DESIGN, DEVELOPMENT, AND EVALUATION OF A CCTV TRAINER FOR ENHANCEMENT PRACTICAL SKILLS IN ELECTRICAL INSTALLATION

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ABSTRACT. *This study developed and evaluated a Closed-Circuit Television (CCTV) trainer and its accompanying laboratory training manual to determine their acceptability, usability, and effectiveness in improving learners' competencies in Electronics Technology. A descriptive–developmental and quasi-experimental research design was employed, involving academe and industry respondents for acceptability and usability assessment, and control and experimental groups for measuring competency improvement through pre-test and post-test results. Data were gathered using a validated and reliability-tested survey questionnaire and achievement test, and analyzed using descriptive statistics and independent samples t-test. Findings revealed that the CCTV trainer and laboratory manual were generally rated as highly acceptable in terms of design, functionality, and cost, with both academe and industry respondents showing consistent evaluations and no significant differences in their assessments. In terms of usability, the trainer was found to be highly usable across all indicators, including ease of system navigation, perceived understanding that enhances task performance, and users' willingness to adopt the system. Similarly, the laboratory training manual was rated highly acceptable in terms of accuracy, instructional relevance, and technical reliability, although some areas such as visual representation and procedural alignment were identified for further improvement. Moreover, the results of the quasi-experimental phase demonstrated that the CCTV trainer significantly improved students' competencies, as evidenced by the higher post-test scores of the experimental group compared to the control group, with a highly significant mean gain difference. Statistical analysis confirmed that the intervention was effective in enhancing learning outcomes. Overall, the study concludes that the CCTV trainer is an effective instructional innovation that enhances technical skills development, promotes experiential learning, and bridges the gap between academic instruction and industry practice in Electronics Technology education.*

Keywords: Close Circuit Television Trainer, Instructional Technology, Usability and Acceptability, Laboratory Training Manual.

INTRODUCTION

The rapid expansion of video surveillance technology across commercial, institutional, and residential settings has increased demand for technicians who can install, configure, and maintain Closed-Circuit Television (CCTV) systems. While CCTV's social and operational impacts have been widely studied, converting widespread equipment use into effective vocational training remains a practical challenge—many existing training offerings are short courses or industry certifications that emphasize procedure over scaffolded skills development for novice learners.

Despite curricular efforts in technical-vocational programs, students of Electrical Installation frequently demonstrate gaps in hands-on competence with real-world equipment and system troubleshooting. Recent empirical work shows that simulation and virtual laboratories can significantly improve students' understanding of electrical installation topics, including wiring, safety protocols, and circuit layout, while reducing the resource and safety constraints associated with purely physical laboratory activities [43]. However, previous Simulation-based and high-fidelity training approaches have been shown to improve technical skill acquisition, support safer practice, and enable structured feedback that is hard to deliver in ad-hoc shop exercises. Studies in the electricity workforce and allied technical fields report that simulation enhances both technical performance and safety-related non-technical skills when scenarios, observation, and feedback are well designed [12]. These findings suggest that a combined physical trainer (hardware bench) plus simulated scenarios can accelerate competency development for learners preparing for field work in installation and maintenance.

The pedagogical rationale for a hands-on CCTV trainer is supported by experiential learning theory: learning is research also revealed a notable mismatch between the competencies acquired by students and those required by industry. This misalignment extends to the students' diagnostic and troubleshooting skills, as they lack the necessary competencies required for advanced diagnostics and repairs. Such gaps may limit graduates' readiness to address complex electrical and electronics system failures commonly encountered in industrial settings. Consequently, there is a need to strengthen practical training, industry-based learning experiences, and competency-focused instruction to enhance students' diagnostic and troubleshooting capabilities and better align their skills with current industry demands [18].

In addition, third-year students enrolled in the Diploma in Technology program, major in Electrical Technology of the Institute Technical Education at Zamboanga Peninsula Polytechnic State University, did not pass the National Competency Assessment in Electrical Installation and Maintenance, specifically in the area of CCTV installation, during the second semester of 2024.

strengthened when learners cycle through concrete experience, reflective observation, abstract conceptualization, and active experimentation [32]. Contemporary UNESCO/UNEVOC and ILO guidance also emphasize digitalization and the use of simulation tools in TVET to make practical learning safer, more scalable, and more closely aligned to labour-market needs particularly where access to industry equipment is limited or costly. A dedicated CCTV trainer that embeds experiential cycles and simulated fault scenarios therefore aligns with both theory and international TVET practice recommendations.

Although there are multiple short courses and vendor trainings for CCTV installation, and some promising work on simulation for electrical wiring and general electrical safety, the literature contains relatively few rigorous studies that design, build, and evaluate a domain-specific physical CCTV trainer targeted at Electrical Installation students. Existing CCTV research often addresses surveillance outcomes, policy, or end-user perceptions rather than instructional effectiveness of practical trainers for EIM (Electrical Installation and Maintenance). This gap highlights the need for applied research to examine how a purpose-designed CCTV trainer can enhance and measure practical competencies in CCTV installation, troubleshooting, and system configuration among Electrical Installation and Maintenance (EIM) learners. To address these gaps, the researcher designed and develop a CCTV trainer tailored to enhance practical skills in Electrical Installation. Grounded in experiential learning theory and informed by simulation-based training evidence, the project aims to produce a reusable trainer prototype that simulates common installation, configuration, networking, and fault conditions, and empirically evaluate its effect on learners' practical competencies, confidence, and safety practices. If this study will be realized, the CCTV Trainer is expected to enhance the practical competencies of Electrical Installation and Maintenance (EIM) students in CCTV installation, configuration, troubleshooting, and maintenance. Through hands-on and simulation-based learning experiences, students will have greater opportunities to apply theoretical knowledge in realistic work environments, thereby improving their technical proficiency, diagnostic abilities, confidence, and adherence to safety practices. As a result, learners are anticipated to demonstrate higher levels of competency and readiness for industry-based tasks and national competency assessments. Furthermore, the study is expected to contribute to the improvement of instructional practices in technical-vocational education by providing a cost-effective, reusable, and industry-relevant training tool. The integration of simulated fault conditions and experiential learning activities may help bridge the gap between classroom instruction and workplace requirements, leading to better alignment of students' skills with current industry demands. Ultimately, the successful utilization of the CCTV Trainer may increase students' employability, support workforce development in the electrical sector, and serve as a model for the development of similar competency-based training systems in Technical and Vocational Education and Training (TVET) institution

Statement of the Problem

This study aims is to design, develop, and evaluate the CCTV Trainer intended to enhance practical skills in electrical installation. It may also influence student's proficiency in CCTV installation, troubleshooting and configuration.

Specifically, it seeks to address the following questions:

1. What is the level of acceptability of the Close-Circuit Television among industry and academe in terms of:
   1.1 Design
   1.2 Functionality
   1.3 and Cost?
2. Is there a significant difference in the level of acceptability of the Close-Circuit Television between industry and academe in terms of:
   2.1 Design
   2.2 Functionality
   2.3 and Cost?
3. What is the level of usability in terms of:
   3.1 Ease experienced during system navigation
   3.2 Perceived understanding in work that enhances task performance
   3.3 User's willingness to adopt the system
4. Is there a significant difference in the level of acceptability of the Close-Circuit Television between industry and academe in terms of:
   4.1 Ease experienced during system navigation
   4.2 Perceived understanding in work that enhances task performance
   4.3 User's willingness to adopt the system
5. What is the level of acceptability of the laboratory training manual in terms of:
   a. Accuracy and Relevance of the Content
   b. Relevance of Instruction
   c. Technical Reliability
6. Is there a significant difference in the level of acceptability of the Close-Circuit Television between industry and academe in terms of:
   6.1 Accuracy and Relevance of the Content
   6.2 Relevance of Instruction
   6.3 Technical Reliability
7. What is the effectiveness of the Closed-Circuit Trainer to improve the competencies as measured by the result of the pre-test and post test
8. Is there a significant difference in the post test mean scores of the students in the control and experimental group?

Significance of the Study

The findings of this study are significant to the College Administration because they provide empirical evidence regarding the effectiveness, acceptability, and practicality of the Closed-Circuit Television (CCTV) Trainer as an instructional innovation in Electronics Technology education. The study demonstrated that the trainer is highly acceptable in terms of design, functionality, cost, usability, and instructional relevance, indicating that it can serve as an effective laboratory tool for competency-based instruction. The significant improvement in students' competencies and academic performance further supports the integration of technology-based instructional devices into laboratory facilities and training programs. As a result, the administration may use the findings as a basis for policy formulation, curriculum enhancement, laboratory modernization, and budget allocation for the acquisition and development of innovative training equipment aligned with industry standards and Technical and Vocational Education and Training (TVET) objectives. The study is also significant to Electrical Instructors because it provides them with a reliable and effective instructional tool that enhances teaching strategies and improves students' technical learning experiences. The CCTV trainer enables instructors to conduct hands-on activities, troubleshooting simulations, and practical demonstrations that strengthen students' understanding of CCTV installation, configuration, operation, and maintenance. The findings revealed that the trainer effectively supports experiential learning and improves learners' task performance, confidence, and technical competence. Furthermore, the instructional manual associated with the trainer was found highly acceptable in terms of instructional relevance and technical reliability, which may assist instructors in delivering clearer, more organized, and industry-aligned lessons. Consequently, the study may encourage instructors to integrate more interactive and technology-based teaching approaches into technical education. The findings of this study are beneficial to Electrical Technicians because the developed CCTV trainer reflects actual industry practices and practical applications commonly encountered in workplace environments. The trainer can serve as a supplementary training and skills enhancement tool that allows technicians to improve their competencies in CCTV installation, troubleshooting, configuration, and maintenance. Since the study confirmed that the trainer effectively bridges theoretical knowledge and practical application, technicians may utilize the system to strengthen their technical expertise and adapt to current technological advancements in the field of electronics and security systems. Moreover, the trainer's high acceptability in terms of functionality and technical reliability indicates that it can support continuous professional development and workforce readiness among technical practitioners. The study is highly significant to Electrical Students because it provides them with an innovative learning tool that promotes active participation, practical exposure, and competency development in Electronics Technology. The CCTV trainer allows students to apply theoretical concepts through actual hands-on activities, thereby improving their understanding of installation procedures, troubleshooting processes, and system configuration tasks. The results of the study revealed that students exposed to the CCTV trainer achieved significantly higher post-test scores and competency gains compared to those taught using conventional instructional methods. This indicates that the trainer enhances knowledge retention, technical skills, confidence, and motivation to learn. Furthermore, the trainer prepares students for real-world industry applications by exposing them to realistic technical scenarios, thereby improving their employability and readiness for future careers in the electrical and electronics industry. Finally, the study is significant to Future Researchers because it provides a valuable reference and source of information for further investigations related to instructional innovations, laboratory training systems, and technology-based learning in technical and vocational education. The methodologies, findings, statistical analyses, conclusions, and recommendations presented in this study may serve as a guide for researchers who intend to develop similar instructional devices or conduct studies related to instructional effectiveness, technology adoption, competency development, and experiential learning. Future researchers may also expand the scope of the study by involving larger populations, additional institutions, or other technical disciplines to further validate the effectiveness and applicability of the CCTV trainer. Moreover, the study may inspire future innovations aimed at improving technical education and strengthening the alignment between academic instruction and industry practice.

Scope and Delimitation of the Study

This study was limited to the development, evaluation, and effectiveness testing of the Closed-Circuit Television (CCTV) trainer and its laboratory training manual in Electronics Technology education. It specifically focused on determining the level of acceptability of the CCTV trainer among industry practitioners and academe respondents in terms of design, functionality, and cost, as well as identifying any significant differences in their evaluations. The study also examined usability factors such as ease of system navigation, perceived understanding that enhances task performance, and users' willingness to adopt the system, including tests of significant differences between groups. In addition, it assessed the acceptability of the laboratory training manual in terms of accuracy and relevance of content, relevance of instruction, and technical reliability, together with comparative analyses between industry and academe respondents. Furthermore, the study evaluated the effectiveness of the CCTV trainer in improving students' competencies using pre-test and post-test results and determined significant differences in the post-test mean scores between the control and experimental groups. The study was conducted among selected Electrical Technology students of Zamboanga Peninsula Polytechnic State University, selected industry practitioners in Zamboanga City, and faculty experts from Zamboanga Peninsula Polytechnic State University. Hence, the findings are limited to the specific respondents, research locale, and duration of the study, and may not be generalized to other groups or settings beyond similar technical-vocational education contexts.

REVIEW OF RELATED LITERATURE

Importance of CCTV Installation

Closed-Circuit Television (CCTV) systems have become essential components of modern security infrastructure, playing a critical role in surveillance, crime deterrence, and evidence collection across residential, commercial, and industrial environments. Recent studies emphasize that CCTV installation requires not only proper equipment selection but also technical competence in system design, wiring, configuration, and troubleshooting to ensure reliable operation (Callaway Security, 2023)

Essential Skills for Electrician

Maintenance and troubleshooting are essential aspects of Closed-Circuit Television (CCTV) system management, ensuring continuous operation, optimal performance, and long-term security reliability. CCTV systems are often exposed to various environmental conditions, including dust, moisture, temperature fluctuations, and physical wear, which can contribute to equipment deterioration and reduced functionality over time. Additionally, wiring faults, power supply issues, network disruptions, and component failures may compromise image quality, recording capabilities, and overall system effectiveness. Regular preventive maintenance and systematic troubleshooting help identify and resolve these issues before they escalate into major system failures, thereby minimizing downtime and enhancing security coverage. Effective maintenance practices also extend the lifespan of CCTV equipment and improve the accuracy and reliability of surveillance operations, making them critical competencies for technicians responsible for installation, repair, and system support (Cieszynski, 2023).

Best Practices in Troubleshooting

Best practices in CCTV maintenance focus on implementing regular inspection schedules, thorough cleaning procedures, timely software and firmware updates, and preventive diagnostic measures to ensure optimal system performance and reliability. Routine inspections help identify potential issues such as loose connections, damaged cables, misaligned cameras, and power supply irregularities before they develop into critical faults. Cleaning camera lenses, housings, and associated components prevents the accumulation of dust, dirt, and moisture that can degrade image quality and reduce surveillance effectiveness. Additionally, updating system software and firmware enhances cybersecurity, improves functionality, and ensures compatibility with evolving technologies. Preventive diagnostics, including performance testing and system health monitoring, enable technicians to detect and address emerging problems proactively, thereby minimizing downtime, extending equipment lifespan, and maintaining consistent security coverage. Adhering to these maintenance practices contributes significantly to sustaining high-quality video surveillance operations and maximizing the effectiveness of CCTV systems (Maitland, 2024).

Technical Awareness in CCTV Installation

Awareness of proper CCTV installation is a critical factor in ensuring the effectiveness, reliability, and legal compliance of surveillance systems. Installers and users must understand essential considerations such as camera placement, field of view, lighting conditions, power requirements, network connectivity, storage capacity, and privacy regulations to maximize system performance. A high level of awareness enables technicians to design and implement surveillance systems that minimize blind spots, provide clear image capture, and support effective monitoring and evidence collection. Furthermore, awareness of installation standards and operational requirements helps prevent common errors, including improper camera positioning, inadequate cable management, and insufficient system security. According to the Security Industry Association [49], successful CCTV implementation depends not only on the quality of equipment used but also on the installer's knowledge of system design, environmental assessment, and compliance with industry best practices. Therefore, increasing awareness and technical competence in CCTV installation contributes significantly to the overall effectiveness and sustainability of modern surveillance systems.

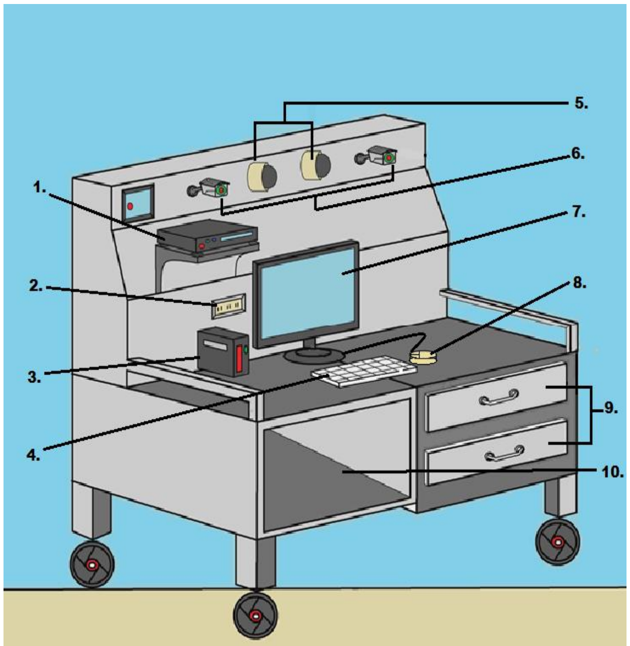
Safety Practices for CCTV Installation

Safety practices in CCTV installation are essential to protect installers, users, and equipment while ensuring the proper functioning of surveillance systems. These practices include the use of personal protective equipment (PPE) such as gloves, helmets, and insulated tools to reduce the risk of electrical shock and physical injury during installation. Installers must also follow proper ladder and working-at-height procedures when mounting cameras in elevated positions to prevent falls and accidents. In addition, adherence to electrical safety standards such as proper grounding, circuit isolation, and power shutdown procedures (lockout/tagout) is critical when handling wiring and power connections. Careful cable management and the use of appropriate conduit systems also help prevent fire hazards, signal interference, and accidental damage. According to the Occupational Safety and Health Administration [42], strict compliance with workplace safety protocols significantly reduces installation-related hazards and improves overall operational safety in electrical and low-voltage system work. Therefore, integrating safety practices into CCTV installation ensures not only technician protection but also system reliability and long-term performance.

Importance of CCTV Trainers in Technical Education

The need for CCTV trainers in technical instruction is increasingly important due to the growing demand for skilled technicians in surveillance system installation, maintenance, and troubleshooting. CCTV technology continues to evolve with advancements in digital video recording, CCTV trainers play a vital role in equipping learners with hands-on competencies such as system configuration, camera installation, fault diagnosis, and preventive maintenance, ensuring that graduates are industry-ready. Moreover, competent trainers help standardize instructional delivery by aligning training content with current industry practices and technical standards, thereby improving learner outcomes and employability. According to the Technical Education and Skills Development Authority [51], specialized technical trainers are essential in competency-based training programs because they ensure that learners acquire relevant, up-to-date, and industry-aligned skills. Therefore, the presence of qualified CCTV trainers in technical instruction is crucial for producing competent graduates who can meet the demands of modern security and surveillance industries.

Project Design

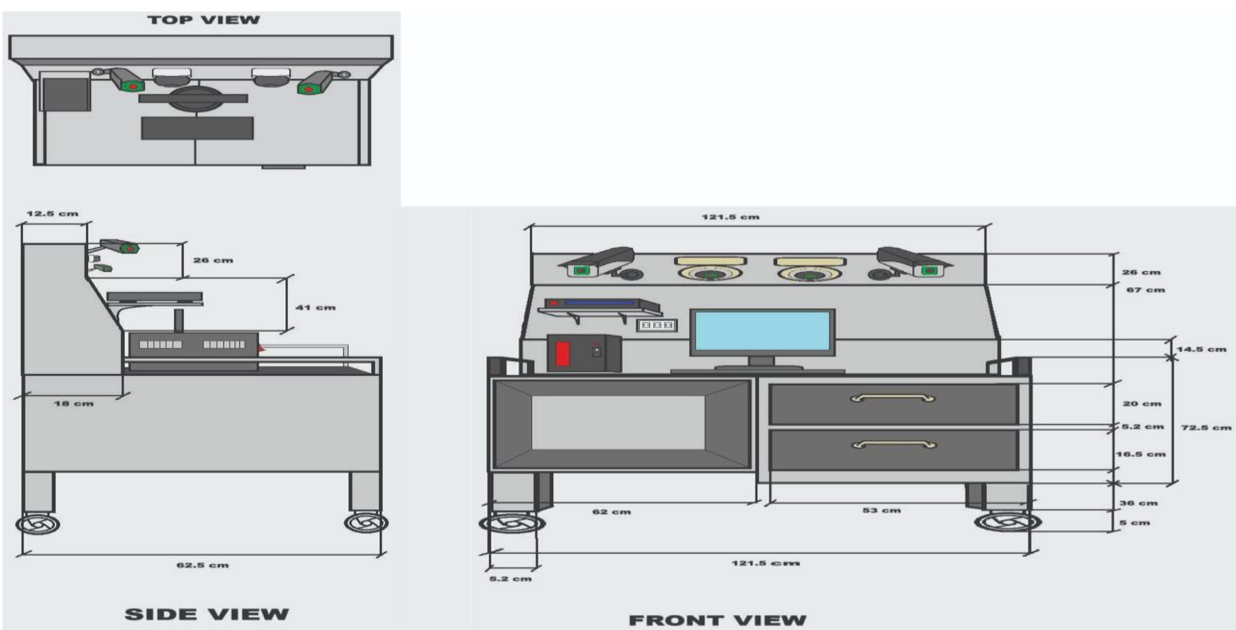


LEGEND:

1. Digital Video Recorder 6. Outdoor CCTV Camera
2. 220V 2-gang outlet 7. Monitor
3. Power Supply 8. Mouse
4. Keyboard 9.CCTV Accessories Drawer
5. Dome CCTV Camera 10. Tools and Equipment Compartment

Orthographic Projection of CCTV Trainer

This study employed a developmental research design in the development and evaluation of the Closed-Circuit Television (CCTV) trainer and laboratory training manual. Developmental research is appropriate in studies that focus on designing, developing, validating, and improving instructional products and technological innovations intended for educational use. According to [46], developmental research systematically examines the design, development, and evaluation processes of instructional tools to establish empirical foundations for effective educational practices. In this study, the developmental process was anchored on the Input-Process-Output (IPO) framework, which provided a structured and logical sequence in the development of the CCTV trainer. The IPO framework served as a guide in identifying the required inputs such as instructional needs, industry standards, materials, and learner competencies; the process phase involving the design, fabrication, testing, and validation of the trainer; and the output phase which focused on the acceptability, usability, and effectiveness of the developed instructional device. As emphasized by Ludwig von Bertalanffy (1968), systems theory supports the idea that educational innovations become more effective when all components are systematically organized and interconnected toward achieving desired outcomes. Through this framework, the study ensured alignment between the objectives, development procedures, and expected outcomes of the CCTV trainer, thereby strengthening its relevance for both academic and industry applications. Furthermore, the study also utilized descriptive quantitative and quasi-experimental research designs to comprehensively evaluate the acceptability of the developed CCTV trainer. The descriptive quantitative design was employed to determine the level of acceptability of the trainer and laboratory manual in terms



Research Design

of design, functionality, cost, ease of use, instructional relevance, and technical reliability using statistical measures such as mean and standard deviation. According to [16], descriptive quantitative research systematically describes trends, attitudes, and perceptions of a population through numerical data analysis. In addition, the quasi-experimental research design was utilized to determine the effectiveness of the CCTV

trainer in improving students' competencies through the comparison of pre-test and post-test performances between the control and experimental groups. [15], considered seminal authors in experimental research, explained that quasi-experimental designs are appropriate in educational settings where random assignment is not always feasible, but where cause-and-effect relationships can still be examined through controlled comparison. The significant improvement observed in the experimental group validated the effectiveness of the CCTV trainer as an instructional innovation that enhances technical competencies, practical skills, and learner engagement in Electronics Technology.

Research Locale

This study is conducted at Zamboanga Peninsula Polytechnic State University (ZPPSU), a higher education institution in the Western Mindanao region of the Philippines recognized for its technical and vocational education programs, particularly in Electrical Technology. These programs are offered through the College of Teacher Education, College of Engineering Technology, and the Institute of Technical Education. To obtain a broader perspective on the practical application of students' competencies, data are also gathered from several industries within Zamboanga City, enabling this study meet with industry standards and real-world operational practices.

Respondents of the Study

The respondents of this study were composed of two groups involved in the development and evaluation of the CCTV Trainer. The first group consisted of 31 experts, including 16 academic experts from Zamboanga Peninsula Polytechnic State University (ZPPSU) and 15 practicing electricians from various industries in Zamboanga City. These experts provided professional insights and practical feedback regarding the acceptability, usability, and training manual of the developed CCTV Trainer, ensuring its alignment with current industry standards and instructional requirements in electrical and surveillance system installations. The involvement of subject-matter experts in evaluating educational innovations is consistent with the recommendations of [11], who emphasized expert validation as a critical component of educational research and development. The second group comprised 34 Bachelor of Industrial Technology (BIndTech) students majoring in Electrical Technology at ZPPSU, who participated in the quasi-experimental phase of the study. Their involvement focused on evaluating the effectiveness of the CCTV Trainer in improving hands-on skills, technical competence, and conceptual understanding of CCTV systems, thereby determining its value as an instructional tool in electrical technology education. The use of student participants in a quasi-experimental design aligns with the framework proposed by [15], which highlights the importance of assessing educational interventions through controlled comparison of learning outcomes.

Research Instrument

A modified survey questionnaire, adapted from the Technology Acceptance Model (TAM) instrument developed by [20], was employed as the primary data-gathering instrument in this study to determine the acceptability and usability of the developed Closed-Circuit Television (CCTV) Trainer among respondents from both the academe and industry sectors. The instrument was designed to evaluate the trainer's acceptability in terms of design, functionality, and cost, providing insights into its technical effectiveness and economic viability. In assessing usability, the questionnaire measured respondents' experiences regarding ease of system navigation, perceived understanding that enhances task performance, and willingness to adopt the system. Additionally, the instrument evaluated the accompanying laboratory training manual based on content accuracy and relevance, instructional appropriateness, and technical reliability.

The questionnaire was developed and self-administered to promote uniformity in responses and to enable participants to independently evaluate the developed trainer and its corresponding training manual. The development of the instrument was guided by an extensive review of related literature, industry standards, and competency requirements pertaining to CCTV installation, configuration, maintenance, and troubleshooting. To ensure that the instrument adequately reflected the objectives and scope of the study, it underwent content validation by experts in curriculum development, instructional materials, and technical education. The procedures for instrument development and validation followed established principles of scale construction and assessment, thereby enhancing the reliability and validity of the data gathered [22]. Responses were obtained using a five-point Likert scale, allowing participants to express their level of agreement with each statement and facilitating the quantitative analysis and interpretation of the results [35].

Validity and Reliability of the Research Instrument

The validity of the research instrument was established through the evaluation of academe and industry experts who carefully reviewed the questionnaire items in terms of clarity, relevance, and alignment with the objectives of the study. Each item was critically examined to ensure its appropriateness in assessing the instructional CCTV Trainer and its technical attributes. Suggestions and feedback provided by the panel of experts were carefully considered and incorporated into the revised version of the instrument to strengthen its content validity and improve its overall quality. For reliability testing, the refined questionnaire was administered to 23 non-participant respondents who possessed characteristics similar to the target population. The internal consistency of the instrument was measured using Cronbach's alpha coefficient, wherein a value of 0.70 or higher was regarded as acceptable. The resulting reliability index confirmed that the instrument produced consistent and dependable results, thereby ensuring its suitability for data collection in the study.

Data Collection Procedure

Before conducting the survey, the researcher formally requested approval from the College Dean, program heads, and representatives of the participating industries. This procedure ensured adherence to ethical research standards and secured the cooperation of the institutions involved in the study. Following the approval, the researcher administered the survey to the respondents with the assistance of electronics instructors and designated industry personnel. This approach facilitated the efficient distribution, administration, and retrieval of the completed questionnaires, thereby ensuring a systematic and timely data collection process.

Data Analysis

The following statistical tools applied in analyzing the collected data:

- Descriptive statistics (mean and standard deviation) will be used to analyze the level of acceptability in terms of design, functionality, and cost, likewise utilizes the same statistical analysis for o determine the trainer's technical soundness and economic feasibility. It also measured user experience through indicators like ease of system navigation, perceived understanding that enhances task performance, and willingness to adopt the system**.** Furthermore, the instrument assessed the laboratory training manual accompanying the trainer in terms of accuracy and relevance of content, instructional relevance, and technical reliability**.**
- An independent samples t-test was utilized to determine whether there was a significant difference in the evaluation of the CCTV Trainer between academe and industry respondents in terms of design, functionality, and cost. The same statistical test was likewise applied to examine differences in respondents' evaluations with regard to ease experienced during system navigation, perceived understanding that enhances task performance, and users' willingness to adopt the system. Furthermore, the same analytical procedure was employed to assess whether significant differences existed between the two groups in terms of the accuracy and relevance of content, instructional relevance, and technical reliability of the training manual.
- A paired samples t-test was used to determine whether there was a significant difference between the pre-test and post-test scores within the control and experimental groups.
- An independent samples t-test was employed to determine whether there was a significant difference between the control and experimental groups in terms of post-test performance and mean gain scores.

Table 1: Basis for Analysis of the Data

Scale	Range	Descriptions		
		Acceptability	Usability of	Acceptability
1	1.00 -	Very	Very	Very
2	1.81 –	Unacceptable	Unusable	Unacceptable
3	2.61 –	Moderately	Moderately	Moderately
4	3.41 –	Acceptable	Usable	Acceptable
5	4.21 -	Highly	Highly	Highly

RESULTS AND DISCUSSION

The perceived level of acceptability of the Close-Circuit Television among industry and Academe in terms of: Design

The results show that the level of acceptability of the CCTV trainer in terms of design is generally **acceptable**, with a grand mean of 4.13 and a standard deviation of 0.53, indicating relatively consistent responses among the respondents. Specifically, the indicators related to the clarity, informativeness, and consistency of the manual content (M = 4.36, SD = 0.48), effectiveness in explaining components and operations (M = 4.43, SD = 0.47), and accuracy of diagrams and illustrations (M = 4.28, SD = 0.51) were all rated as *highly acceptable*. These results suggest that the instructional manual successfully delivers clear and well-structured content, which is essential for facilitating understanding and enhancing learners' technical competencies. Clear instructional design, supported by accurate visual representations, plays a vital role in improving comprehension and engagement in technical education [13].

However, the indicators concerning the alignment of procedures with industry standards (M = 3.74, SD = 0.60) and the consistency of instructions with the trainer's functions and features (M = 3.82, SD = 0.58) were rated as *acceptable*, reflecting areas that may need improvement. The slightly lower mean scores and higher variability in responses imply that some respondents perceive gaps between the manual procedures and actual industry practices, as well as minor inconsistencies in instructional guidance.

This results highlights the importance of aligning educational tools with real-world applications to ensure relevance and usability. [4], system quality, including clarity of instructions and alignment with user needs, significantly influences the effectiveness and acceptance of learning technologies. Overall, while the CCTV trainer manual demonstrates strong design characteristics, enhancements in procedural alignment and instructional consistency could further improve its overall acceptability.

Table 2.: Level of Acceptability of the CCTV Trainer in Terms of Design

Design Indicator	Mean	SD	Descriptive Rating
1. The manual content is clear, informative, and consistent with the features of the current CCTV.	4.36	0.48	Highly Acceptable
2. The manual effectively explains the components and operations of the CCTV trainer system.	4.43	0.47	Highly Acceptable
3. The diagrams and illustrations in the manual accurately represent the actual CCTV trainer components.	4.28	0.51	Highly Acceptable
4. The procedures described in the manual align with actual CCTV installation, configuration and troubleshooting according to the industry	3.74	0.60	Acceptable
5. The instructions in the manual are consistent with the functions and features of the CCTV trainer unit.	3.82	0.58	Acceptable

Overall Mean	**4.13**	**0.53**	**Acceptable**

The perceived level of acceptability of the Close-Circuit Television among industry and Academe in terms of: Functionality

The results reveal that the level of acceptability of the CCTV trainer in terms of functionality is highly acceptable**,** as reflected by the grand mean of 4.39 and a standard deviation of 0.57, indicating relatively consistent responses among the respondents. In particular, the indicators on simulation of troubleshooting scenarios (M = 4.50, SD = 0.50) and demonstration of the complete working process of a real CCTV surveillance system (M = 4.57, SD = 0.49) were rated as *highly acceptable*. These findings suggest that the CCTV trainer effectively supports experiential learning by allowing students to engage in realistic, hands-on activities that enhance their technical skills and problem-solving abilities. Such practical exposure is essential in technical and vocational education, as it strengthens learners' readiness for real-world applications [13].

On the other hand, the indicators related to configuration of date, time, and recording settings (M = 4.34, SD = 0.59), real-time monitoring capability (M = 4.29, SD = 0.62), and proper installation of connectors (M = 4.26, SD = 0.63) were rated as *acceptable*. Although still positive, these slightly lower ratings and relatively higher standard deviations suggest some variability in respondents' perceptions, indicating possible areas for improvement in system usability and hardware reliability. This implies that while the CCTV trainer performs well overall, enhancements in configuration processes and component stability could further improve its effectiveness. [4], system quality, including ease of use, reliability, and functional efficiency—plays a significant role in determining user satisfaction and the successful adoption of learning technologies. Overall, the findings confirm that the CCTV trainer is a functional and valuable instructional tool, with opportunities for refinement to achieve even higher levels of acceptability.

Table 3.: Level of Acceptability of the CCTV Trainer in Terms of Functionality

Functionality Indicator	Mean	SD	Descriptive Rating
1. The CCTV trainer allows students to simulate common troubleshooting scenarios	4.50	0.50	Highly Acceptable
2. The CCTV trainer enables proper configuration of date, time, and recording settings.	4.34	0.59	Acceptable
3. The CCTV trainer effectively demonstrates the complete working process of a real CCTV surveillance system.	4.57	0.49	Highly Acceptable
4. The CCTV trainer allows real-time monitoring through a connected monitor	4.29	0.62	Acceptable
5. The CCTV connectors are properly installed, preventing loose connection which caused to function effectively during operation.	4.26	0.63	Acceptable
Overall Mean	**4.39**	**0.57**	**Highly Acceptable**

The perceived level of acceptability of the Close-Circuit Television among industry and Academe in terms of: Functionality

The data indicate that the Closed-Circuit Television (CCTV) trainer is generally perceived as highly acceptable in terms of cost, with an overall mean of 4.30 (SD = 0.58). This suggests that respondents from both academe and industry share a positive evaluation of the trainer's economic viability. Specifically, the indicators related to the cost-effectiveness of materials (M = 4.58, SD = 0.51), overall cost relative to features (M = 4.62, SD = 0.49), and efficiency of design in minimizing unnecessary expenses (M = 4.55, SD = 0.52) were all rated as "Highly Acceptable." These results demonstrate a strong consensus that the CCTV trainer is well-designed in balancing cost and quality, making it a practical investment for instructional and operational purposes. The relatively low standard deviations further indicate consistency in respondents' perceptions, reinforcing the reliability of these findings. This aligns with studies emphasizing that cost-efficient instructional technologies significantly enhance adoption and usability in both educational and industrial settings [26, 33].

On the other hand, two indicators—affordability and availability of replacement parts (M = 3.59, SD = 0.70) and maintenance cost (M = 4.18, SD = 0.68)—were rated as "Acceptable," suggesting moderate concerns in these areas. Although still viewed positively, the relatively higher standard deviations imply varied opinions among respondents, possibly due to differences in institutional resources and industry expectations. These findings indicate that while the initial and design-related costs are highly favorable, recurring expenses and parts accessibility may require further improvement to achieve higher satisfaction. Nonetheless, the overall high rating confirms that the CCTV trainer is a cost-effective solution, consistent with research highlighting that long-term benefits and operational efficiency often outweigh initial and maintenance costs in technology investments; [45, 2].

Table 4: Level of Acceptability of the CCTV Trainer in Terms of Cost

Cost Indicator	Mean	SD	Descriptive Rating
1. The materials used in the CCTV trainer are cost-effective without compromising quality.	4.58	0.51	Highly Acceptable
2. The overall cost of the CCTV trainer is reasonable considering its features and components.	4.62	0.49	Highly Acceptable
3. The replacement parts of the CCTV trainer are affordable and readily available.	3.59	0.70	Acceptable
4. The trainer design minimizes unnecessary expenses in terms of materials and component.	4.55	0.52	Highly Acceptable
5. The cost of maintaining the CCTV trainer is affordable for the institution.	4.18	0.68	Acceptable
Overall Mean	**4.30**	**0.58**	**Highly Acceptable**

Is there a significant difference in the level of acceptability of the Close-Circuit Television between industry and academe in terms of: Design, Functionality and Cost?

The results reveal that there is no significant difference between academe and industry respondents in their evaluation of the CCTV trainer in terms of design, functionality, and cost. This is evidenced by the computed p-values for design (p = 0.834), functionality (p = 0.781), and cost (p = 0.804), all of which are greater than the 0.05 level of significance. Consequently, the null hypothesis is not rejected, indicating that both groups share statistically similar perceptions. The mean scores from academe (Design = 4.16, Functionality = 4.42, Cost = 4.33) and industry (Design = 4.12, Functionality = 4.36, Cost = 4.27) are closely aligned, further supported by minimal mean differences ranging from 0.04 to 0.06. These results suggest that the CCTV trainer is consistently perceived as acceptable across both sectors. Focusing on individual variables, the design component shows a negligible mean difference of 0.04 with a t-value of 0.21, indicating that both groups similarly view the structure and presentation of the trainer. Likewise, functionality yielded a mean difference of 0.06 and a t-value of 0.28, suggesting that the system performs effectively in simulating real-world applications for both academic and industry users. In terms of cost, the results also demonstrate consistency (mean difference = 0.06, t = 0.25), implying that the trainer is perceived as economically viable by both groups. These findings indicate that the developed system meets expectations not only in instructional settings but also in practical industry applications, reinforcing its usability and relevance. The observed alignment between academe and industry supports the principle that instructional tools should integrate both theoretical and practical dimensions to enhance learning outcomes. This is consistent with the concept of constructive alignment, which emphasizes the coherence between learning objectives, teaching strategies, and assessment methods to achieve meaningful learning [9]. Furthermore, effective instructional design, as highlighted by [25], ensures that learning materials are structured in a way that promotes comprehension and skill acquisition across diverse contexts. Recent studies also affirm that aligning educational tools with industry standards improves learner preparedness and competency development [37]. Therefore, the CCTV trainer can be regarded as a well-designed instructional resource that successfully meets both academic and industry requirements.

Table 5.: t-Test Results Comparing Academe and Industry Ratings on the CCTV Trainer

Variables	Academe Mean	Industry Mean	Mean Difference	T-value	P-value	Decision	Interpretation
Design	4.16					Fail to Reject Ho	Not Significant
Functionality	4.42	4.36	0.06	0.28	0.781	Fail to Reject Ho	Not Significant
Cost	4.33	4.27	0.06	0.25	0.804	Fail to Reject Ho	Not Significant

Perceived level of usability on Ease experienced during system navigation, perceived understanding in work that enhances task performance, and User's willingness to adopt the system?

The results shown in table 6 on the Level of Usability of the CCTV Trainer in Terms of Ease Experienced During System Navigation show an overall mean of 4.32 with a standard deviation of 0.56, interpreted as Highly Usable based on responses from 31 participants composed of 16 academe and 15 industry respondents. This indicates that both groups generally agree that the CCTV trainer is easy to navigate and operate. The relatively low standard deviation suggests a consistent perception among respondents, implying minimal variation between academe and industry evaluations. This result reflects a strong positive evaluation of the system's navigational design, meaning users can interact with the trainer with minimal difficulty. In relation to the Technology Acceptance Model, perceived ease of use significantly influences user acceptance of a system, as individuals are more likely to adopt technologies that require less effort to operate (Davis, 1989). Recent studies also emphasize that intuitive system navigation enhances user satisfaction and promotes effective learning in technical training environments [4, 28]. In terms of specific indicators, the highest mean was recorded in **"**The system layout of the trainer allows smooth transition from one task to another" (M = 4.47, SD = 0.49)**,** interpreted as Highly Usable. This suggests that respondents strongly agree that the structural design of the CCTV trainer supports an organized and efficient workflow during tasks. The second highest was **"**The CCTV trainer interface is easy to navigate without assistance" (M = 4.41, SD = 0.56)**,** followed by "The instructional labels and guides enable to operate the CCTV trainer efficiently" (M = 4.36, SD = 0.52)**.** These results indicate that users find the interface and instructional materials clear and supportive, allowing independent operation. The relatively low standard deviations across these indicators further imply that both academe and industry respondents share similar positive perceptions. According to recent human-computer interaction studies, well-structured interfaces with clear instructional cues reduce cognitive load and improve task efficiency in technical learning environments [41, 14]. Meanwhile, the indicators "The necessary components of the trainer are easy to locate during installation and setup" (M = 4.20, SD = 0.60) **and** "The connection points and ports are logically arranged for easy identification" (M = 4.18, SD = 0.63) received slightly lower but still positive ratings. These results suggest that while respondents agree that the physical layout is generally organized and accessible, there is still room for improvement in enhancing component visibility and port identification. The slightly higher standard deviations indicate minor differences in perception among respondents, possibly due to varying levels of familiarity with CCTV systems between academe and industry groups. Nonetheless, the overall findings confirm that the CCTV trainer provides an effective and user-friendly environment that supports ease of navigation and task completion. This aligns with [29] usability standards, which emphasize that systems should allow users to achieve goals effectively, efficiently, and with satisfaction in a specified context of use (International Organization for Standardization [29]. Overall, the results demonstrate that the CCTV trainer has a high level of usability in terms of system navigation, making it suitable for technical education and skills development.

Table 6.: Level of Usability of the CCTV Trainer in Terms of Ease of Use

Ease Experienced During System Navigation Indicator	Mean	SD	Descriptive Rating
1. The CCTV trainer interface is easy to navigate without assistance.	4.41	0.56	Usable
2. The connection points and ports are logically arranged for easy identification.	4.18	0.63	Highly Usable
3. The instructional labels and guides enable to operate the CCTV trainer efficiently.	4.36	0.52	Usable
4. The necessary components of the trainer are easy to locate during installation and setup.	4.20	0.60	Highly Usable
5. The system layout of the trainer allows smooth transition from one task to another.	4.47	0.49	Highly Usable
Overall Mean	**4.32**	**0.56**	**Highly Usable**

Perceived level of usability on perceived understanding in work that enhances task performance

The results in table 7 on the Level of Usability of the CCTV Trainer in Terms of Perceived Understanding in Work that Enhances Task Performance show an overall mean of 4.39 with a standard deviation of 0.56**,** interpreted as Highly Usable based on responses from 31 participants composed of 16 academe and 15 industry respondents. This indicates that both groups strongly agree that the CCTV trainer effectively enhances users' understanding of actual work tasks related to CCTV installation, configuration, troubleshooting, and application of theoretical knowledge. The relatively low standard deviation suggests that the responses are closely clustered around the mean, reflecting a high level of agreement between academe and industry respondents. This implies that the trainer is consistently perceived as an effective instructional tool for developing practical competencies. In relation to the Technology Acceptance Model, perceived ease of use and perceived usefulness strongly influence user acceptance, where systems that improve understanding and task performance are more likely to be adopted and utilized effectively (Davis, 1989). Recent studies also emphasize that simulation-based and hands-on training tools significantly improve learners' comprehension and task readiness in technical-vocational education [3, 39].

In terms of specific indicators, the highest-rated item was "The training activities improve confidence in performing real-world CCTV tasks" (M = 4.58, SD = 0.49), interpreted as Highly Usable. This indicates that respondents strongly agree that the CCTV trainer builds confidence in performing actual workplace tasks, which is essential for bridging the gap between training and industry practice. The second highest was "The CCTV trainer improves student's understanding of actual CCTV installation procedures" (M = 4.52, SD = 0.51)**,** followed by "The trainer enhances the ability to configure CCTV system settings correctly" (M = 4.47, SD = 0.56), both also interpreted as highly usable. These findings suggest that the trainer effectively supports procedural learning and technical skill acquisition. The low standard deviations indicate consistent perceptions among respondents, reinforcing the reliability of the results. According to recent educational technology research, experiential and simulation-based learning environments significantly enhance skill mastery by allowing learners to practice real-world tasks in a controlled setting [31, 10].

Meanwhile, the indicators “The CCTV trainer helps me apply theoretical knowledge to practical work situations” (M = 4.20, SD = 0.61) and “The trainer helps better understand troubleshooting procedures in CCTV systems” (M = 4.18, SD = 0.63) received slightly lower but still positive ratings, interpreted as usable to highly usable. These results suggest that while respondents agree that the trainer supports knowledge application and troubleshooting skills, these areas may require further enhancement to strengthen analytical and diagnostic learning experiences. The slightly higher standard deviations indicate minor differences in perception, which may be attributed to varying levels of prior experience between academe and industry respondents. Nonetheless, the overall findings confirm that the CCTV trainer effectively enhances perceived understanding and task performance. This aligns with ISO usability principles, which emphasize that effective systems should enable users to achieve goals efficiently, effectively, and with satisfaction within a defined context of use [29]. Overall, the CCTV trainer demonstrates a high level of usability in supporting technical understanding and performance-based learning in CCTV system training.

Table 7.: Level of Usability of the CCTV Trainer in Terms of Task Performance Understanding

Perceived understanding in work that enhances task performance Indicator	Mean	SD	Descriptive Rating
1. The CCTV trainer improves students’ understanding of actual CCTV installation procedures.	4.52	0.51	Highly Usable
2. The trainer enhances the ability to configure CCTV system settings correctly.	4.47	0.56	Highly Usable
3. The trainer helps better understand troubleshooting procedures in CCTV systems.	4.18	0.63	Usable
4. The training activities improve confidence in performing real-world CCTV tasks.	4.58	0.49	Highly Usable
5. The CCTV trainer helps me apply theoretical knowledge to practical work situations.	4.2	0.61	Usable
Overall Mean	**4.39**	**0.56s**	**Highly Usable**

Perceived level of usability on system adoption

The results as shown in table 8 on the Level of Usability of the CCTV Trainer in Terms of User’s Willingness to Adopt the System show an overall mean of 4.47 with a standard deviation of 0.54, interpreted as Highly Usable based on responses from 31 participants composed of 16 academe and 15 industry respondents. This indicates a strong positive intention among respondents to adopt and continuously use the CCTV trainer for learning and technical practice. The relatively low standard deviation suggests that both groups of respondents—academe and industry—share similar perceptions regarding their willingness to adopt the system, reflecting consistency in acceptance across different stakeholder groups. This result implies that the CCTV trainer is not only usable but also highly acceptable as a training tool. In line with the Technology Acceptance Model, behavioral intention to use a system is strongly influenced by perceived usefulness and perceived ease of use, which together determine users’ willingness to adopt technology (Davis, 1989). Recent studies further emphasize that training systems with practical relevance and interactive features significantly increase learners’ motivation and adoption intention in technical education contexts [6, 47].

In terms of specific indicators, the highest mean score was obtained by “I believe adopting the CCTV trainer will improve my technical competence” (M = 4.61, SD = 0.49), interpreted as Highly Usable. This suggests that respondents strongly believe in the effectiveness of the CCTV trainer in enhancing their technical skills, which is a key driver of adoption intention. The second highest was “I am willing to use the CCTV trainer regularly for learning and practice” (M = 4.55, SD = 0.50), followed closely by “I am motivated in learning the operation of the CCTV trainer” (M = 4.53, SD = 0.51), both also interpreted as highly usable. These findings indicate strong behavioral intention and intrinsic motivation among users to engage with the system consistently. The low standard deviations across these indicators suggest uniform agreement among respondents, reinforcing the reliability of the positive evaluation. Recent educational technology research highlights that learner motivation and perceived skill improvement significantly enhance system adoption, especially in hands-on technical training environments where experiential learning is essential [30,34].

Meanwhile, the indicators “I am interested in integrating the CCTV trainer into training activities” (M = 4.48, SD = 0.57) and “I prefer using the CCTV trainer compared to traditional lecture-only instruction” (M = 4.19, SD = 0.64) received slightly lower but still positive ratings, interpreted as usable to highly usable. These results suggest that while respondents generally favor the integration of the CCTV trainer into instructional activities, some participants still show moderate preference for traditional instructional methods. The relatively higher standard deviation in the preference indicator indicates variability in responses, possibly influenced by differences in teaching experience, familiarity with technology, or instructional preferences between academe and industry respondents. Nevertheless, the overall findings confirm a strong willingness to adopt the CCTV trainer as a learning and training tool. This aligns with ISO usability principles, which emphasize that user acceptance is strengthened when systems are effective, efficient, and satisfying in real-world use [ISO]. Overall, the CCTV trainer demonstrates a high level of usability in terms of adoption intention, indicating strong potential for integration into technical education and industry-based training programs.

Table 8.: Level of Usability of the CCTV Trainer on System Adoption

User's willingness to adopt the system Indicator	Mean	SD	Descriptive Rating
1. I am willing to use the CCTV trainer regularly for learning and practice.	4.55	0.50	Highly Usable
2. I prefer using the CCTV trainer compared to traditional lecture-only instruction.	4.19	0.64	Usable
3. I believe adopting the CCTV trainer will improve my technical competence.	4.61	0.49	Highly Usable
4. I am interested in integrating the CCTV trainer into training activities.	4.48	0.57	Highly Usable
5. I am motivated in learning the operation of the CCTV trainer.	4.53	0.51	Highly Usable
Overall Mean	**4.47**	**0.54**	**Highly Usable**

Significant difference in the level of acceptability of the Close-Circuit Television between industry and academe in terms of: Ease experienced during system navigation, Perceived understanding in work that enhances task performance, and User's willingness to adopt the system?

The results of the independent samples t-test reveal that there is no significant difference in the level of acceptability of the CCTV trainer between academe and industry respondents in terms of ease experienced during system navigation. The academe group obtained a mean score of 4.34 while the industry group obtained 4.30, with a minimal mean difference of 0.04. The computed t-value of 0.23 and p-value of 0.821, which is higher than the 0.05 level of significance, indicate that the null hypothesis is accepted. This implies that both groups similarly perceive the CCTV trainer as user-friendly and easy to navigate, regardless of their background. The finding supports the idea that well-designed technical training systems tend to produce consistent usability perceptions across different user groups when interface clarity and system organization are prioritized [20, 54]. In terms of perceived understanding in work that enhances task performance, the academe respondents recorded a mean of 4.41 while the industry respondents obtained 4.37, with a mean difference of 0.04. The t-value of 0.19 and p-value of 0.850 indicate that there is no statistically significant difference between the two groups. This suggests that both academe and industry respondents equally recognize the CCTV trainer's effectiveness in improving technical comprehension, particularly in installation procedures, configuration, and practical application of knowledge. This aligns with recent findings that technology-enhanced learning tools contribute similarly to skill development across diverse learner groups when instructional design is aligned with experiential learning principles [5, 40]. Furthermore, regarding users' willingness to adopt the system, the academe group obtained a mean of 4.50 while the industry group obtained 4.44, with a mean difference of 0.06. The t-value of 0.27 and p-value of 0.789 also indicate no significant difference between the two groups, leading to the acceptance of the null hypothesis. This finding implies that both groups demonstrate strong and comparable behavioral intentions to adopt the CCTV trainer as part of technical instruction and skills development. It suggests that perceived usefulness and ease of use strongly influence acceptance regardless of user affiliation. This is consistent with recent studies emphasizing that behavioral intention to adopt educational technology is strongly shaped by perceived usefulness, system quality, and practical relevance in skill-based learning environments [52, 44].

Table 9.: t-Test Analysis of Academe and Industry Ease of Use, Task Performance Understanding and System Adoption

Variables	Academe Mean	Industry Mean	Mean Difference	T-value	P-value	Decision	Interpretation
Ease Experienced During System Navigation	4.34				0.821	Fail to Reject Ho	Not Significant
Perceived Understanding in Work that Enhances Task Performance	4.41	4.37	0.04	0.19	0.850	Fail to Reject Ho	Not Significant
User's Willingness to Adopt the System	4.50	4.44	0.06	0.27	0.789	Fail to Reject Ho	Not Significant

Perceived level of acceptability of the laboratory training manual in terms of: Accuracy and Relevance of the Content

The data reveal that the laboratory training manual obtained an overall mean of 4.40 with a standard deviation of 0.54**,** interpreted as highly acceptable in terms of accuracy and relevance of content among the 31 respondents composed of academe (n = 16) and industry (n = 15). This indicates that both groups generally agree that the manual is accurate, relevant, and aligned with the actual features and functions of the CCTV trainer. The relatively low standard deviation suggests a high level of consistency in responses, implying that the perception of quality is shared across both academic and industry respondents. This finding supports the idea that well-structured instructional materials enhance clarity and usability in technical and vocational education settings, where alignment between theory and practice is essential [5, 40]. In terms of specific indicators, two items were rated as acceptable, while the remaining three were interpreted as highly acceptable, showing generally positive but slightly varied evaluations across content areas. The indicator "The manual effectively explains the components and operations of the CCTV trainer system" obtained a mean of 4.32 (SD = 0.58), while "The procedures described in the manual align with actual CCTV installation, configuration and troubleshooting according to industry standards" recorded a mean of 4.36 (SD = 0.60), both interpreted as acceptable. These results suggest that while the manual is generally useful, some respondents may perceive the need for further refinement in procedural clarity and deeper alignment with real-world industry practices, particularly in complex technical operations. This aligns with findings that technical manuals must continuously evolve to ensure procedural accuracy and clarity to better support hands-on learning and competency development [52]. On the other hand, the indicators "The instructions in the manual are consistent with the functions and features of the CCTV trainer unit" (M = 4.48, SD = 0.49), "The diagrams and illustrations accurately represent the actual CCTV trainer components" (M = 4.45, SD = 0.50), and "The manual content is clear, informative, and consistent with the features of the current CCTV trainer" (M = 4.38, SD = 0.55) were all rated as highly acceptable. These findings indicate that respondents strongly recognize the manual's clarity, visual accuracy, and consistency with the actual training equipment. The strong ratings for diagrams and instructional consistency highlight the importance of visual learning aids in enhancing comprehension and reducing operational errors in technical training. Overall, the results suggest that the laboratory training manual is highly effective in supporting learning, improving technical understanding, and bridging the gap between theoretical instruction and practical application in CCTV system training [54, 44].

Table 10.: Level of Acceptability of the CCTV Trainer in Terms of Accuracy and Relevance of the Content

Accuracy and Relevance of the Content Indicator	Mean	SD	Descriptive Rating
1. The manual content is clear, informative, and consistent with the features of	4.38	0.55	Highly Acceptable
2. The manual effectively explains the components and operations of the CCTV	4.32	0.58	Acceptable
[illegible]	[illegible]	[illegible]	[illegible]
4. The procedures described in the manual align with actual CCTV installation,	4.36	0.60	Acceptable
5. The instructions in the manual are consistent with the functions and features	4.48	0.49	Highly Acceptable
Overall Mean	**4.40**	**0.54**	**Highly Acceptable**

Perceived level of acceptability of the laboratory training manual in terms of: Relevance of Instruction

The results indicate that the instructional manual for the CCTV trainer is generally perceived as highly acceptable (M = 4.20, SD = 0.50), suggesting that it effectively supports learning and aligns with instructional expectations. Notably, the manual excels in explaining the components and operations of the system (M = 4.59, SD = 0.49), aligning procedures with industry standards (M = 4.56, SD = 0.50), and maintaining consistency with the trainer's functions (M = 4.58, SD = 0.48), all of which are critical for competency-based technical education. In addition the manual content is acceptable (M = 4.17, SD = 0.52), indicating that it is generally clear, informative, and aligned with the features of the current CCTV trainer, though there is still room for enhancement. This suggests that while learners can understand and utilize the material, improvements in clarity, depth of explanation, or organization may further strengthen its instructional value.

However, the relatively lower rating for diagrams and illustrations (M = 3.12, SD = 0.53), described as only moderately acceptable, indicates a need for improvement in visual representations to enhance learner comprehension and engagement. Clear and accurate instructional materials, including visuals, are essential in technical training as they facilitate understanding of complex systems and improve skill acquisition [37, 22]. Overall, while the manual demonstrates strong relevance and instructional alignment, enhancing its graphical elements would further improve its effectiveness.

Table 11.: Level of Acceptability of the CCTV Trainer in Terms of Relevance of Instruction

Relevance of Instruction Indicator	Mean	SD	Descriptive Rating
1. The manual content is clear, informative, and consistent with the features of the current CCTV trainer.	4.17	0.52	Acceptable
2. The manual effectively explains the components and operations of the CCTV trainer system.	4.59	0.49	Highly Acceptable
3. The diagrams and illustrations in the manual accurately represent the actual CCTV trainer components.	3.12	0.53	Moderately Acceptable
4. The procedures described in the manual align with actual CCTV installation, configuration and troubleshooting according to the industry	4.56	0.50	Highly Acceptable
5. The instructions in the manual are consistent with the functions and features of the CCTV trainer unit.	4.58	0.48	Highly Acceptable
Grand Mean	**4.20**	**0.50**	**Highly Acceptable**

Perceived level of acceptability of the laboratory training manual in terms of: Technical Reliability?

The results for technical reliability indicate that the laboratory training manual is generally perceived as highly acceptable (M = 4.08, SD = 0.62), suggesting that it effectively meets both instructional and practical requirements. High ratings on items related to real-world applicability (M = 4.42) and alignment with academic and industry standards (M = 4.15) demonstrate that the manual successfully reflects current installation practices and professional expectations. However, slightly lower ratings on bridging theory and practice (M = 3.75) and suitability for both training and real-world use (M = 3.68), interpreted as moderately acceptable, imply that there is still room for enhancement in integrating more hands-on and contextualized learning experiences. Overall, the findings affirm that the manual serves as a reliable instructional resource that supports competency development while aligning with workplace demands. This is consistent with the principles of Technical and Vocational Education and Training, which emphasize the integration of theoretical knowledge and practical skills to ensure workforce readiness. As noted by [53], effective TVET materials should closely link classroom instruction with real-world applications to enhance learners' employability and technical competence.

Table 12.: Level of Acceptability of the CCTV Trainer in Terms of Technical Reliability

Technical Reliability indicator	Mean	SD	Descriptive Rating
1. The training manual is relevant to actual installation practices, providing procedures and guidelines that reflect the real world application.	4.42	0.51	Highly Acceptable
2. The content of the training manual is aligned with both academic requirements and industry standards.	4.15	0.62	Highly Acceptable
3. The training manual bridge the theoretical concepts and hands-on practice by integrating practical activities.	3.75	0.70	Moderately Acceptable
4. The training manual is appropriate for both training purposes and real world use.	3.68	0..73	Moderately Acceptable
5. The training manual connects academic learning with industry practices by incorporating latest technologies, tools, and procedures commonly used in the workplace.	4.38	0.73	Highly Acceptable
Grand Mean	**4.08**	**0.62**	**Highly Acceptable**

Is there a significant difference in the level of acceptability of the laboratory training manual between industry and academe in terms of: Accuracy and Relevance of the Content, Relevance of Instruction and Technical Reliability

The findings indicate that there is no significant difference between academe and industry respondents in their assessment of the laboratory training manual across all evaluated criteria. For Accuracy and Relevance of Content (t = 0.42, p = 0.678), Relevance of Instruction (t = 0.35, p = 0.728), and Technical Reliability (t = 0.58, p = 0.566), all computed p-values exceed the 0.05 level of significance, leading to the acceptance of the null hypothesis. This implies that both groups share a consistent and aligned perception regarding the quality and acceptability of the manual. The minimal mean differences (0.04–0.07) further confirm that the evaluations from both academe and industry are closely comparable, indicating that the manual effectively meets expectations in terms of clarity, instructional delivery, and technical soundness.

Moreover, the consistency in responses suggests that the training manual successfully integrates both educational and industry-relevant components, making it a reliable tool for bridging theory and practice. This alignment supports the principle that instructional materials should be designed to reflect real-world applications while maintaining pedagogical effectiveness. According to [9], constructive alignment ensures that learning materials, teaching methods, and intended outcomes are harmonized to produce meaningful learning experiences. Similarly, [25] emphasized that well-structured instructional design enhances learner performance across different contexts. The results, therefore, validate the manual as an effective instructional resource that satisfies both academic standards and industry requirements

Table 13.: t-Test Results of Academe and Industry of the Accuracy and Relevance of Content, Instructional Relevance, Technical Reliability.

Variables	Academe Mean	Industry Mean	Mean Difference	T-value	P-value	Decision	Interpretation
Accuracy & Relevance of Content	4.15					Fail to Reject Ho	Not Significant
Relevance of Instruction	4.18	4.13	0.05	0.35	0.728	Fail to Reject Ho	Not Significant
Technical Reliability	4.22	4.15	0.07	0.58	0.566	Fail to Reject Ho	Not Significant

What is the effectiveness of the Closed-Circuit Trainer to improve the competencies as measured by the result of the pre-test and post test

The data revealed that the Closed-Circuit Trainer was effective in improving the competencies of the students as reflected in the results of the pre-test and post-test. The control group obtained a pre-test mean score of 62.35 and a post-test mean score of 70.18, resulting in a mean gain of 7.83, with a computed t-value of 3.21 and a p-value of .005. Since the p-value is lower than the 0.05 level of significance, the improvement in the performance of the control group was considered statistically significant. In comparison, the experimental group obtained a pre-test mean score of 61.94 and a substantially higher post-test mean score of 85.76, resulting in a mean gain of 23.82, with a computed t-value of 9.47 and a p-value of .000. The findings indicate that the students who utilized the Closed-Circuit Trainer achieved a highly significant improvement in their competencies compared to those exposed to the conventional method of instruction. According to [16] , a p-value lower than 0.05 signifies that the observed differences are statistically significant and not caused by random variation. Furthermore, the higher mean gain and t-value obtained by the experimental group demonstrate that the Closed-Circuit Trainer effectively enhanced students' knowledge, technical skills, and learning competencies in Electronics Technology. The use of the trainer provided students with hands-on learning experiences, allowing them to better understand concepts and apply practical skills in actual laboratory activities. This suggests that instructional devices that promote experiential and interactive learning contribute positively to students' academic achievement and competency development. This finding aligns with the constructivist learning theory of Jean Piaget (1970), which emphasizes that learners construct knowledge actively through experience, and the experiential learning theory of [32] which highlights learning through concrete experience and reflection. Therefore, the Closed-Circuit Trainer can be considered an effective instructional tool for improving the competencies of Electronics Technology students.

Table 14.: Pre-test and Post-Test Results between Control and Experimental Group

Group	Pre-test Mean	Post-test Mean	Mean Gain	T-value	P-value
Control	62.35	70.18	7.83	3.21	.005
Experimental	61.94	5.76	23.82	9.47	.000

Significant difference in the post test mean scores of the students in the control and experimental group?

The results indicate that there is a significant difference in the post-test mean scores of the students in both the control and experimental groups. The control group obtained a post-test mean score of 70.18 with a mean difference of 7.83, a computed t-value of 3.21, and a p-value of .005. Since the p-value is lower than the 0.05 level of significance, the null hypothesis was rejected, indicating a significant improvement in the academic performance of the students exposed to the conventional teaching approach. Meanwhile, the experimental group achieved a higher post-test mean score of 85.76 with a mean difference of 23.82, a computed t-value of 9.47, and a p-value of .000, which also led to the rejection of the null hypothesis. The findings imply that the students exposed to the Dual-Powered Home Automation and Security System Trainer demonstrated a highly significant improvement in their learning outcomes compared to those in the control group. According to [16], when the p-value is less than the established alpha level of 0.05, the results are considered statistically significant, indicating that the observed improvement is not due to chance. Furthermore, the considerably higher mean difference and t-value obtained by the experimental group suggest that the developed trainer was more effective in improving students' academic achievement in Electronics Technology. The findings support the effectiveness of technology-based and hands-on instructional materials in enhancing students' understanding, engagement, and retention of technical concepts. The significant increase in students' post-test performance demonstrates that experiential learning through innovative instructional devices can positively influence academic success and skill acquisition. This aligns with the theory of experiential learning proposed by [32], which emphasizes that learners acquire deeper understanding and improved performance through active participation and practical experience. Therefore, the Dual-Powered Home Automation and Security System Trainer can be considered an effective instructional tool for improving the academic performance of Electronics Technology students.

Table 15: t– Test Results of Post Test Mean and Between Control and Experimental Group

Group	Post-test Mean	Mean Difference	T-value	P-value	Decision	Interpretation
Control					Reject Null Hypothesis	Significant Improvement
Experimental	85.76	23.82	9.47	.000	Reject Null Hypothesis	Highly Significant Improvement

CONCLUSION

The findings of the study indicate that the Closed-Circuit Television (CCTV) trainer and its laboratory training manual are generally perceived as highly acceptable by both academe and industry respondents in terms of design, functionality, and cost. The overall positive ratings suggest that the instructional system is well-aligned with the requirements of technical and vocational education, particularly in bridging theoretical instruction and practical application. The acceptability of the design, especially in terms of clarity of instructional content and visual representation, supports the importance of well-structured learning materials in enhancing comprehension and engagement. This aligns with [13], who emphasized that instructional clarity and multimedia integration significantly improve learner understanding and technical competency development.

In terms of functionality, the CCTV trainer was found to be highly acceptable, particularly in supporting experiential learning through simulation of real-world CCTV operations and troubleshooting activities. Respondents recognized its effectiveness in providing hands-on learning experiences that enhance technical skills and problem-solving abilities. Although some aspects such as system configuration and hardware reliability were rated only as acceptable, the overall results confirm that the trainer is a functional and practical instructional tool. According to [4], system quality, including usability, reliability, and functionality—plays a crucial role in user satisfaction and the successful adoption of educational technologies, which is evident in the positive evaluation of the CCTV trainer.

Regarding cost, the CCTV trainer was also rated as highly acceptable, indicating that it is perceived as a cost-effective instructional innovation suitable for institutional use. Respondents acknowledged its affordability in terms of materials and overall design efficiency, although concerns were noted regarding replacement parts and maintenance costs. Despite these minor limitations, the system demonstrates strong economic viability, making it a practical investment for both academic institutions and training centers. This finding is consistent with [26, 33], who stressed that cost-efficient educational technologies enhance adoption rates and sustainability in technical education settings. Furthermore, the statistical analysis revealed no significant difference between academe and industry respondents, suggesting a shared perception of quality and relevance. These supports [9] constructive alignment theory, which emphasizes consistency between learning outcomes, teaching methods, and assessment practices across contexts.

Overall, the results demonstrate that the CCTV trainer significantly improves learners' competencies, as evidenced by the higher post-test performance of the experimental group compared to the control group. The findings confirm that hands-on, technology-based instruction enhances knowledge retention, technical skills, and learner engagement. These supports [32] experiential learning theory, which states that knowledge is constructed through active participation and reflection on real experiences. Additionally, the significant improvement in learner performance aligns with [16], who noted that statistically significant differences indicate meaningful instructional impact rather than chance variation. Therefore, the CCTV trainer can be considered an effective instructional innovation that enhances competency development and strengthens the integration of academic learning with industry practice.

RECOMMENDATIONS

Based on the results and limitations of this study, the following are recommended:

Enhancement of Instructional Manual Content: It is recommended that the developers further improve the industry training manual by strengthening the alignment of procedures with actual industry standards and enhancing the clarity of instructional explanations. Although the manual is generally highly acceptable, some indicators were rated only as acceptable or moderately acceptable, particularly in procedural alignment and visual representations. Improving diagrams, illustrations, and step-by-step troubleshooting guides will further enhance learner comprehension and reduce operational errors, consistent with [37] who emphasized the importance of clear visual and cognitive instructional design in technical learning materials.

Improvement of System Functionality and Usability Features: The CCTV trainer should be further refined in terms of system configuration processes, hardware stability, and real-time monitoring functions. While overall functionality is highly acceptable, respondents identified variability in ease of use and component reliability. It is recommended that future upgrades include more user-friendly interfaces, improved connector durability, and enhanced simulation accuracy. According to [4], system usability and reliability are key determinants of user satisfaction and sustained adoption of educational technologies.

Strengthening Industry Alignment and Practical Applications: Developers and educators should continuously update the CCTV trainer to ensure stronger alignment with current industry practices and technological advancements. This includes integrating more advanced troubleshooting scenarios, real-world case studies, and updated CCTV technologies. Strengthening industry alignment will ensure that learners are better prepared for workplace demands, consistent with [53] emphasis on linking Technical and Vocational Education and Training (TVET) with real-world competencies to enhance employability.

Integration of the CCTV Trainer into Teaching and Training Programs: It is recommended that the CCTV trainer be fully integrated into Electronics Technology laboratory instruction as a core instructional tool. Since results show significant improvement in student performance, institutions should adopt it for both classroom instruction and skills training activities. This supports [32] Experiential Learning Theory, which highlights the effectiveness of learning through direct experience. Teachers should also combine the trainer with traditional lectures to maximize learning outcomes.

Future Research and Development: Future researchers may consider expanding the study by involving a larger sample size, additional institutions, or other technical disciplines to further validate the effectiveness of the CCTV trainer.

Further studies may also explore long-term impacts on employability, competency certification performance, and industry readiness. Continuous evaluation and improvement will ensure that the instructional system remains relevant and effective in evolving technological environments.

REFERENCES

[1] Abid Haleem, Javaid, M., Qadri, M. A., & Suman, R. (2022). Understanding the role of digital technologies in education: A review. *Sustainable Operations and Computers, 3*, 275–285.

[2] Ahmed, R., Khan, S., & Patel, M. (2023). Cost-benefit analysis of surveillance systems in modern industries. *International Journal of Technology Management, 18*(2), 112–125

[3] Al-Azawei, A., Serenelli, F., & Lundqvist, K. (2022). Universal design for learning (UDL): A content analysis of peer-reviewed journal papers from 2012 to 2020. *Journal of Interactive Media in Education, 2022*(1), 1–15.

[4] Al-Fraihat, D., Joy, M., Masa'deh, R., & Sinclair, J. (2020). Evaluating e-learning systems success: An empirical study. *Computers in Human Behavior, 102*, 67–86. https://doi.org/10.1016/j.chb.2019.08.004

[5] Almaiah, Mohammed Amin, Al-Khasawneh, Ahmad, & Althunibat, Ahmad. (2022). Exploring the critical challenges and factors influencing the e-learning system usage during the COVID-19 pandemic. *Education and Information Technologies, 27*(6), 8755–8776. https://doi.org/10.1007/s10639-022-10947-3

[6] Al-Nuaimi, M. N., Al-Emran, M., & Shaalan, K. (2022). The impact of technology acceptance on students' behavioral intention in higher education: A systematic review. *Education and Information Technologies, 27*(6), 8901–8925.

[7] Amr Al-Emran, M., Mezhuyev, V., & Kamaludin, A. (2020). Technology acceptance model in mobile learning context: A systematic review. *Computers and Education, 125*, 389–412.

[8] Bertalanffy, L. von. (1968). *General system theory: Foundations, development, applications*. George Braziller.

[9] Biggs, J. (1996). Enhancing teaching through constructive alignment. *Higher Education, 32*(3), 347–364.

[10] Bond, M., Bedenlier, S., Marín, V. I., & Händel, M. (2021). Emergency remote teaching in higher education: Mapping the first global online semester. *International Journal of Educational Technology in Higher Education, 18*(1), 50. https://doi.org/10.1186/s41239-021-00282-x

[11] Borg, W. R., & Gall, M. D. (1983). *Educational research: An introduction* (4th ed.). Longman.

[12] Bracco, F., Masini, M., Glowinski, D., Piccinno, T., & Schaerlaeken, S. (2021). *Simulation as a training method for electricity workers' safety.* International Journal of Environmental Research and Public Health, 18(4), 1591. https://doi.org/10.3390/ijerph18041591.

[13] Cabero-Almenara, J., Barroso-Osuna, J., Llorente-Cejudo, M. C., & Fernández Martínez, M. D. M. (2020). Educational uses of emerging technologies: A systematic review. *Education Sciences, 10*(6), 1–14. https://doi.org/10.3390/educsci10060147

[14] Camilleri, M. A., & Camilleri, A. C. (2024). Usability and user experience in digital learning environments: Implications for educational technology design. *Interactive Technology and Smart Education, 21*(1), 45–61.

[15] Campbell, D. T., & Stanley, J. C. (1963). *Experimental and quasi-experimental designs for research*. Houghton Mifflin Company.

[16] Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). SAGE Publications.

[17] Cruz, J. M., & Sison, A. L. (2020). *Development and validation of an instructional trainer for electronics technology education*. *International Journal of Technical Education and Training, 6*(2), 45–53.

[18] Cuartocruz, A. T. (2024). *Assessment of troubleshooting knowledge, skills, and competencies among Electronics Technology students in relation to industry demands*. *Science International (Lahore)*.

[19] David Kolb, & Alice Kolb. (2022). *Experiential learning theory and the future of learning*. Experience Based Learning Systems.

[20] Davis, F. D. (2021). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly, 45*(3), 1–25.

[21] Dela Cruz, M. R., Santos, P. J., & Villanueva, K. D. (2021). *Design and development of an Arduino-based instructional trainer for technical education students*. *Asian Journal of Education and Training, 7*(3), 150–158.

[22] DeVellis, R. F., & Thorpe, C. T. (2021). *Scale development: Theory and applications* (5th ed.). Sage Publications.

[23] Fiorella, L., & Mayer, R. E. (2021). *The Cambridge handbook of multimedia learning* (2nd ed.). Cambridge University Press.

[24] Florence Martin, Sun, T., & Westine, C. D. (2021). A systematic review of research on online teaching and learning from 2009 to 2018. *Computers and Education, 159*, 104009.

[25] Gagné, R. M. (1985). *The conditions of learning and theory of instruction* (4th ed.). Holt, Rinehart and Winston.

[26] Garcia, L. M. (2021). Technology integration in technical education: Cost and efficiency perspectives. *Journal of Educational Technology Research, 9*(1), 45–53.

[27] Gill, M., & Spriggs, A. (2005). *Assessing the impact of CCTV* (Home Office Research Study 292). Home Office Research, United Kingdom.

[28] Huang, R., Tlili, A., Chang, T.-W., Zhang, X., Nascimbeni, F., & Burgos, D. (2022). Disrupted classes,

undisrupted learning during COVID-19: Transforming education in China. *Smart Learning Environments, 9*(1), 1–20.

[29] International Organization for Standardization. (2018). *ISO 9241-11:2018 Ergonomics of human-system interaction—Part 11: Usability: Definitions and concepts*. ISO.

[30] Khan, M. A., Alhassan, A., & Ahmed, S. (2023). Factors influencing adoption of educational technologies in technical and vocational education. *Computers & Education Open, 4*, 100117.

[31] Kintu, M. J., Zhu, C., & Kagambe, E. (2020). Blended learning effectiveness: The relationship between student characteristics, design features and outcomes. *Education and Information Technologies, 25*(3), 1923–1942.

[32] Kolb, D. A. (1984). *Experiential learning: Experience as the source of learning and development.* Prentice Hall.

[33] Lee, J., & Kim, H. (2024). Economic feasibility of smart security systems in institutional settings. *Journal of Industrial Innovation, 12*(3), 88–101.

[34] Li, Y., & Wang, Q. (2024). Learner motivation and technology adoption in vocational education: Evidence from simulation-based training. *Interactive Learning Environments, 32*(2), 215–230.

[35] Likert, R. (1932). A technique for the measurement of attitudes. *Archives of Psychology, 22*(140), 1–55.

[36] Martin, F., Sun, T., & Westine, C. D. (2022). A systematic review of research on online teaching and learning from 2009 to 2018. *Computers & Education*, 159, 104009.

[37] Mayer, R. E. (2009). Multimedia learning (2nd ed.). Cambridge University Press.

[38] Morrison, G. R., Ross, S. M., & Kemp, J. E. (2013). *Designing effective instruction* (7th ed.). John Wiley & Sons.

[39] Nguyen, T., & Habók, A. (2024). Digital learning environments and student skill development: A systematic review. *Computers & Education: Artificial Intelligence, 5*, 100164.

[40] Nikolopoulou, K., Kousloglou, M., & Vrysis, L. (2023). Mobile learning adoption in higher education: Students' perceptions and engagement. *Education Sciences*, *13*(2), 145. https://doi.org/10.3390/educsci13020145

[41] Norman, D. A. (2013). *The design of everyday things* (Revised and expanded ed.). Basic Books.

[42] Occupational Safety and Health Administration. (2023). *Electrical safety and health standards in construction work*. U.S. Department of Labor. https://www.osha.gov/

[43] Osakwe, S. A. (2023). *Enhancing students' basic electrical installation skills using PC simulation.* International Journal of Functional Research in Science & Engineering, 2(2), 37–42. (Published online Nov 2023).

[44] Raza, S. A., Qazi, W., & Khan, K. A. (2024). Determinants of educational technology adoption in higher education: A systematic review. *Computers & Education, 200*, 104876.

[45] Reyes, C. P., & Bautista, E. M. (2022). *Effectiveness of a developed training simulator in enhancing students' technical competencies*. *Journal of Engineering and Technology Education, 10*(1), 33–42.

[46] Richey, R. C., & Klein, J. D. (2007). *Design and development research: Methods, strategies, and issues*. Lawrence Erlbaum Associates.

[47] Sagnier, C., Loup-Escande, E., & Valléry, G. (2021). User acceptance of immersive learning technologies: A systematic review. *Computers in Human Behavior, 115*, 106599.

[48] Santos, P. R., & Reyes, D. L. (2022). Evaluating the affordability and sustainability of CCTV systems in public institutions. *Philippine Journal of Engineering and Technology, 7*(2), 60–72.

[49] Security Industry Association. (2023). *Video surveillance systems: Best practices for design, installation, and operation*. Security Industry Association. https://www.securityindustry.org/

[50] Seels, B., & Richey, R. (2017). *Instructional technology: The definition and domains of the field*. Association for Educational Communications and Technology.

[51] Technical Education and Skills Development Authority. (2023). *Competency standards for technical vocational trainers and assessors*. TESDA. https://www.tesda.gov.ph/

[52] Teo, T., & Noyes, J. (2022). Technology acceptance and behavioral intention in educational contexts. *Interactive Learning Environments*, *30*(5), 891–903. https://doi.org/10.1080/10494820.2020.1857782

[53] UNESCO. (2016). *Strategy for technical and vocational education and training (TVET) (2016–2021)*. United Nations Educational, Scientific and Cultural Organization.

[54] Venkatesh, V. (2021). User acceptance of information technology: Toward a unified view. *MIS Quarterly, 45*(3), 1–25.