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Optimizing User Interaction and Notification Efficiency in Smart Coin-Operated Printing Kiosk with Real-Time SMS Notifications and Interactive Features

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Abstract: This study aims at designing and implementing a prototype coin-operated printing kiosk that will be able to run on an SMS notification system and GSM technology in error management and user interaction monitoring. The prototype kiosk was tested using a prototyping design with real customers to gauge accuracy, effectiveness, and learnability metrics. Data collection was done using a modified Prototype Demo Form and questionnaires based on Whiteside, Bennett, and Holtzzblatt's and ISO 9241 usability metrics. Results showed that the kiosk efficiently completes printing tasks and documents copies are well accounted for, and that the kiosk is user-friendly. The findings were that the kiosk offers realistic and convenient printing services within the school campus, therefore cutting down the number of times students need to leave campus over their printing needs.

Keywords: Interactive Features, Printing Kiosk, Real-Time SMS Notification, GSM Device, Arduino Microcontroller

I. Introduction

Technological innovation has become essential in today's world, primarily aimed at enhancing community life. In this line, present research into IoT in both academic and industrial sectors have focused on system architecture, communication protocols, and sensor networks, with security and privacy protection taken into consideration, and many applications are involved [1]. Among the numerous innovations jump-started by this technological evolution are smart coin-operated printing kiosks. This new technology in kiosks embeds a number of advanced features to increase user convenience and operation efficiency. Against the traditional vending machine, there are major improvements in terms of offering real-time communication and interactivity to make user interactions easier.

These kiosks offer convenient on-the-go printing solutions, but their effectiveness relies significantly on optimizing both user interaction and notification efficiency [2].

The modern student in school now greatly depends on technology to help the student complete tasks that include the printing of various assignments, projects, and other important documents. The need for students to conveniently and prudently print led to the initiation of the smart coin-operated printing kiosks, which enhance its advanced features to fit the needs of a modern student.

Further, these smart kiosks far outperform the traditional printing methods with the aid of features such as real-time SMS notifications and responsiveness in improving the overall user experience. The addition of real-time SMS notifications against system status and user activities through GSM makes this very significant to smart kiosks. This improves not only the user experience with timely feedback and error alerts to users, but also the operational management of the kiosks by means of proactive error resolution and system maintenance.

These innovations have also been accompanied by challenges related to the optimization of user interaction and notification efficiency. Real-time notifications in a user-friendly interface should be duly balanced. Efficient interaction design allows for ease of use, while an efficient notification system will alert on time, always having relevant content without overwhelming the user.

The challenges to be addressed in this work pertain to the optimization of real-time SMS notifications and interactivity within a smart coin-operated printing kiosk. This piece of research evaluates the kiosk's performance on the bases of user interaction, notification efficiency, and general effectiveness in establishing insights on how to improve both user experience and operational efficiency for such systems. The findings in this study are expected to have an impact on the further development of more intuitive and responsive smart kiosks and hence their utility in various settings and users' satisfaction.

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Research Objectives

The main objective of this study was to develop and implement a coin-operated printing kiosk designed to provide practical and convenient printing services. Specifically, it aimed to:

1. Design and develop a prototype of an interactive coin-operated printing kiosk with an integrated SMS notification system.
2. Estimate the effectiveness of the GSM device as an interface for handling system errors at the printing kiosk.
3. Express the level of user interaction provided by the printing kiosk concerning each of the following:
    a. Accuracy: Print Job Accuracy and Error Management.
    b. Effectiveness: It is the overall functionality and performance concerning the fulfilment of user needs.
    c. Learnability: How easily a user can understand the kiosk and the tasks associated.

II. Literature Review

Digital printing technologies use bitmap images or patterns created by a computer to jet ink onto substrates. Over the years, they have been predominantly employed for printing graphics and documents. Recent development efforts are focused on production printing, with methods such as low-cost and high-frequency jetting, and high-resolution techniques. In addition, intensive research has been underway to try and use digital printing for directly depositing functional materials. The reason may be due to direct printing that offers advantages over conventional photolithographic methods and mainly reduces the manufacturing costs since it is capable of additive manufacturing [12]. Automation's primary advantage is its ability to enhance efficiency, simplify management, and enable multitasking across various contexts. This prototype offers a solution for paper retailers and printing/photocopy shop centers at the University of Science and Technology of Southern Philippines, catering to students who use bond papers, newsprints, and yellow papers for exams and other purposes. The vending machine features a coin-slot mechanism and will automatically dispense the selected type of paper based on the amount of money inserted by the student [13]. Traditional unmanned vending machines cannot bargain over prices and, simultaneously, cannot provide personalized bargaining services [3]. Smart vending machines, as essential tools in the domain of unstaffed document printing, will become prominent [4].

Vending machines are some of the machines in public places that dispense or vend products, including snacks, drinks, newspapers, tickets, and cigarettes. According to these recent evolutions, they require control systems that have different products of varying nature. According to Yang and Zhu, 2014 [6], a vending machine is an automated business device that does not require help from a person; hence, it enjoys flexible operation hours.

While vending machines are more prevalent in private schools than public ones, the school stores a very common in both [7]. The internet is acting as a catalyst in these technological advancements and is therefore affecting most markets, including the vending markets. The latest models of vending machines provide services such as mobile phone charging, offering free Wi-Fi, and USB drive printouts [5]. These machines use several communication standards, and GSM is used for tracking sales, users and machine operations, and sending multi-media messages [8].

It may further be capable of monitoring the availability of products and the health of the entire machine, thus keeping the owner or user informed. Some recent trends in vending machines are high-definition touchscreens, cashless payment, integration into IoT devices, and cloud services. A typical automatic selling machine is controlled by a Vending Machine Controller, which normally controls all the basic tasks of an automatic selling machine, such as processing money and managing refrigeration, lighting, and product dispensers [5].

The different elements of the vending machine communication system integrate to give a perfect experience to users. The touch screen serves as an interface for multimedia, control, and communication. A standalone connection powers real-time, two-way communication between the machine and users [8]. Data storage and processing servers tabulate statistical data for easy management and stocking of vending machines. This brings a complete solution to the consumer's demand by enhancing system efficiency [9].

III. Methodology

This study will follow the interaction design process which consists of 5 stages. The first stage was the establishment of the requirements through interviews with the students, checking their work documents, and observation of them while interacting with each other. Second stage was the analysis, which comprised the organization of the results from the observation to stress the major issues to be addressed within the design phase. Third stage was the design phase itself where the requirements are translated into detailed programs following the principles and rules of design, taking into consideration the different types of users, all in an effort to ensure easy interaction and navigation.

In the fourth stage, a prototype of the coin-operated printing kiosk was developed and tested for evaluation. This was in respect to the assessment of the prototype's design, functionality, and improvement segments by real-user testing. The analysis of feedback was done in view of verifying the effectiveness, accuracy, and usability of the design. The study used criteria from Whiteside, Bennett, and Holtzblatt, 1998; and the Prototype Demo Form from the Rochester Institute of Technology. The results were used to base further improvements of the architecture and the design of the kiosk with respect to accuracy, effectiveness, and learnability issues resulting from user evaluations.

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The last stage was the implementation of the final design incorporating all necessary adjustments and enhancements.

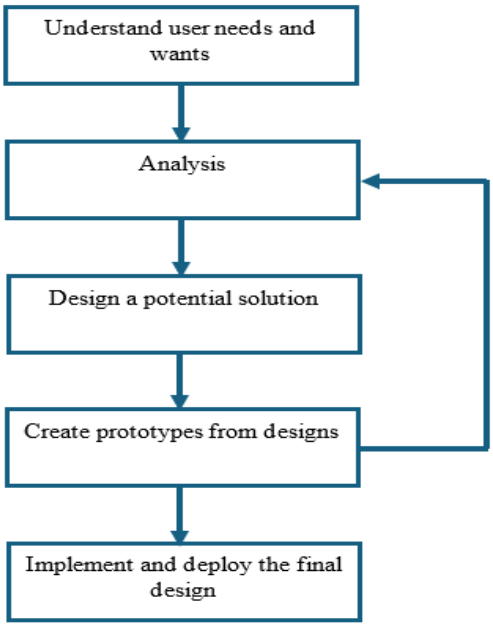

Figure 1 Interaction Design Process of the study.

A. Research Design

This study fell under a developmental research design, which Richey defined as a systematic approach to designing, developing, and evaluating instructional programs, processes, and products to ensure criteria for internal consistency and effectiveness in 1994. In adherence to this approach, this researcher has designed, developed, and implemented an interactive coin-operated printing kiosk. Testing of the kiosk was done early in its lifecycle with real users for assessing the accuracy, effectiveness, learnability, and user experience. This research design has also allowed the researcher to collect data for refining the design of the kiosk and its processes by focusing on the critical interface elements of the printing kiosk.

B. Research Environment

This research was conducted at Sogod National High School in Sogod, Southern Leyte. Being the only mega-secondary school in the Division of Southern Leyte and being one of the bigger schools in Region VIII, it caters to a student population of 4,005 served by 126 teaching staff. Because of its large potential user base, the prototype of the coin-operated printing kiosk was pilot-tested in this location. These are the SPA, SPS, STEM, and the regular and senior high school classes. Where in kiosks can be likewise deployed in other high-volume areas such as businesses or offices where printing is a regular need.

C. Research Respondents and Sampling Procedure

The respondents of the study consisted of the faculty, staff, and students of Sogod National High School. This sample size was then proportionally allocated in every group using Slovin's formula, with a margin of error of ±0.05, as shown below:

$$n = \frac{N}{1 + Ne^2}$$

where n = sample size

N = population size

e = margin of error (0.05)

Table 1. Distribution of Respondents

Respondents	Population Size	Sample size
SHS Teachers	45	41
JHS Teachers	89	73
Junior High School Students	2,740	349
Senior High School Students	1,265	304
TOTAL	4,139	767

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Table 1 gives the various categories of the target population, namely SHS Teachers, JHS Teachers, Junior High School Students, and Senior High School Students with their actual population size and sample size. Almost all the SHS Teachers were sampled since out of a population of 45 teachers, 41 of them were used thus accounting for 91.1% of the population. For the JHS Teachers, 73 of the 89 were sampled, hence making up 82% of their population. For the Junior High School Students, it had a population of 2,740, having 349 samples, accounting for about 12.7%. In relation, 304 of the 1,265 were sampled from Senior High School Students, representing 24% of their population. In summary, the study sampled 767 of the total population of 4,139, approximately 18.5%. It means a strong representation of teachers and many students are expected in the study to ensure a complete dataset for analysis.

D. Research Instrument

Data was obtained through a modified Prototype Demo Form from the Rochester Institute of Technology, which was rated by the specified research respondents. The form assessed the printing kiosk for attributes, such as functionality, performance, robustness, and workmanship. A five-point scale was used: 100-90, Superior; 89-80, Above Average; 79-70, Average; 69-60, Below Average; and below 59, Failing. Also, a questionnaire form revised with criteria by Whiteside, Bennett, and Holtzblatt, 1998; Usability Metrics from ISO 9241 is a major instrument for data collection. There are two parts to the survey questionnaire: Part 1 of the questionnaire targeted the assessment of the efficiency of the GSM instrument at system error management, and Part 2 rated the accuracy, effectiveness, and learnability of the printing kiosk. Responses to these facets of the kiosk's performance were rated on a four-point Likert scale.

IV. Results and Discussion

A. Prototype Designing and Development

The architectural framework of the smart coin-operated printing kiosk system as shown in Fig. 2 is designed for users to interact more effectively and receive efficient notification by including real-time SMS notifications and interactive features. Basically, in the system, users select documents for printing, then insert their coins for payment; a device verifies the amount paid before processing the request for printing. The activities herein described are tasks of the central processing unit, involving the microcontroller and server to ensure smooth running operations. Real-time SMS notifications are triggered at the end of every transaction to users for verification and alert them in case there is a paper jam or any such issue. It is also integrated with cloud storage and database that provide security along with scalability in managing data. There are some interactive features by which users can give feedback or seek help directly from the interface of the kiosk. Therefore, the above module becomes an all-in-one framework towards better efficiency, user satisfaction, and reliability; thus, this printing kiosk system is very robust in efficiently managing the interaction of users and their notifications.

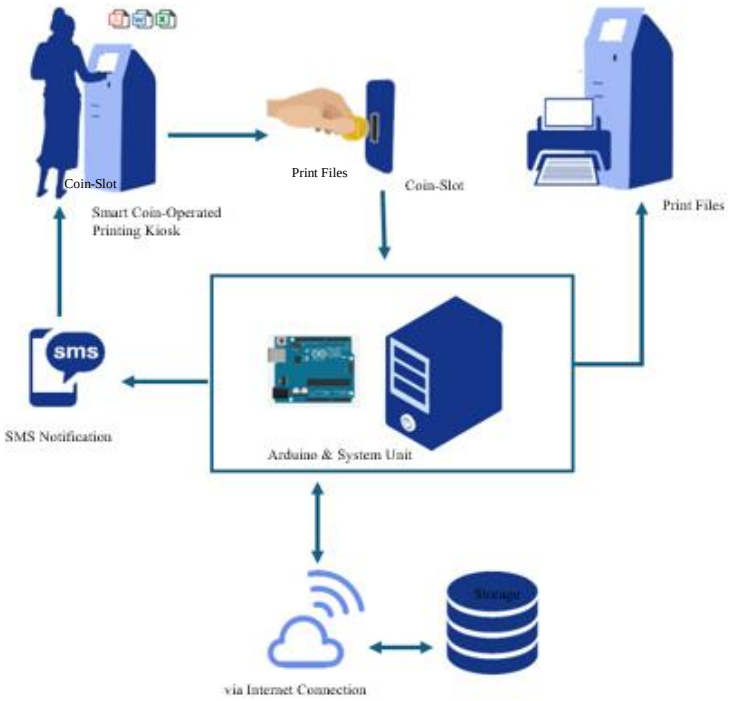

Figure 2. Architectural Framework of the study

B. System's Interface

To achieve a user-friendly environment, there must be software use in printing documents. The software that manages a vending machine or a system of connected machines must exchange information with the controllers of the machines to monitor the availability of the products offered, to control the financial flows and operations of the users [10][11].

Fig. 3 shows the administrator connecting the Visual Basic program to the Arduino program to control the functionality of the coin-operated printing kiosk.

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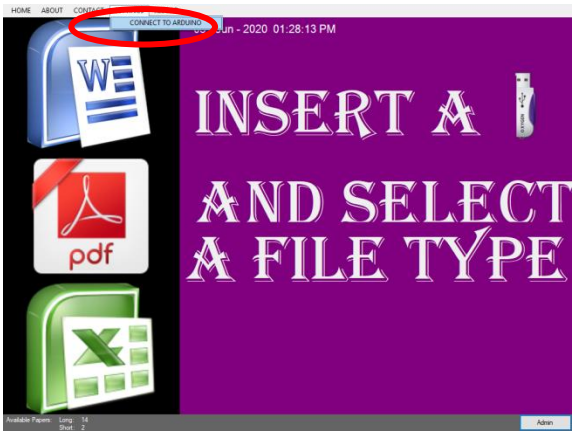

Figure 3. Connect Visual Basic Program to Arduino Program

Fig. 4 shows that the administrator has to log in to the admin system to first set the paper in the printer's paper tray, adjusting predefined watermark copy, and log machine transactions like paper jamming, out of paper alert, and low ink levels. The other option available to the administrator is changing the password for the admin log-in.

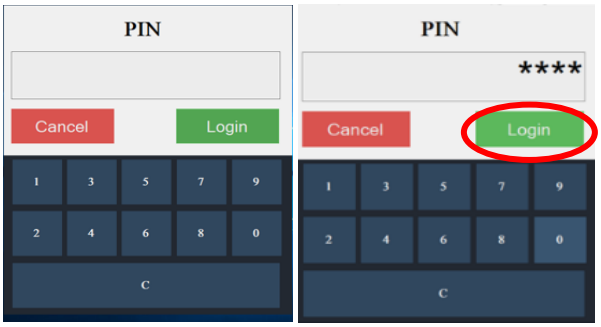

Figure 4. Administrator Login

Fig. 5 displays the administrator page, where the administrator can add paper of different sizes to the printer by selecting the options shown on the screen. The paper count for each printer tray is also displayed on this page.

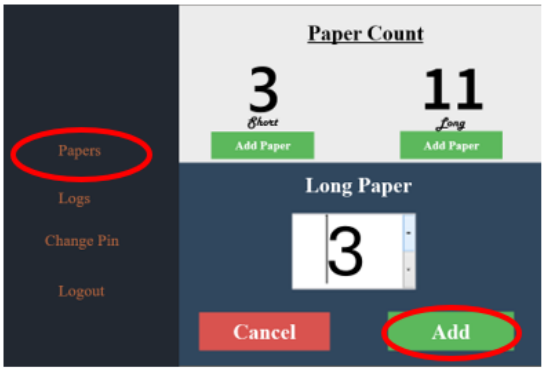

Figure 5. Adding Paper

Fig. 6 shows a popup button after a flash drive is inserted into the USB port. Users can then view and select the document types to print from their flash drive.

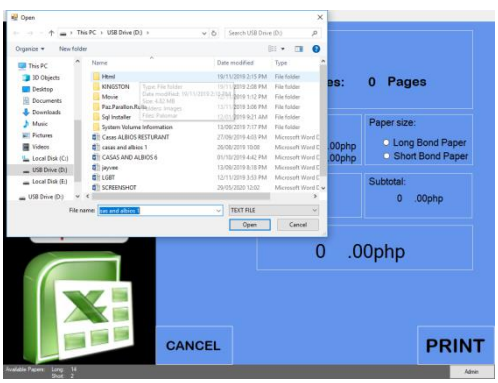

Figure 6. Users select file location

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The page shown in Fig.7 displays the required amount of coins to be inserted into the coin slot, as indicated in the subtotal column. It also features a print button for MS Word documents, which becomes active once the correct amount of coins has been inserted, allowing the user to proceed with printing their documents.

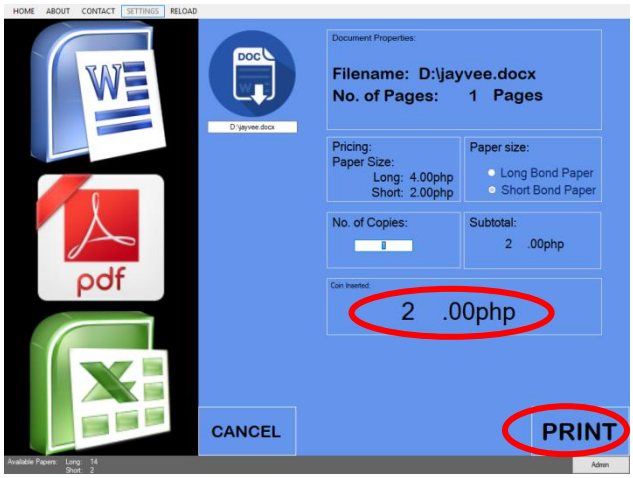

Figure 7. Printing File

C. Efficiency of GSM device in Handling system errors

Table 2. Efficiency of GSM Device

Efficiency of GSM device in managing system errors	Mean	Interpretation
1. Time to complete a task	3.5	Very Efficient
2.Relativeefficiency compared with an expert user	3.62	Very Efficient
3. Time to learn criterion	3.54	Very Efficient
4. Time spent on correcting errors	3.70	Very Efficient
5. Frequency of help and documentation used	3.72	Very Efficient
6. Number of times the user is disrupted from a work task	3.75	Very Efficient
7. Number of times users need to work around a problem	3.76	Very Efficient
8. Number of errors	3.77	Very Efficient
Overall Results	**3.67**	**Very Efficient**

Weighted Mean	**Descriptive Interpretation**
1.00 – 1.74	Not Efficient
1.75 – 2.49	Moderately Efficient
2.50 – 3.24	Efficient
3.25 – 4.00	Very Efficient

According to the teacher and student respondents, the GSM device of the printing kiosk is rated to be "Very Efficient" with a Mean = 3.67, in handling system errors as was experienced during pilot testing and trials conducted by the respondents as shown in Table 2. These findings are very similar to those obtained in a study by the AMA Computer Engineering Department, which reported that 45% and 40% of its respondents rated the efficiency of coin-operated printing machines as "Very Satisfactory" and "Excellent," respectively.

This proves that some of the mistakes which were identified during the pilot testing were actually noted by the system, which sent an SMS to the researcher about the problems in the machine. All these errors were resolved on time by the researcher following the notifications.

D. Express the level of user interaction in the machine

Table 3. Accuracy of Kiosk Printing

Accuracy	Mean	Interpretation
1. The number of pages to be printed is equal to the amount requested by the printing kiosk.	3.12	Accurate
2. The number of coins inserted is correctly recognized and	2.62	Accurate

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counted.		
3. The system correctly displays the file/s to be printed.	3.25	Very Accurate
4. The onscreen instruction is accurate.	3.08	Accurate
5. Ratio of success to failures	3.10	Accurate
6. Number of times user expresses frustration or satisfaction	3.70	Very Accurate
7. Number of times user loses control of the system	3.20	Accurate
8. Number of available commands not invoked	3.23	Accurate
Overall Results	**3.16**	**Accurate**

Weighted Mean Descriptive Interpretation

1.00 – 1.74 Not Accurate

1.75 – 2.49 Moderately Accurate

2.50 – 3.24 Accurate

3.25 – 4.00 Very Accurate

As shown in Table 3, the teachers and students of both Senior and Junior High School in Sogod National High School have responded that the printing kiosk is "Accurate" in printing documents in relation to the amount required by the system with an overall mean of 3.16. The buttons on the screen were also said to be real-time, reflecting accurate functionality.

Moreover, it can be noted that all the respondents liked the accuracy of the printing kiosk's overall functionality when tested for real applications. Even though there were some cases wherein the coins were recognized but not continually counted with those already deposited in the coin collector, the system usually gave an accurate countdown and the correct number of prints.

Table 4. Effectiveness of Kiosk Printing

Effectiveness	Mean	Interpretation
1. Percentage of goals achieved	3.35	Very Effective
2. Number of power features used	3.45	Very Effective
3. Percentage of functions learned	3.38	Very Effective
4. Percentage of errors corrected successfully	3.50	Very Effective
5. The printing kiosk process input data fast.	3.47	Very Effective
6. Error/s in the input data is easily corrected.	3.17	Effective
7. Printing of files is fast.	3.45	Very Effective
8. Viewing contents of the file/s to be printed is fast.	3.49	Very Effective
9. An SMS is sent immediately to the researcher if paper jam and no paper fed were detected.	3.62	Very Effective
Overall Results	**3.43**	Very Effective

Weighted Mean Descriptive Interpretation

1.00 – 1.74 Not Effective

1.75 – 2.49 Moderately Effective

2.50 – 3.24 Effective

3.25 – 4.00 Very Effective

As can be seen in Table 4, the printing kiosk, according to teachers and students, is rated as "Very Effective" in performing its functions, with a general mean of 3.43. The need to correct errors on the input data was considered "Effective" with an average mean of 3.17, which implies that the printing kiosk is very effective in viewing and processing input data, with very minimal errors during actual operation. It also shows that the kiosk meets the expectations of the respondents insofar as it is effective for doing their printing jobs.

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Table 5. Learnability of Kiosk Printing

Learnability	Mean	Interpretation
1. On-screen instruction is very clear and easy to follow.	3.54	Excellent
2. An "error" message will pop-up if wrong input is done.	3.62	Excellent
3. "Back" screen menu is available in the system to go back to previous step.	3.62	Excellent
4. Instructions are simple and easy to understand.	3.66	Excellent
5. First time users can use the printing kiosk with ease and accuracy	3.70	Excellent
6. Simple instruction is provided for users to follow.	3.62	Excellent
7. The printing kiosk is generally user-friendly.	3.72	Excellent
8. Number of times interface misleads the user	3.72	Excellent
Overall Results	**3.65**	**Excellent**

Weighted Mean Descriptive Interpretation

1.00 – 1.74 Poor

1.75 – 2.49 Average

2.50 – 3.24 Good

3.25 – 4.00 Excellent

Table 5 reveals that respondents were able to manipulate the printing kiosk easily by simply following the instructions provided and displayed on the screen. An overall mean of 3.65, with a descriptive interpretation of "Excellent," indicates that the printing kiosk was very easy to operate, even for first-time users. This further implies that both teachers and students were able to use the printing kiosk effectively and admirably, even without assistance from the researcher.

E. Prototype Demonstration and Evaluation Form result

This section presents the results of the printing kiosk evaluation conducted by 10 IT experts from Southern Leyte, using the adapted "Prototype Demonstration and Evaluation Form" from the Rochester Institute of Technology.

Table 6. Prototype Evaluation Result

Attributes	**Percentage**	**Interpretation**
Functionality	89	Above Average
Performance	90	Above Average
Robustness	89	Above Average
Workmanship	95	Superior
Overall Result	91	Superior

Weighted Mean Descriptive Interpretation

100.00 - 90.00 Superior

89.00 - 80.00 Above Average

79.00 - 70.00 Average

69.00 - 60.0 Below Average

59.00 - Below Failing

As shown in Table 6, the functioning and robustness of the printing kiosk were rated 89% by the evaluators, while performance received a rating of 90%. Workmanship was rated the highest at 95%. The overall rating for the printing kiosk was 91%. With these results, the kiosk has successfully met all the attributes it was evaluated on by the assessment of the IT experts using the adapted "Prototype Demonstration and Evaluation Form" from the Rochester Institute of Technology.

V. Conclusion

Based on the findings, it is realized that the developed coin-operated printing kiosk is a reliable solution for the provision of practical, instant, and convenient printing services within the school campus. This kiosk will greatly reduce the need for students to leave the campus to print projects, assignments, and other school-related documents. Further, this study finds out

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that the accuracy, effectiveness, efficiency, and learnability of the kiosk are highly acceptable to users. This printing kiosk is therefore targeted to benefit not just students and teachers at this particular school but the entire school at large and prospective entrepreneurs that may be eying this kind of business.

V. Recommendation

Based on the findings and conclusions, a refinement of the printing kiosk design is proposed to include:

1. Integrated printer: be furnished with a single printer with a more versatile paper tray, accommodating short, long, and A4 sizes, storing reams of bond paper for improved functionality and convenience.
2. Improved Payment Facilities: A paper bill slot/acceptor should be fitted in the kiosk alongside the coin acceptor. This will enable the kiosk to accept paper bills and return change in case the amount inserted is more than that demanded. Or may apply a cashless payment method.
3. Ergonomic and Aesthetic Improvements: Further research on the design should be conducted to ensure that the printing kiosk is more ergonomically effective and more pleasing in appearance to potential users.

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