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UNIVERSITY SMART FOOD BANK APPLICATION TOWARDS DEVELOPING A HUNGER-FREE CAMPUS

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ABSTRACT

Food insecurity, a pervasive global challenge, extends its reach to university campuses, posing a pressing concern that affects the well-being of both individuals and entire academic communities. Within the academic realm, campuses grapple with the multifaceted issue of ensuring food security for students, a challenge that demands attention and concerted efforts. Addressing the complexities of this problem involves exploring sustainable solutions and fostering a campus environment where every student has reliable access to nutritious and affordable food options, promoting not only physical health but also overall academic success and well-being. To address this issue, a Smart Food Bank application has been developed for the Android platform, aiming to efficiently manage the university food bank and contribute to achieving zero hunger within the university community. The application encompasses key functions such as food stock management, food allocation, food applications, food donations, and user registration management. Users can track their application status and request food by sharing their location through a map, while donors can specify their donation drop-off points. Designed to streamline interactions among administrators, applicants, and donors, the application aligns with Sustainable Development Goals (SDGs) by targeting hunger eradication and promoting health and well-being. This innovative food bank application not only has the potential to enhance the quality of life for less fortunate members of the university community but also supports broader SDG objectives. Serving as a platform for providing healthy meals, it addresses the university's specific challenges while contributing to global sustainability goals. The application's success suggests its potential for scalability, allowing it to be extended to other food bank facilities or similar organisations. With positive findings, feedback, and impactful outcomes, the Smart Food Bank application stands as a promising tool in the collective effort to achieve zero hunger on a larger scale.

Keywords: food insecurity, hunger-free campus, mobile application, smart food bank, zero hunger.

INTRODUCTION

Food insecurity, the lack of consistent access to sufficient and nutritious food, is a growing concern even within university campuses. Many students face difficulties affording proper meals due to rising tuition fees, high living costs, and limited income opportunities. These challenges often force them to opt for cheaper, less nutritious food or skip meals altogether.

On campus, hunger not only undermines students' physical health but also affects their academic performance, mental well-being, and overall participation in university life. The stigma associated with seeking assistance often discourages students from addressing their food needs, making the problem less visible but equally pressing.

A campus food bank has emerged as a practical and compassionate solution to address student hunger, providing accessible, stigma-free support for those in need. Such initiatives can help ensure that all students, regardless of financial background, have access to adequate and nutritious food.

This article proposes the design and development of a digital food bank application tailored for campus use. The system aims to improve food donation and distribution processes, enhance accessibility, reduce stigma through discreet digital requests, and foster community engagement. By integrating technology into the food bank model, the proposed application aims to create a more efficient, inclusive, and sustainable approach to addressing food insecurity among university students, ultimately advancing the vision of a hunger-free campus.

PREVIOUS WORK

Food Insecurity in Campus

Food insecurity among university students has been widely studied in the US and Canada, with research showing prevalence rates significantly higher than national averages (Coleman-Jensen et al., 2016). Rising tuition fees, living costs, and limited income opportunities have left many students unable to afford sufficient, nutritious food. This issue, once considered "invisible" due to stigma and shame (Cady, 2014), impacts students' health, academic performance, and overall well-being.

Multiple studies identify economic hardship as a primary driver of campus food insecurity, particularly among students with high financial need, loans, housing insecurity, or from minority racial and ethnic backgrounds (e.g., Payne-Sturges et al., 2018; Martinez et al., 2018). Living off-campus without food provision and being financially independent also increases risk (Bruening et al., 2017). Some findings challenge existing literature, such as those by Ahmad, Sulaiman, and Sabri (2021), who found that students with working fathers still experienced food insecurity, possibly due to intra-household resource allocation patterns.

Food insecurity is linked to adverse academic outcomes, with affected students reporting lower GPAs, reduced class attendance, and difficulty concentrating (Morris et al., 2016; Patton-Lopez et al., 2014; Farahbakhsh et al., 2017). Many must work long hours to afford food, further limiting study time (Logan, 2016). Some studies, however, found no direct association with performance (Ahmad Nadzri et al., 2020).

The issue also affects student health and social participation. Food-insecure students are more likely to experience depressive symptoms, suicidal thoughts, and unhealthy eating habits, such as high fast-food

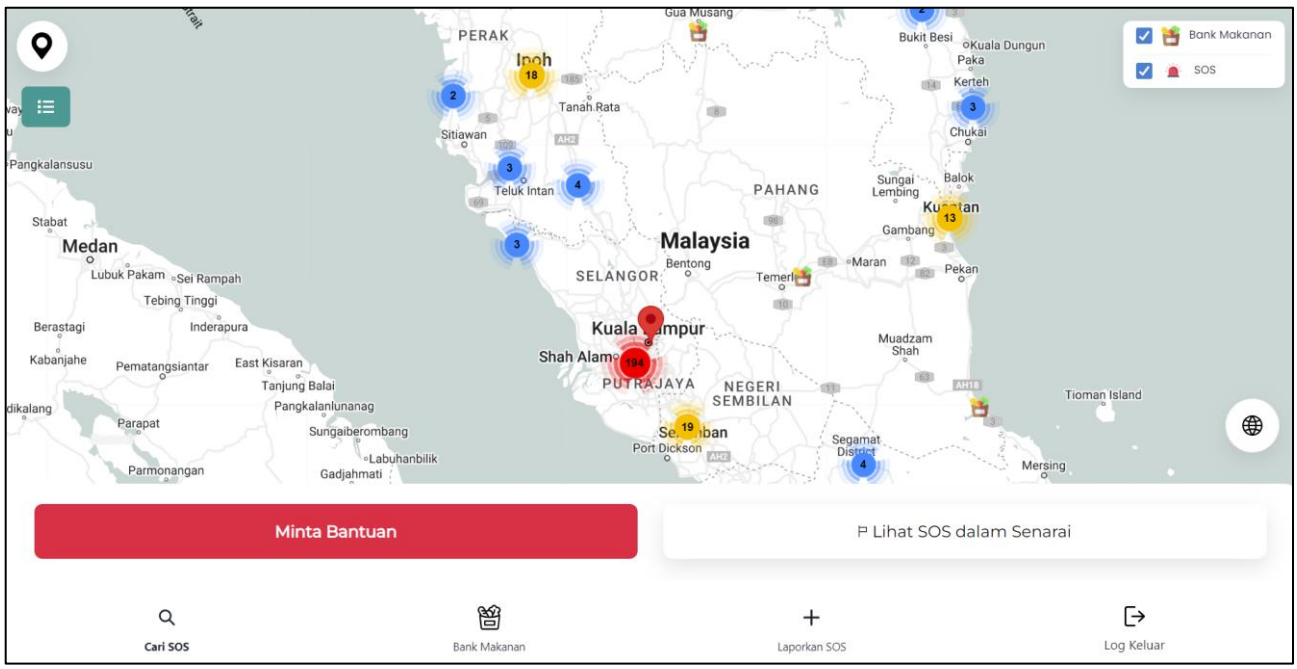
consumption and skipping breakfast (Bruening et al., 2018; Goldrick-Rab et al., 2015). Social exclusion is standard, with students avoiding food-centred events due to financial constraints (Allen & Alleman, 2019).

Foodbank Initiatives

Several applications have been designed to offer essential support to those in need and have been implemented in Malaysia, including notable initiatives like Sambal SOS, Yayasan Food Bank Malaysia, and The Lost Food Project. Sambal SOS, originally named Bendera Putih, stands as a non-profit, youth-led initiative that harnesses crowdsourced information to identify locations marked by white flags and food banks across Malaysia. Developed by a team of students from Multimedia University, this web-based application emerged in response to the urgent pleas for assistance from those adversely affected by the Movement Control Order (MCO) during the COVID-19 pandemic. As depicted in Figure 1, the Sambal SOS interface is designed to be organised and straightforward, facilitating easy navigation for users seeking information about food bank locations and areas where aid is required.

Figure 1

Interface of Sambal SOS



Despite their usefulness, existing platforms face challenges in usability and accessibility. Yayasan Food Bank Malaysia, founded in 2019, distributes food to B40 communities, higher learning institutions, and welfare centres. However, its complex website design and lack of a clear user guide may hinder effective use, especially for those in remote areas.

Similarly, The Lost Food Project redistributes surplus food to charity partners, B40 families, refugees, and vulnerable groups. While its website is visually appealing and easy to navigate, issues such as layout imbalance and occasional blank screens affect usability.

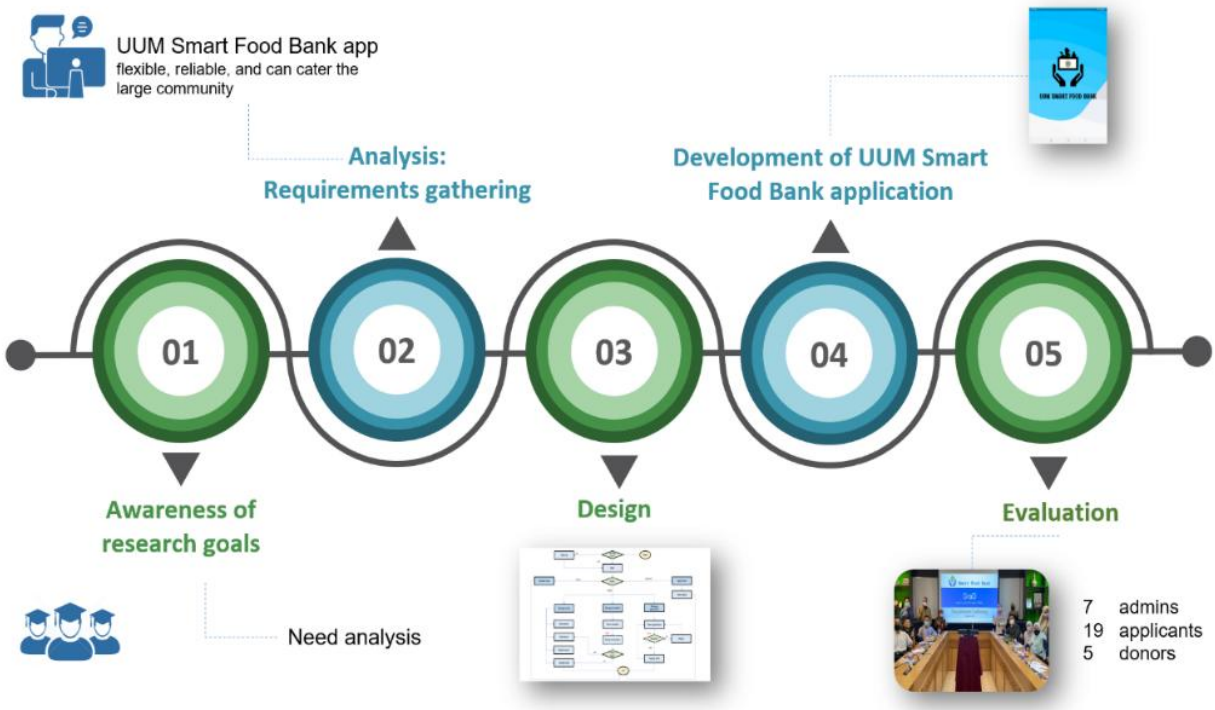
These limitations, common in web-based platforms, highlight the need for a mobile-based application. A dedicated mobile app could offer greater convenience, improved accessibility, and better user experience, ensuring vital assistance reaches those who need it most.

METHODOLOGY

The development of our proposed Food Bank mobile application has undergone a comprehensive process involving five main phases, as presented in Figure 2. Each phase plays an important role in ensuring the functionality, user-friendliness, and effectiveness of the mobile application. This approach encompasses not only the technical aspects of application development but also considers the user experience, addressing potential challenges and optimising features through an iterative process.

Figure 2

Methodology for developing the Smart Food Bank application



Design

Before designing the Smart Food Bank application, two sessions were conducted to gather requirements and capture user needs. Participants represented key user groups: administrators managing the food bank, and applicants and potential donors from the university community. The first session, with administrators, focused on essential features for efficient management, allowing them to share insights on workflows, preferences, and required functionalities. The second session engaged applicants and donors, primarily students, to identify expectations, user-friendly features, and support mechanisms through guided surveys and discussions.

These two approaches ensured a holistic understanding of diverse needs, enabling the development team to design an inclusive, functional, and user-centric application. User input was analysed and categorised into functional and non-functional requirements (Tables 1 and 2), forming the basis for the mobile app's design for campus use.

Table 1

Functional Requirements of the UUM Smart Food Bank Application

Requirement ID	Requirements Description	Priority
USFB_01	**Sign Up**	
USFB_01_01	Register a new account	**M**
USFB_01_02	Choose a local or an international student.	**M**
USFB_02	**Log In**	
USFB_02_01	Log in to the system	**M**
USFB_02_02	Reset your password by entering the correct OTP code sent to your email.	**M**
USFB_02_03	Select "Remember Me" to remember the user's login information.	**D**
USFB_03	**Manage User Details**	
USFB_03_01	Users can update their user details	**O**
USFB_04	**Donate Food, Daily Necessities or Cash**	
USFB_04_01	Donors enter details info	**M**
USFB_04_02	Donors choose donation items	**M**
USFB_04_03	Donors check the bank account of the management	**M**
USFB_04_04	Donors link FPX and online banking	**D**
USFB_04_05	Donors choose to get the current location or enter the location	**M**
USFB_04_06	Donors set the delivery time	**D**
USFB_04_07	Donors view the list of donations.	**D**
USFB_04_08	Donors edit the information about the donation.	**D**
USFB_04_09	Donors cancel the donation.	**D**
USFB_05	**Apply for Food, Daily Necessities, Cash or Voucher Assistance**	
USFB_05_01	Applicants view the allocation list.	**M**
USFB_05_02	Applicants enter their matric number, IC number, and family information when applying for assistance.	**M**
USFB_05_03	Applicants enter reasons for applying for food.	**M**
USFB_05_04	Applicants choose categories of assistance	**O**
USFB_05_05	Applicants choose to apply for themselves or others.	**M**
USFB_05_06	Applicants can either have the current location obtained by the system or enter the location themselves.	**M**
USFB_05_07	Applicants enter other people's information	**M**
USFB_05_08	Students choose options for allergies, health, vegetarians or other issues.	**M**
USFB_05_09	Students can view the status of the request.	**M**
USFB_05_10	Students can edit the request before the item is sent.	**M**
USFB_05_11	Students can cancel the request.	**M**
USFB_05_12	Staff can help students apply for assistance.	**D**
USFB_06	**Manage Stock**	
USFB_06_01	Staff can add stock and its information	**M**
USFB_06_02	Staff can view the list of stock and its information	**M**
USFB_06_03	Staff can edit stock information	**M**
USFB_06_04	Staff can delete stock information.	**M**
USFB _07	**Manage Allocation**	
USFB_07_01	Staff create a table for students as records	**M**
USFB_07_02	Staff edit the allocation table.	**D**
USFB_07_03	Delete the record from the allocation table.	**D**
USFB_07_04	View allocation history	**O**
USFB _08	**Manage Application**	
USFB_08_01	View the list of applications.	**M**
USFB_08_02	View the applicants' list	**M**
USFB_08_03	Approve applications	**M**
USFB_08_04	Reject applications	**M**
USFB _09	**Manage Donor**	
USFB_09_01	View the list of donors.	**M**
USFB_09_02	View the list of donation items	**M**
USFB_09_03	View donors' information	**M**

USFB_09_04	Approve donors.	**M**
USFB_09_05	Reject donors.	**M**
USFB_10	**Report Issues**	
USFB_10_01	Students and donors can report issues	**D**
USFB_11	**Manage Language**	
USFB_11_01	Users can change the language	**M**
USFB_12	**Send Notification**	
USFB_12_01	Send notifications about expiration dates.	**M**
USFB_13	**View Help Desk**	
USFB_13_01	View the admin's contact information	**M**
USFB_13_02	View guideline.	**D**
USFB_13_03	View the frequently asked questions.	**O**

Table 2

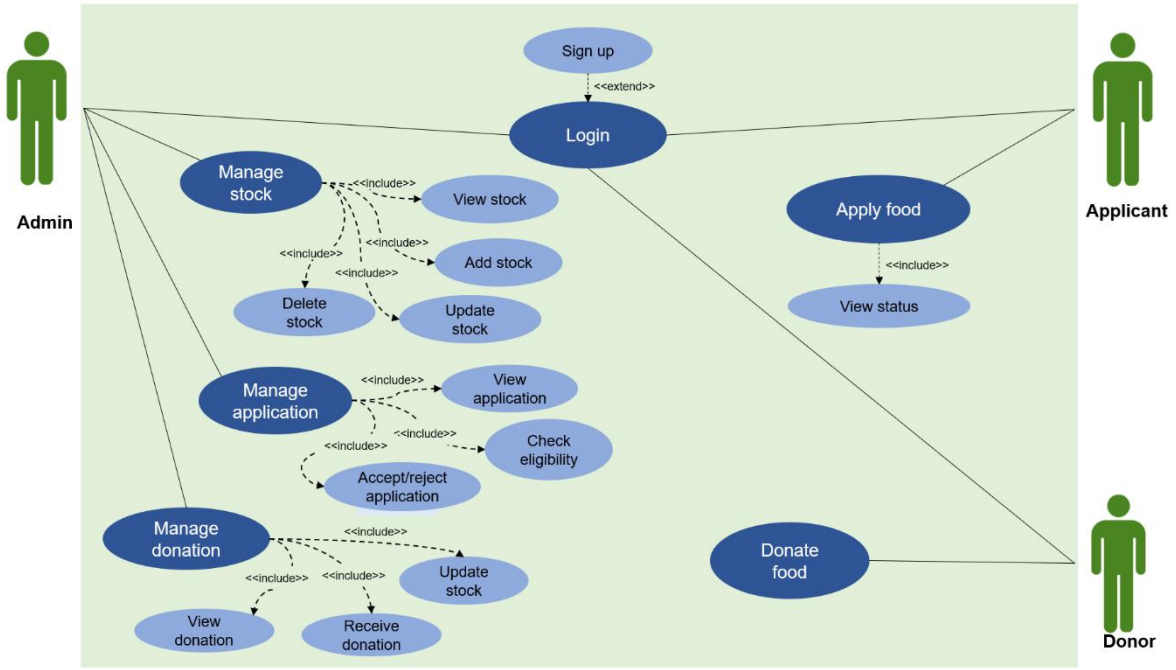
Functional Requirements of the UUM Smart Food Bank Application

Requirement ID	Requirements Description	Priority
USFB _14	**Usability**	
USFB_14_01	The system must be easy to use.	**M**
USFB_14_02	The system must have a clear title for each item.	**M**
USFB_14_03	The system interface must be a simple colour.	**D**
USFB_14_04	The system must have simple and easy-to-understand icons.	**D**
USFB_14_05	The system must have an organised screen structure.	**O**
USFB _15	**Safety**	
USFB_15_01	Names should be hidden when applying for assistance.	**M**
USFB_15_02	The user's account ID must be unique.	**M**
USFB_15_03	The user's personal details should be encrypted inside the database.	**M**
USFB_15_04	Neither students nor donors are allowed to view other users' data.	**M**

Based on the gathered requirements, structural components of the proposed mobile application are crafted and modelled. Utilising the Unified Modelling Language (UML) as a powerful tool for visualising and articulating software requirements, the application's architecture is thoughtfully captured. Figure 3 serves as a comprehensive representation, providing a view of the behavioural interactions among users and the intricate network of use cases that underpin the application's functionality. This detailed modelling process establishes the groundwork for the application's design, ensuring a robust and user-centric structure that aligns seamlessly with the identified requirements.

Figure 3

Use case of the University Smart Food Bank mobile application.



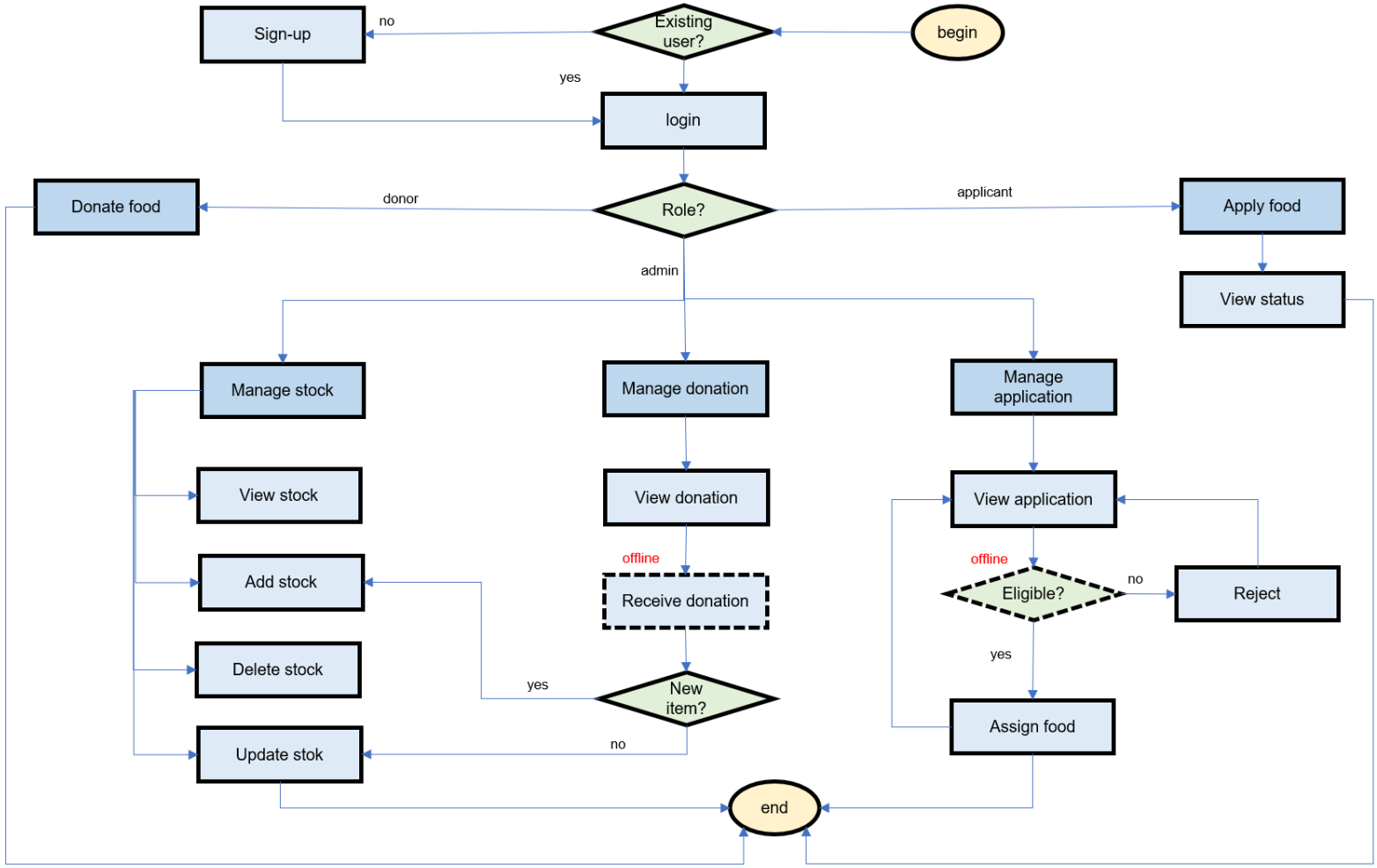
The proposed University Smart Food Bank mobile application operates with five primary functions, overseen by three distinct user roles. Admin manages key functions such as Stock Management, Food Application Management, and Donation Management. Applicants can apply for food assistance and track their application status, while donors can offer contributions and monitor their donation status. Despite efforts to automate most Smart Food Bank operations online, two crucial functions remain offline.

Due to certain constraints, verifying applicant eligibility and accepting donations require offline processes. The admin responsible for processing food applications must verify applicant eligibility through the university portal and update the status in the Smart Food Bank to streamline processes. Similarly, for the donation receipt, the admin engages in offline communication with potential donors to coordinate methods of donation reception. These offline functions are essential aspects that require attention in the ongoing enhancement of the University Smart Food Bank application. Future endeavours will focus on integrating these offline functions into the online framework, ensuring a comprehensive and seamless user experience.

The overall flow of processes within the UUM Smart Food Bank is visually presented in the Figure. 4. The two processes outlined by a red dotted line signify functions that are to be conducted offline, as elaborated earlier.

Figure 4

Overall flow of the University Smart Food Bank application

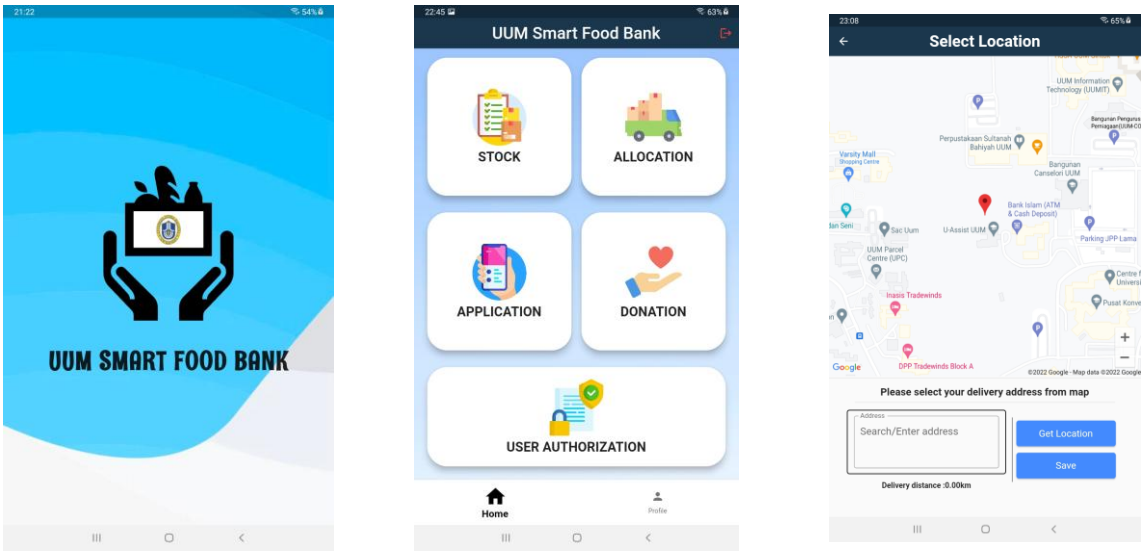


The University Smart Food Bank's conceptual design is transformed into a functional application using Flutter, with Visual Studio Code as the primary integrated development environment (IDE). Facilitating crucial functionalities like user authentication and secure database storage, the cPanel web server plays a pivotal role in the development process. Figure 5 offers a visual representation of selected interfaces from the University Smart Food Bank application, showcasing the landing screen (Figure 5a), five primary administrative functions for Admin (Figure 5b), and the location-sharing page (Figure 5b).

Providing users with an initial point of interaction, the landing screen depicted in Figure 5a sets the tone for the application experience. Figure 5b focuses on the administrative capabilities by highlighting the five main functions designed for Admin to manage the Smart Food Bank application efficiently. The location-sharing page, also featured in Figure 5b, stands out as a significant feature that benefits both applicants and donors, enhancing the application's overall functionality and engagement.

Figure 5

Selected interfaces of the UUM Smart Food Bank application



(a) (b) (c)

The location-sharing function serves a dual purpose within the application framework. For applicants, it signifies the destination for the dispatched food, streamlining the delivery process. Simultaneously, donors utilise this feature to communicate their geographical location, providing essential information for the admin to coordinate the pickup of donations. This dual functionality enhances the practicality of the University Smart Food Bank application, fostering seamless interaction between applicants, donors, and the administrative team.

RESULTS AND DISCUSSION

The University Smart Food Bank application has been successfully evaluated in two sessions involving 31 testers, including the same participants involved during requirements gathering: admin, applicants, and donors. The first session was primarily for the admin group to focus on admin functions, while the second session was for both applicants and donors, with 19 and five testers, respectively. The purposes of

evaluation are to test its correctness, measure user acceptance of the application, and assess its impact on achieving a hunger-free campus.

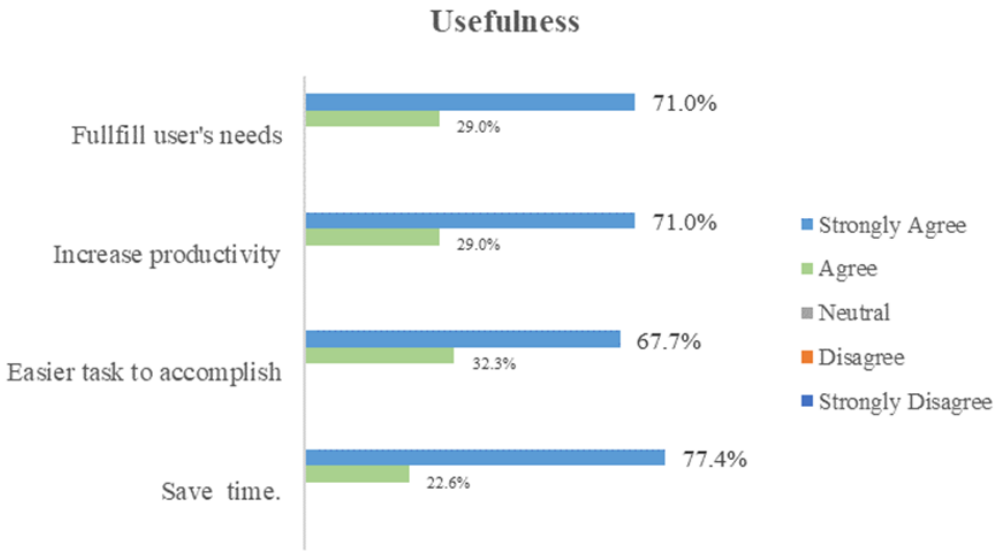
There are six evaluation dimensions included in the test: design and layout, simplicity, usefulness, effectiveness, learnability, and satisfaction. There are 20 measurement metrics involved, which are categorised into design and layout, simplicity, usefulness, effectiveness, learnability, and satisfaction.

Usefulness

The assessment of the Smart Food Bank's usefulness is conducted through four distinct measurement items, each providing valuable insights into the application's impact and efficacy. The results are shown in Fig. 6. The first measurement, U1, explores the extent to which the Smart Food Bank fulfils the needs of its users. With an average score of 4.77, the application indicates a high level of user satisfaction and suggests that it effectively addresses the essential requirements of individuals within the university community.

Figure 6

Users' feedback on the usefulness of the Smart Food Bank application



U2 measures the perceived increase in productivity resulting from the utilisation of the Smart Food Bank. With an average score of 4.68, it is evident that users believe the application contributes positively to their efficiency and effectiveness in various tasks. This underscores the potential of the Smart Food Bank not only to address hunger but also to enhance the overall productivity of its users. Additionally, U3 assesses how easily tasks can be accomplished through the Smart Food Bank. The average score of 4.71 suggests that users find the application user-friendly, providing a seamless experience in managing food-related tasks within the university community.

The last item, U4, measures the perceived time-saving benefits attributed to the Smart Food Bank. With an average score of 4.71, users acknowledge the application's efficiency in streamlining processes, ultimately saving valuable time. This aspect is crucial, as it emphasises the practical advantages of the Smart Food Bank in addressing time-sensitive challenges related to food distribution and donation management. In summary, the high average scores across these four measurement items indicate that users

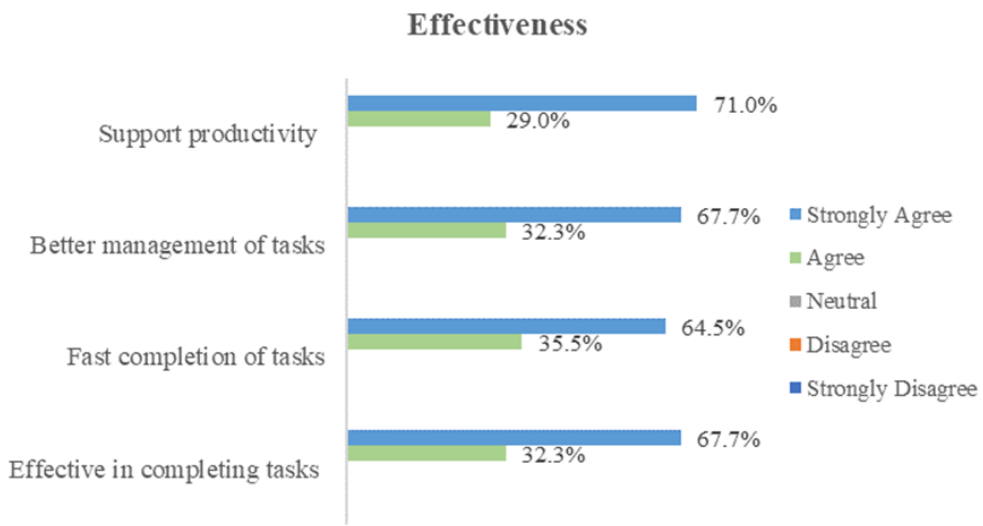
perceive the Smart Food Bank as a valuable and effective tool, fulfilling their needs, enhancing productivity, providing ease of use, and saving time.

Effectiveness

Effectiveness is a critical dimension in evaluating the impact of the Smart Food Bank application, assessed through four distinct measurement items. Beginning with E1, the score of 4.68 indicates a strong consensus among users that the application significantly supports productivity at work, particularly in the context of managing the Food Bank on campus as seen in Fig. 7. This suggests that the Smart Food Bank serves as an effective tool in enhancing the operational efficiency of those responsible for overseeing food distribution and donation management within the university.

Figure 7

Users' feedback on the effectiveness of the Smart Food Bank application



E2, which measures the app's support in managing tasks, scored 4.65, indicating that it equips users with practical tools for organising and administering food bank activities. E3, assessing its ability to speed up task completion, scored 4.68, indicating the app streamlines processes for timely operations. E4, evaluating overall task effectiveness, achieved a score of 4.71, reflecting intense user satisfaction with its role in ensuring smooth food bank management.

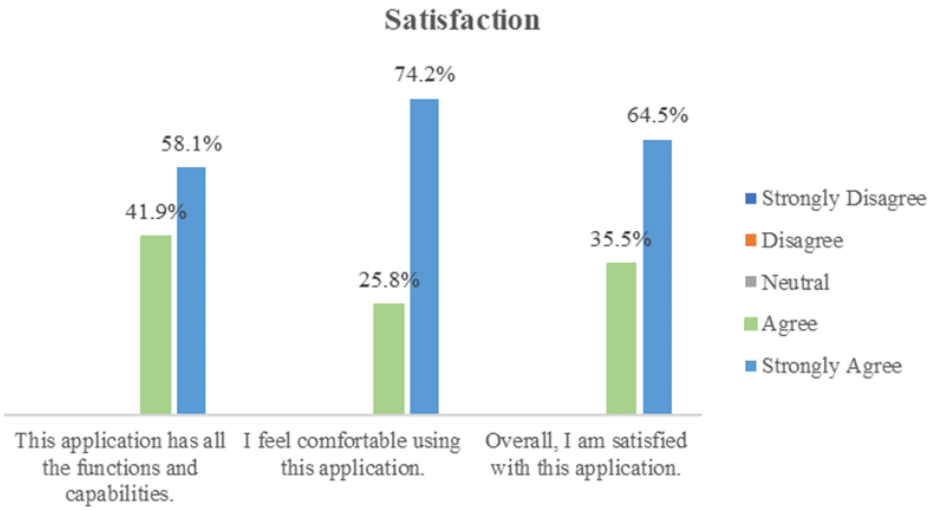
Overall, the consistently high scores confirm the Smart Food Bank's effectiveness in boosting productivity, improving task management, expediting operations, and supporting efficient food distribution and donation management within the university.

Satisfaction

The assessment of user satisfaction with the Smart Food Bank application involves three key measurement items, each shedding light on different aspects of user experience, as shown in Fig. 8. Commencing with S1, the score of 4.58 indicates users' satisfaction with the application's functionality and its capability to address the tasks at hand effectively. This suggests that users perceive the Smart Food Bank as a comprehensive solution that aligns with their expectations, meeting their functional requirements and successfully resolving the challenges associated with food distribution and management on campus.

Figure 8

Users' feedback on satisfaction with the Smart Food Bank application



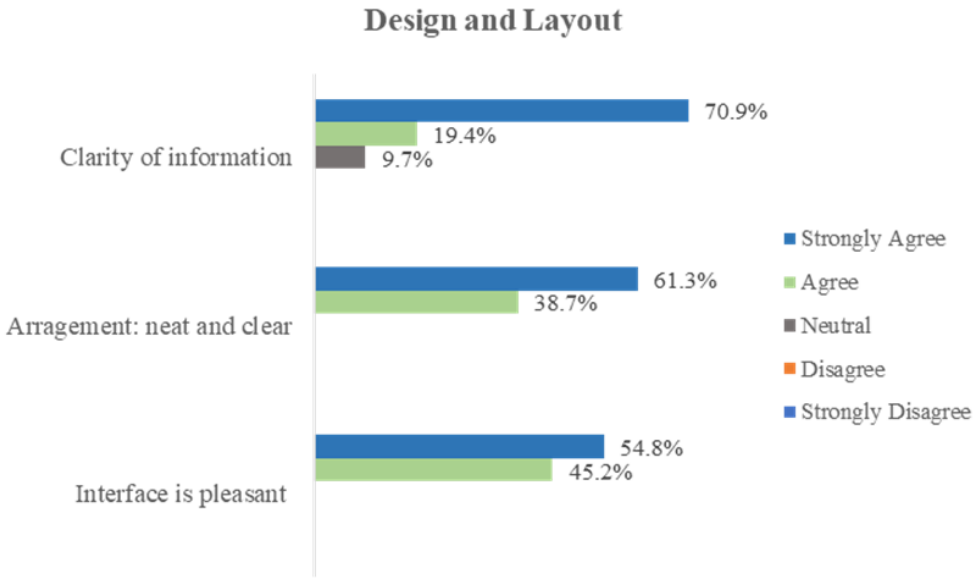
S2 evaluates the comfort level of users when interacting with the Smart Food Bank app, achieving a high mean score of 4.74. This indicates that the app is perceived as intuitive, user-friendly, and easy to navigate. S3 measures overall user satisfaction, with a mean score of 4.65, reflecting positive feedback on both functionality and usability. These strong results highlight the app's success in meeting user expectations, enhancing the user experience, and effectively serving the needs of the university community.

Design and Layout

The evaluation of the Smart Food Bank application extends beyond its functional aspects, encompassing users' perceptions of its visual design and aesthetics. This aspect is crucial in determining the overall appeal and user engagement with the application. Three specific measurement items were employed to assess users' perceptions of the application's look and feel, as shown in Fig. 9. Beginning with D1, which measures the clarity of information included in the application, the average score of 4.55 indicates that users find the information presented within the Smart Food Bank clear and comprehensible. This suggests that the application effectively communicates information related to food distribution, donation management, and other relevant tasks, contributing to a positive user experience.

Figure 9

Users' feedback on the design and layout of the Smart Food Bank application



D2, assessing UI neatness and arrangement, scored 4.61, indicating users find the Smart Food Bank well-organised and easy to navigate. D3, measuring overall interface pleasantness, also scored 4.61, reflecting satisfaction with its visual appeal. These results show the application is straightforward, functional, and aesthetically pleasing, enhancing usability, engagement, and user satisfaction. A balance of functionality and aesthetics supports a practical, user-friendly design that attracts and retains university users.

Impacts Of Smart Food Bank Application Towards Hunger-Free Campus

The University Smart Food Bank application unfolds as a transformative tool with a significant impact on fostering a hunger-free campus environment. One of its key contributions lies in its ability to streamline and optimise the food assistance process. By providing a user-friendly platform for applicants, donors, and administrators, the application enhances the efficiency of food distribution and donation management. This streamlined process not only expedites the delivery of food to those in need but also facilitates a more organised and transparent approach to managing food resources within the campus community.

The Smart Food Bank application also catalyses raising awareness and engagement in addressing food insecurity. Through its user-friendly interfaces and functionalities, the application encourages active participation from both applicants' seeking assistance and donors looking to contribute. The transparent tracking of donations and food requests not only empowers users with information but also fosters a sense of community involvement and support. This increased awareness and engagement contribute to building a campus culture that values collective efforts in eradicating hunger and ensuring the well-being of all members of the academic community.

In a broader context, the Smart Food Bank application plays a pivotal role in promoting sustainability and reducing food wastage. Through efficient management of food resources and the coordination of donations, the application contributes to a more sustainable approach to addressing hunger on campus. By leveraging technology to match surplus food with those in need, the application aligns with broader sustainability goals, promoting responsible resource utilisation and minimising the environmental impact associated with

food waste. In essence, the Smart Food Bank application not only addresses immediate hunger concerns but also champions a sustainable and community-driven approach to ensuring food security within the campus environment.

CONCLUSION

The Smart Food Bank mobile application represents a significant stride toward achieving a hunger-free campus. Its user-centric design, produced by design research and experimental methodology, ensures that the application caters to the unique needs and preferences of the university community. By leveraging the capabilities of mobile technology, the application streamlines the process of accessing and distributing food resources, fostering inclusivity and community support.

The impact of the Smart Food Bank application is multifold. Firstly, it directly addresses the immediate needs of students facing food insecurity, providing a reliable and accessible platform for obtaining essential food items. This, in turn, contributes to alleviating the stress and challenges associated with food scarcity, allowing students to focus more effectively on their academic pursuits. The application's user-friendly interface and features enhance the overall experience, creating a sense of empowerment and dignity for those utilising its services.

As the application is integrated into campus life, its impact extends beyond immediate relief. The cultivation of a hunger-free campus environment creates a supportive community where students feel valued and cared for. Additionally, the data generated by the application can contribute to a better understanding of food insecurity trends within the university, enabling administrators and policymakers to implement targeted interventions and support programs. The Smart Food Bank mobile application, with its potential to transform the campus food ecosystem, lays the groundwork for addressing the root causes of food insecurity and fostering a resilient and nourishing academic community.

Looking ahead, continuous improvement and expansion of the application will be crucial for sustaining its positive impact. Incorporating additional features based on ongoing user feedback, expanding outreach to other campuses, and forging partnerships with local businesses or organisations are avenues for further enhancement. By promoting awareness and fostering a culture of mutual support, the Smart Food Bank application has the potential to create enduring positive changes in the lives of students and contribute to the broader mission of building resilient and hunger-free academic communities.

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