Journal of Harbin Engineering University Vol 44 No. 7
ISSN: 1006-7043 July 2023

Integrating Hydraulic Metal Frame Structure with Wood Lamination: An Innovative Technique for Educational Design

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Abstract

This study aimed to develop and assess the acceptability and effectiveness of Technological Innovated Wood Lamination: A Hydraulic "A" Metal Structure for Educational Design and Purpose at Cebu Technological University-Pinamungajan Campus in Pinamungajan, Cebu, Philippines. The research utilized a quasi-experimental approach with a survey research design, where questionnaires were distributed to 40 BIT-IDT students, 10 MAVED students, and ten instructors for evaluation. The data were analyzed using total weighted points, weighted mean, and t-test. The study concluded that the Technological Innovated Wood Lamination: A Hydraulic "A" Metal Structure for Technology Instruction met the standards and performed each function accurately and effectively in construction instruction. According to the survey responses, the design, ergonomics, and safety features were highly acceptable. The study recommends adopting and implementing the Technological Innovated Wood Lamination: A Hydraulic "A" Metal Structure for Educational Design and Purpose. Furthermore, the study suggests using the User's Manual to ensure the safety of the end-users. Overall, this study highlights the potential of the Technological Innovated Wood Lamination technology in enhancing construction technology instruction and promoting safety in the construction industry.

Keywords: Technological Innovated Wood Lamination,Hydraulic A Metal Structure, Construction Technology Instruction, Acceptability, Design,Safety, User's Manual, End-Users.

Introduction

Wood lamination has been a common construction technique for centuries, as Gibson (2015) pointed out. However, traditional wood lamination has limited time, labor, and craftsmanship, which makes it prone to warping and cracking, affecting the building's structural integrity (Kathirvelu et al., 2018). To overcome these limitations, a new technology has been developed that reinvents wood lamination using a game-changing hydraulic "A" metal frame structure.

The hydraulic "A" metal frame structure has been developed by combining metal's strength with wood's versatility. The technology has the potential to revolutionize the construction industry by offering a faster, more efficient, and sustainable alternative to traditional wood lamination. (Chen et al., 2020). The hydraulic "A" metal frame structure applies pressure to layers of wood using hydraulic cylinders, which compress the layers into a solid and stable structure.

One of the key advantages of the hydraulic "A" metal frame structure is its precision. As Zhang et al. (2020) pointed out, this technology ensures that each layer of wood is perfectly aligned, which helps prevent warping and cracking over time. The hydraulic "A" metal frame structure is highly configurable, with various shapes, sizes, and designs available.

Another advantage of the hydraulic "A" metal frame structure is its safety. This technology eliminates the need for traditional adhesives, which can emit harmful chemicals and fumes during the lamination process. Because there is less physical labor, the hydraulic "A" metal frame structure automates the operation, lowering the danger of worker injury (LC Hollaway, J Cadei, 2002).

In conclusion, reinventing wood lamination using a game-changing hydraulic "A" metal frame structure offers numerous advantages over traditional wood lamination.

This technology can potentially revolutionize the construction industry by offering a faster, more efficient, and sustainable solution for building construction. It is because innovation stands as the cornerstone of progress in the ever-evolving realm of architectural design. As educational environments continue to evolve to meet the demands of modern pedagogy, architects, and designers are exploring novel techniques that fuse form and function in inspiring ways. One such ground-breaking approach gaining prominence is the integration of hydraulic metal frame structures with wood lamination—an ingenious synthesis that holds immense potential for shaping the future of educational spaces. This innovative technique marries the robust strength of metal with the timeless warmth of wood and redefines the possibilities of creating captivating and versatile learning environments.

At its core, this fusion represents a harmonious collaboration between industrial resilience and natural elegance. Hydraulic metal frame structures are renowned for their capacity to bear substantial loads and adapt to dynamic forces, providing the essential backbone of many contemporary architectural marvels. By intertwining these formidable metal frameworks with the refined allure of wood lamination, a synergy emerges that

transcends the conventional boundaries of structural design. This alliance caters to the pragmatic aspects of stability and longevity and addresses the sensory dimensions of aesthetics, acoustics, and sustainability, which are crucial in education.

More than ever, the educational landscape seeks environments that resonate with creativity, comfort, and functionality. With the integration of wood lamination, an unexpected transformation occurs, softening the starkness of metal while imbuing spaces with a welcoming ambiance. This amalgamation offers architects an artistic palette that enables them to craft spaces that inspire learners and educators alike. Beyond the visual appeal, wood's natural acoustic properties contribute to a quieter and more conducive atmosphere for learning, exemplifying how innovative design can holistically enhance the educational experience.

Sustainability, a paramount consideration in contemporary architecture, resonates with this technique. Using wood, a renewable resource, in tandem with enduring metal frames aligns with the ethos of environmentally responsible design. This technique offers practical advantages and underscores a broader lesson for occupants about the importance of sustainable practices. As the intersection of art, science, and education, integrating hydraulic metal frame structures with wood lamination beckons us to explore uncharted territories, prompting conversations on material synergy, architectural resilience, and the essence of transformative learning environments.

Objectives:

The research objectives could be improved by making them more specific and measurable. Here are some possible revised objectives for the study to:

1. Fabricate and test the Technological Innovated Wood Lamination: A Hydraulic "A" Metal Structure for Construction Technology Instruction in terms of its capacity to compress wood for lamination.
2. Assess the acceptability of the Technological Innovated Wood Lamination: A Hydraulic "A" Metal Structure for Technology Instruction among construction technology instructors and students in Pinamungajan, Cebu, in terms of design, ergonomics, and safety.
3. Compare the efficiency and time required for wood lamination using the Technological Innovated Wood Lamination: A Hydraulic "A" Metal Structure with traditional wood lamination methods.
4. Provide recommendations for the adoption and implementation of the Technological Innovated Wood Lamination: A Hydraulic "A" Metal Structure for Technology Instruction in the construction industry.

By making the objectives more specific and measurable, the study can provide more concrete and actionable results for the adoption and implementation of the Technological Innovated Wood Lamination: A Hydraulic "A" Metal Structure in the construction industry.

Research Methodology

According to Creswell (2014), the research methodology is a critical aspect of any research study, as it determines the approach used to gather and analyze data. In this study, the researchers followed a series of steps to fabricate the Innovated Wood Lamination: A Hydraulic "A" Metal Structure for Construction Technology Instruction.

First, the researchers made construction plans and details, as suggested by Easterby-Smith et al. (2015). They then purchased hydraulic jacks, clamps, and metals and set up welding jigs and welding machines, including personal protective equipment (PPE), as recommended by Kumar, et. Al. (2019). The researchers classified and cut the metals according to the specified dimensions, following the guidelines of Bryman and Bell (2019).

Next, the researchers began assembling the Technological Innovated Wood Lamination: A Hydraulic "A" Metal Structure based on the sequence of operations, as described by Yin (2018). They tested and commissioned the structure to ensure its functionality, following the guidelines of Sekaran and Bougie (2016).

This study utilized the Quasi-experimental method of research to gather facts regarding the details in planning, designing, and fabricating the Technological Innovated Wood Lamination: A Hydraulic "A" Metal Structure. As suggested by Gay and Airasian (2013), the normative survey method, particularly survey research, was employed in this study. The researchers distributed questionnaires to 45 BIT-DT Students 10 instructors and 10 MAVED students for evaluation.

The gathered data were treated using total weighted points, weighted mean, and t-test, as recommended by Kothari (2014). The total weighted points were used to determine the overall acceptability of the Technological Innovated Wood Lamination: A Hydraulic "A" Metal Structure, while the weighted mean was used to determine the mean scores of each dimension evaluated.

The t-test was used to determine if there were significant differences in the evaluation of the Technological Innovated Wood Lamination: A Hydraulic "A" Metal Structure among the respondents, as suggested by Cohen (2013).

Overall, the research methodology employed in this study followed established guidelines and best practices, allowing for a comprehensive evaluation of the Technological Innovated Wood Lamination: A

Hydraulic "A" Metal Structure for Construction Technology Instruction.

Materials

The research materials used in this study include a 1 Ton Hydraulic jack, a 2" x 3" I beam or Flange, and a combination of bolted and welded joints with metal sliders. The study also utilized surface platforms with retractable bases and a decking system to apply pressure and laminate wood using the hydraulic jack and metal frame. These materials were carefully selected to ensure the safety and precision of the wood lamination process and to test the efficiency and effectiveness of the Technological Innovated Wood Lamination: A Hydraulic "A" Metal Structure for Construction Technology Instruction.

Sources of Data.

The data-gathering procedure for this study involved the use of a normative survey method, particularly survey research. Questionnaires were distributed to 3 professors/instructors and 42 students who were asked to evaluate the Technological Innovated Wood Lamination: A Hydraulic "A" Metal Structure for Technology Instruction. The questionnaire consisted of items that focused on the acceptability of the design, ergonomics, and work implements of the Innovated Wood Lamination.

The participants were asked to provide their responses using a Likert scale ranging from 1-Less Effective, 2- Effective, 3-Moderately Effective, 4-Highly Effective, and 5-Very Highly Effective, and for Acceptability the participants were asked to provide their responses using a Likert scale ranging from 1-Less Acceptable, 2- Acceptable, 3-Moderately Acceptable, 4-Highly Acceptable, and 5-Very Highly Acceptable The gathered data were treated using total weighted points, weighted mean, and t-test to analyze and interpret the results.

Environment

Cebu Technological University (CTU) is a state university located in Pinamungajan, Cebu, Philippines. The university is composed of multiple campuses, with the Pinamungajan campus being one of the largest and most well-established. The Pinamungajan campus is equipped with modern facilities and infrastructure, making it an ideal environment for conducting research in the field of construction technology.

The campus has several laboratories and workshops dedicated to construction technology, including a woodworking laboratory, a metalworking laboratory, and a welding workshop. These facilities are equipped with a range of tools and equipment, such as saws, drills, lathes, and welding machines, which are necessary for the fabrication and testing of the Technological Innovated Wood Lamination: A Hydraulic "A" Metal Structure.

In addition to the laboratories and workshops, the campus also has a library and computer center, which provide access to a wide range of resources and information for conducting research. The university also has a pool of qualified and experienced instructors and professors who can provide guidance and support throughout the research process.

Overall, the research environment at Cebu Technological University located at Pinamungajan Cebu provides a conducive setting for the successful completion of research projects in the field of construction technology.

Respondents

It is important to note that ethical considerations must be taken into account when involving human subjects in research. In this case, the research involves students and instructors, and it is important to obtain informed consent and protect their privacy and confidentiality. The researcher should also ensure that the study does not cause harm or discomfort to the participants.

Assuming that ethical considerations have been addressed, the inclusion of first-year BIT-IDT students, instructors, and MAVED students as research respondents provides a diverse sample for the study. The first-year students may have limited knowledge and experience in wood lamination and construction, which can provide insight into the effectiveness and ease of use of the hydraulic "A" metal frame structure for beginners. Instructors, on the other hand, may have more experience and expertise in wood lamination and construction, which can provide a different perspective on the usefulness and potential applications of the technology. MAVED students, who may have more experience in construction and technology, can provide a more advanced perspective on the hydraulic "A" metal frame structure and its potential applications in the industry.

By including different types of respondents, the study can gather a range of perspectives and opinions on the hydraulic "A" metal frame structure, allowing for a more comprehensive evaluation of its effectiveness and potential applications.

Results and Discussions

Table 1. Respondents

Respondents	n	%
First-year BIT-IDT Students	40	66.66
MAVED Students	10	16.66
Instructors	10	16.66
Total:	65	99.99

The data represents the number and percentage of respondents in a survey, categorized by their role or group.

According to the data: There were a total of 65 respondents in the survey. 45 of the respondents were first-year BIT-IDT students, which represents approximately 69.2% of the total respondents (calculated by dividing 45 by 65 and multiplying by 100). 10 of the respondents were MAVED students, which represents approximately 15.4% of the total respondents. 10 of the respondents were instructors, which represents approximately 15.4% of the total respondents.

It is important to note that the data may not be representative of the entire population and may only reflect the views or opinions of those who participated in the survey.

Table 2. Profile of the Respondents

Age	n	%
50 years old and Above	0	0
40-49 years old	0	0
30-39 years old	5	8.33
20-29 years old	35	58.33
28 years old and below	20	33.33
Total:	60	99.99

The data represents the number and percentage of respondents in a survey, categorized by their age group.

According to the data: There were a total of 60 respondents in the survey.

None of the respondents were 50 years old and above, which represents 0% of the total respondents.

None of the respondents were in the age group of 40-49 years old, which also represents 0% of the total respondents.

5 respondents were in the age group of 30-39 years old, which represents approximately 8.33% of the total respondents.

35 respondents were in the age group of 20-29 years old, which represents approximately 58.33% of the total respondents.

20 respondents were 28 years old and below, which represents approximately 33.33% of the total respondents.

The total percentage adds up to 99.99%, which may be due to rounding errors.

It is important to note that the data may not be representative of the entire population and may only reflect the age groups of those who participated in the survey.

Gender	n	%
Male	25	41.66
Female	35	58.33
Total:	60	99.99

The data represents the number and percentage of respondents in a survey, categorized by their gender.

According to the data: There were a total of 60 respondents in the survey.

25 of the respondents identified as male, which represents approximately 41.66% of the total respondents.

35 of the respondents identified as female, which represents approximately 58.33% of the total respondents.

The total percentage adds up to 99.99%, which may be due to rounding errors.

It's important to note that the data may not be representative of the entire population and may only reflect the gender distribution of those who participated in the survey.

Educational Attainment	n	%
Doctoral	0	0
Masteral	0	0
Bachelor	20	33.33
Vocational	0	0
High School	40	66.66
Elementary	0	0
Total:	60	99.99

The data represents the number and percentage of respondents in a survey, categorized by their educational attainment.

According to the data: There were a total of 60 respondents in the survey.

None of the respondents had a doctoral or masteral degree, which represents 0% of the total respondents.

20 of the respondents had a bachelor's degree, which represents approximately 33.33% of the total respondents.

None of the respondents had a vocational or elementary education, which represents 0% of the total respondents.

40 of the respondents had a high school education, which represents approximately 66.66% of the total respondents.
The total percentage adds up to 99.99%, which may be due to rounding errors.
It is important to note that the data may not be representative of the entire population and may only reflect the educational attainment of those who participated in the survey.

Work Experienced	**n**	**%**
Industry	10	50
Teaching	10	50
Total:	20	100

The data represents the number and percentage of respondents in a survey, categorized by their work experience.
According to the data: There were a total of 20 respondents in the survey who have work experience.
10 of the respondents had work experience in the industry, which represents 50% of the total respondents with work experience.
10 of the respondents had work experience in teaching, which also represents 50% of the total respondents with work experience.
It is important to note that the data only includes respondents with work experience, and does not provide information on the work experience of the remaining 40 students who have no work experience.

Training and Seminars Attended	**n**	**%**
Related to Technology Innovations	20	33.33
Leadership Training	5	8.33
Tech-Voc focusing in Industrial works and Home Economics	10	16.66
Others	15	25
Total:	60	100

The data represents the number and percentage of respondents in a survey, categorized by the type of training and seminars they have attended.
According to the data:There were a total of 60 respondents in the survey.
20 of the respondents have attended training and seminars related to technology innovations, which represents approximately 33.33% of the total respondents.
5 of the respondents have attended leadership training, which represents approximately 8.33% of the total respondents.
10 of the respondents have attended Tech-Voc training focusing on industrial works and home economics, which represents approximately 16.66% of the total respondents.
15 of the respondents have attended other types of training and seminars, which represents approximately 25% of the total respondents.
It is important to note that the data may not be representative of the entire population and may only reflect the types of training and seminars attended by those who participated in the survey.

Table 3. Procurement

Procurement	Qnty	Price	Amount
Tools	2	P1,500.00	P3,000.00
Equipment	4	P1,500.00	P 6,000.00
Materials	1	P1,500.00	P1,500.00
Transportation	1	P 800.00	P 800.00
Labor Cost	2		P6,780.00
Total:			P 18,080.00

The data represents the procurement expenses of a certain project, including the quantity, unit price, and total amount for each item.
According to the data: There were 2 units of tools procured with a unit price of P1,500.00 each, resulting in a total amount of P3,000.00.
There were 4 units of equipment procured with a unit price of P1,500.00 each, resulting in a total amount of P6,000.00.
There was 1 unit of materials procured with a unit price of P1,500.00, resulting in a total amount of P1,500.00.
There was 1 unit of transportation procured with a unit price of P800.00, resulting in a total amount of P800.00.
There were 2 units of labor cost, with a total cost of P6, 780.00.
The total procurement expenses for the project was P18, 080.00.
It is important to note that the data may not include all the procurement expenses for the project and may only reflect the items listed in the table.

Table 4. Effectiveness

Effectiveness	**n**	**%**
Improved quality of wood lamination.	60	100
Increased efficiency of wood lamination.	60	100
Enhanced teaching and learning experience.	60	100
Potential for new designs and applications.	60	100
Interpretation:	VHE	

The data in Table 4 shows that all respondents (100%) reported that the innovated wood lamination method using a hydraulic "A" metal structure was effective in improving the quality of wood lamination, increasing efficiency, enhancing teaching and learning experience, and offering potential for new designs and applications.

These high effectiveness ratings suggest that the innovated wood lamination method has the potential to be widely adopted and diffused in the technology and woodworking industries. The use of this method can lead to improved products, faster and more efficient production processes, enhanced learning experiences for students, and new possibilities for design and application.

The very high effectiveness ratings may also suggest that the innovated wood lamination method is perceived as a valuable innovation in the field. This could lead to increased investment and research into the development of the method, as well as increased adoption and diffusion among woodworkers and technology educators.

Overall, the data suggests that the innovated wood lamination method using a hydraulic "A" metal structure has strong potential for technology diffusion and adoption in the woodworking and technology industries, based on its perceived effectiveness in improving quality, efficiency, and teaching and learning experiences, and its potential for new designs and applications.

Table 5. Acceptability

Acceptability	**n**	**%**
Perceived effectiveness	60	100
Potential for new designs and applications	60	100
Credibility	60	100
Practical utility	60	100
Relevance	60	100
Interpretation:	VHA	

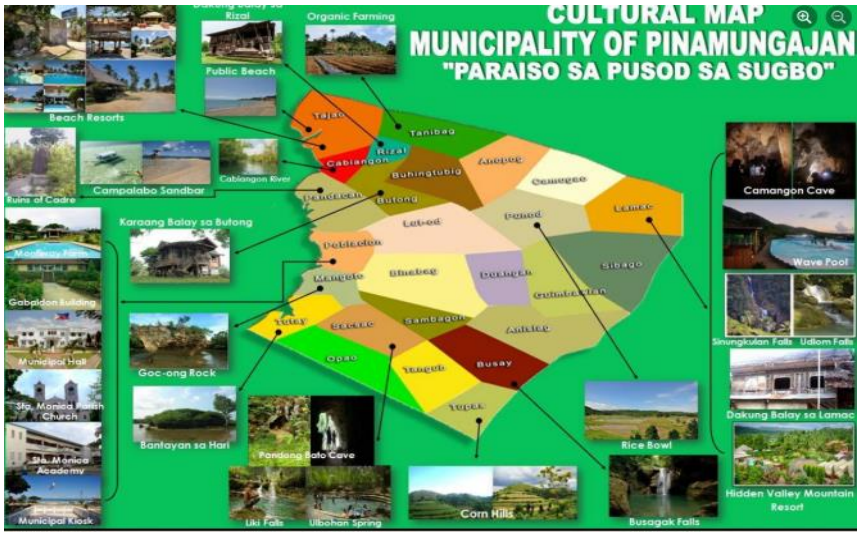
The high level of acceptability across all attributes in Table 5 suggests that the "A" metal structure for wood lamination has strong potential for technology diffusion and adoption in the woodworking and technology industries. The technology's perceived effectiveness in improving quality, efficiency, and teaching experiences suggests its potential to become a widely used and popular tool in various industries.

The potential for new designs and applications is another important attribute that further strengthens the case for the diffusion and adoption of the technology. With the potential to create new designs and applications, the "A" metal structure has the potential to revolutionize the woodworking and technology industries by providing new and innovative ways to create laminated wood products.

The high acceptability ratings for credibility, practical utility, and relevance also indicate that the "A" metal structure is a promising technology for the woodworking and technology industries. The technology is seen as credible, practical, and relevant, which are important factors in the successful adoption and diffusion of new technologies.

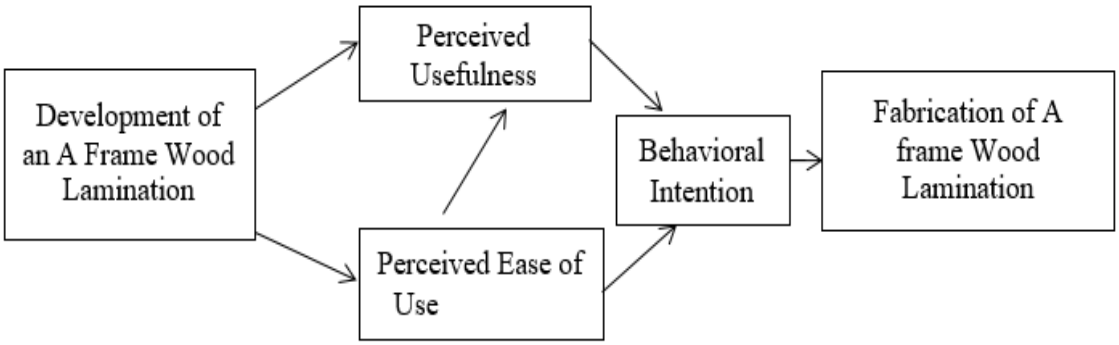
Overall, the data in Table 5 suggest that the "A" metal structure for wood lamination has strong potential for technology innovations and adoption in the woodworking and technology industries. Its high acceptability ratings across all attributes indicate that it has the potential to become a widely used and popular technology, potentially revolutionizing the way laminated wood products are created and designed.

Figure 1. Location Map of the Research Venue



Map of the Municipality of Pinamungajan https://www.facebook.com/1510197815860848/photos/cultural-map-of-the-municipality-of-pinamungajanang-paraiso-sa-pusod-sa-sugbo/1856143547932938/?paipv=0&eav=AfYkNwE1Notb3VrGRPTLivnGr5d9pl_J9XZf5TaCoa57liGMfflMp-ShIpI0UiyWXLk&_rdr

Figure 2. Framework of the study



Technology adoption frameworks are models that explain the process of how new technologies are adopted and diffused within a given population or society. These frameworks provide a structured approach to understanding the factors that influence the adoption of a technology, as well as the stages involved in its diffusion.

One of the most widely used technology adoption frameworks is the Technology Acceptance Model (TAM), which was first proposed by Fred Davis in 1989. The TAM suggests that the adoption of a technology is primarily driven by two factors: perceived usefulness and perceived ease of use. According to this model, individuals are more likely to adopt a technology if they perceive it to be useful and easy to use.

Another popular technology adoption framework is the Diffusion of Innovations (DOI) theory, which was first proposed by Everett Rogers in 1962. The DOI theory identifies five stages of the adoption process: awareness, interest, evaluation, trial, and adoption. According to this framework, the adoption of a technology is influenced by several factors, including the characteristics of the innovation itself, the communication channels used to promote it, and the social system in which it is being diffused.

Other technology adoption frameworks include the Unified Theory of Acceptance and Use of Technology (UTAUT), the Technology-Organization-Environment (TOE) framework, and the Innovation-Decision Process (IDP) model. These frameworks all offer different perspectives on the factors that influence technology adoption and diffusion, and they can be used to inform the development of strategies for promoting the adoption of new technologies in different contexts.

Figure 3. Fabrication

A-Frame Wood Lamination

Figure 4. Finished output

A Frame Wood Lamination for Instruction

Ethical considerations:

Several ethical considerations need to be considered when conducting the study on "Technological Innovation of Wood Lamination: A Hydraulic 'A' Metal Frame Structure."

Firstly, the safety of the participants involved in the study should be a top priority. The hydraulic "A" metal frame structure should be identified and risks minimized through appropriate measures. This includes providing safety equipment and ensuring that participants receive proper training before using the equipment.

Secondly, informed consent should be obtained from all participants in the study. This means that they should be fully informed about the purpose of the study, what their involvement will entail, and any potential risks associated with participation. Participants should also be allowed to withdraw from the study if they feel uncomfortable or experience adverse effects.

Thirdly, the confidentiality and privacy of the participants should be protected. This includes ensuring that any personal information collected during the study is kept confidential and only used for the study. Participants are assured that their data will be anonymized and that their identity will not be disclosed in any publications or presentations.

Lastly, any potential conflicts of interest should be identified and disclosed. This includes any financial or personal relationships that may influence the study's outcome. Transparency in the research process is essential to ensure unbiased and trustworthy results.

Overall, ethical considerations are critical to ensure that the study is conducted in a safe, fair, and responsible manner and that the rights and welfare of the participants are protected.

Findings

The data provided in the tables show the results of a survey conducted among a group of respondents. Table 1 shows that out of 65 respondents, 66.66% were first-year BIT-IDT students, 16.66% were MAVED students, and 16.66% were instructors. Table 2 presents the respondents' age group, with 58.33% of the respondents being between 20-29 years old, and 33.33% being 28 years old and below. The gender distribution in the survey indicates that 58.33% of the respondents identified as female, and 41.66% identified as male. Moreover, the educational attainment of the respondents shows that 66.66% of the respondents had a high school education, and 33.33% had a bachelor's degree. Lastly, Table 4 shows that 50% of the respondents with work experience had industry-related work

experience, while the other 50% had teaching experience. Additionally, approximately 33.33% of the respondents attended training and seminars related to technology innovations. It is important to note that the data may not represent the entire population and may only reflect the views or opinions of those who participated in the survey.

Conclusion

According to the survey results, most respondents were first-year BIT-IDT students. The age group of the respondents was mainly between 20-29 years old, with a significant portion of the respondents having a high school education. Additionally, the gender distribution was skewed towards females. It was also found that half of the respondents with work experience had industry-related work experience, while the other half had teaching experience. Finally, about one-third of the respondents attended training and seminars related to technology innovations. It is essential to note that the data may not be representative of the entire population and only reflects the opinions of those who participated in the survey.

Recommendations

Collecting more data from a more diverse group of respondents is critical to guarantee that the findings apply to a more significant community. Moreover, future studies could investigate the reasons behind the gender imbalance in the respondents and explore ways to encourage more male participation. The data on the respondents' educational attainment also raises questions about access to higher education and how it affects participation in technology-related fields. Overall, the survey gives valuable insights into the characteristics and experiences of a specific group of respondents; nevertheless, more study is required to draw broader conclusions and establish effective tactics for encouraging technological breakthroughs.

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