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ELKEA Technology: A Self-Service Automated Cashless Canteen Transactions

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Abstract – Traditional canteen management is complex and involves manual cash transactions and pen-and-paper record-keeping. This leads to issues like long waiting times, inefficient inventory control, and deficient real-time tracking. These problems make it difficult to serve food efficiently and adapt to changing operational requirements. The study investigates the efficiency of ELKEA technology, an advanced automated system that enables self-service, cashless transactions, and seamless integration with modern technologies, with the goal of transforming traditional canteen management. This research employs a true experimental design to evaluate the efficiency of ELKEA technology in a university canteen, specifically focusing on its impact on product scanning and payment efficiency. The study aims to determine if ELKEA can significantly reduce waiting times, streamline inventory management, and improve overall customer satisfaction. Data gathering involves simulating transactions, testing omnidirectional scanners, and evaluating real-time tracking via a website. A statistical test, specifically an individual t-test, was used to test the significant differences in efficiency between the ELKEA technology and the traditional canteen. The results show that there is a significant difference between the level of efficiency of ELKEA technology and traditional canteen management. Hence, the implications of this study are broad, benefiting students by offering faster and more convenient transactions, reducing canteen staff workload, providing real-time transaction tracking, and reducing accounting errors.

Keywords— omni directional bar code scanner, cashless payment, canteen management, self-service, queuing system, inventory, student id

I. INTRODUCTION

Canteen management oversees all activities to ensure sufficient inventory and effective food service. The management of a canteen is a complicated process that involves managing inventory carefully, providing food services in a convenient manner, and strictly adhering to safety guidelines. In addition to keeping the area tidy, this extensive responsibility entails effective inventory management and regular financial monitoring. The manual processes of cash transactions and pen-and-paper record-keeping inherent in traditional canteen management provide a number of challenges. Therefore, there are natural barriers such as long queues, challenges managing inventories, and a need for real-time transaction tracking (Fegade, 2019). These traditional methods unintentionally lead to bottlenecks, which hinder canteen operations and make it difficult to adjust to changes in the environment. The ease, efficiency, and transparency of canteen operations are seriously compromised by such challenges, according to Sumacot (2023). Furthermore, Peng (2021) stated that increased flexibility in response to evolving standards is necessary due to the natural challenges of these manual procedures. There is a compelling argument to switch to automated, high-tech solutions in response to the ongoing issues. With their capacity for enhanced operational efficiency and smooth integration with modern canteen management techniques, these technologies bring in a new era of efficiency and competence in the institutional canteen.

Recently, a number of innovative developments have been created to greatly increase the effectiveness of ordering, payment processing, and inventory management in canteens. These programs make use of cutting-edge technologies and have a lot to offer. Digitalized scanning technology was introduced by Espinosa et al. (2021) to speed up payment transactions in canteen and related environments. The Cashless Payment System was proposed by Olipas and Espereron (2020) and makes use of Automatic Identification and Data Capture (AIDC). Additionally, the digital scanning feature of the Cashless Canteen Management System frees up canteen employees to concentrate on other duties rather than maintaining records. Error-free accounting, reduced development costs, improved security, and quicker service are all provided by this system (Kale, 2022). The implementation of these advanced technologies not only addresses immediate needs but also positions these systems at the forefront of

technology-driven service delivery. This aligns with the growing consumer expectation for efficient transactions and systemized record-keeping within canteens.

Innovative solutions have been developed in the canteen management sector to target inefficient billing processes and other underlying challenges. According to Martia et al. (2020), e-wallet integration is a crucial penetration that will provide students with easy cashless payments, automate inventory management, and reduce canteen staff workloads. The focus is more on the Cashless Canteen Management System, a complex technology integration created to digitalize the scanning of products and payments and manage sales and canteen information in a holistic manner. It also includes user information, product data, order information, and the entire range of canteen activities. Ambrika et al. (2020) claim that the user interfaces of modern-day technology ensure both long-term data retention and fast access. With an all-encompassing solution that automates cashless payments and inventory monitoring in school canteens, this innovative technology takes center stage. The system greatly improves the efficiency, convenience, and transparency of school canteen operations by addressing issues like waiting times and inventory accuracy. According to Lalitha (2022), its integration promises to new operational processes by enabling faster payments for customers and real-time monitoring for canteen operators. This will reduce waiting times, food shortages, and the possibility of accounting errors caused by human error. The goal of this research is to develop a technology by combining several current technologies. This technology envisions a future where canteen management achieves exceptional efficiency, convenience, and transparency in institutional canteen services.

Research Questions

This study aimed to make a technology that makes Self-Service Automated Cashless Canteen Transactions. Specifically, this study will be conducted to seek answers to the following questions:

1. What is the level of efficiency of the ELKEA technology in product scanning and payment processing?
    a. 1 product
    b. 2 products
    c. 3 products
    d. 4 products
    e. 5 products

2. Is there a significant difference in the efficiency of product scanning and payment processing in a university canteen when using ELKEA technology compared to traditional canteen management?

Hypothesis

There is no significant difference in the level of efficiency of product scanning and payment processing in a university canteen when using ELKEA, and this difference is influenced by the number of products involved in each transaction.

Significance of the Study

The results of the study would benefit the students by enhancing students experience by streamlining transactions, increasing convenience and time savings, and promoting financial literacy. The canteen staffs benefit by significantly reducing workload, allowing more time for food preparation, and enhancing overall customer service. The system's precision minimizes errors, ensuring the integrity of financial records. The parents, on the other hand, gain the ability to monitor and guide their children's spending, fostering responsible financial habits. Moreover, the study served as a foundation for future researchers to delve into the broader implications of cashless transactions in schools, providing insights.

Research Paradigm

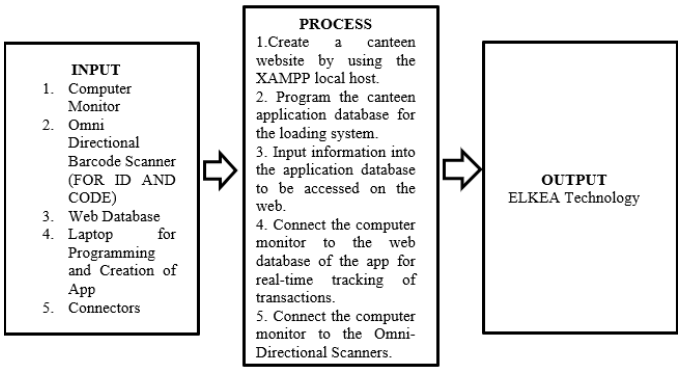

Figure 1: *The Equipment and Framework of the ELKEA Technology*

The figure shows the setup for ELKEA Technology's Self-Service Automated Cashless Canteen Transaction system. The process starts with the creation of a canteen web-based application, followed by programming the web-based application database for the loading system. Information is then input into the database. The computer monitor is connected to the web database for real-time transaction tracking and linked to Omni-Directional Scanners. The integrated components work collectively, resulting in the output of a seamless self-service automated transaction system.

II. METHODS

A. Research Design

A quantitative research design was employed, specifically a true experimental research design, to investigate the efficiency of ELKEA technology on self-service and automated cashless canteen transactions.

B. Locale of the Study

The study was conducted at the university canteen of the University of Saint Louis in Tuguegarao City, Cagayan.

C. Materials

Figure 2. Computer Set
This set of hardware functions as the display interface during canteen transactions.

Figure 3. *Omni Directional Barcode Scanner*

The barcode scanner will serve as the scanner on ID cards and food items.

Figure 4. *Barcode Sticker*

The barcode sticker will serve as a food items identification code.

Figure 5. *Canteen Products*

These materials will be used to test the technology's speed in scanning, identifying, and recording products.

Figure 6. *School ID*

The school ID will be used as an input to test the technology's speed in identifying IDs during payment transactions.

Figure 7. *Cellphone*
The cellphone serves as a tool to monitor the purchases and the outstanding balance of the student purchases in their GMAIL.

D. Data Gathering Procedure

A. **Letters**

Researchers sent letters to a language editor, a statistician, and an Information Technology specialist seeking their endorsement and recommendations. Additionally, the researchers contacted the Information Technology Department of the Technical Education and Skill Development Authority to inquire about the feasibility of the project and technology development and identify a qualified individual to assist with the experiment.

B. **Web App Development** (Jackson-Barnes, S., 2022, Alias, Azmi, & Salim, 2020)

a. Prepare for Information Gathering Meeting
b. Conduct Meeting with IT Specialist
c. Establish Team and Review Existing Code
d. Create Wireframe Sketches
e. Develop Interactive Mock ups
f. Choose Front-End Technologies
g. Set Up Back-End Infrastructure Implement SEO Strategies
h. Write Clear and Concise Content
i. Conduct Thorough Testing
j. Address Issues and Launch

k. Provide Ongoing Maintenance

C. **Database Development** (Student Information System) (Reynolds, I. J. H., 2023)

a. Define Data Entities
b. Design Database Schema
c. Choose Database Management System
d. Implement Database
e. Incorporate Security Measures
f. Test Thoroughly
g. Deploy to Production Environment

D. **Loading Process** (Yasay, 2021)

a. The student proceeds to the designated loading area within the school canteen.
b. The student hands over the correct amount of cash that they wish to load onto their account.
c. The staff accesses the loading system using their credentials.
d. The staff enters the student's ID number into the system.
e. The system displays the student's name, ID number, and loading amount for confirmation.
f. The staff verifies the information and approves the transaction.

E. **Set up the omnidirectional scanner to capture information from both the student ID and Barcode sticker** (Barcode Scanner with Database Sample jQM App, n.d.)

a. Database Setup
b. Server Code Scripts
c. Script for Listing Products
d. Testing the Listing Script
e. Script for Searching the Database
f. Testing the Search Script
g. Script for Saving/Updating Products
h. Testing the Save

F. **Assembling the Technology** (VARTEQ Inc., 2023)

F.1 **Hardware Integration**:

a. Deploy the web app on Virtual Private Server (VPS).
b. Connect the barcode scanner to the network.
c. Install Omnidirectional Scanner throughout the designated area and connect them to the central computer via a USB cable.

F.2 **Software Integration**:

a. API Development: Define and implement APIs for communication between the web app
b. Configure the Omnidirectional reader software to send student ID information to the database upon detection.

F.3 **Data Flow and Interfaces**:

a. Create a visual representation of how data will flow between each component, including scanned barcode data, student information from Omnidirectional, and interaction from the web app.
b. Choose appropriate protocols (e.g., REST APIs, MQTT) for efficient and secure data exchange between components.

G. Testing the ELKEA technology

a. Prepare the test environment
b. Simulate Transactions
c. Check the web-based application for the records of data
d. Monitor transactions of costumers via gmail

E. Data Analysis

Data analysis for this study employed independent t-test to determine if there is a significant difference between the mean time of transactions in ELKEA technology and the traditional canteen transaction. The mean time of transaction for ELKEA technology was calculated through three trials of each specific number of products (1 product, 2 products, 3 products, 4 products, and 5 products). To calculate the mean time for the Traditional canteen transaction three trials is also utilized of each specific number of products (1 product, 2 products, 3 products, 4 products, and 5 products). The mean time of the two different types of transactions is then compared to determine if the proposed technology is more efficient to use.

III. RESULTS

Table 1: *Level of efficiency of the ELKEA technology in product scanning and payment processing.*

Type of Transaction	Number of Products	TRIAL 1	TRIAL 2	TRIAL 3	Mean Time (seconds)
ELKEA	1 product	4.13 seconds	5.91 seconds	5.65 seconds	5.23 seconds
	2 products	9.32 seconds	9.71 seconds	10.89 seconds	9.97 seconds
	3 products	13.75 seconds	13.33 seconds	12.56 seconds	13.21 seconds
	4 products	17.92 seconds	16.77 seconds	16.34 seconds	17.01 seconds
	5 products	20.88 seconds	20.73 seconds	21.40 seconds	21.00 seconds

Table 1 shows the time taken for each trial with a different number of products using ELKEA technology. These results imply that as the number of products increases, the average time for each transaction also increases.

Table 2: *Level of efficiency of the traditional canteen management.*

Type of Transaction	Number of Products	TRIAL 1	TRIAL 2	TRIAL 3	Mean Time (seconds)
TRADITIONAL CANTEEN MANAGEMENT	1 product	25.59 seconds	24.53 seconds	22.98 seconds	24.37 seconds
	2 products	31.48 seconds	37.76 seconds	33.64 seconds	34.41 seconds
	3 products	45.41 seconds	46.55 seconds	45.33 seconds	45.76 seconds
	4 products	54.42 seconds	52.65 seconds	57.09 seconds	54.72 seconds
	5 products	70.50 seconds	69.33 seconds	68.79 seconds	69.54 seconds

Table 2 shows that managing a greater number of products naturally increases task duration. Traditional canteen management uses more time since it uses manual and staff-dependent methods. such as payment of products.

Table 3: *Difference in the efficiency of product scanning and payment processing in a university canteen when using ELKEA technology compared to traditional canteen management.*

Number of Products	Type of Transaction	Mean Time (in seconds)	t-value	p-value	Decision
1 product	Traditional	24.37	-20.40	0.00	Reject Ho
	ELKEA	5.23			
2 products	Traditional	34.41	-13.5	0.00	Reject Ho
	ELKEA	9.97			
3 products	Traditional	45.76	-61.9	0. 00	Reject Ho
	ELKEA	13.21			
4 products	Traditional	54.72	-27.9	0.00	Reject Ho
	ELKEA	17.01			
5 products	Traditional	69.54	-89.2	0.00	Reject Ho
	ELKEA	21.00			

Table 3 above shows that the null hypothesis is rejected. The level of efficiency of ELKEA technology is higher than that of the traditional canteen in terms of time. Hence, there is a significant difference in the level of efficiency of product scanning and payment transactions in a university canteen when using ELKEA.

IV. DISCUSSION

This study aimed to assess the efficiency of ELKEA technology in scanning products and facilitating payment transactions in a university canteen, comparing its performance with traditional canteen management. Manual processes like cash transactions and pen-and-paper record-keeping have numerous challenges, including long queues, inventory management difficulties, and a lack of real-time transaction tracking (Fegade, 2019). This challenge can compromise the efficiency and transparency of canteen operations (Sumacot, 2023). Also, the transition to a cashless payment system contributes to sustainability by reducing paper waste and lowering the carbon footprint associated with cash production (Smith, 2022). Additionally, these systems can provide business intelligence through data analytics, enabling canteens to track customer buying behavior, oversee inventory, and monitor sales (Lewis & Clark, 2020). According to Martia et al. (2020), incorporating e-wallets could provide students with effortless cashless payments and reduce canteen staff workloads, leading to increased efficiency and satisfaction with transactions. Furthermore, it can reduce employment costs, improve security, and provide quicker service, all of which are provided by this system (Kale, 2022).

ELKEA technology has demonstrated good results in reducing transaction time in scanning and payment systems, which is aligned with the current trend towards automatic technologies. Our research has indicated a notable reduction in the average transaction time for three products, decreasing from 45.76 seconds using traditional methods to just 13.21 seconds with the use of ELKEA technology. This enhancement underscores the efficiency ELKEA can provide. These findings are consistent with the research of Baihaqi et al. (2020), who determined that modernize payment processing system results in fewer manual tasks and errors in managing money. Similarly, Carter (2023) discovered that barcode scanning technology significantly enhances data accuracy and transaction speeds. In addition to the five products, it further underscores the advantages of utilizing the technology. The average processing time was only 21 seconds, compared to the 69.54 seconds of traditional canteen management. This aligns with the research of Hor et al. (2020), who highlighted the effectiveness of self-service technology in reducing user wait times. Espeleta (2022) also highlighted the operational benefits of automation in enhancing operational efficiency by minimizing manual tasks. Furthermore, Alias et al. (2020) showed the operational efficiency advantages of automated technology in the payment process by eliminating manual money counting.

Despite the potential benefits of automated technology, implementing it like ELKEA may pose challenges. As Hambali et al. (2020) pointed out, significant initial costs and technical complexities are associated with cashless payment systems. Transitioning to an automatic system may require regular updates, as Cordial (2020) emphasized, to ensure the smooth operation of inventory management tools. These studies collectively suggest that businesses contemplating the adoption of such technology must be prepared to tackle operational and technical issues. Another is that employees need to understand and adopt the new system that changes their workflows; failure to do this can also lead to operational efficiencies (Glover and Kent, 2018). Additionally, poorly implemented new technology can also result in customer dissatisfaction (Taylor and Green, 2022).

The acceptance of technology by customers is pivotal for its successful implementation. Rahman et al. (2022) found that consumer attitudes towards cashless payment systems are heavily influenced by perceived risks and trust factors. On the other hand, Goel et al. (2019) underscored consumers'

preference for quicker and more efficient payment methods. Galabo (2019) noted that cashless systems often result in enhanced service quality and increased customer satisfaction. These results underscore the importance of addressing both technical challenges and customer expectations to ensure the seamless integration of technology-based systems like ELKEA in payment and scanning processes. Additionally, according to Lalitha (2022), its integration promises to revolutionize operational processes by enabling prompt payments for customers and real-time monitoring for canteen operators. Hence, in support of the study of Olipas and Esperon (2020) about cashless payment systems, there is a significant difference in the efficiency of ELKEA technology for automated cashless payments compared to traditional management

V. Conclusion

Traditional canteen management involves overseeing inventory, providing food services, and ensuring safety guidelines are followed. However, the problem lies with providing convenience due to the existence of natural barriers such as long queues and for tracking inventories. Moreover, with the help of technology, innovative solutions have emerged in canteen management to address issues like inefficient billing processes and other underlying challenges. With this, the researchers came up with the development of the ELKEA technology to solve the following gaps: Firstly, the findings indicate that the efficiency of ELKEA Technology in scanning products is directly related to the time taken, showing that as the average time increases, the number of products scanned also increases. This suggests that handling more products naturally extends the task's duration. Lastly, the finding reveals that the null hypothesis was not accepted, indicating that the efficiency of ELKEA technology surpasses that of the traditional canteen system. This suggests that there is a significant difference in the efficiency of product scanning and payment transactions within a university canteen when ELKEA technology is utilized.

VI. Recommendations

The researchers recommend the following for the enhancement of the study:

1. Provide comprehensive training for students, staff, and canteen operators on how to use ELKEA effectively. This training should cover system functionalities, cashless payment procedures, data security protocols, and troubleshooting common user issues. Consider incorporating interactive training modules or video tutorials to enhance user engagement and knowledge retention.
2. Explore the feasibility of integrating ELKEA with existing school systems, such as student ID databases or accounting software. Streamlining data management through this integration would enhance overall system efficiency and reduce manual data entry errors. Additionally, investigate the possibility of integrating with loyalty programs or food allergen databases to cater to specific user needs.
3. Conduct secure payment authentications like personal identification numbers (PINs) or even multi-factor authentication (MFA) using biometrics or one-time codes beyond just student ID verification to further protect user financial information during transactions and avoid unauthorized use of the personal account.
4. Establish a system for gathering continuous user feedback on their experience with ELKEA Technology. This feedback can be collected through surveys, suggestion boxes, or dedicated online forums. Implement a feedback loop to ensure that user concerns and suggestions are addressed and incorporated into future updates of the ELKEA system. This demonstrates a commitment to user-centric design and continuous improvement.
5. Develop a strong data analytics and reporting module within ELKEA. This module would allow canteen operators to track user purchasing trends, identify popular menu items, and optimize inventory management. Additionally, usage data can be analyzed to identify areas for improvement within the ELKEA system itself.

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