

DEVELOPMENT AND ACCEPTABILITY EVALUATION OF MULTI-PURPOSE HAND TOOL

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Abstract

A multi-purpose hand tool, a versatile and innovative instrument designed to streamline a wide array of woodworking and metalworking tasks. The study aimed to develop, fabricate, test, and evaluate a multi-purpose hand tool in terms of its technical features. It also sought to assess the tool's acceptability based on design, efficiency, effectiveness, functionality, and features. The study employed the developmental-descriptive research method, using a researcher-made instrument administered to 16 respondents from the woodworking and metalworking industries. The instrument was designed to evaluate the hand tool's acceptability concerning design, efficiency, effectiveness, functionality, and features. The study's results revealed that the multi-purpose hand tool successfully manifested its technical features, including ease of assembly and disassembly, interchangeable attachments, and multi-functionality, as it meticulously adhered to its planned design, workflow, and fabrication process. Test trials demonstrated that the hand tool could be assembled and disassembled in a minute or less, enabling it to perform a variety of wood and metal tasks. Furthermore, the study indicated that the hand tool achieved very high acceptability ratings across the identified parameters. It is recommended to explore alternative materials for constructing future versions of the hand tool and to consider providing additional attachments tailored to other trades and safety features to further enhance the project.

Keywords: Multi-Purpose Hand Tool, Acceptability Evaluation, Developmental-Descriptive Research Method and Interchangeable Attachments.

Introduction

The creation of hand tools comes into existence because of its formidable function in making man's work easier and faster. Tracing history these hand tools undergo a number of modifications depending on the need and challenges of time. It is inevitable that over the course of history these hand tools are also undergoing drastic advancement in terms of functionalities and performance. These hand tools were not spared to adapt these changes that aside from its basic functionalities these hand tools should also be responsive and resilient to the growing demands of various shops and industries.

Berger (2015) made mentioned that in this golden age of electric-powered machinery, knowing the basics of handsaws, planes, chisels, measuring and marking tools is an essential skill set that can add quality and personality to project. Furthermore, Buckley (2014) emphasized that hand tools are the key to understanding humanity. As a society develops and progress so does with the development of hand tools and equipment to further elevate both workmanship and concept of various products.

Workers are wholly dependent on these tools as being used in performing their various projects. Today, hand tools are available in more types than ever before. There are also countless models, variants and features to choose from. These ranges from manufacturer-patented designs to performance-enhancing treatments and variants specialised for highly specific purposes. It is evident that hand tools will continually to evolve and make a lot of modifications to not only perform its conventional rules ranging from measuring, cutting and testing various materials but also set new rules that deviates from how these tools are being used before. Overtime, hybrid or multi-functional hand tools gradually gaining grounds as the new standard for modern craftsmen's partner.

A single tool basically performs a single specific job and to finish projects entailing more processes demands one to bring along more tools. This condition adds-up to the burden by having to carry a range of hand tools. Likewise, conventional tools will occupy a lot of space in the tool box or cabinet

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and buying the complete set of tools is costly.

It is in this premise that the study was conducted to develop a single tool that can perform multiple works or functionalities as a potential remedy or answer effectively and efficiently the dilemma on bringing lots of hand tools and spending on acquiring variety of tools. With multi-purpose hand tool's unique feature of body and detachable attachments, one will accomplish the task with ease and comfort.

Objectives of the Study

The main objective of the study is to fabricate a multi-purpose hand tool. Specifically, the study aims to:

1. design and fabricate a prototype multi-purpose hand tool with the following technical features:
 - a. easy to assemble and disassemble
 - b. interchangeable attachments
 - c. multi-functional
2. test the performance of the multi-purpose hand tool in terms of:
 - a. assemble and disassembly rate
 - b. weight comparison of developed tool to standard tools
3. determine the acceptability of the multi-purpose hand tool in the aspects of:
 - a. design
 - b. efficiency
 - c. effectiveness
 - d. functionality and
 - e. features
4. develop a user's manual.

Framework of the Study

The development of the multi-purpose massage table was based on design thinking and Input, Process, and Output (IPO) models.

According to Brown (2008), design thinking is a problem-solving approach that emphasizes empathy, creativity, and collaboration to generate innovative solutions. Furthermore, it is a discipline that uses the designer's sensibility and methods to match people's needs with what is technologically feasible and what a viable business strategy can convert into customer value and a market opportunity. The steps of design thinking may vary depending on the source but typically include the following: Empathy, which involves understanding the users' needs and pain points through observation and interaction; Define, which means defining the problem or challenge based on the insights gathered in the empathy stage; Ideate, which centers on

generating a range of potential solutions through brainstorming and other ideation techniques; Prototype, which involves building a tangible representation of the best ideas to test and refine the solution; Test, which includes testing the prototype with users to gather feedback and refine the solution iteratively. On the other hand, the Input-Process-Output (IPO) model, according to Walley (2017), is a simple yet effective framework used to describe and understand various processes or systems. It is a fundamental concept in the fields of systems analysis, management, and engineering. The IPO model helps break down a process into three main components. The input is the data, information, or resources that are fed into a system or process, representing the starting point of the process. The process refers to the activities, operations, or transformations that occur when the inputs are acted upon. This is the heart of the system or process and involves the steps, functions, or procedures that manipulate, analyze, or transform the inputs into something meaningful or valuable. The output is the result or outcome of the process, representing the product, information, or services that are generated as a result of processing the inputs.

The design and development of the multi-purpose hand tool followed a structured process that integrated design thinking and IPO models. In the input phase, the team empathized with users and conducted a prior art search. The process phase encompassed defining the problem, ideation, prototyping, testing, and iterative refinement. The final output included a multi-purpose hand tool and a user's manual, ensuring the tool effectively addressed user needs and was ready for practical use, as shown in Figure 1.

The test performance of the hand tool in terms of assemble and disassembly rate was done by assembling and disassembling claw hammer, ball peen hammer, sledge and axe in three occasions using a timer. While the dimension comparison of developed tool to standard tools is done by comparing the weight and measurement of both categories of tools.

The respondents of the study were from eight identified industries along woodworking and metalworking industries. These eight industries are comprised of four woodworking industries and four metal industries. Wherein two personnel from each industry was identified. Thus, a total of sixteen (16) personnel as final respondents are utilized for the study.

The mean and standard deviation were used as statistical tools to evaluate performance testing and acceptability of the hand tool.

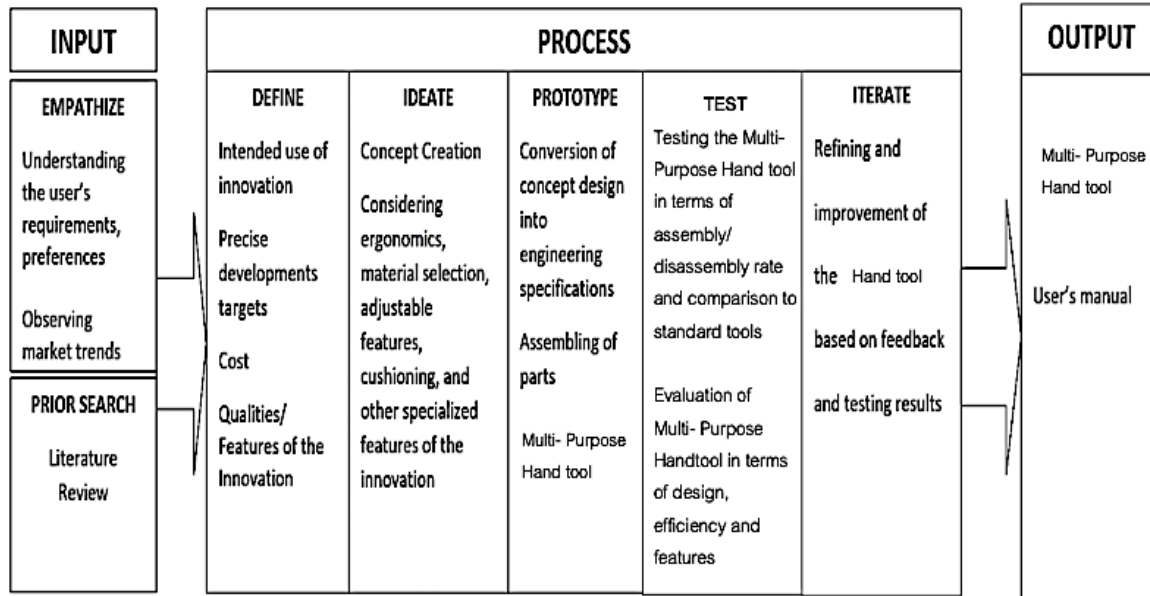


Figure 1: Schematic Diagram Illustrating the Conceptual Framework of the Study

Methodology

The study employs both developmental and descriptive research methods. The developmental research component involved the development, fabrication, testing, and evaluation of the hand tool, while the descriptive research component focused on assessing the acceptability of the hand tool using a researcher-made instrument.

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Design and Fabrication of the Multi-Purpose Hand Tool

The project consists of two major parts, the body and six attachments. The design of the multi-purpose hand tool is made up of a body which has an easy-to-grip handle and an ending threaded part which connects the various attachments by threading. Figure 2, shows the design with specifications of the multi-purpose hand tool.

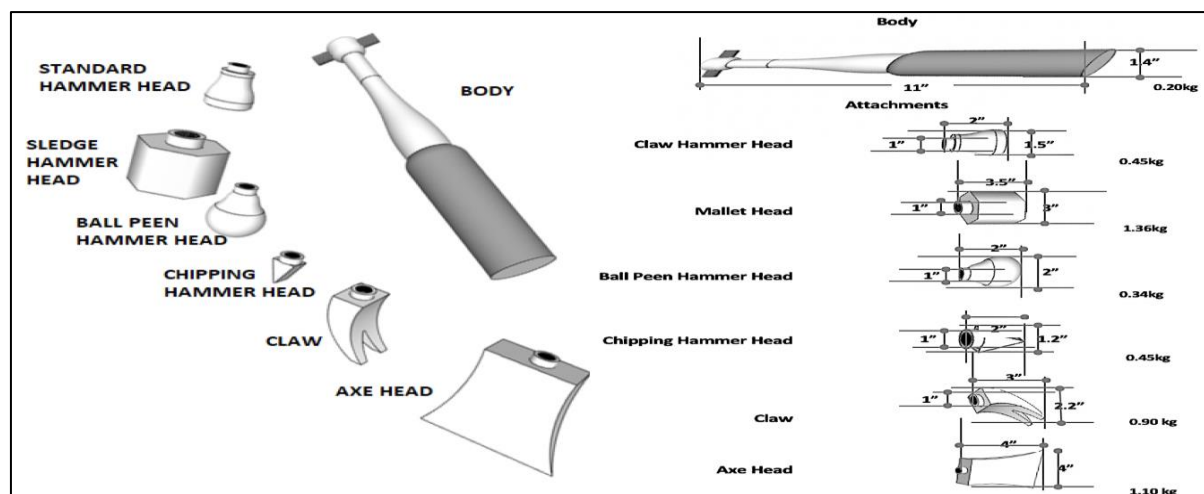


Figure 2: Design and Dimension of Multi-Purpose Hand Tool

As depicted in Figure 2, the design and dimensions of the multi-purpose hand tool were meticulously planned and engineered. This versatile hand tool comprises a well-crafted handle that serves as the core element. The handle is ingeniously designed to accommodate a variety of attachments, including a sledgehammer head, a ball-peen hammer head, a chipping hammer head, a claw, and an axe head. The attachment process is made possible through a precisely engineered threading mechanism, ensuring that each attachment is securely fastened in place. Both the handle and the attachments underwent a comprehensive design phase, adhering closely to the specifications of established hand

tools. Weight and length considerations played a pivotal role in the design process, with a focus on ensuring that the multi-purpose hand tool was in alignment with the industry standards. This meticulous design approach aimed to strike a balance between durability and user-friendliness, ultimately resulting in a tool that not only met the demands of various woodworking and metalworking tasks but also ensured the user's comfort and safety. These specifications were a fundamental aspect of the development process, providing a foundation for the tool's functionality and effectiveness.

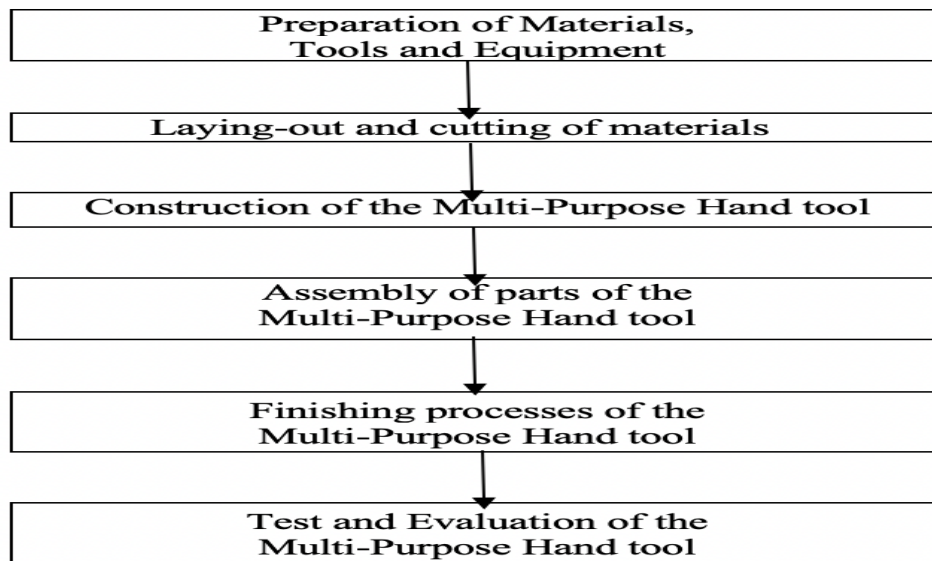


Figure 3: Workflow of the Multi-Purpose Hand Tool

Result and Discussion

Design and Fabrication of the Multi-Purpose Hand Tool

The first objective of the study is to design and fabricate a multi-purpose hand tool with the following technical features easy to assemble and disassemble, interchangeable attachments and multi-functional.

a. Easy to assemble and disassemble

One of the features of the multi-purpose hand tool, as elucidated in Figure 4, resides in its inherent capacity for facile assembly and disassembly, thereby endowing users with a seamless and efficient operational modality.



Figure 4: The Handle and Attachments of The Multi-Purpose Hand Tool with Threading

Figure 4 shows the handle and attachments of the Multi-Purpose Hand Tool, featuring threading that allows easy assembly and disassembly for versatile task performance, enhancing both efficiency and user safety. This adaptability streamlines carpentry and metalwork tasks, eliminating the need to carry an array of tools, thus simplifying workflow and lightening the physical burden on users. Moreover, the tool's portability and space-saving design make it ideal for professionals and homeowners alike, reducing clutter and enhancing convenience. In essence, the threading connection and interchangeable design of the Multi-Purpose Hand

Tool offer an innovative and invaluable solution across a broad spectrum of applications, simplifying tasks, optimizing efficiency, and improving user convenience.

b. Interchangeable attachments

An additional salient attribute inherent to the Multi-Purpose Hand Tool resides in its inherent capacity for transformation, thereby affording its users the flexibility to assume distinct tool archetypes, tailored to the specific exigencies of diverse tasks and applications.

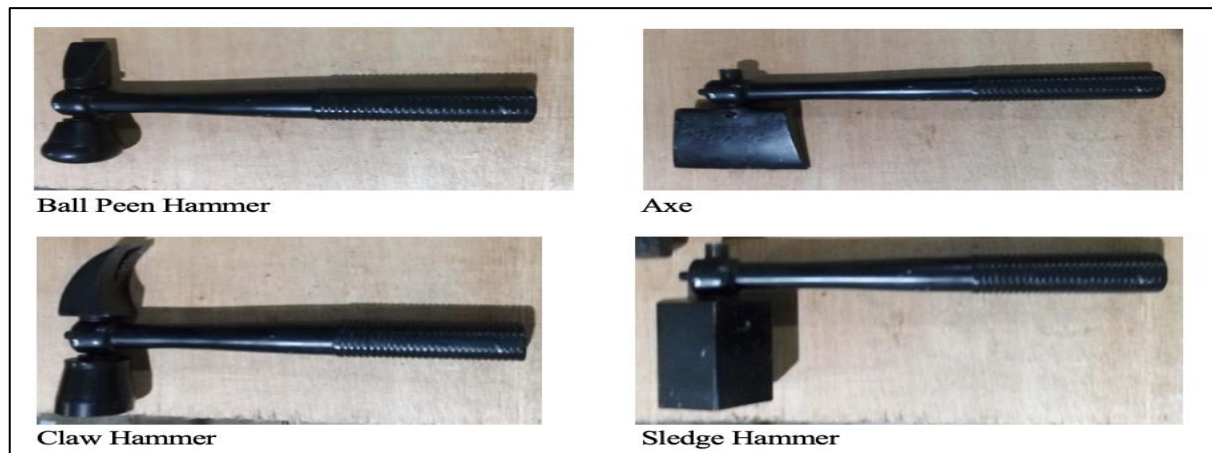


Figure 5: The Multi-Purpose Hand Tool with Attachments

In Figure 5, shows various tool forms, including a ball-peen hammer, an axe, a claw hammer, and a sledge hammer. The versatility of this hand tool, allowing it to seamlessly transition between these forms, is made possible through its threading connection and secure locking mechanisms. This capability not only simplifies the tool's adaptability but also underscores its suitability for fundamental woodworking and metalworking tasks. Moreover, the inclusion of a locking mechanism adds an extra

layer of security, ensuring the stable attachment of various tool components.

c. Multi-functional

The hand tool is design to perform multiple functionalities by changing its attachment with its threading that ensures a secured connections. The various functionalities of the hand tools are shown in Figure 6.



Figure 6: The Hand Tool As Sledge Hammer, Axe, Chipping Hammer and Ball Peen Hammer

Chipping Hammer and Ball Peen Hammer. The various functionalities of the hand tool is made possible because of the threading mechanism of each attachment. This implies that these various functionalities are made feasible due to the presence of a threading mechanism in each attachment. This threading mechanism allows for the secure attachment and interchangeability of different tool heads, enhancing the versatility and adaptability of the hand tool for a range of tasks and applications in carpentry, metalwork, or other related activities.

Performance Test of the Multi-Purpose Hand Tool

The second objective of the study is to conduct a performance test of the multi-purpose hand tool in terms of assemble and disassembly rate and dimension comparison of developed tool to standard tools.

a. Assemble and disassembly rate

The assemble and disassembly rate of a multi-purpose hand tool with various tool heads refers to the speed and ease with which users can attach and detach different tool components.

Table 1: Assemble and Disassembly Rate of Multi-Purpose Hand Tool

Multi-Purpose Hand Tool	Test Trials (in minutes)			Mean Score (in minutes)
	First Trial	Second Trial	Third Trial	
Sledge Hammer Assembly	1.23	1.15	1.09	1.16
Axe Assembly	0.47	0.56	0.48	0.50
Chipping Hammer Assembly	0.35	0.34	0.32	0.34
Ball Peen Hammer Assembly	0.41	0.42	0.40	0.41
Sledge Hammer Disassembly	1.19	1.10	1.08	1.12
Axe Disassembly	0.48	0.27	0.48	0.41
Chipping Hammer Disassembly	0.35	0.32	0.33	0.33
Ball Peen Hammer Disassembly	0.40	0.42	0.39	0.40

Table 1 illustrates the assembly and disassembly rates of the hand tool as tested in three trials. Notably, the sledge hammer exhibits a mean assembly time of 1.16 minutes, followed by the axe at 0.50 minutes, the chipping hammer at 0.34 minutes, and the ball peen hammer at 0.41 minutes. In terms of disassembly rates, the sledge hammer yields a mean score of 1.12 minutes, which notably represents the lengthiest disassembly time compared to other attachments. Conversely, the axe and ball peen hammer are observed with mean scores of 0.41 and 0.40 minutes, respectively. The chipping hammer boasts the lowest mean score of 0.33

minutes for disassembly, signifying the least amount of time required. This analysis suggests that the multi-purpose hand tool can be assembled and disassembled within a minute, affording users more time for the execution of related tasks.

b. Weight comparison of developed tool to standard hand tools

The weight comparison between a multipurpose hand tool and a standard hand tool is a crucial factor in research as it directly impacts user fatigue and efficiency, influencing the tool's overall usability and practicality.

Table 2: Multi-Purpose Hand tool and Standard Hand Tools Weight Comparison

Aspects	Standard Hand Tool	Multi-Purpose Hand Tool	Variance
Sledge Hammer	16 pounds	17.2 pounds	1.2 pounds
Axe	3 pounds	3.2 pounds	0.2 pounds
Chipping Hammer	4 pounds	4.5 pounds	0.5 pounds
Ball Peen Hammer	2 pounds	2.2 pounds	0.28 pounds

As indicated in Table 2, the weight comparison between the developed multipurpose hand tools and their respective standard counterparts is noteworthy. Specifically, the standard sledge hammer registers a weight of 16 pounds, while the developed sledge hammer weighs 17.2 pounds, resulting in a variance of 1.2 pounds, signifying the increased heft of the developed sledge hammer in comparison to the

standard model. Likewise, the standard axe tips the scales at 3 pounds, whereas the developed axe commands a weight of 3.2 pounds, rendering it heavier than its conventional counterpart. Similarly, the standard chipping hammer boasts a weight of 4 pounds, while the developed chipping hammer registers a weight of 4.5 pounds, clearly positioning the latter as the heavier alternative. In addition, the

standard ball peen hammer bears a weight of 2 pounds, while the developed ball peen hammer is notably heavier at 2.28 pounds, resulting in a variance of 0.28 pounds. These findings underscore that the developed multipurpose hand tools, including the sledge hammer, axe, chipping hammer, and ball peen hammer, exhibit a weight advantage over their standard counterparts,

enhancing their users' capability to deliver impactful force when employing these tools.

Acceptability Evaluation of the Multi-Purpose Hand Tool

The third objective of the study was to determine the acceptability of the multi-purpose hand tool in the aspects of design, efficiency and features.

Table 3: Summary of Mean Scores on Acceptability Evaluation of the Multi-Purpose Hand Tool

Item	Mean	SD	Interpretation
Design	4.23	0.413	Very Highly Acceptable
Efficiency	4.28	0.364	Very Highly Acceptable
Effectiveness	4.30	0.292	Very Highly Acceptable
Functionality	4.33	0.285	Very Highly Acceptable
Features	4.36	0.365	Very Highly Acceptable
Total	4.30		Very Highly Acceptable

In Table 3, you can see the results of the acceptability evaluation of the multi-purpose hand tool, as rated by 16 respondents in the wood and metal industries. All items in the acceptability evaluation of the hand tool received very high ratings. Among these items, 'features' received the highest mean score of 4.36, indicating it was interpreted as very highly acceptable, while 'design' received the lowest mean score of 4.23, also interpreted as very highly acceptable. The findings reveal that respondents highly appreciate the features of the multi-purpose hand tool due to its innovative design that aligns with their needs, as well as its fine threading and locking mechanism

that simplifies the assembly of the body and attachments. Meanwhile, the lower score for 'design' suggests that there may be room for improvement in the proportion of the body and parts of the multi-purpose hand tool.

The User's Manual of the Multi-Purpose Hand Tool

The fourth objective of the study focused on the creation of a comprehensive user manual for the Multi-Purpose Hand Tool. This manual was crafted to provide users with guidance regarding the project's specifications, proper usage, and safety precautions.



Figure 4: Multi-Purpose Hand Tool User's Manual Cover

Findings

The following is a summary of the study's findings:

1. The multi-purpose hand tool successfully met its technical specifications, offering ease of assembly and disassembly, interchangeable attachments, and multifunctionality, largely due to its strict adherence to the planned design specifications and workflow construction procedures.
2. In terms of assembly and disassembly rates, the sledgehammer takes one minute, while the other attachments, namely the claw hammer, chipping hammer, ball peen hammer, and axe, each require less than a minute. When comparing the weight of the developed tool to standard hand tools, the developed sledgehammer exhibits the most significant variance, while the rest exhibit negligible weight differences.
3. The acceptability of the developed multi-purpose hand tool was rated very highly by industry respondents. The 'features' category received the highest mean score, while 'design' received the lowest mean score.
4. A user's manual was developed to provide guidance to the target users on the proper use and care of the hand tool, thereby extending its operational lifespan.

Conclusion

The following are the conclusions of the study:

1. The technical features of the developed hand tool will greatly assist target users in performing various tasks involving wood and metal works. These features will also reduce the need for carrying a variety of hand tools, providing users with greater convenience and comfort.
2. The fast assembly and disassembly rate of the developed hand tool will enable its target users to complete more wood and metal works efficiently. Additionally, due to its close resemblance to standard hand tools, users will find it easy to seamlessly integrate the developed hand tool into their work.
3. The very high acceptability evaluation of the developed hand tool indicates that users appreciate its features, effectiveness, efficiency, and design as an alternative tool for wood and metal work.
4. The user's manual will ensure the proper and safe use of the developed hand tool.

Recommendations

Based on the findings and conclusions of the study, the following recommendations have been formulated:

1. It is recommended that the multi-purpose hand tool be utilized in various wood and metal industries. Given its advantageous features and excellent performance, the multi-purpose hand tool is poised to enhance the productivity and efficiency of its target users.
2. Given the very high acceptability evaluation of the multi-purpose hand tool, wood and metal workers may reconsider incorporating this developed tool into their collection of equipment to aid them in accomplishing their tasks.
3. Future researchers are encouraged to undertake further studies related to the multi-purpose hand tool in wood and metal works. These studies could involve exploring potential materials and devising additional attachments for various trades.

Conflict of Interest

There is no conflict of interest between the authors in this manuscript.

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