their health. A review in the Journal of Medical Internet Research suggested that mobile apps can facilitate self-care management by providing educational resources, medication reminders, symptom tracking, and communication with healthcare providers (W. Y. Li et al., 2020). This review explored the impact of CKD on patients' lives, the risks associated with inadequate care, and strategies for effective management, including the role of medical mobile apps.

The exploration process undertaken in this review delved into previous research focusing on self-care management, particularly for patients with CKD. By analyzing literature and technological advancements related to CKD management, including epidemiology, diagnosis, treatment strategies, and patient engagement, insights were synthesized from 24 research articles as presented in Table 1. These insights serve to highlight the development of the "My-Kidney app," envisioned as a user-centric healthcare application tailored to the specific needs of CKD patients. The analysis conducted aims to identify existing features, gaps, challenges, and opportunities in CKD management. By examining the literature, this review sets out to determine the critical elements necessary for the proposed app's development. Through this exploration, the review seeks to uncover insights that will shape the creation of a more effective and user-centric healthcare solution for CKD patients. Central to this review is the assessment of features present in existing applications, encompassing areas such as symptom monitoring, dietary guidance, educational resources, self-management tools, medication tracking, fluid balance monitoring, patient information provision, accessibility, ease of navigation, and user-friendliness. By evaluating these features across a spectrum of reviewed applications authored by different researchers, this review sheds light on the diverse dimensions of functionality and usability within the realm of CKD management applications.

Table 1: Review on Published Papers Based on Features of My Kidney-Application Development

Author	Year	Application Feature					Technological Integration		Patient		
		Symptom monitoring	Dietary Guidance	Education Resource	Self -Management	Medication Tracking	Fluid balance	Patient Information	Accessibility	Easy to Navigate	User-Friendly
Siddique et al.	2019	✓	✓		✓	✓		✓			
Markossian et al.,	2021	✓	✓	✓		✓			✓		
Schrauben et al	2021	✓			✓						
Che Johan et al	2023	✓		✓					✓		
W. Y. Li et al.	2020	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Lee et al.	2018	✓			✓	✓					
Lightfoot et al.	2022	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Lo et al.	2017	✓	✓			✓	✓				
Kovesdy	2022	✓		✓				✓			
Chen et al.	2019	✓		✓	✓				✓		

The works of Chen et al. (2019) provided a broad environment in the domain of health application research for chronic disease management. The studies inquiry confirmed the inclusion of features such as symptom monitoring, nutritional assistance, self-management, and medication recording. Besides that, study by Chen et al. (2019) emphasized comparable elements but did not go into detail on education resources, fluid balance monitoring, patient information offering accessibility, ease of navigation, or user-friendliness. A study by Ghelichi-Ghojogh et al. (2022) highlighted symptom monitoring and self-management components but did not address dietary guidance, education resources, medication tracking, fluid balance monitoring, patient information provision, accessibility, ease of navigation, or user-friendliness. A study conducted in 2023 acknowledged symptom monitoring, self-management, and accessibility features but did not mention dietary guidance, education resources, medication tracking, fluid balance monitoring, patient information provision, ease of navigation, or user-friendliness (Che Johan et al., 2023). A comprehensive 2021 study of Markossian et al. (2021) stood out for its inclusive coverage of features such as symptom monitoring, dietary guidance, education resources, self-management, medication tracking, fluid balance monitoring, patient information provision, accessibility, ease of navigation, and user-friendliness.

Besides that, in Siddique et al. (2019), application developments focus on symptom monitoring, self-management, and medication tracking but exclude nutritional assistance, education resources, fluid balance monitoring, patient information availability, accessibility, simplicity of navigation, and user-friendliness. On the other hand, Liu et al. (2014) considered a wide range of features, such as symptom monitoring, dietary guidance, education resources, self-management, medication tracking, fluid balance monitoring, patient information provision, accessibility, ease of navigation, and user-friendliness. However, although most studies focused on monitoring and nutritional guidance, they failed to examine education resources, self-management, medication tracking, fluid balance monitoring, patient information availability, accessibility, simplicity of navigation, or usability. In further support of Liu et al. (2014), a review by Lee et al. (2018) acknowledged symptom monitoring, self-management, and accessibility, but it made no clear mention of nutritional guidance, education resources, medication tracking, fluid balance monitoring, patient information providing, ease of navigation, or user-friendliness. Several challenges emerged from the literature review, notably the inconsistencies in the inclusion of essential features across different CKD management applications. While some studies comprehensively covered a wide range of features, others lacked depth in certain areas, such as educational resources, fluid balance monitoring, and ease of navigation. Additionally, the varying emphasis placed on different aspects of CKD management by different researchers contributed to discrepancies in the findings. Addressing these challenges requires a nuanced approach, including the development of standardized criteria for evaluating CKD management applications and fostering collaboration among researchers to ensure comprehensive coverage of essential features.

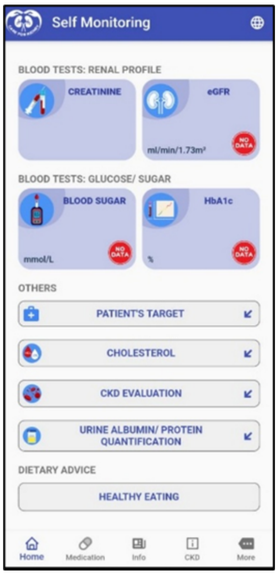
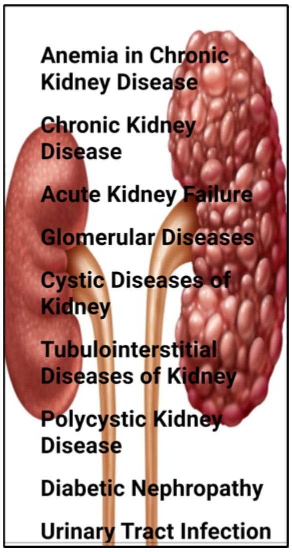
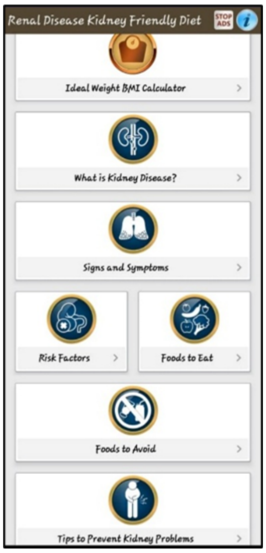
The analysis of various applications dedicated to CKD management reveals several key features and technological integrations aimed at supporting patients in self-care management. Symptom monitoring emerges as a prevalent feature across the majority of applications, indicating a strong emphasis on real-time tracking to facilitate timely intervention and management. Similarly, dietary guidance features are widely incorporated, highlighting the recognition of nutrition's critical role in disease management and the importance of aiding patients in adhering to dietary restrictions. While about half of the applications offer educational resources, indicating a focus on patient education and empowerment, self-management tools are prevalent, underscoring the significance of empowering patients to take an active role in their care. Medication tracking functionalities are also common, aiding patients in adhering to complex medication regimens critical for optimizing treatment outcomes. However, the presence of fluid balance monitoring features is comparatively limited, suggesting a potential area for improvement in future app developments to address this essential aspect of CKD care. Moreover, the provision of patient information across many applications facilitates access to essential health resources and fosters informed decision-making among patients. While not explicitly listed, considerations such as accessibility, ease of navigation, and user-friendliness are integral to enhancing the overall usability and effectiveness of healthcare applications. Overall, the analysis underscores a positive trend towards leveraging technology to support CKD patients in self-care management, while also highlighting potential areas for further enhancement and innovation to provide comprehensive and patient-centered care solutions. To overcome the challenges identified, several solutions can be proposed. Firstly, establishing clear guidelines or criteria for evaluating CKD management applications can help ensure consistency and comparability across studies. This would enable researchers to systematically assess the presence and effectiveness of key features, facilitating more meaningful comparisons and insights. Secondly, fostering collaboration and knowledge-sharing among researchers in the field can enhance the collective understanding of CKD management applications and facilitate the identification of best practices. Finally, continuous monitoring and evaluation of emerging technologies and trends in CKD management can guide ongoing refinement and improvement of existing applications, ensuring their relevance and effectiveness in addressing the evolving needs of CKD patients. Through these measures, the literature review contributes to the ongoing discourse on CKD management applications, offering insights into current challenges and potential avenues for future research and development efforts.

3. REVIEW OF EXISTING APPLICATION

This study seeks to empower CKD patients to prioritize personal care management and address health and lifestyle concerns affecting themselves and their peers. Through the utilization of a digital application, the study aims to assess patients' knowledge regarding CKD management and potential threats to their well-being. To guide the development of this application, a review of existing systems with similar objectives was conducted to identify essential features that can be incorporated and customized. Three existing applications with comparable purposes were selected for analysis, with each application summarized for reference. Table 2 presents the detailed comparison of similar products related to CKD.

Table 2: Comparison of Similar CKD Mobile Applications

System Name	CKd(Care for Kidney)	All Kidney Disease	Kidney Renal Disease Diet Help
Developer Name	Altus Solution Sdn Bhd	Devo Dream Team	Data Recovery Software
Manufactured Year	2022	2022	2016
Purpose	The "Care for Kidney (CKd)" app promotes kidney health and educates users about chronic kidney disease through user-friendly features, language options, and personalized self-monitoring tools.	The app offers a user-friendly interface and comprehensive information on renal disease, along with expert advice on kidney-friendly foods from qualified nutritionists. This empowers users to take control of their kidney health and maintain optimal well-being	Renal Health Guide" is an app providing answers to user questions and offering diet tips approved by dietitians for kidney health. It's designed for kidney patients and anyone seeking better kidney health.
Strength	The "Care for Kidney (CKd)" app, funded by the National Kidney Foundation Malaysia, helps promote kidney health and educate users about chronic kidney disease (CKD). It's easy to use, with features like self-monitoring, medication reminders, and health education. Users can share their health data with healthcare providers, and healthcare workers can monitor multiple users through a central web app.	The "All Kidney Diseases Guide" app on Android is a one-stop resource for kidney health information. It covers kidney diseases like CKD, infections, stones, and injuries, offering expert advice on symptoms, treatments, and prevention. It's a handy tool for anyone looking to keep their kidneys healthy.	"Renal Disease Info & Diet Tips" is an easy-to-use app that gives comprehensive details on kidney diseases, causes, symptoms, and recommended foods. Reviewed by dietitians, it's well-organized for simple navigation, empowering kidney patients and those interested in kidney health.
Weakness	The "Care for Kidney (CKd)" app has some strengths, like being available in multiple languages and letting users set personalized goals. But it also has challenges, such as technical issues and keeping users engaged. To make it better, the app could focus on improving data security, adding more educational content,	The "All Kidney Diseases Guide" app has some flaws, including the need for frequent content updates, improving navigation and accessibility in the user interface, and ensuring the accuracy of medical information. Adding interactive features and feedback systems could enhance the app's	To stay current with developments in renal health, the "Renal Disease Info & Diet Tips" app might need regular updates. Enhancing user engagement through interactive features and feedback mechanisms could enhance the app's overall user experience.

	and considering cultural differences. It could also integrate wearable devices, offer better personalization, provide user training, and seek clinical validation to enhance its impact on kidney health promotion and self-management.	effectiveness, reliability, and user satisfaction.	Expanding its audience to include healthy individuals, both men and women, could also broaden its reach and effectiveness.
System Interface			

In summary, each app presents its unique strengths and weaknesses, addressing various aspects of kidney health. Altus Solution Sdn Bhd's "CKD (Care for Kidney)" app, developed in 2022, prioritizes personalized care and multilingual accessibility, supported by the National Kidney Foundation Malaysia. While it offers self-monitoring tools, it faces challenges like technological limitations and user engagement sustainability. Enhancements such as improved data security and cultural adaptations are underway to address these issues. On the other hand, the "All Kidney Diseases Guide" app provides expert advice on kidney health issues but requires frequent content updates and improvements in user interface navigation. Finally, Data Recovery Software's "Renal Disease Info & Diet Tips" software, launched in 2016, offers extensive information on renal disorders and diets, boasting an easy-to-use interface and educational content. However, regular upgrades and increased user involvement through interactive features and feedback mechanisms are recommended to enhance the overall user experience.

Moreover, in order to provide best features for the proposed app, the comparison analysis of the three existing systems in the market focuses on evaluating their features related to fluid balance, educational materials, dietary guidance, blood pressure monitoring, and diabetes monitoring as presented in Table 3. These components are crucial for effective kidney health management. The review aims to provide users with insights into the unique offerings of each product, enabling them to make informed decisions based on their specific needs and preferences. This comparative analysis is also essential for researchers seeking to propose the best features for the development of the MyKidney app.

Table 3. Comparison of Features for Proposed Model

Features	Products vs. Proposed App			
	CKd(Care for Kidney)	All Kidney Disease	Kidney Renal Disease Diet Help	Propose App
Fluid Intake Balance	No	No	No	Yes
Educational Material	Yes	Yes	Yes	Yes
Dietary Guidance	No	No	Yes	Yes
Blood Pressure Monitor	Yes	No	No	Yes
Diabetes Monitoring	Yes	No	No	Yes

In evaluating the features of existing kidney health applications, including CKd (Care for Kidney), All Kidney Disease, and Kidney Renal Disease Diet Help, each app presents specific strengths and limitations. CKd stands out for its educational material, blood pressure monitoring, and diabetes monitoring features, yet it lacks functionalities such as fluid intake balance management and dietary guidance. On the other hand, All Kidney Disease offers comprehensive educational content, dietary guidance, and blood pressure monitoring. Meanwhile, Kidney Renal Disease Diet Help emphasizes dietary guidance and blood pressure monitoring but falls short in addressing fluid intake balance and diabetes monitoring.

In contrast, the proposed My-Kidney application aims to encompass all features listed in the table. From fluid intake balance management to educational materials, dietary guidance, blood pressure monitoring, and diabetes monitoring, My-Kidney strives to offer a comprehensive and user-friendly solution for individuals managing kidney health. By amalgamating these functions into a single application, My-Kidney seeks to bridge existing gaps in feature availability within current applications, providing users with a robust platform to proactively manage their kidney health with ease and efficacy.

4. METHODOLOGY

In the development of the healthcare application for CKD patients, a qualitative study approach was adopted, incorporating open-ended interview questions to glean insights from a sample size of two CKD patients and two staff members. To ensure patients' comfort and facilitate in-depth discussions, each session was recorded and later transcribed for analysis. Thematic analysis was applied to identify recurring themes, which were then coded to align with the development of the application. Figure 2 illustrates the research design of this study.

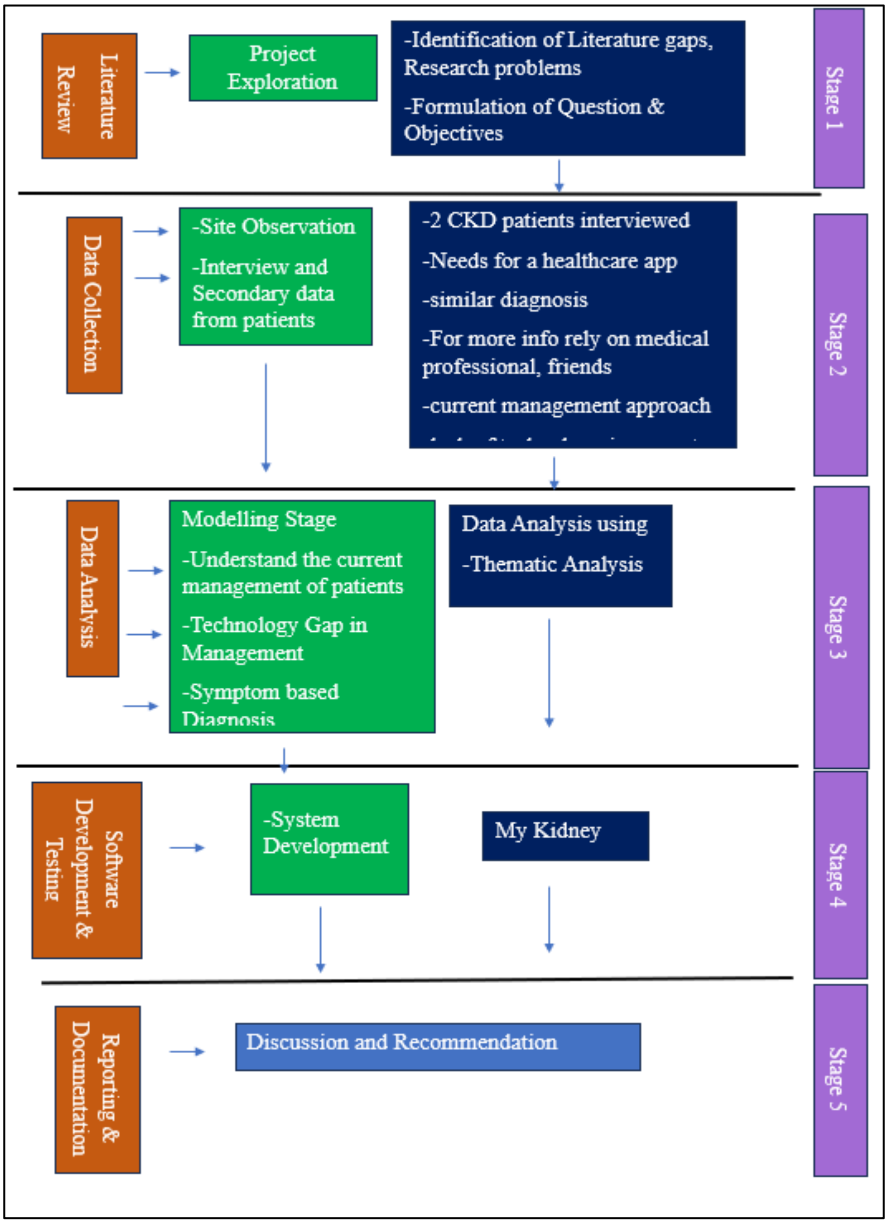


Fig.2. Research Design

The Agile methodology was chosen for the development process due to its fundamental flexibility, adaptability, and patient-centric approach. Agile's iterative development method enables constant feedback and real-time adaptations, which are crucial in the dynamic landscape of healthcare. This approach allows for the incorporation of changing healthcare recommendations, patient needs, and regulatory requirements. Furthermore, Agile's patient-centered approach resonates effectively with the development of a CKD application tailored to meet patients' specific needs and experiences. By emphasizing cooperation among cross-functional teams, Agile ensures that medical expertise is integrated into the development process, which is essential for a healthcare application. The adaptability of Agile to changes, continuous delivery of incremental value, and risk mitigation strategies make it well-suited for the complexities and uncertainties inherent in healthcare projects. Ultimately, this approach contributes to the development of a responsive, patient-centered, and effective CKD application that addresses the diverse needs of patients and healthcare providers alike. Table 4 presents a summary of the process flow.

Table 4: Agile Process Description

Phases	Input	Process	Output
Planning	-Meet supervisor, discuss on plan, -search for relevant paper according to title -Plan to visit dialysis centre	-Conduct search for case study -Definition of project scope and objectives	Completed project thesis of chapter 1 and 2
Design	-Sketch UML Diagrams - Design Interview Questions	-Creation of UML diagrams (e.g use case diagram, class diagram) - Visited a Dialysis Centre and Interviewed two patients.	-Completion of UML diagrams for application -Successfully conducted at Sai Ananda Free Hemodialysis Centre
Development	-Begin to develop the application	- Iterative coding and development -Regular meet up with supervisor	- Functional healthcare application
Testing	-test the developed application	- Conduct unit testing, user acceptance testing	- Bug-free and fully functional application
Deploy	-The tested phase completed and the application is approved	- Deploy the application on any platform -Monitor for any possible issues	- Successfully deployed healthcare app
Review	-Check for user feedback	- Evaluate feedback and performance of the app -Changes are made based on the feedback given	-Updated version of the healthcare app

4.1. Case Study

The chosen case study focuses on a dialysis center located in Laksamana, 340, Jalan Laksamana 2/2, 68100 Batu Caves, Selangor, which has been operational since 2018 as illustrated in Fig. 3. Over time, the center has witnessed a significant increase in the number of patients it serves, transitioning from an initial number of 4 patients to a current count of 36 individuals. Operating seven days a week, the center offers dialysis services from 7: 00 a.m. to 5:00 p.m. daily except on Sundays and public holidays. Presently, the center is staffed with a team comprising 9 employees, including supervisors and management staff. However, an interview with management personnel revealed a concerning trend wherein most patients lack personal care management records and rely solely on the center's record-keeping system. This reliance poses a considerable risk during emergencies, as there is no provision for shared electronic records via cloud-based platforms for the management of CKD patients, especially concerning individual treatment histories and immediate care requirements. This scenario underscores the critical need for enhanced data management practices and technological solutions within the dialysis center to ensure comprehensive and timely care for CKD patients. By implementing cloud-based electronic health records (EHR) systems, the center can facilitate seamless sharing of patient information among healthcare providers, enabling swift and informed decision-making during emergencies. Moreover, personalized care management plans can be established and updated regularly, incorporating patient-specific treatment protocols and preferences. Through such initiatives, the dialysis center can mitigate risks associated with inadequate record-keeping practices, thereby improving the quality and efficiency of care delivery for CKD patients.

Fig. 3. Sai Dialysis Centre

5. FINDINGS

The aim of this pilot study was to obtain a deeper understanding of the management of Chronic Kidney Disease (CKD) by conducting semi-structured interviews with CKD patients who are receiving treatment at a hemodialysis center. Table 5 presents the demographic summary applied for this pilot study.

Table 5: Demographic Summary of Semi-Structured Interview Participants

Age	Race	Gender	Occupation	Location	Years of Dialysis
68	Indian	Male	Unemployed	Selayang	5 years
43	Indian	Male	Employed	Batu Caves	2 years
33	Indian	Male	Employed	Sungai Tua	6 years
36	Indian	Male	Employed	Selayang	3 years
33	Indian	Male	Employed	Selayang	3 years
38	Chinese	Female	Unemployed	Sungai Tua	6 years
36	Chinese	Male	Employed	Selayang	4 years
67	Indian	Male	Unemployed	Selayang	4 years
45	Chinese	Male	Employed	Batu Caves	5 years
38	Chinese	Female	Unemployed	Sungai Tua	2 years

The demographic data of the research participants are summarized in the above table. There are five Indian males sampled, with their age ranging from 33-68 years. Their occupational statuses also vary with one out of work, while the rest are employed. In terms of geographical residence, there are three residing at Selayang, one at Batu Caves, and one residing at Sungai Tua. It also indicates the time dependencies of treatment from dialysis, with a range of 2 to 6 years. As such, this demographic data presents a whole background against which the experiences and perceptions of the interviewees can be understood. The interviews unveiled various significant discoveries. Initially, the participants frequently mentioned symptoms such as edema in the legs, high blood pressure, and diabetes as crucial signs that resulted in their diagnosis of chronic kidney disease (CKD), emphasizing the significance of promptly identifying and dealing with these symptoms. Furthermore, participants highlighted the importance of controlling fluid and sugar intake as a critical aspect of managing CKD, indicating that dietary adjustments have a vital role in this regard. This emphasizes the significance of tailored nutritional advice and assistance for individuals with chronic kidney disease (CKD). Moreover, the process of undergoing dialysis was characterized as physically strenuous and disruptive to everyday activities, highlighting the significant burden that dialysis places on patients and the necessity for comprehensive assistance. Ultimately, the participants indicated a desire for actionable recommendations and direction from their peers, emphasizing the importance of peer support networks in supplementing official healthcare education. In summary, the results indicate that healthcare technology solutions and interventions should be created with a specific emphasis on the viewpoints and requirements of patients. By incorporating patient perspectives and giving priority to user-friendly and tailored solutions, healthcare practitioners and technology developers can optimize results in managing chronic kidney disease (CKD) and enhance the overall quality of life for CKD patients.

The thematic analysis of the semi-structured interviews with CKD patients and staff members revealed several key themes essential for the design and functionality of the My-Kidney application. The thematic analysis method was chosen for its ability to identify and interpret patterns within qualitative data, providing a nuanced understanding of participants' experiences and needs. By examining the themes that emerged from the interviews, this study seeks to align the My-Kidney application with the real-world requirements of CKD patients and healthcare providers. The findings from this analysis are crucial for developing a user-centric application that enhances patient engagement, self-management, and overall health outcomes.These themes, identified through rigorous analysis, highlight the critical areas necessary for improving CKD management through mobile health applications. Table 6 presents the identified themes from the pilot study.

Table 6: Thematic Analysis Findings

Theme	Identified Need	Exisiting Literature
Symptom Monitoring	Monitoring symptoms like edema, high blood pressure, and blood sugar levels	Consistent with Schrauben et al. (2021)
Dietary Guidance	Adjusting diet, controlling fluid and sugar intake	Supported by Lee et al. (2018) and Markossian et al. (2021)
Educational Resources	Comprehensive materials on CKD management	Corroborated by Chen et al. (2019) and Lightfoot et al. (2022)
Medication Tracking	Adherence to complex medication regimens	Highlighted by Siddique et al. (2019) and W. Y. Li et al. (2020)
Peer Support Networks	Support from peers for education and recommendations	Noted as beneficial by Schrauben et al. (2021)
User-Friendly Interface	Usability and ease of navigation for sustained u	Emphasized by Lo et al. (2017) and Kovesdy (2022)

The My-Kidney healthcare app integrates several critical themes to provide a comprehensive platform for CKD management. Accurate and user-friendly symptom monitoring tools are essential for early detection and management of CKD complications. The challenge lies in ensuring that patients consistently use these features, which require intuitive designs and continuous patient education. Advances in wearable technology and IoT offer promising solutions for real-time tracking of symptoms like edema, blood pressure, and blood sugar levels. However, integrating these technologies into a mobile application must balance affordability and accessibility (Kovesdy, 2022). Additionally, maintaining patient engagement through motivational features like reminders and progress tracking is crucial for the success of symptom monitoring tools. Providing personalized dietary recommendations is another critical theme that presents several challenges. Accurate patient data is necessary to tailor dietary guidelines, which must be continuously updated to reflect current best practices. Additionally, cultural and individual dietary preferences must be considered to ensure adherence. Technological integration of meal logging and instant feedback features can enhance dietary management, but ensuring the accuracy of logged data and providing meaningful insights remains challenging. Educating patients about the significance of dietary management and effective use of these features is crucial for their success (W. Y. Li et al., 2020).

Developing and maintaining up-to-date educational content requires collaboration with healthcare professionals and regular updates. Ensuring that the information is engaging and accessible is also a challenge. Interactive educational tools, like videos, quizzes, and infographics, can significantly enhance patient learning. However, creating high-quality content demands substantial resources. Encouraging patients to utilize these resources requires integrating them with other app features, such as symptom monitoring and dietary guidance, to make learning a seamless part of their daily self-management routine. Medication tracking is vital for ensuring adherence to complex medication regimens. Technological solutions, such as medication reminders, pill identification tools, and interaction warnings, can enhance medication management. However, integrating these features without overwhelming users with notifications requires careful design. Educating patients on the importance of medication adherence and providing clear, easy-to-use interfaces are essential for ensuring compliance. Effective medication tracking can also be supported by educational resources that explain the importance of each medication and its role in managing CKD (Che Johan et al., 2023).

Facilitating meaningful interactions within peer support networks presents challenges, including ensuring the quality and reliability of shared information and addressing privacy concerns. Technological features like forums, chat groups, and peer mentoring programs can foster a supportive community. However, maintaining active participation and a positive environment requires ongoing management. Encouraging patients to engage with peer support networks involves highlighting their benefits and integrating these features seamlessly within the app to make them easily accessible. Peer support can also enhance the effectiveness of educational resources and dietary guidance by providing practical advice and emotional support (Subbiah et.al, 2024).

The My-Kidney healthcare app integrates these critical themes to create a comprehensive and effective platform for CKD management. Addressing the challenges associated with each theme—such as intuitive design, continuous education, accurate data integration, and active patient engagement—will enhance the app's functionality and user experience. By leveraging advances in technology and fostering a supportive community, the My-Kidney app aims to transform CKD management and improve patient outcomes.

6. MY-KIDNEY APPLICATION DEVELOPMENT

Current mobile applications mostly concentrate on monitoring diabetes and blood pressure, but there is a significant deficiency in addressing the specific requirements of those with chronic kidney disease (CKD). Understanding the significance of customized solutions for this specific group, "My-Kidney" seeks to transform healthcare management by placing water intake monitoring as a key focus. Unlike general health applications, "My-Kidney" is specifically tailored to meet the distinct needs of individuals with Chronic Kidney Disease (CKD), providing a comprehensive platform to enhance health results.

The objectives of the project are:

1. To understand how CKD patients plan their health management, including their current strategies, challenges faced, and areas for improvement.

2. To identify and promote health information and self-monitoring practices related to water intake among CKD patients, empowering them to make informed decisions about their hydration levels.

3. To develop a mobile healthcare application, "My-Kidney," tailored to the needs of CKD patients, providing user-friendly tools for tracking water intake, accessing educational resources, and facilitating communication with healthcare providers.

The following images of Fig. 4 illustrates the MyKidney M-Healthcase Application Designs.

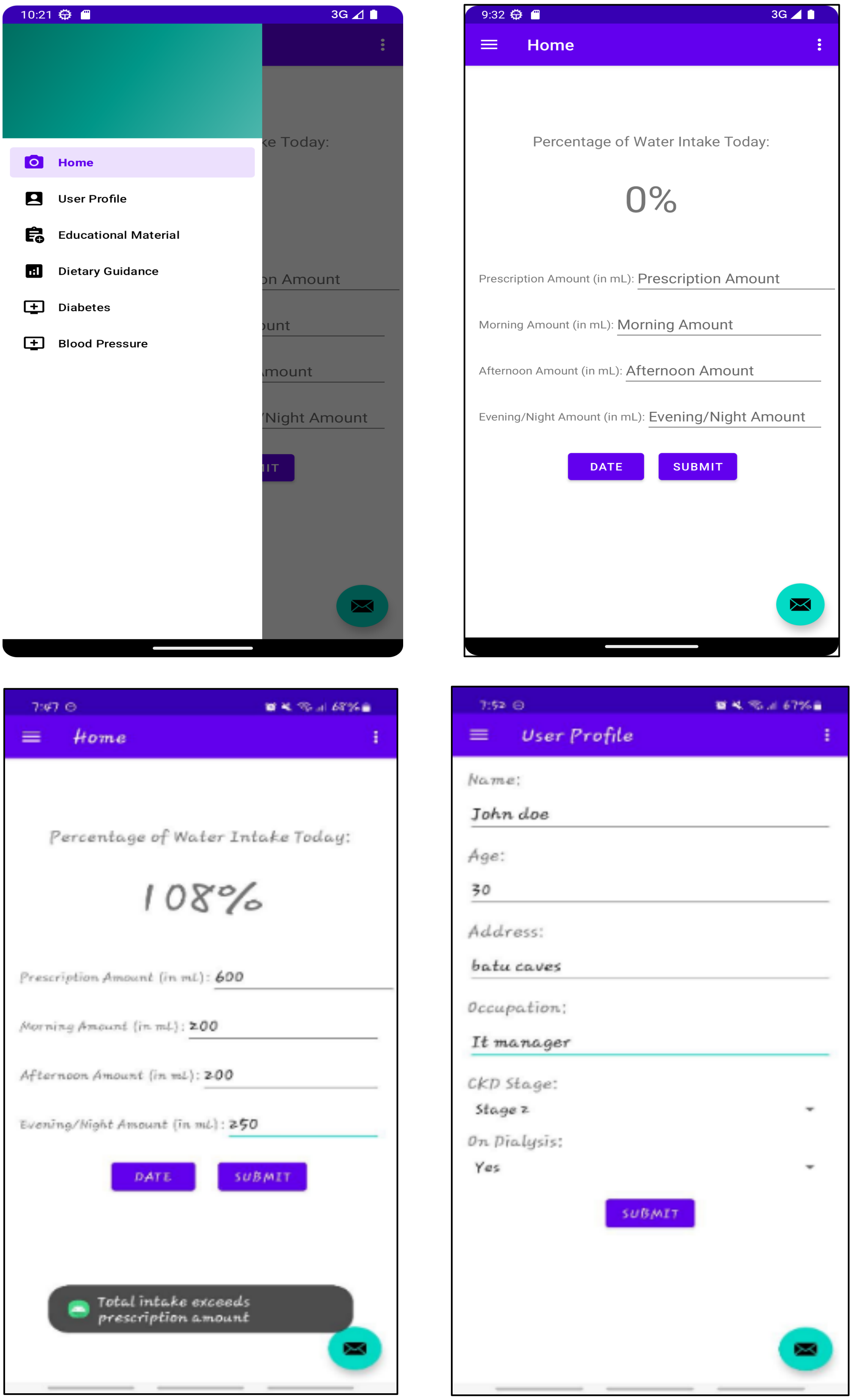


Fig. 4. My-Kidney Application Interface Design

7. CONCLUSION

The My-Kidney healthcare app is an essential tool for treating chronic renal failure. It combines knowledge of CKD pathology, patient needs, and technological improvements to bridge the gap between traditional and modern healthcare solutions. The application's user-centric design and iterative development approach create a solid platform for self-management, teaching, and monitoring. It has functions such as fluid intake tracking, blood pressure monitoring, diabetes management, and instructional materials. The seamless connection between users and administrators ensures that the information is relevant, accurate, and adaptable. The My-Kidney system design is a comprehensive approach to CKD management that aims to transform healthcare delivery and enhance patient outcomes. The My-Kidney healthcare app integrates these critical elements to create a comprehensive and effective platform for CKD management. Addressing the challenges associated with each element—such as intuitive design, continuous education, accurate data integration, and active patient engagement—will enhance the app's functionality and user experience. By leveraging advances in technology and fostering a supportive community, the My-Kidney app aims to transform CKD management and improve patient outcomes. The app's holistic approach ensures that all aspects of CKD management are covered, from monitoring and education to dietary management and emotional support.

Looking forward, the insights gained from the development and implementation of the My-Kidney app will be invaluable for future projects. The emphasis on user-centric design, continuous education, and technological integration provides a blueprint for developing similar applications for other chronic diseases. Future projects can benefit from the lessons learned in balancing technological sophistication with user accessibility and engagement. By continuously refining these strategies based on user feedback and technological advancements, we can create even more effective healthcare solutions that address the specific needs of different patient populations, ultimately improving health outcomes and quality of life on a broader scale.

ACKNOWLEDGEMENT

This study is based on Final Year Project (FYP) under the Information System for the Bachelor' in Computer Science program, Faculty of Information Sciences & Engineering (FISE), Management and Science University, Malaysia.

REFERENCES

Che Johan, N. A. S., Mohd Rasani, A. A. & Soon, L. K. (2023). Chronic kidney disease patients' views of readiness and ability to use mHealth apps. *British Journal of Nursing*, 32(2), 74-80.

Chen, T. K., Knicely, D. H., & Grams, M. E. (2019). Chronic Kidney Disease Diagnosis and Management: A Review. In JAMA - Journal of the American Medical Association*,* 322(13), 1294–1304. American Medical Association.

Deng, Y., Li, N., Wu, Y., Wang, M., Yang, S., Zheng, Y., Deng, X., Xiang, D., Zhu, Y., Xu, P., Zhai, Z., Zhang, D., Dai, Z., & Gao, J. (2021). Global, Regional, and National Burden of Diabetes-Related Chronic Kidney Disease From 1990 to 2019. Frontiers in Endocrinology, *12*. Retrieved from https://doi.org/10.3389/fendo.2021.672350

Ghelichi-Ghojogh, M., Fararouei, M., Seif, M.,& Pakfetrat,M. (2022).Chronic kidney disease and its health-related factors: a case-control study. BMC Nephrology, 23(1), 24.

Kovesdy C. P. (2022). Epidemiology of chronic kidney disease: an update 2022. Kidney international supplements, 12(1), 7–11.

Lee, J. A., Choi, M., Lee, S. A., & Jiang, N. (2018). Effective behavioral intervention strategies using mobile health applications for chronic disease management: A systematic review. BMC Medical Informatics and Decision Making, 18(1), 12.

Lightfoot, C. J., Wilkinson, T. J., Hadjiconstantinou, M., Graham-Brown, M., Barratt, J., Brough, C., Burton, J. O., Hainsworth, J., Johnson, V., Martinez, M., Nixon, A. C., Pursey, V., Schreder, S., Vadaszy, N., Wilde, L., Willingham, F., Young, H. M. L., Yates, T., Davies, M. J., & Smith, A. C. (2022). The Codevelopment of "My Kidneys & Me": A Digital Self-management Program for People With Chronic Kidney Disease. Journal of medical Internet research, 24(11), e39657.

Li, P. K. T., Garcia-Garcia, G., Lui, S. F., Andreoli, S., Fung, W. W. S., Hradsky, A., Kumaraswami, L., Liakopoulos, V., Rakhimova, Z., Saadi, G., Strani, L., Ulasi, I., & Kalantar-Zadeh, K. (2020). Kidney health for everyone everywhere— from prevention to detection and equitable access to care. Hong Kong Medical Journal, 26(1), (e1–e9). Hong Kong Academy of Medicine Press.

Li, W.-Y., Chiu, F.-C., Zeng, J.-K., Li, Y.-W., Huang, S.-H., Yeh, H.-C., Cheng, B.-W., & Yang, F.-J. (2020). Mobile Health App With Social Media to Support Self-Management for Patients With Chronic Kidney Disease: Prospective Randomized Controlled Study. Journal of Medical Internet Research, *22*(12), e19452.

Liu M, Li XC, Lu L, Cao Y, Sun RR, Chen S, Zhang PY. (2014). Cardiovascular disease and its relationship with chronic kidney disease. European review for medical and pharmacological sciences, 18(19), 2918–2926.

Lo, C., Teede, H., Fulcher, G., Gallagher, M., Kerr, P. G., Ranasinha, S., Russell, G., Walker, R., & Zoungas, S. (2017). Gaps and barriers in health-care provision for co-morbid diabetes and chronic kidney disease: a cross-sectional study. BMC Nephrology, 18(1), 80.

Markossian, T. W., Boyda, J., Taylor, J., Etingen, B., Modave, F., Price, R., & Kramer, H. J. (2021). A Mobile App to Support Self-management of Chronic Kidney Disease: Development Study. JMIR Human Factors, 8(4), e29197.

Russell, C. R., Zigan, C., Wozniak, K., Soni, K., Hill Gallant, K. M. and Friedman, A. N. (2022). A Systematic Review and Qualitative Analysis of Existing Dietary Mobile Applications for People With Chronic Kidney Disease. Journal of Renal Nutrition, 32(4), 382–388.

Schrauben, S. J., Appel, L., Rivera, E., Lora, C. M., Lash, J. P., Chen, J., Hamm, L. L., Fink, J. C., Go, A. S., Townsend, R. R., Deo, R., Dember, L. M., Feldman, H. I., Diamantidis, C. J., He, J., Nelson, R. G., Rao, P. S., Rahman, M., Shah, V. O., & Unruh, M. L. (2021). Mobile Health (mHealth) Technology: Assessment of Availability, Acceptability, and Use in CKD. American Journal of Kidney Diseases, *77*(6), 941-950.

Siddique, A. B., Krebs, M., Alvarez, S., Greenspan, I., Patel, A., Kinsolving, J., & Koizumi, N. (2019). Mobile Apps for the Care Management of Chronic Kidney and End-Stage Renal Diseases: Systematic Search in App Stores and Evaluation. JMIR MHealth and UHealth, 7(9), e12604.

Subbiah, A., Darshan, D., Mahfoud, A., & Hamidu, R. (2024). A Comprehensive Review on

Enhancing Urban Efficiency in Klang Valley through Smart Sensor-Based Road Management. Journal of Computing Research and Innovation, 9(1), 16–30.

Webster, A. C., Nagler, E. V, Morton, R. L., & Masson, P. (2017). Chronic Kidney Disease. The Lancet, 389(10075), 1238–1252.