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Development and Acceptability of Galvanized Iron (G.I.) Pipe Bender

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Abstract— This study aimed to design and develop a Galvanized Iron (G.I.) Pipe Bender that can accommodate three pipe sizes, namely, ½ inch, ¾ inch, and 1 inch, within a single setup. The developmental-descriptive research method was employed. There were 30 purposively chosen respondents, comprising of five fabricators, five teachers, and 20 students from the Technical-Vocational Livelihood (TVL) Shielded Metal Arc Welding program at Tabaco National High School. The acceptability of the pipe bender was evaluated across four criteria, which are functionality, durability, portability, and cost. This indicates the respondents' general agreement on the effectiveness and practicality of the developed tool.

Keywords— Galvanized Iron, Pipe bender, pipe sizes

INTRODUCTION

In an Industry 4.0 environment, where change is the only constant, workers must be able to move across industries and occupations, along career paths that may be nonlinear. In that regard, all levels of the education and skills supply system need to work in tandem to ensure that flexible pathways exist between different levels of formal education and for the recognition and development of skills acquired outside formal education (Asian Development Bank, 2021). One emerging trend in this context is the development and utilization of teacher-developed tools that provide a platform for in-depth exploration by the researcher.

The demand for proficient pipe-bending skills extends far beyond national borders, forming a critical competency in the global welding and fabrication industry. From large-scale infrastructure projects and energy pipelines to advanced manufacturing and shipbuilding, industries worldwide rely on skilled tradespeople capable of precise pipe manipulation. Students graduating without adequate hands-on experience in pipe-bending face significant hurdles in a globally competitive job market, limiting their opportunities for international employment and advanced training.

In the Philippine context, the welding industry faces unique challenges and opportunities. According to the 2012 Philippine Metalworking Industry Profiling Study conducted by the Department of Science and Technology - Metals Industry Research and Development Center (DOST-MIRDC), inadequate access to raw materials and welding supplies remains a prevalent issue. Commonly used equipment, such as Shielded Metal Arc Welding (SMAW) and Oxy-acetylene Welding (OAW) machines, are reported to be predominantly brand new, though their origins (imported or local) are often unspecified. The International Covenant on Economic, Social and Cultural Rights, Article 13 (2023) recognizes the right of everyone to education, including that secondary education in its different forms, including technical and vocational secondary education, shall be made generally available and accessible to all by every appropriate means. This implies the need for relevant resources and tools to make this education effective and meaningful.

Meanwhile, The field of Technical and Vocational Livelihood (TVL) education stands as a cornerstone for preparing individuals in specialized areas like Shielded Metal Arc Welding (SMAW). This educational landscape has witnessed a notable shift towards prioritizing practical skills and hands-on learning experiences, particularly within the Technical-Vocational-Livelihood domain. The ever-changing educational landscape in the Philippines has brought dynamic innovations in teaching and learning. These changes kept teachers on their toes to embrace these changes to remain relevant in the 5th Industrial Revolution (Gepilla, 2020). Furthermore, the fourth Sustainable Development Goal (SDG) on quality education specifically aims to increase the number of youth and adults who have relevant skills for employment, decent jobs, and entrepreneurship (Mundy and Manion, 2023).

Moreover, the field of welding continues to thrive as technological advancements and industry demand drive innovation in tools and techniques globally. The growing adoption of modern welding technologies, such as laser welding, hybrid welding (e.g., laser-MIG/MAG hybrid), and advanced techniques like powder plasma and cold-arc technology highlight the industry's dynamic evolution (Kah, 2018). These innovations reflect the increasing demand for efficiency, precision, and versatility in welding applications across industries, including construction, automotive, and manufacturing. Likewise, the use of advanced materials such as high-strength low-alloy steels, and new high-alloy high-temperature steels underscore the need for tools and equipment that can adapt to these material advancements. As international welding equipment sales continue to rise, the sector's significance in global economic and industrial growth is evident.

Within the realm of TVL education in the Philippines, the emphasis on practical skills and hands-on learning aligns with the growing demand for skilled welders in the job market. As TVL programs aim to prepare individuals for specialized trades, the development of teacher-created tools such as the Galvanized Iron (G.I.) Pipe Bender emerges as a promising innovation. This tool addresses the specific needs of SMAW practitioners, providing a versatile solution for bending G.I. pipes in multiple sizes (½", ¾", and 1" diameters). Beyond functionality, the tool symbolizes the creativity and problem-solving capabilities of educators and welders, which highlight the transformative potential of teacher-developed innovations in vocational education.

At Tabaco National High School, students in the TVL-SMAW strand lack a crucial skill in pipe bending. This is due to the absence of a G.I. pipe bender, a tool essential for developing this competency. The school's limited Maintenance and Other Operating Expenses (MOOE) funding has prevented its purchase. Recognizing this gap, this research aims to develop an innovative solution.

Current pipe-bending machines are often too costly and unavailable in public schools, leaving students with limited opportunities to gain practical experience in fabrication. By designing and creating an accessible G.I. pipe bender, we can provide students with the hands-on practice needed to master pipe-bending techniques. This will allow for a more comprehensive teaching and learning process, integrating both theory and practical application, ultimately benefiting TVL-SMAW students at Tabaco National High School.

OBJECTIVES

This study aimed to develop a Galvanized Iron (G.I.) Pipe Bender and determine its acceptability for SMAW students of Tabacco National High School, Division of Tabacco City for School Year 2023 – 2024.

Specifically, this study sought to answer the following.

1. What are the processes involved in the development of the pipe bender?
2. What are the distinctive features of the developed pipe bender along:
   a. Functionality;
   b. Durability;
   c. Portability, and,
   d. Cost?
3. What is the level of acceptability of the developed pipe bender as evaluated by the teachers, students, and fabricators along the identified variables?
4. What G.I. Pipe Bender User's Guide may be developed?

METHODOLOGY

This study focuses on the development and evaluation of the Galvanized Iron Pipe Bender. The study employed a descriptive-developmental research design, utilizing a quantitative approach to determine the acceptability of the developed product, including functionality, durability, portability, and cost.

The respondents were purposively selected from students and teachers at Tabaco National High School and fabricators at the City of Tabaco. A survey questionnaire was used to evaluate the developed product. The gathered data was statistically treated using the weighted mean.

RESULT AND DISCUSSION

Based from the data gathered, the following findings were revealed:

1. The development process of a G.I. (Galvanized Iron) Pipe Bender involves three iterative stages under the ADDIE Model. It begins with design, where a needs assessment is conducted to identify the inadequacies of tools needed by welders and TVL-SMAW students. Following this, the conceptualization and planning stage involves brainstorming design ideas, creating sketches, and planning the project timeline and resources. The next sub-step is material selection and costing,

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where appropriate materials for constructing the pipe bender are chosen, along with the initial cost that includes labor costs. Also, the identification of the tools and equipment needed in the development of the G.I. Pipe Bender. The second procedure is development, a prototype fabrication, where a working model is built based on the conceptual design. The third process is testing. The prototype is then subjected to testing and evaluation to assess its performance, including the accuracy of bends and ease of use. Based on the testing results, modifications and refinements are made to improve the design and efficiency.

2. The key features of G.I. Pipe Bender are shown in its functionality, durability, portability, and cost-effectiveness. Its functionality is evident in its ability to perform precise pipe-bending tasks efficiently, making it an essential tool for various applications. The durability of the G.I. Pipe Bender is ensured by its high-quality materials and robust construction, allowing it to withstand heavy use and demanding conditions. While it is not the most portable tool due to its sturdy build, its manual operation eliminates the need for power sources, adding a degree of flexibility in its use across different settings. Finally, the cost of the G.I. Pipe Bender is highly competitive, offering excellent value for money
3. The developed G.I. Pipe Bender was evaluated by teachers, students, and fabricators based on its functionality, durability, portability, and cost to determine its level of acceptability.

    a. The functionality of the pipe bender was highly rated, which has an average weighted mean (AWM) of 4.49, categorized as Acceptable (A). This reflects the tool's ability to perform its intended tasks efficiently and consistently, meeting user expectations in precision, accuracy, and ease of use.
    b. Durability of the product is rated with an AWM of 4.36, described as Acceptable (A). The use of high-strength materials and protective coatings ensures the pipe bender's capacity to withstand rigorous use and exposure to environmental factors.
    c. The portability of the pipe bender, scored slightly lower than the other three variables, gathered an AWM of 4.12, described as Acceptable (A). Fabricators rated this aspect higher than teachers and students. This highlights the need for improvements in making the tool more user-friendly for less experienced individuals or those who require greater convenience during transport and storage.
    d. The cost of the pipe bender was described as Acceptable with a 4.28 average weighted mean. The intended users recognized its affordability and operational cost-efficiency, particularly fabricators and teachers. However, students provided a slightly lower score, suggesting that the perceived value of the tool could vary depending on user experience and financial perspectives.

4. A user's guide is crafted to help, assist, and guide the user of the product. As per the user's guide, the pipe bender is a manual tool designed to bend pipes to various angles using a handle or lever. It consists of key components such as the Roller or Pressure Die, Frame, Handle, and Bending Die. To use it, place the pipe between the Roller and Bending Die, then apply steady pressure with the handle to achieve the desired bend. Ensure safety by wearing protective gear and keeping the bender on a stable surface. Regular maintenance, including checking for wear and lubricating parts, will ensure smooth operation and longevity.

Based from the findings, the following CONCLUSIONS are drawn:

1. The processes involved in the development of the pipe bender includes design, development, and testing.
2. The key features of G.I. Pipe Bender are embedded in its functionality, durability, portability, and cost-effectiveness.
3. The developed G.I. Pipe Bender is acceptable in terms of functionality, durability, portability, and cost as evaluated by teachers, students, and fabricators.
4. The G.I. Pipe Bender comes with a user guide for beginner users, particularly students. The user guide shows instructions for use as well as components, dimensions, safety tips, and maintenance.

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RECOMMENDATIONS

In view of the conclusion drawn of this study, the following are recommended:

1. Further improvements may be made to refine the developed Galvanized Iron (G.I.) Pipe Bender, particularly in accessibility for less experienced users, weight, and portability, as well as affordability.
2. The developed Galvanized Iron (G.I.) Pipe Bender may be utilized in teaching and learning activities of the Technical and Vocational Livelihood strand, specializing in Shielded Metal Arc Welding.
3. The developed Galvanized Iron (G.I.) Pipe Bender may be further evaluated for its acceptability by a different group of experts, such as shop owners from nearby provinces in the region.
4. The user guide should serve as a practical tool for operating and applying the G. I. Pipe Bender. To maximize its value, explore how distinct user groups-segmented by experience level-engage with and benefit from the guide. Conduct further research to understand how beginners, intermediate users, and experts adapt to utilize its instructions effectively.
5. Future studies may explore the potential impact of satisfaction and overall product adoption from the users.

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