IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Creating A Self-Service Kiosk For School Canteens Using Liquid Crystal Display Modules

Evelyn S. Mariñas[a], Therese Winifred A. Tan[b], Sofia Jasmin F. Lucena[c], Fervy Aisha M. Flores[d], Bill Philippe M. Saño[e], Mica S. Constantino[f], Hidaya U. Piping[g], Jose Maria Angelo V. Carpio[h]

Philippine School Doha, Bldg. 01, St. 1008 Zone 56 Mesaimeer Area, Doha, P.O. Box 19664, Qatar

Quality Assurance and Accreditation Department, PSD, Doha Qatar

Research Capstone Project, PSD, Doha, Qatar

Abstract: The experience of waiting in lines is a common concern for people across different aspects of life. In educational settings, students are often delayed during meal payments, which needs effective solutions. This study aimed to address the concern by creating a Self-Service Kiosk using liquid crystal display modules. **Methodology:** A quantitative approach and an experimental research design were used to assess the processing speed, accuracy speed, and transaction speed of the device. **Results:** The results of the study proved that the self-service kiosk effectively displayed information on the LCD 20x4 screen for as early as 0.24 milliseconds. This indicated varied button response times, with "add to cart" consistently fast averaging 0.13 milliseconds, while "reset cart" was slightly slower at 0.15 milliseconds. The "Total Price" button maintained stable response times at 0.24 milliseconds. The processing speed showed an average of 100% accuracy rate for all buttons, while the transmission speed between the kiosk and the host device displayed as fast as 0.193 milliseconds, which emphasized the importance of button responsiveness. **Discussion:** The purpose of the Self-Service Kiosk was to enhance efficiency and augment customer experience in the context of a school canteen, which aided in creating a simplified ordering system and optimizing workflow. The success of each trial was evident, which affirmed the reliability and effectiveness of the kiosk. **Recommendation:** Future researchers are recommended to integrate higher-quality materials to improve the device's performance. Exploring alternative features could optimize the user experience in similar settings while considering possible limitations.

***Keywords*:** Arduino Uno; LCD Modules; Self-Service Kiosk.

1. INTRODUCTION

Waiting in line is a common, unavoidable experience in many areas of life. People might want to access a service or a product directly and be able to receive it right away; however, waiting in lines can lead to frustration and can be tedious. The short period breaks are mostly spent waiting in lines to pay for their meals, leaving students only a few minutes to eat. The majority of colleges and high schools encounter common problems during the busiest mealtimes, such as high traffic, crowded dining areas, and lengthy lines. As a result, students are less satisfied with the canteen's efficiency and level of service quality (Li et al., 2014).

Placing an order in front of a cashier is one of the routine tasks of some students and can pose challenges for many. Students can be discouraged from eating in school due to poor dining facilities, limited food, long waiting times, and short lunch breaks, leading students to purchase food from competing local outlets (Townsend et al., 2015). Social Anxiety is a common health disorder with onset in childhood and adolescence. It tends to be a chronic, stable condition that severely disrupts long-term functioning if left untreated. This condition is associated with a higher likelihood of experiencing depression, substance misuse, severe social restrictions, early school dropout, lower educational attainment, and peer victimization (Ranta et al., 2015).

To address these issues, self-service kiosks have emerged as a promising solution, offering customizable ordering options and streamlined transactions in various industries, including the fast-food sector (Susandra et al., 2021). A kiosk refers to an electronic system created specifically for an application that can expressly boost operational effectiveness. An interactive or self-service kiosk is a self-service device, also known as a computer terminal, installed in a public area that allows users to interact with digital content and information via an accessible interface (Wani, 2023).

Kiosks provide significant benefits to companies, such as reduced wait times, greater revenue, resource and labor optimization, and an improved customer experience. Customers can quickly access information and complete tasks when self-service options are offered, thereby reducing lines and keeping the line moving. Furthermore, kiosks enable resource and labor optimization, allowing them to focus on other critical responsibilities such as cleanup and customer satisfaction. Kiosks can also enhance overall productivity by allowing technology to do routine tasks (Jatindrall, 2023).

The use of LCD (liquid crystal display) modules in self-service kiosks for school canteens offers several benefits, as it has become an important component of modern devices. It addresses the growing need for low-power, space-saving, and better display technologies, opening the path for huge commercial potential. The advantage of using LCDs is their durability and ability to withstand harsh environments, making them suitable for use in busy school canteens. A 20x4 centimeters LCD (Liquid Crystal Display) is a basic electronic module that finds widespread use in various devices and circuits. These modules are preferred over seven segments and other multi-segment LEDs because of their cost-effectiveness and absence of limitations in displaying similar features, special characters (unlike in seven segments), animations, and so on (Ufoaroh et al., 2015). Various existing inventions are similar to the self-service kiosk concept. A 3D touch-screen kiosk named i-Showcase was placed in a mall to allow users to choose the best path to go from their current location to the desired shop. A category menu, a search bar, or a shortcut menu were available for users to request the locations of shops. A usability study was performed to compare the effectiveness of the above options. Results showed a notably high task completion rate, particularly among participants familiar with the kiosk experience. Users rated the kiosk as acceptable for being simple to use and valuable in determining the best course of action (Bazzano et al., 2018).

The senior vice president of a retail and outdoor recreation services corporation once said, “We are taking our fundamental strength in customer service to a new level by bringing the range and convenience of the internet to the store and marrying it with the insight and knowledge of our staff to create a powerful customer experience.” Retail convergence between retail channels and technology provides customers with a compelling and enhanced shopping experience, marking them as the future for all e-businesses. Kiosks are more accurate than human employees as they store the contents of the business’s inventory and specific product searches (Reynolds, 2017).

This study could benefit the students and provide a convenient way for them to access services and complete transactions, especially in the school canteen. Self-service kiosks can help the school canteen operate more efficiently and effectively, while also providing convenience and customization options for students. It can allow students to place their orders quickly and easily, reducing wait times and freeing up staff time to focus on preparing and serving food. It also allows them to customize their orders and pay for their meals using cash, which can help reduce the need for cash handling and potentially reduce instances of errors and theft.

2. STATEMENT OF THE PROBLEM

The objective of this study was to create a Self-Service Kiosk with the use of Liquid Crystal Display Modules. Specifically, this research aimed to answer the following questions:

1. What is the timeframe between the button being pressed and the corresponding information appearing on the screen?
2. What is the accuracy rate of the self-service kiosk in terms of correctly processing user inputs?
3. What is the speed of transmission between the self-service kiosk and the host device?

3. PURPOSES OF THE STUDY

The purpose of the Self-Service Kiosk is to improve and augment customer experience in the context of a school canteen, which aided in creating a simplified ordering system and optimizing workflow, ultimately streamlining the entire food service process. By providing students and staff with a user-friendly interface for placing orders and making payments, this device aims to reduce wait times, minimize errors, and empower students to customize their orders according to their preferences, thus fostering a more seamless and enjoyable dining experience within the school environment.

4. OBJECTIVES OF THE STUDY

The objective of this study is to create a Self-Service Kiosk made out of LCD modules in school canteens that can enhance efficiency and increase the overall dining experience for the students. These kiosks, utilizing LCD modules, will be designed to offer a user-friendly interface, allowing individuals to easily place orders, and customize their selections according to their preferences without worrying about the long wait times of the limited lines in the canteen. Utilizing technologies such as Arduino Uno and wifi modules, this study aims to ensure a successful connection and accurate item selection.

5. RESEARCH HYPOTHESIS

H1: It is feasible to create a Self-Service Kiosk with the use of Liquid Crystal Display Modules.

6. RESEARCH METHODOLOGY

6.1 Research Design

This study utilized the experimental design of research. Through experimental research, one or more independent variables were altered and applied to one or more dependent variables to determine how they affected the former and let researchers make inferences about the relationships between two categories of data (Mutz & Pemantle, 2015).

In this study, the liquid crystal display module was the independent variable, and the self-service kiosk was the dependent variable. Furthermore, the quantitative research approach sought to gather data by measurement, examine the data for patterns and relationships, and validate the measurements taken, ensuring that the experiment was structured through a systematic investigation (Watson, 2015). It was essential to use this method as it provided a high level of control over the variables that demonstrated an outcome and was advantageous in obtaining accurate, consistent, and precise results.

6.2 Research Locale

This research study was conducted at Philippine School Doha in Doha, State of Qatar, specifically in the Mesaimeer Area (Zone 56), Al Khulaifat Al Jadeeda Street (St. 1011), as the researchers were not only students of this school but also required facilities present in the school that enabled them to make their product.

6.3 Data Gathering Procedure

The procedure shows the step-by-step process of creating a self-service kiosk using liquid crystal display modules and how its durability will be tested.

6.3.1 Ensuring the protection and safety

1. Wear personal protective equipment such as safety goggles, anti-static gloves, anti-static wrist straps, and safety shoes while performing the procedures below to avoid hazardous conditions;
2. Stay cautious around sharp objects such as a cutter; and
3. Avoid heat sources from coming into contact with the electric components.

Wiring of the components of the Liquid Crystal Display 20x4

1. Connect a wire from the Ground pin to their respective pinhole in the Breadboard.
2. Connect a wire from the VCC (Voltage Common Collector) pin to their respective pinhole in the Breadboard.
3. Connect a wire from the SDA (Serial Data Pin) pin to their respective pinhole in the Analog In section of the Arduino Uno Rev3; and
4. Connect a wire from the SCL (Serial Clock Pin) pin to their respective pinhole in the Analog In section of the Arduino Uno Rev3.

Wiring of the components of the Arduino ADKeyboard into the Arduino Uno Rev3

1. Connect a wire from the OUT pin to the A0 pinout in the Analog In section.

Wiring of the components of the Arduino ADKeyboard into the Breadboard

1. Connect a wire from the VCC pin to their respective pinhole; and
2. Connect a wire from the GND pin to their respective pinhole.

Wiring of the components of the Arduino Uno Rev3 into the Breadboard

1. Connect a wire from D~10 to their respective pinhole;
2. Connect a wire from 5V to their respective pinhole; and
3. Connect a wire from GND to their respective pinhole.

Wiring of the components of the Breadboard

1. Connect a wire from a positive terminal to a positive terminal.

Programming the commands

1. Header: The code includes necessary header files for interfacing with the LiquidCrystal library and Wire library, which are used for controlling the LCD and I2C communication.
2. Global Variables: It declares global variables, including the analog pin for reading keypad input, variables to store the analog values read from the keypad, an array of menu items (texts), an instance of the LiquidCrystal_I2C class for controlling the LCD, and variables for tracking the current menu item index, total price, and orders.
3. Setup Function: In the setup function, the serial communication is initialized for debugging, the LCD is initialized, the backlight is turned on, and the analog pin is set as input. A welcome message is displayed on the LCD screen for 8 seconds before it is cleared.
4. Loop Function: The loop function continuously reads the analog value from the keypad and performs different actions based on the value read. If the value indicates a button press to reset the cart, the total price, or to navigate to the next or previous menu item, corresponding functions are called.
5. NextText and PreviousText Functions: These functions handle navigation between menu items by incrementing or decrementing the currentIndex variable and ensuring it wraps around the array of menu items.
6. DisplayText Function: This function displays the current menu item on the LCD screen and prints the item's name to the serial monitor for debugging.
7. UpdateVariable Function: This function updates the total price variable and the orders string based on the selected menu item. It checks the analog value read from the keypad to determine which button was pressed and updates the total price accordingly.
8. PrintTotalPrice Function: This function displays the total price of items in the cart on the LCD screen and prints the list of orders to the serial monitor.

Setting up the closing panel for the exterior

1. Carve out a 9.8cm x 6cm hole in the upper center of the missing panel of the cardboard box;
2. Carve out 4 1.5cm x 1.5cm holes in a diamond position in the lower center of the missing panel of the cardboard box;
3. Carve out a 1.5cm x 1.5cm hole 1.35cm to the center-right of the diamond position holes; and
4. Using a piece of paper and marker, label the top hole with “scroll up”, the left hole with “reset cart”, the right hole with “add to cart”, the bottom hole with “scroll down”, and the rightmost hole with “total price”.

Attachment and Placements of the Parts and Components

1. Using the hollow cardboard box with one missing side, attach the breadboard to the upper left corner and secure it with adhesive tape;
2. Attach and secure the Liquid Crystal Module 20x4 centimeters to the upper center hole in the missing panel;
3. Attach and secure the Arduino Uno Rev3 to the right of the Liquid Crystal Module 20x4 centimeters;
4. Attach and secure the Arduino ADKeyboard to the lower center hole of the missing panel below the Liquid Crystal Module 20x4 centimeters, and check if the buttons fit securely in 1.5cm carved holes;
5. Secure all of the jumper wires into place using adhesive tape; and
6. Using the glue gun and glue stick, seal the cardboard box and missing panel together.

7. RESULTS

This section of the paper presents the results of the data obtained during the testing procedure in relation to the research questions.

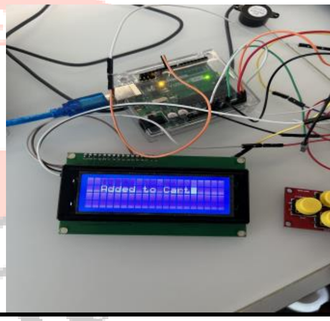
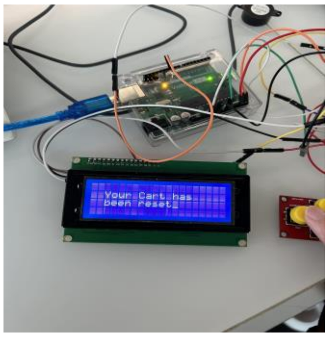
7.1 Timeframe of corresponding information being displayed on screen

Table 1: **Timeframe of Corresponding Information Being Displayed**

Table 1 showed how fast the self-service kiosk responded to different action buttons from the speed at which procedures were processed. To ensure correctness, a total of three trials were conducted, and the average was found by adding the number of results obtained, and then dividing by three. From the three trials, the “Add to Cart” button consistently showed a fast response as follows: 0.13 milliseconds, 0.13 milliseconds, and 0.11 milliseconds. The “Reset Cart” button also showed a reaction as follows: 0.18 milliseconds, 0.13 milliseconds, and 0.13 milliseconds. In all three trials, the "Scroll-Up" button displayed a range of processing times, from 0.16 milliseconds to 0.42 milliseconds. Likewise, the response durations indicated by the "Scroll-Down" button varied, ranging from 0.41 milliseconds to 0.28 milliseconds to 0.22 milliseconds in the corresponding trials. Finally, the operational speed of the “Total Price” button kept steady moderately since it logged 0.22 milliseconds, 0.22 milliseconds, and 0.28 milliseconds. Based on the results from Table 1, the interactive features that could be accessed through different action buttons of the self-service kiosk had positive features concerning delay times with particular reference to processing speed. This was attributed to the consistently quick response of the “add to cart” button hence indicating how well it works leading to smooth interaction by a customer.

7.2 Accuracy Rate of the Self-Service Kiosk in Processing User Inputs

Table 2: Accuracy Rate in Processing User Inputs

Action (Button Pressed)	Trial 1	Trial 2	Trial 3	Average accuracy	Documentation
Add to Cart	100%	100%	100%	100%	
Action (Button Pressed)	Trial 1	Trial 2	Trial 3	Average accuracy	Documentation
Reset Cart	100%	100%	100%	100%	

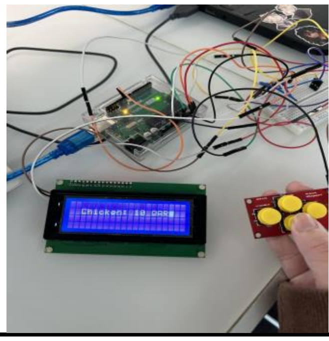
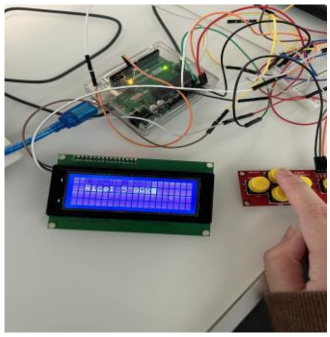
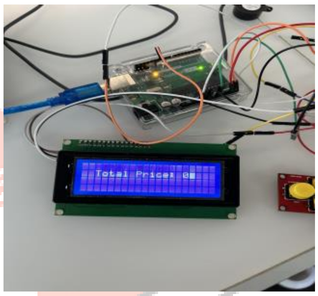
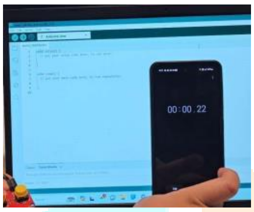
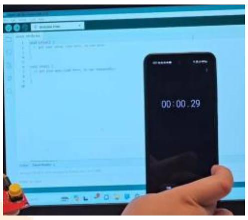
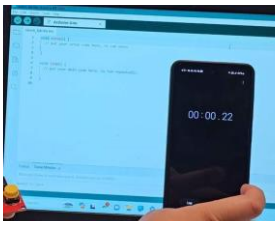
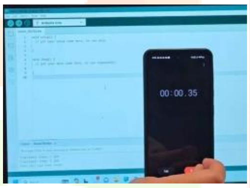
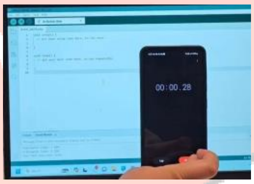
Scroll Up (once)	100%	100%	100%	100%	
Scroll Down (once)	100%	100%	100%	100%	
Total Price	100%	100%	100%	100%	

Table 2 displayed the accuracy of the self-service kiosk, determining if it had passed by displaying the correct output or failed by displaying the incorrect output. The percentage of accuracy was determined by the average of the trials, whether they passed or failed. In each three trials, all of the action buttons passed and showed the right output without a miss, hence ensuring 100% accuracy throughout the trials. These trials showed that the self-service kiosk replied accurately to user input.

The accuracy rate of the self-service kiosk in responding to user inputs was carefully measured to gauge how precise and dependable the system had been. Table 2 contains a comprehensive examination of the kiosk performance, separating successful results from ineffective ones. To derive the accuracy percentage, we averaged results from various attempts. Remarkably, each of the action buttons aced all three trials, translating into a 100% accuracy rate. In these findings the self-service kiosk is seen to have been responsive towards user's input, in a manner that is accurate and reliable, making it a promising technology.

7.3 Speed of the Transmission Between the Self-Service Kiosk and the Host Device

Table 3: Speed of the Transmission Between the Self-Service Kiosk and the Host Device

Action (Button Pressed)	Trial 1	Trial 2	Trial 3	Average Time
Add To Cart	0.22 milliseconds	0.29 milliseconds	0.22 milliseconds	0.243 milliseconds
Photos				
Reset Cart	0.22 milliseconds	0.35 milliseconds	0.28 milliseconds	0.283 milliseconds
Photos				
Total Price	0.74 milliseconds	0.48 milliseconds	0.54 milliseconds	0.587 milliseconds

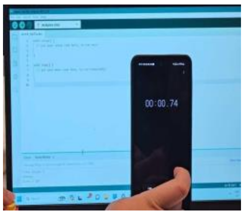
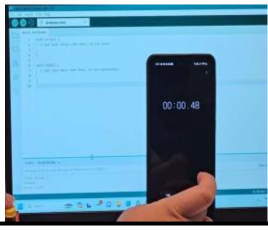
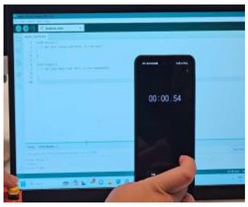
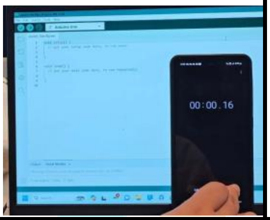
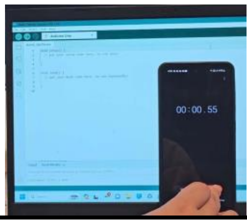
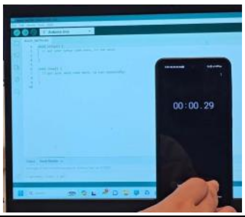
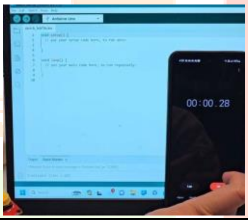
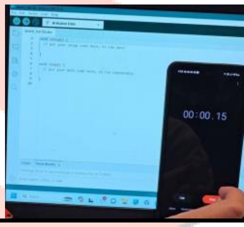
Photos				
Scroll Up (once)	0.16 milliseconds	0.55 milliseconds	0.29 milliseconds	0.33 milliseconds
Photos				
Scroll Down (once)	0.15 milliseconds	0.28 milliseconds	0.15 milliseconds	0.193 milliseconds
Photos				

Table 3 displayed the transmission speed between the self-service kiosk and the host device. The average of the trials was calculated by summing all of the trials and dividing by three to ensure that the findings were consistent. In three trials, the fastest speed was shown by the scroll-down button taking 0.15 milliseconds, 0.28 milliseconds, and 0.15 milliseconds, respectively. Likewise, the add-to-cart button maintained a consistent transmission speed at 0.22, 0.29, and 0.22 milliseconds. However, the transmission speed for the reset button seemed to be varying from 0.22 milliseconds to 0.28 milliseconds, thus indicating a slower reaction compared to its previous buttons. Throughout the trials, the scroll-up button displayed a significant gap between each trial that demonstrated speeds of 0.16, 0.55, and 0.29 milliseconds, respectively. Lastly, the total price button showed timings of 0.74 milliseconds, 0.48 milliseconds, and 0.54 milliseconds. The speed of transmission between the self-service kiosk and the host device, as depicted in Table 3, revealed significant performance differences between buttons. The add to cart button and scroll down button performed efficiently compared to the rest had different speeds. However, when tests were carried out consistently all the previous ones scrolled fastest on average. This concludes that it has less consistent functioning than either add to cart or scroll down keys. Some indication that there could be some way out in terms of speeding up the page load lies in differences observed in how fast the scroll-up option opened in various attempts.

8. DISCUSSION

Self-service technologies have been increasingly integrated into this generation of the service industry. The ability to understand how customers perceive these services and the improvement of quality is therefore important for researchers. However, there are circumstances in which it has been subjected to failures like other services due to technological malfunction or user error (Park et al., 2021). People are surprised by the arrival of self-service technologies because of commercial hospitality, especially restaurants, which is still considered a human-to-human service industry (Widarsyah, 2022). With the help of self-service kiosks, these technologies are considered customer-possessed and controlled smart service devices that aim to solve problems from the customer's perspective, frequently introducing entirely new service processes and ecosystems as defined by customers (Gummerus et al., 2019). Self-service kiosks have proven to be beneficial and convenient for improving customer service by providing better efficiency and access while reducing manual labor. Additionally, customers can earn happiness by performing tasks on their own. It also provides the customers or students with a feeling of accomplishment with enhanced efficiency and satisfaction (Galdolage, 2021).

This study developed a self-service kiosk utilizing liquid crystal display modules—a thin, light, and energy-efficient screen that provides decent image quality while also producing minuscule heat—for the kiosk to be used for long periods within the school. LCDs have become one of the most successful optoelectronic technologies and have become an integral part of enabling technology and communication devices (Jones, 2017). With the use of LCD, the self-service kiosk will be an affordable device that is economical for convenience in educational settings and can mostly help the students place their orders without the necessity of engaging in interpersonal communication. This research sought to evaluate the responsiveness of the self-service kiosk in terms of processing speed. The accuracy rate was determined by the percentage and how it responded to user inputs. Lastly, the average time consumed for the information to be displayed was also tested.

Based on the results, the self-service kiosk could quickly display information, demonstrating its effective processing speed and swift feedback. Notably, the add to cart, reset cart, scroll up, scroll down, and total price buttons consumed an average duration of 0.123 milliseconds, 0.147 milliseconds, 0.26 milliseconds, 0.303 milliseconds, and 0.24 milliseconds, respectively. The reliability of the kiosk was proven through successful trials, demonstrating its robust design that effectively handled user interactions. A quicker processing speed plays a crucial role in creating a seamless user experience by minimizing waiting times, optimizing transaction efficiency, and potentially fostering higher user adoption and satisfaction with self-service kiosk systems (Ekşioğlu, 2016). Moreover, the self-service kiosk exhibited its accuracy in processing user inputs, where it displayed the selected items and orders correctly on the LCD screen and within the host device.

The average time was determined by the speed of the transmission of the information to be received by the host device. The self-service kiosk exhibited a 100% accuracy rate. Pressing the buttons yielded instant displays of the requested information, solidifying the kiosk's reliability and efficiency. This work described and analyzed the results of the usability evaluation of this kiosk, taking into account the average time per screen, the average time of a complete kiosk session, the application design, and the user interaction with devices (Pacheco et al., 2020). Not only that, but the effectiveness of the system was also evident in the swift transmission time it took for the host device to receive the information. The scroll-down button displayed the fastest speed, acquiring an average time of 0.193 milliseconds. The first action to the fourth action consumed more time, with an average of 0.243 milliseconds, 0.283 milliseconds, 0.587 milliseconds, and 0.333 milliseconds. These findings emphasized the relevance of considering button responsiveness in maximizing the user experience and transmission efficiency with self-service kiosks (Writer, 2015).

9. CONCLUSION

The success of each trial was evident through the immediate visibility of the requested information upon button presses, affirming the reliability and effectiveness of the system. These findings emphasized the relevance of considering button responsiveness in maximizing the user experience and transmission efficiency with self-service kiosks (Writer, 2015).

It is recommended for future researchers to attach other components, such as a bill acceptor and thermal printer, to improve the device's versatility. It is also advised to install a wifi module for the kiosk's connection to the canteen system and receive orders, allowing enough time for the student to collect them. The capacity of the device and its limitations in receiving orders over extended distances could be investigated further.

Finally, future researchers may use this study as a roadmap to create projects with similar purposes or components. For better performance, future researchers may also utilize alternative display technologies, such as TFT LCD panels, to potentially replace the existing LCD screen. A larger display could not only improve visibility but also allow images to be incorporated alongside the menu items. It is also recommended to enhance the kiosk into a solar-type device for it to be energy-efficient and eco-friendly. This enhancement could create a more captivating and informative user interface, which could further enhance the overall user experience.

ACKNOWLEDGEMENT

The researchers wish to express their gratitude and appreciation to all those who supported and guided them throughout the study, especially to the following:

Dr. Alexander S. Acosta, the Principal of the Philippine School Doha, for letting the researchers experience crafting a research paper;
Dr. Lorina S. Villanueva, the QAAD Vice Principal, and **Dr. Noemi F. Formaran**, the Senior High School Vice Principal, for allowing the researchers to conduct their study in Grade 12;
Dr. Evelyn S. Mariñas, the researchers' Research Teacher, for guiding, teaching, and advising the researchers throughout the study;
Engr. Geoffrey Michael M. Flores, Mr. Aries L. Paco, and Mr. Junrey R. Barde for enabling the researchers to refine their output further through insightful critiques and feedback;
Mr. and Mrs. Lucena, **Mr., and Mrs. Constantino**, **Mr. and Mrs. Tan**, **Mr. and Mrs. Flores, Mr., and Mrs. Saño**, **Mr. and Mrs. Piping**, **and Mr. and Mrs. Carpio,** for supporting and motivating the researchers to complete the paper; and
Mainly, the **Almighty God** for giving the researchers strength and motivation throughout the study

REFERENCES

[1] F. Bazzano and F. Lamberti, "Human-Robot Interfaces for Interactive Receptionist Systems and Wayfinding Applications," *Robotics*, vol. 7, no. 3, p. 56, Sep. 2018, doi: https://doi.org/10.3390/robotics7030056.

[2] M. Ekşioğlu, "User Experience Design of a Prototype Kiosk: A Case for the İstanbul Public Transportation System," *International Journal of Human–Computer Interaction*, vol. 32, no. 10, pp. 802–813, Jul. 2016, doi: https://doi.org/10.1080/10447318.2016.1199179.

[3] B. S. Galdolage, "Interplay between Performance and Convenience in Customer Choice of Self-Service Technologies," *Current Journal of Applied Science and Technology*, vol. 40, no. 10, pp. 80–91, May 2021, doi: https://doi.org/10.9734/cjast/2021/v40i1031361.

[4] J. Gummerus, M. Lipkin, A. Dube, and K. Heinonen, "Technology in use – characterizing customer self-service devices (SSDS)," *Journal of Services Marketing*, vol. 33, no. 1, pp. 44–

56, Feb. 2019, doi: https://doi.org/10.1108/jsm-10-2018-0292.

[5] Jatindrall, "What are the Advantages and Disadvantages of Kiosks?," *Medium*, Jul. 11, 2023. https://medium.com/@jatindrall32/what-are-the-advantages-and-disadvantages-of-kiosks-adcee4c32e5f

[6] J. P. Dakin and Robert, *Handbook of Optoelectronics, Second Edition*. Informa, 2017. doi: https://doi.org/10.1201/9781315156996.

[7] H. Li, J. Shuyuan, J. Jihan, and C. Hong, "Innovative Applications of IE Technological in the Service Sector: the Case Study-A Case of Panzhihua University Canteen Service System," *Journal of applied science and engineering innovation*, vol. 1, no. 5, 2014, Available: http://www.jasei.pub/PDF/1-5/1-338-344.pdf

[8] D. C. Mutz and R. Pemantle, "Standards for Experimental Research: Encouraging a Better Understanding of Experimental Methods," *Journal of Experimental Political Science*, vol. 2, no. 2, pp. 192–215, 2015, doi: https://doi.org/10.1017/xps.2015.4.

[9] P. Pacheco, F. Santos, J. Coimbra, E. Oliveira, and N. F. Rodrigues, "Designing Effective User Interface Experiences for a Self-Service Kiosk to Reduce Emergency Department Crowding," *IEEE Xplore*, Aug. 01, 2020. https://ieeexplore.ieee.org/document/9201858

[10] S. Park, X. Lehto, and M. Lehto, "Self-service technology kiosk design for restaurants: An QFD application," *International Journal of Hospitality Management*, vol. 92, p. 102757, Jan. 2021, doi: https://doi.org/10.1016/j.ijhm.2020.102757.

[11] K. Ranta, A. M. La Greca, L.-J. Garcia-Lopez, and M. Marttunen, "Introduction," *Social Anxiety and Phobia in Adolescents*, pp. 1–7, 2015, doi: https://doi.org/10.1007/978-3-319-16703-9_1.

[12] J. Reynolds, "LOGISTICS AND/OR FULFILLMENT MODELS," *CRC Press eBooks*, pp. 237–292, Apr. 2001, doi: https://doi.org/10.1201/9781482295566-13.

[13] K. Susandra, A. R. Nurulizwa, & S. Samer, An Insight of Customer's Behavior Intention to Use Self-Service Kiosks in Melaka Fast Food Restaurant. The Journal of Technology Management and Technopreneurship (JTMT), 9(1), 13–24, 2021, https://jtmt.utem.edu.my/jtmt/article/view/6020

[14] N. Townsend, "Shorter lunch breaks lead secondary-school students to make less healthy dietary choices: multilevel analysis of cross-sectional national survey data," *Public Health Nutrition*, vol. 18, no. 9, pp. 1626–1634, Sep. 2014, doi: https://doi.org/10.1017/s1368980014001803.

[15] S. U. Ufoaroh, C. O. Oranugo, and M. E. Uchechukwu, "HEARTBEAT MONITORING AND ALERT SYSTEM USING GSM TECHNOLOGY," *International Journal of Engineering Research and General Science*, vol. 3, no. 4, 2015, Available: http://pnrsolution.org/Datacenter/Vol3/Issue4/4.pdf

[16] T. Wani, "Self-Service Kiosk Market Research, Forecast by End-use Industry (Hospitality & Entertainment, Financial, QSR, Healthcare, Retail, Airport, Education)," *www.linkedin.com*, Apr. 05, 2023. https://www.linkedin.com/pulse/self-service-kiosk-market-research-forecast-

end-use-industry-wani

[17] R. Watson, “Quantitative Research,” *Nursing Standard*, vol. 29, no. 31, pp. 44–48, Apr. 2015, doi: https://doi.org/10.7748/ns.29.31.44.e8681.

[18] R. Widarsyah, “Examination of Self-Service-Technology’s Integration in Casual Dining Restaurants - ProQuest,” *www.proquest.com*, Aug. 2022. https://www.proquest.com/openview/927f40cb5e4fd3f6fa855e88bf5aec3d/1?pq-origsite=gscholar&cbl=187 50&diss=y

[19] S. Writer, “Application Kiosk Design - Responsive Kiosk UI part 2,” *Self Service Kiosk Machine*, Jan. 02, 2015. https://kioskindustry.org/application-kiosk-design-responsive-kiosk-interface-part-2/ (accessed May 08, 2024)