Research Article

PAPER DOCUMENT AT YOUR FINGERTIPS: INNOVATING BOND PAPER PRINTING WITH VENDING MACHINE

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Abstract: *This research addresses the integration of automated service technology into educational settings, specifically with the creation of Paper Document at Your Fingertips: Innovating Bond Paper Printing with Vending Machine—a self-service bond paper printing vending machine to offer instant and convenient printing accessibility. With the increasing need for convenient printing services, particularly among students in busy academic environments, conventional printing facilities tend to be inadequate because of long lines, restricted shop hours, and dependency on human support. Acknowledging these shortcomings, this research presents a novel solution that integrates hardware automation and easy-to-use software to provide a secure, on-the-move printing option.*

Even with the growing digitalization of documents, hard copies are still necessary for most academic, administrative, and professional transactions. Yet, most educational institutions still do not have instant access to printing services, especially during off-peak hours. The proposed vending machine system fills these loopholes by enabling users to upload documents through USB, phone cable transfer, or Bluetooth, and print them immediately after a secure payment process. Moreover, it can also scan and print hard copy documents after payment verification—simplifying what is otherwise a time-consuming process. This study seeks to develop, deploy, and test the Paper Document at Your Fingertips system using ISO 25010 - Software Quality, and ISO 9241 - Ergonomics of Human-System Interaction. Through the automation of the bond paper printing process, the study hopes to increase user independence, minimize reliance on conventional print shops, and provide a scalable solution that can be applied to schools, libraries, and other educational institutions.

Keywords: Automated Service Technology, Bond Paper Printing Vending Machine; Hardware Automation

1. INTRODUCTION

In educational institutions, traditional printing services are frequently associated with several operational inefficiencies, including long wait times, high operational costs, and frequent machine malfunctions. These challenges are exacerbated by limited access to printing resources, especially during peak periods when students need to meet various academic deadlines (Ashmore & Morris, 2024). Additionally, according to Karovič et al. (2020), the cost of printing is still a major issue for students, especially those with limited budgets. Short hours of operation and dependence on staff further limit the provision of traditional printing services, ultimately stifling students' ability to print documents when necessary.

In order to tackle such problems, the proposed vending machine-based printing system offers an innovative solution that seeks to make it easier to print documents. The system allows the students

to upload their documents via phone cable transfer/USB flash drive, or Bluetooth transfer. After choosing the desired document, users can personalize necessary print settings, including the number of copies, page range, paper size, and color options. The system is based on a coin slot payment system, where one pays the exact amount before printing begins. This self-service method reduces the intervention of staff, thus increasing the autonomy and efficiency of students.

The proposed system has a number of significant benefits. First, it addresses the issue of long queues faced by users in traditional printing services. By facilitating automated, self-service printing, the system reduces waiting times significantly, making it convenient for students to access and allowing them to print documents at their convenience. By being able to upload files remotely and print them without waiting for machine availability or staff assistance, students can effectively utilize their time, particularly when working on tight deadlines.

This study aims to develop an innovative system that addresses the inefficiencies and limitations of conventional printing services commonly found in educational institutions. The proposed system seeks to enhance service accessibility, reduce operational costs, and promote a more efficient, user-centered learning environment through the integration of automation and self-service technology. Specifically, the study pursues the following objectives:

First, to design and implement a vending machine-based printing system capable of fulfilling user print requests with high accuracy, reduced waiting time, and ease of operation.

Second, to evaluate the system's software quality in accordance with the ISO/IEC 25010 standard, with emphasis on key attributes including functional suitability, performance efficiency, usability and interaction capability, reliability, maintainability, and security.

Lastly, to assess the system's user interface and interaction design using the ISO 9241 framework, particularly in terms of task suitability, self-descriptiveness, controllability, conformity with user expectations, error tolerance, support for personalization, and facilitation of user learning. Finally, the study seeks to explore the scalability and applicability of the proposed system in broader institutional contexts, and to assess its potential long-term impact on user productivity and satisfaction.

2. METHOD & MATERIAL

The researchers used a developmental quantitative approach to investigate the effects of the Paper Document at Your Fingertips, innovating bond paper printing with a vending machine on the users' printing service experiences. The research objectives were formulated to systematically address and provide insights into the research questions.

According to Rana (2024), quantitative research is the collection and examination of quantifiable data to verify the hypothesis raised in a given study. It takes a logical route, focusing on theory testing, and is guided by both sides of the view. Quantitative research determines specific traits and meaningful differences to draw conclusions.

Figure 1. Agile Methodology: Scrum Development Cycle. Image Source: Vecteezy. Retrieved from https://www.vecteezy.com/vector-art/24789663-agile-development-methodology-software-developments-sprint-develop-process-management-and-scrum-sprints-vector-illustration

The development process in Agile Scrum is structured into the following phases:

- **Planning Stage**: Budgeting and planning for resources take precedence at this phase. The researchers conducted an assessment of the pricing of necessary components and equipment to ensure cost efficiency and system compatibility. Various suppliers were considered to compare prices, quality, and availability of essential hardware, such as the printer, mini pc with touchscreen display, Arduino Uno, coin-slot payment system, and USB reader. In budgeting and ensuring that the components all meet the specified requirements for smooth integration. Subsequently, project planning and task assignment help in offering a smooth developmental process. A Gantt chart was created, including activities like purchasing parts, designing the system, testing, and completing implementation. This aided the researchers in effectively planning their time to meet academic requirements.
- **Designing Phase**: The physical frame of the printing vending machine is designed to ensure the proper position of the machine's parts, like the coin slot, USB reader, touchscreen interface, and paper output tray. This provides enhanced visualization of the entire structure prior to actual construction. Further, PCB design is used to create the internal electronic layout, making connections between hardware elements, and facilitating seamless data communication between the software and hardware.
- **Development Phase**: The user interface will be coded with Python to build an easily understandable platform where users can choose print options like paper size, color, and number of copies, ensuring that the vending machine can process file uploads, execute print commands, and verify payments. It will also serve as a bridge, enabling communication between the Arduino Uno and the system for the exchange of data smoothly. For hardware integration, the researchers will construct the required parts, such as the mini pc with touchscreen display, USB reader, and coin slot.
- **Testing Phase**: The researchers will conduct Alpha testing to identify and address the hardware and software issues that will affect the overall performance of the system. The researchers will test such important functionalities as document uploads, print execution, payment processing, and scanning functionalities. All defects or inefficiencies discovered will be systematically debugged and enhanced to ensure smooth running before proceeding to the next phase.

  After Alpha Testing, the system will proceed to Beta Testing, which will be performed by the selected users chosen through the simple random sampling technique. This technique allows for the recruitment of respondents with relevant experience of dealing with printing services and use of vending machines, to provide meaningful feedback.
- **Deployment Phase**: The system will first be deployed using Python to test its functionalities. It will test how the system systematically has all its features, like uploading documents via phone, cable transfer/USB or Bluetooth transfer, printing execution, processing coin-slot payment, and scanning operations function correctly. After completing software deployment, the system will be installed at Holy Cross College, the locale of this study. Real-world testing will enable the users to engage with the printing vending machine.
- **Review Phase**: The feedback from the users will be gathered and examined by the researchers to verify the overall performance of the system. The review process will focus on document uploading via phone cable transfer/USB flash drive or Bluetooth transfer, correct printing execution, and precise payment via coin slot. Technical errors, such as printing delay or malfunctioning hardware, will be noted. Necessary adjustments and improvements will be implemented to maximize the system's overall performance.
- **Launch Phase**: After successful deployment and evaluation stages, the system will be launched formally for universal use by the intended users. The final release of the vending machine at Holy Cross College will be done with appropriate promotional work to introduce the system to the users. The researchers will test all components and ensure users are informed on the use of the system via user guides or demonstrations. Monitoring post-launch will persist in monitoring use,

resolving any issues that may arise, and making sure that the system performs well under actual conditions.

This research involved 25 respondents, with 5 individuals chosen from each of the following departments: School of Arts, Sciences, and Education (SASED), School of Business and Accountancy (SBA), School of Criminal Justice (SCJ), School of Engineering, Computer, and Library Studies (SECLS), and School of Hospitality and Tourism Management (SHTM). This equal distribution ensured a balanced representation across academic disciplines, providing a diverse range of insights relevant to the study.

Table 1. Distribution of Respondents per College Department

Department	Sample Size
School of Arts, Sciences, and Education (SASED)	5
School of Business and Accountancy (SBA)	5
School of Criminal Justice (SCJ)	5
School of Engineering, Computer, and Library Studies (SECLS)	5
School of Tourism and Hospitality Management (STHM)	5
Total	25

The respondents of this study are the college students in Holy Cross College, Sta. Lucia, Sta. Ana, Pampanga chosen through the simple random sampling technique. The researchers used this method as it minimizes bias, enhances the sample representativeness, and guarantees confidence in the generalizability of findings. This technique provides an equal chance, and it avoids the use of personal judgment and decreases overrepresentation and underrepresentation of some groups.

The study employed a structured survey questionnaire as the primary data collection tool to evaluate the performance and user experience of the paper-printing vending machine. Grounded in the ISO 25010 and ISO 9241 quality frameworks. A 5-point Likert scale was utilized to capture respondent perceptions, ranging from Strongly Disagree (1) to Strongly Agree (5). The resulting data were analyzed using weighted mean calculations to identify user satisfaction levels and determine areas requiring further refinement in the system's design and functionality.

Table 2. Descriptive Evaluations Chart per Likert Scale Point

Point Scale	Descriptive Interpretation
5	Strongly Agree
4	Agree
3	Neutral
2	Disagree
1	Strongly Disagree

Data collection for this study focused on evaluating the functional suitability, performance efficiency, usability/interaction capability, reliability, maintainability, and security of the system, in accordance with ISO 25010 and ISO 9241 standards. Ethical considerations, including the confidentiality and privacy of respondents' information, were strictly observed in compliance with the Data Privacy Act of 2012 (R.A. 10173). The study objectives were clearly communicated to participants, who were then invited to complete questionnaires designed to assess the system's overall performance. Completed questionnaires were systematically collected and analyzed to ensure data accuracy and completeness.

Prior to data collection, the study secured the necessary approvals from Holy Cross College to ensure compliance with institutional regulations and guidelines. Respondents were informed of the research objectives in clear and accessible language, emphasizing the protection of their privacy and confidentiality. The survey instrument, developed based on ISO 25010 and ISO 9241 frameworks, was administered to gather comprehensive feedback on the system's performance metrics. The researchers reviewed the collected responses to validate the data before proceeding with the analysis.

The researchers employed a five-point Likert scale as a standardized instrument to quantitatively assess respondents' perceptions and attitudes captured through the survey questionnaire. This methodological approach facilitated reliable and consistent data analysis, thereby enhancing the overall rigor and validity of the study's results.

Weighted Mean: $Wm = \frac{\Sigma w}{\Sigma r}$

Wm	=	Weighted Mean
Σw	=	Summation of weighted responses
Σr	=	Summation of the number of respondents

Table 3. Descriptive Evaluations Chart of Five-Point Likert Scale

Weighted Mean	Point Scale	Descriptive Interpretation
4.20-5.00	**5**	Strongly Agree
3.40-4.19	4	Agree
2.60-3.39	3	Neutral
1.80-2.59	2	Disagree
1.00- 1.79	1	Strongly Disagree

To have a better insight into the experiences and views of the respondents, the researchers employed a multi-dimensional data analysis by grouping the weighted mean scores into different categories. A weighted mean score of 4.20 to 5.00 was included under a "Strongly Agree" response, thus implying that the respondents were highly satisfied with the performance, design, and overall impact of the system. Then, a weighted mean score from 3.40 to 4.19 was designated as "Agree," showing that the respondents viewed the system in a positive light and serves its purpose. A score within this 2.60 to 3.39 suggests that respondents neither expressed strong satisfaction nor dissatisfaction. This group's feedback indicates that the system neither significantly impressed nor disappointed them, reflecting a more ambivalent stance towards its functionality and design. Alternatively, a score between 1.80 and 2.59 was labelled as "Disagree," as the respondents were not amazed in any function and were dissatisfied with the features of the system. Lastly, the score between 1.00 to 1.79 was classified as "Strongly Disagree" because the respondents had severe problems or difficulties with the system that led to strong discontent with some aspect of the system.

The researchers identified and analyzed the functionality of the software system, focusing on how the system functions to make printing services available to users. To gain a better understanding of the system processes, the researchers utilized various diagramming methods, such as flowcharts and system architecture diagrams, to document and display the procedures between the user, the hardware components, and the software. These graphs helped to explain the process flow, enabling the researchers to grasp key functionalities and areas of possible optimization within the system.

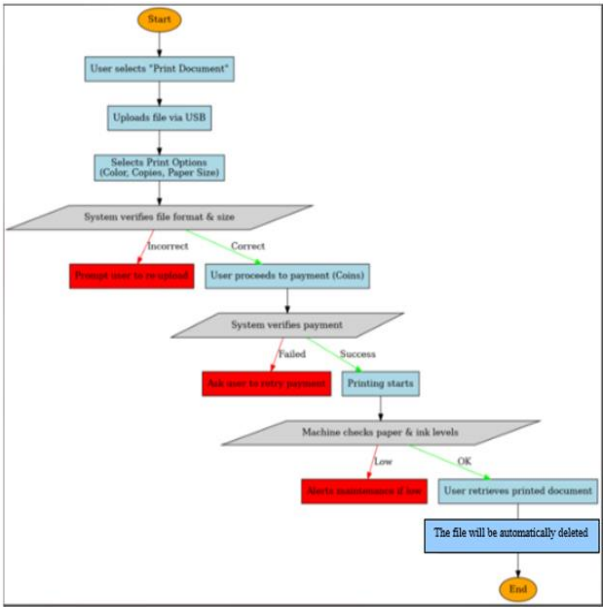

Figure 2. Flowchart Model of the Paper Document at Your Fingertips: Innovating Bond Paper Printing with Vending Machine

The document printing process flow of the paper vending machine is designed to be an efficient, systematic, and user-friendly service. It begins when the user selects the "Print Document" function from the machine interface, triggering the process. The user uploads the intended file through a USB connection, thereby providing the machine with information for printing.

Once uploaded, the user selects specific print settings like color or monochrome printing, the number of copies needed, and the paper size needed. This allows personalization according to the user's needs and makes the system more flexible. After these choices have been made, the system checks the format and size of the uploaded file to ensure compatibility with its printing needs. If the file does not pass this test, due to improper format or size limit breaches, the system will ask the user to re-upload a revised file. Only after successful checking does the user move on to the payment process.

The user must input coins as a payment for the service. The system then validates the transaction. If the payment is incomplete or does not work, the system will ask the user to make the payment again. It must be stressed here that if the user fails to input the proper coins, the printing process will not continue. This verification procedure ensures services are only rendered once payment is verified, maintaining the financial sustainability of the machine. Upon successful verification of payment, the system will automatically perform the printing procedure. Upon completion of the printing job, the user gets the printed document and the file will automatically be erased.

3. FINDINGS

Following the development of the system, the researchers conducted a post-trial testing phase involving selected respondents who had prior experiences with printing delays. During this phase, the participants were guided through the operation of the system to ensure a clear understanding of its features and functionalities. The researchers provided necessary support and instruction throughout the testing process, facilitating a seamless user experience and enabling the respondents to interact with the system effectively and without difficulty.

The results of the evaluation are presented in this section to demonstrate the system's readiness and performance after implementation. Moreover, after conducting the ISO 25010 and ISO 9241 evaluations, the researchers computed the weighted means of the data gathered from the respondents and used a five-point Likert scale to interpret the results. This approach aimed to determine whether the respondents found the developed system effective based on its overall performance.

3.1 Letter-size (8.5" by 11") and Legal-size (8.5" by 13") Print Time Data

The researchers monitored the print time performance of the Brother DCP-T520DW and DCP-T720DW printers, which were utilized for printing Letter-size (8.5" by 11") and Legal-size (8.5" by 13") documents, respectively. The observed results are as follows:

Table 4. Evaluation of Print Time Efficiency of Printing on Letter Size Bond Paper Using Brother DCP-T520DW Printer

Pages	B/W Total Time (sec)	Color Total Time (sec)
2	7	13
4	15	27
6	21	41
8	29	55
9	32	60
Average per page	**~4 sec/page**	**~7 sec/page**

Table 5. Evaluation of Print Time Efficiency of Printing on Legal Size Bond Paper Using Brother DCP-T720DW Printer

Pages	B/W Total Time (sec)	Color Total Time (sec)
2	9	17
4	18	34
6	26	52
8	35	69
9	40	77
Average per page	**~5 sec/page**	**~8.5 sec/page**

The print time performance evaluations of the Brother DCP-T520DW and DCP-T720DW printers revealed notable distinctions in speed and efficiency across different paper sizes and printing modes. The DCP-T520DW demonstrated faster average print times per page, particularly for letter-sized documents, with approximately 4 seconds for black-and-white and 7 seconds for color printing. In contrast, the DCP-T720DW, used for legal-sized documents, showed slightly longer durations—averaging 5 seconds per page for black-and-white and 8.5 seconds for color printing. These findings highlight the influence of paper size on printing efficiency and suggest that while both models perform reliably, the DCP-T520DW is more suitable for faster, routine print jobs, whereas the DCP-T720DW is better positioned for tasks requiring larger formats. Overall, these results support informed selection and deployment of printing equipment based on specific operational demands and output requirements.

3.2 ISO 25010 Survey Questionnaire Results

Table 6. Descriptive Interpretation and Frequency Distribution of the Developed System's Functional Suitability

Functional Suitability		
Questions	**Mean**	**Standard Deviation**
Functional completeness	5	.000
Functional correctness	5	.000
Functional appropriateness	5	.000
OVERALL MEAN	**5**	**0**
VERBAL INTERPRETATION	**STRONGLY AGREE**	

According to the information presented in Table 6, the functional suitability criterion received a weighted mean score of 5 and a descriptive interpretation of "Strongly Agree." This suggests that the respondents strongly agreed that the system meets all of the specified tasks satisfactorily.

Table 7. Descriptive Interpretation and Frequency Distribution of the Developed System's Performance Efficiency

Performance Efficiency		
Questions	**Mean**	**Standard Deviation**
Time behavior	4.78	.441
Resource utilization	4.67	.500
Capacity	4.44	.527
OVERALL MEAN	**4.63**	**0.04**
VERBAL INTERPRETATION	**STRONGLY AGREE**	

Based on the data shown in Table 7, the performance efficiency criterion attained a weighted mean score of 4.63, which corresponds to a descriptive interpretation of "Strongly Agree." This indicates that the respondents generally affirmed that the system effectively fulfills its designated performance-related functions.

Table 8. Descriptive Interpretation and Frequency Distribution of the Developed System's Usability/Interaction Capability

Usability/Interaction Capability		
Questions	**Mean**	**Standard Deviation**
Appropriateness recognizability	4.56	.527
Learnability	4.67	.500
Operability	4.89	.333
User error protection	4.56	.527
User interface aesthetics	4.78	.441
Accessibility	4.67	.500
OVERALL MEAN	**4.69**	**0.07**
VERBAL INTERPRETATION	**STRONGLY AGREE**	

According to the figures presented in Table 8, the usability/interaction capability criterion achieved a weighted mean score of 4.69, equivalent to a descriptive rating of "Strongly Agree." This means that the respondents believed the system is easy to learn and use, and that it effective and efficient.

Table 9. Descriptive Interpretation and Frequency Distribution of the Developed System's Reliability.

Reliability		
Questions	**Mean**	**Standard Deviation**
Maturity	4.44	0.527
Availability	4.56	0.527
Fault Tolerance	4.67	0.500
Recoverability	4.56	0.527
OVERALL MEAN	**4.56**	**0.01**
VERBAL INTERPRETATION	**STRONGLY AGREE**	

Table 9 shows that the reliability criterion received a weighted mean score of 4.56, which corresponds to the descriptive rating of "Strongly Agree." This suggests that respondents viewed the system as stable, dependable, and capable of maintaining consistent performance even in the presence of minor faults.

Table 10. Descriptive Interpretation and Frequency Distribution of the Developed System's Maintainability

Maintainability		
Questions	**Mean**	**Standard Deviation**
Modularity	4.56	.527
Reusability	4.78	.441
Analyzability	4.78	.441
Modifiability	4.67	.500
Testability	4.67	.500
OVERALL MEAN	**4.69**	**0.04**
VERBAL INTERPRETATION	**STRONGLY AGREE**	

As shown in Table 10, the maintainability criterion earned a weighted mean score of 4.69, which is interpreted as "Strongly Agree." This indicates that the respondents perceived the system as easy to update, analyze, and manage, with minimal risk of introducing errors during modifications.

Table 11. Descriptive Interpretation and Frequency Distribution of the Developed System's Security

Security		
Questions	**Mean**	**Standard Deviation**
Confidentiality	4.56	.527
Integrity	4.56	.527
Non-repudiation	4.67	.500
Accountability	4.33	.500
Authenticity	4.78	.441
OVERALL MEAN	**4.58**	**0.04**
VERBAL INTERPRETATION	**STRONGLY AGREE**	

As reflected in Table 11, the security criterion received a weighted mean score of 4.58, which corresponds to a descriptive interpretation of "Strongly Agree." This suggests that respondents acknowledged the system's effectiveness in safeguarding data, maintaining integrity, and ensuring secure access and user accountability.

3.3 ISO 9241 Survey Questionnaire Results

Table 12. Descriptive Interpretation and Frequency Distribution of the Developed System's Suitability for the Task

Suitability for the Task		
Questions	**Mean**	**Standard Deviation**
The system helps users complete their tasks effectively.	4.40	.707
The features provided are sufficient for the tasks users need to perform.	4.20	.707
The system meets the users' needs for the tasks they want to complete.	4.32	.627
OVERALL MEAN	**4.31**	**0.05**
VERBAL INTERPRETATION	**STRONGLY AGREE**	

As reflected in Table 12, the Suitability for the Task criterion received a weighted mean score of 4.31, corresponding to a descriptive interpretation of "Strongly Agree." This suggests that respondents recognized the system's high level of suitability for the tasks it was designed for, indicating that it effectively meets user needs and expectations. The weighted mean score highlights the system's alignment with the intended purpose and its ability to support task completion.

Table 13. Descriptive Interpretation and Frequency Distribution of the Developed System's Self-Descriptiveness

Self-Descriptiveness		
Questions	**Mean**	**Standard Deviation**
The system is easy for users to understand without external help.	4.08	.997
The system's interface clearly explains how to use its features.	4.00	.816
The system provides sufficient visual cues to guide users through tasks.	4.36	0.700
OVERALL MEAN	**4.15**	**0.15**
VERBAL INTERPRETATION	**AGREE**	

Table 13 shows that the Self-Descriptiveness criterion received a weighted mean score of 4.15, interpreted as "Agree." This reflects that the respondents perceived the system as easy to understand, with features and functions that clearly communicate their purpose and guide user interaction.

Table 14. Descriptive Interpretation and Frequency Distribution of the Developed System's Controllability

Controllability		
Questions	**Mean**	**Standard Deviation**
Users can easily control and adjust the system to suit their needs.	4.32	.802
The system responds predictably to users' actions.	4.12	.833
The system allows users to undo or redo actions when necessary.	4.24	.831
OVERALL MEAN	**4.23**	**0.02**
VERBAL INTERPRETATION	**STRONGLY AGREE**	

As shown in Table 14, the Controllability criterion received a weighted mean score of 4.23, interpreted as "Strongly Agree." This indicates that the respondents felt they had adequate control over the system's functions, enabling them to operate and manage the system with ease and confidence.

Table 15. Descriptive Interpretation and Frequency Distribution of the Developed System's Conformity with User Expectations

Conformity with User Expectations		
Questions	**Mean**	**Standard Deviation**
The system behaves in a way that matches users' expectations.	4.24	.663
The system design is intuitive and familiar to users.	3.92	.759
The system's layout and functions align with standard practices users have encountered before.	4.20	.707
OVERALL MEAN	**4.12**	**0.05**
VERBAL INTERPRETATION	**AGREE**	

In the data shown in Table 15, the Conformity with User Expectations criterion received a weighted mean score of 4.12, interpreted as "Agree." This suggests that respondents generally found the system's behavior and performance to align with what they expected during its use.

Table 16. Descriptive Interpretation and Frequency Distribution of the Developed System's Error Tolerance

Error Tolerance		
Questions	**Mean**	**Standard Deviation**
When users make a mistake, the system helps them recover easily.	4.04	.676
Error messages are clear and helpful in guiding users to fix issues.	4.00	.764
The system prevents critical errors from occurring.	4.20	.764
OVERALL MEAN	**4.08**	**0.05**
VERBAL INTERPRETATION		**AGREE**

Table 16 shows that the Error Tolerance criterion received a weighted mean score of 4.08, interpreted as "Agree." This indicates that respondents found the system capable of managing user errors, providing support or flexibility that helps users recover from mistakes with ease.

Table 17. Descriptive Interpretation and Frequency Distribution of the Developed System's Suitability for Individualization

Suitability for Individualization		
Questions	**Mean**	**Standard Deviation**
Users can personalize the system to match their preferences.	4.24	.663
The system offers sufficient customization options to suit users' needs.	4.16	.688
The system allows users to adjust settings for better usability based on their preferences.	4.00	.866
OVERALL MEAN	**4.13**	**0.11**
VERBAL INTERPRETATION		**AGREE**

As presented in Table 18, the Suitability for Individualization criterion received a weighted mean score of 4.13, interpreted as "Agree." This implies that respondents found the system to be effective in catering to individual user preferences, providing a personalized experience that improves usability and satisfaction.

Table 18. Descriptive Interpretation and Frequency Distribution of the Developed System's Suitability for Learning

Suitability for Learning		
Questions	**Mean**	**Standard Deviation**
The system is easy for new users to learn and navigate.	4.24	.879
There is adequate support, such as tutorials or help guides, to assist new users in learning the system.	4.32	.627
OVERALL MEAN	**4.28**	**0.18**
VERBAL INTERPRETATION		**STRONGLY AGREE**

In Table 18, the Suitability for Learning criterion received a weighted mean score of 4.28, interpreted as "Strongly Agree." This indicates that respondents found the system highly effective in facilitating the learning process, making it easier for users to grasp and interact with, which enhanced their overall experience.

4. DISCUSSION

Table 19. *Summary of the System's Overall Evaluation based on ISO 25010*

CRITERIA	WEIGHTED MEAN	DESCRIPTIVE INTERPRETATION
Functional Suitability	5.00	Strongly Agree
Performance Efficiency	4.63	Strongly Agree
Usability/Interaction Capability	4.69	Strongly Agree
Reliability	4.56	Strongly Agree
Maintainability	4.69	Strongly Agree
Security	4.58	Strongly Agree
Overall Weighted Mean	**4.69**	**Strongly Agree**

Table 19 shows the summary of system evaluation results from the ISO 25010 quality criteria. Among the attributes that were evaluated, functional suitability yielded the highest weighted mean, and reliability had the lowest mean score. Overall, the system titled "Paper Document at Your Fingertips: Innovating Bond Paper Printing with Vending Machine" received a weighted mean of 4.69, which is equivalent to a descriptive rating of "Strongly Agree." This means that the system is perceived as highly functional, user-oriented, and effective in fulfilling its intended function.

Table 20. *Summary of the System's Overall Evaluation based on ISO 9241*

CRITERIA	WEIGHTED MEAN	DESCRIPTIVE INTERPRETATION
Suitability for the Task	4.31	Strongly Agree
Self-Descriptiveness	4.15	Agree
Controllability	4.23	Strongly Agree
Conformity with User Expectations	4.12	Agree
Error Tolerance	4.08	Agree
Suitability for Individualization	4.13	Agree
Suitability for Learning	4.28	Strongly Agree
Overall Weighted Mean	**4.19**	**Agree**

Table 20 indicates system evaluation results summarized from the ISO 9241 quality criteria. Of the aspects that were analyzed, suitability for individualization had the highest weighted mean while error tolerance generated the lowest mean score. In general, the system "Paper Document at Your Fingertips: Innovating Bond Paper Printing with Vending Machine" had a weighted mean of 4.19, or a descriptive rating of "Agree." This indicates that the system is valued in terms of functionality and flexibility, well addressing the needs of the users while promoting an overall good user experience.

5. CONCLUSION

The researchers designed a bond paper-printing vending machine that underwent Alpha and Beta Testing. The tests show that the system adequately responds to customers' print orders by giving minimal wait times, high accuracy, and ease of use of the system interface whilst providing quality prints.

The researchers designed the bond paper-printing vending machine that stands out in Functional Suitability, as supported by the findings of the survey. The survey respondents showed strong satisfaction with the functional suitability of the machine to address their needs by producing accurate prints. However, it was also shown that there is a need for improvement in Reliability, in terms of error management, to better maximize overall system performance.

The researchers identified the bond paper-printing vending machine performing best in Suitability for Individualization. This results in the system's suitability in enabling the user to customize according to their preferences. Nevertheless, Error Tolerance reported the lowest weighted mean, showing there is much potential for improvement in error handling and recovery mechanisms to enhance user support in the event of system issues. make this journal type publication

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REFERENCES

Abad, E. P. (2017). Design and implementation of paper vending machine for retail of common usable papers for UNSTOP students. *International Journal for Research in Applied Science and Engineering Technology*, *V*(XI), 289–294. https://doi.org/10.22214/ijraset.2017.11042

Alday, J. L. D., Labita, J. H., & Espinosa, M. (2022). Design and fabrication of vending machine with shredding system. *Philippine E-Journals*.

Alejo, L. A., & Alejandro, A. S. (2021). Validating CHIRPS ability to estimate rainfall amount and detect rainfall occurrences in the Philippines. *Theoretical and Applied Climatology*, *145*(3–4), 967–977. https://doi.org/10.1007/s00704-021-03685-y

Almenara, A. P., Elich, J. H., & Saltiveri, T. G. (2024). Past, Present and Future of User-Centred Design Methodologies that Empathise with the User and Generate Better Accessible Experiences. In *Future Perspectives on Human-Computer Interaction Research* (pp. 17–43). https://doi.org/10.1007/978-3-031-71697-3_2

Arcibal, J., Azur, J. A., Puño, V., & Sabangan, R. R. (2019). *PRINTING VENDING*.

Ashmore, B., & Morris, S. E. (2002). From Scraps to Reams: A survey of printing services in academic libraries. *College & Research Libraries*, *63*(4), 342–352. https://doi.org/10.5860/crl.63.4.342

Centofanti, J., Mack, K., Swangjit, N., & Wang, Y. (2015). The future of vending: final report. *UBC Social Ecological Economic Development Studies (SEEDS) Student Report: The Future of Vending*. https://doi.org/10.14288/1.0108831

Desai, S. S., Jadhav, S. M., Patil, P. S., & Sambhaji, G. N. (2017). Automatic chocolate vending machine by using Arduino Uno. *International Journal of Innovative Research in Computer Science & Technology*, *5*(2), 226–229. https://doi.org/10.21276/ijircst.2017.5.2.2

Falcon, N. G. C., Saligue, N. R. Y., & Saligue, N. E. T. (2024). Optimizing User Interaction and Notification Efficiency in Smart Coin-Operated Printing Kiosk with Real-Time SMS Notifications and Interactive Features. *International Journal of Latest Technology in Engineering Management & Applied Science*, *13*(7), 181–189. https://doi.org/10.51583/ijltemas.2024.130722

Flores, D., Caoile, J. J., Felipe, M. A., Centeno, C., Abando, D., & Regala, R. (2024). An Internet of Things Based-Revolutionizing Vending Machine System with Solar Panel and Conversational AI Assistance. *SSRN*. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=5001048

Ganesh, C. S. S., N, S. G., & A, V. (2019). *Advances in engineering technology*. https://doi.org/10.22271/ed.book.426

Guerra-García, C., Nikiforova, A., Jiménez, S., Perez-Gonzalez, H. G., Ramírez-Torres, M., & Ontañon-García, L. (2023). ISO/IEC 25012-based methodology for managing data quality requirements in the development of information systems: Towards Data Quality by Design. *Data & Knowledge Engineering*, *145*, 102152. https://doi.org/10.1016/j.datak.2023.102152

Karovič, V., Kováč, F., Karovič, V., & Veselý, P. (2020). Print management system model in a large organization. *Applied Sciences*, *10*(12), 4193. https://doi.org/10.3390/app10124193

Manoj, R. (2024). How do quantitative research methods revolutionize user experience design? *N/A*.

Market forecast by applications (Commercial places, offices, public places, others), by payment mode (Cash, cashless) and competitive landscape. (2022). *6WResearch*, 70.

Murena, E., Sibanda, V., Sibanda, S., & Mpofu, K. (2020). Design of a control system for a vending machine. *Procedia CIRP*, *91*, 758–763. https://doi.org/10.1016/j.procir.2020.04.136

Nemeth, A., & Bekmukhambetova, A. (2022). Achieving Usability: Looking for Connections between User-Centred Design Practices and Resultant Usability Metrics in Agile Software Development. *Periodica Polytechnica Social and Management Sciences*, *31*(2), 135–143. https://doi.org/10.3311/ppso.20512

Okochi, N., & Yamamoto, Y. (2024). Analysis of the Usage of Vending Machines Considering the Sell-Out Rate of Products. *2024 22nd International Conference on ICT and Knowledge Engineering (ICT&KE)*, 1–8. https://doi.org/10.1109/ictke62841.2024.10787191

Peters, E., & Aggrey, G. K. (2020). An ISO 25010 based quality model for ERP systems. *Advances in Science Technology and Engineering Systems Journal*, *5*(2), 578–583. https://doi.org/10.25046/aj050272

Pope, N. (2023). The impact of quality printing equipment and copiers. *Fisher's Technology*.

Qureshi, M. A., Ibrahim, M., & Ghani, U. (n.d.). DESIGN AND IMPLEMENTATION OF VENDING MACHINE USING VERILOG HDL. https://www.academia.edu/20418982/DESIGN_AND_IMPLEMENTATION_OF_VENDING_MACHINE_USING_VERILOG_HDL

Rana, M. (2024). How do quantitative research methods revolutionize user experience design? *How Do Quantitative Research Methods Revolutionize User Experience Design?*

Sagapsapan, J. D. (2018). Coin Operated Students' Grade Inquiry through Coin Slot Machine. *International Journal for Research in Applied Science and Engineering Technology*, *6*(5), 118–123. https://doi.org/10.22214/ijraset.2018.5018