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Development and Performance Evaluation of a Car Brake Bleeding Tool to Reduce Labor and Service Time at PT. UMC Suzuki Ahmad Yani Surabaya

Raihan Ramadhani[1], M. Khaniful Annas[1], Yoga Guntur Sampurno[1*]

[1]Department of Mechanical and Automotive Engineering, Faculty of Vocational, Universitas Negeri Yogyakarta, Kulon Progo, Yogyakarta 55652, Indonesia

*Corresponding author: yogaguntur@uny.ac.id

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ABSTRACT

The objectives of this research are: (1) Designing a brake bleeding tool that will be used for the process of bleeding car brakes at the UMC Suzuki Ahmad Yani Surabaya workshop, (2) Knowing the effectiveness of the brake bleeding tool when used at the UMC Suzuki Ahmad Yani Surabaya workshop, (3) Finding out work efficiency after work is carried out using the brake bleeding tool at the UMC Suzuki Ahmad Yani Surabaya workshop. The design of the car brake bleeding tool was developed through analysis, design, development, implementation, and evaluation, resulting in a specialized tool that enhances the mechanic's work at the PT UMC Suzuki Ahmad Yani Surabaya workshop. This tool helps mechanics bleed car brakes, which previously required conventional tools and at least 2-3 additional mechanics. With the developed brake bleeding tool, mechanics only need to work with one person. This tool can also reduce the time required for brake bleeding, which is usually 17 minutes, to just 9 minutes. The development of a brake bleeding tool proved very effective in expediting brake bleeding maintenance at the UMC Suzuki Ahmad Yani Surabaya workshop. With this tool, manual bleeding tools are no longer required, making work more effective without additional labor. This tool produces a time efficiency of 55%. This tool makes the brake bleeding process more accurate and reliable, providing consistent quality assurance and, overall, increasing the productivity and effectiveness of workshop operations.

1. Introduction

The development of light vehicles has increasingly become a complex endeavor, consisting of thousands of components organized into dozens of systems. One system that plays an important role in a vehicle is the braking system [1]. The important role of the braking system is to slow and stop the vehicle and maintain its position when parked on an uneven surface. In addition, [2] states that a car's safety lies in its braking system, specifically that this system can affect driving safety and efficiency. The braking system is a vital component of a vehicle because driving safety depends on its proper functioning. Routine maintenance is necessary to ensure the braking system's quality of operation, including replacing the brake fluid.

Bleeding the brake fluid is an important step in brake system maintenance [3]. This step prevents air from entering and becoming trapped in the brake system. Air trapped in the brake system can make the vehicle's braking function suboptimal. Bleeding is also necessary after changing the brake fluid. Changing the brake fluid involves emptying the used fluid from the master cylinder and all brake lines, then refilling with new fluid [4].

PT United Motors Company was founded in Surabaya in 1952, located at Jalan Jendral Basuki Rakhmat No. 14. Due to regulations regarding the use of the name "Limited Liability Company," PT. United Motors Company changed its name to PT United Motors Centre in

2001. Initially, UMC distributed products from General Motors, Datsun, Chrysler, Simca, and Jeep. In line with the times and, of course, after going through several stages, in 1981, through PT. Indohero, UMC was entrusted to become the Main Dealer of Suzuki for the East Java and South Kalimantan regions, led by Jos Mardanus, with a network of sales, service, and spare parts, both managed by UMC branches and appointed sub-dealers [5].

There are several services offered at UMC Suzuki Ahmad Yani Surabaya, including new car sales, vehicle maintenance, and the sale of original Suzuki spare parts. As for vehicle maintenance, several services are available, including periodic servicing, tune-ups, general repairs, Suzuki home service, and booking service. One vehicle maintenance service available is periodic servicing [6]. Regular maintenance is vehicle maintenance that includes various actions, such as inspections, checks, and replacement of damaged components. Thanks to periodic maintenance, vehicles will continue to work properly and reduce the risk of accidents caused by damage or abnormal operation. One vehicle maintenance service is brake system maintenance. Brake bleeding is included in brake system maintenance, which aims to remove air trapped in the braking system [7].

This brake bleeding tool is an aid that can increase mechanics' efficiency when bleeding brake fluid. This brake bleeding aid is very much needed in the automotive industry and by mechanics because it makes the bleeding process easier. The process of bleeding brake fluid with this manual tool can cause brake fluid spills that can damage the car body if it comes into contact with the brake fluid and can also endanger mechanics if they slip on the spilled brake fluid. The brake bleeding work is carried out by two mechanics: one operates the brake pedal, and the other removes air from the system and adds new brake fluid. This technique is considered inefficient in terms of the number of technicians required and the time needed to complete the brake fluid bleeding process. The inefficient brake fluid bleeding technique can be improved by creating an innovative bleeding tool [8].

The benefits of using this brake bleeding tool include making the bleeding process safer and minimizing costs. This tool can help improve technicians' efficiency when bleeding brake fluid. It helps technicians bleed brake fluid efficiently, safely, and comfortably. If technicians can work safely and efficiently, their productivity will increase [8]. The advantages of this brake bleeding tool are that it is more time- and labor-efficient, as it simplifies the brake fluid bleeding process on cars, allowing it to be done relatively quickly and requiring only one person. The disadvantage of this brake bleeding tool is that the battery used for brake fluid suction power can run out at any time, so it must be recharged before it can be used again [9].

This brake bleeding tool makes the brake bleeding process more time- and labor-efficient, as it can be done by just one mechanic. Because this brake bleeding tool works with an automatic system, which eliminates the need to pump the brake pedal in the car. The mechanic only needs to press the on/off switch, and the bleeding tool will automatically suck the air out of the system. The mechanic can also fill the reservoir with new brake fluid, making the brake bleeding process faster [8, 10].

2. Methodology

This final project, entitled Development of a Car Brake Bleeding Tool to Improve Mechanic Work Efficiency at PT. UMC Suzuki Ahmad Yani Surabaya, uses the Research and Development (R&D) method. Research and development is a research method for developing and testing products that will later be developed in the world of education. One of the development models from R&D is ADDIE, which stands for Analysis, Design, Develop, Implement, and Evaluate. The ADDIE development model can be used to develop media,

teaching materials, learning models, and learning strategies. This model enables the design and development of products in accordance with predetermined plans. In addition to its simple, systematic procedures, the ADDIE model allows repeated revisions and evaluations at each stage to produce valid and practical products [11]. The following is an explanation of how to use the ADDIE method:

2.1 Analysis

The first step in designing this tool is to conduct an analysis. This stage aims to identify development needs to ensure that the resulting product is optimal. In addition, the analysis aims to identify the obstacles mechanics face when performing brake bleeding and to determine the material specifications required to manufacture the bleeding tool.

This stage of the needs analysis is important for identifying the problems mechanics experience. The analysis process was carried out during industrial practice activities at PT. UMC Suzuki Ahmad Yani Surabaya. The manufacture of this brake bleeding tool requires important preparations. The first step was to coordinate with the industry to determine what was needed to manufacture this brake bleeding tool, including the tool's shape, the materials to be used, and the size of the tool to be made.

Table 1. Material and tool requirements

No	Material	Tools
1	12-volt DC pump	Measuring tape/Ruler
2	Battery	Hand Grinder
3	Container	Hand Drill
4	Wood or Board	Cutting Pliers
5	Clear Hose	Scissors
6	Nipple	Phillips Screwdriver
7	Hose clamp	Insulation
8	Switch	Glue G
9	Jumper Cable	Marker
10	Fuse	Varnish
11	Fuse box	Thinner
12	Sekun	Brush
13	Faucet	Sandpaper

2.2 Design

With the completion of process analysis, the next step is to design a brake bleeding tool. This tool is designed using Computer-Aided Design (CAD) technology. This modern approach integrates computational capabilities to produce precise, efficient digital designs. With CAD, the design process becomes more structured and controlled, enabling designers to produce models that are more detailed and accurate than with conventional methods. The tool model is created in three dimensions (3D), allowing for a complete representation of the tool's size, shape, features, and internal structure before entering the production stage. For a smooth design process, several steps must be taken, namely:

a. Creating a rough sketch or initial visual outline.
b. Determine the design dimensions.
c. The design creation process.
d. Design results.

2.3 Development

To ensure the design of this bleeding tool runs smoothly, several structured steps must be followed. These structured steps are intended to ensure that the tool to be implemented has a solid foundation during manufacture. The steps to be taken are as follows:

a. Tool and Material Preparation Stage
b. Material Cutting Stage
c. Plywood Gluing and Joining Stage
d. Box/Cover Hole Drilling Stage
e. Assembly Stage

2.4 Implementation

After the three stages of analysis, design, and development are completed, the next stage is to test the completed tool. At this stage, the researcher prepares the instrument to obtain assessments from the foreman and mechanic. This completed instrument is expected to be useful for foremen, mechanics, and industry. The purpose of testing this tool's performance is to obtain results and ensure it works properly and effectively.

Next, after testing this foreman and mechanical, the assessment is conducted by answering 25 questions. Tool testing consists of effectiveness and efficiency tests to determine the extent to which the brake bleeding tool works effectively and to identify any necessary corrections to the tool.

2.5 Evaluate

After completing the analysis, design, development, and implementation stages, the next step is evaluation. The purpose of this evaluation is to assess the effectiveness and efficiency of the developed tool. In the ADDIE model, the evaluation is formative, aimed at ensuring that the brake bleeding tool functions properly during the development and implementation stages and at obtaining feedback from foremen and mechanics. This feedback will later be used to evaluate and improve the parts of the tool that need improvement. Then, a summative evaluation is conducted after the implementation stage to assess the success of the bleeding tool by collecting data on its performance, conducting user satisfaction surveys, and comparing working time before and after using the bleeding tool. Thus, using these two types of evaluation can help ensure that the developed tool is successful and useful at PT. UMC Suzuki Ahmad Yani Surabaya.

This research was conducted at PT UMC Suzuki Ahmad Yani Surabaya during a field work program or internship. This final project is planned to begin in January 2024 and is targeted for completion in August 2024. To ensure the smooth running of the project and increase its effectiveness, an activity matrix was created to carry out the work as follows:

The first stage is the design and construction phase, which will be carried out at two locations: Kos Pak Sapto and Dna Kreasindo. These locations are situated at Kos Putra, Gorongan Jl. Wahid Hasyim No.173A, RT.7/RW.21, Ngropoh, Condongcatur, Depok District, Sleman Regency, Special Region of Yogyakarta 55281, and will run from January 1 to February 29, 2024.

The next stage is testing, which will be conducted at PT UMC Suzuki Ahmad Yani Surabaya. This location is at Jl. Ahmad Yani No.40–44, Ketintang, Kec. Gayungan, Surabaya City, East Java, 60231. Testing is scheduled for September 2, 2024. The division of stages and the schedule are expected to ensure that the project runs systematically to completion within the specified time target.

3. Result and Discussion

The following explains the results from the efficiency and effectiveness testing conducted during the research implementation phase.

Results

a. Efficiency Testing Results

Efficiency is a measure of how effectively an activity uses resources to achieve desired results. The fewer resources used to achieve the expected results, the more efficient the process is. After conducting efficiency testing during the implementation phase, it was clear that this special bleeding rem tool drastically reduced the time required for the bleeding rem maintenance process. Without this tool, the replacement process took about 17 minutes. However, with the help of this bleeding rem tool, the time required was significantly reduced to about half the normal working time, or only about 9 minutes. The following are the results obtained from the tests conducted during the implementation phase.

Table 2. Efficiency test results

No	Test	Bleeding brake time without using the tool	Brake bleeding time using tools	Conclusion
1	Test 1	17 Minutes	9 Minutes	Efficient
Difference		8 Minutes		

b. Effectiveness Testing Results

Effectiveness is the achievement of planned objectives within a specified time frame and with designated personnel. The higher the success rate, the greater the effectiveness. As explained in the effectiveness testing conducted during the implementation phase, the testing involved giving questionnaires to three mechanics. The following table shows the test results obtained:

Table 3. Effectiveness Testing Results

Aspect	Indicator	Item No.	Yes	No
Technical	Availability	1		3
		2	3	
		3		3
		4	3	
		5	3	
		6		3
		7	3	
	Performance	8	3	
		9	3	
		10		3
		11		3
		12	3	
		13	3	
		14	3	
		15		3
		16	3	
		17	3	
	Quality	18		3
		19	3	
		20	3	
		21		3

Aspect	Indicator	Item No.	Yes	No
		22	3	
		23	3	
		24	3	
		25	3	
		Total	51	24

Based on the results and calculations from the effectiveness test, a fairly strong association was found between the indicators of availability, performance, and quality and each respondent's perceptions. This fairly high percentage indicates that the indicators used effectively represented the expected availability, performance, and quality. It also shows that the tools or methods used in this study have sufficiently high validity in measuring the aspects identified.

Discussion

Brake bleeding is an important process in vehicle brake system maintenance that aims to remove air trapped in the hydraulic brake system. The presence of air can reduce brake performance, leading to a soft brake pedal and slower braking response. By bleeding the brakes regularly, users can maintain driving safety and ensure that the brake system operates efficiently. Brake bleeding maintenance requires precision, caution, and expertise from a mechanic. However, the old method, which relies solely on bottles and hoses to bleed brakes on vehicles, is time-consuming and labor-intensive and can sometimes cause accidents for mechanics.

Based on these issues, the development of a brake bleeding tool aims to provide an innovative solution that addresses the challenges mechanics face when bleeding car brakes. This tool is designed to improve work efficiency and effectiveness, reduce the risk of damage to other components, and facilitate the work and safety of mechanics. The development of this brake bleeding tool began with the design stage, taking into account various technical and functional aspects. The initial stage included sketching and creating a 3D model of the tool, followed by a detailed design that covered its dimensions and components. Once the design was completed, the assembly process involved cutting the materials, drilling holes, applying varnish and glue, and joining each component.

The assembly process was carried out precisely and thoroughly to ensure that each component met the specified requirements, using various industrial techniques and tools, including measuring instruments, hand grinders, and hand drills. Efficiency testing at UMC Suzuki Ahmad Yani Surabaya showed that using brake bleeding tools can reduce brake bleeding time from 17 minutes to 9 minutes, resulting in a 55% time efficiency. This efficiency helps reduce wasted time, increase productivity, and alleviate mechanics' workload.

In addition to measuring efficiency, the effectiveness of the brake bleeding tool was also evaluated through a questionnaire administered to mechanics to assess its availability, performance, and quality. The questionnaire results showed positive assessments, with the tool rated as easy to use, effective, and helpful in producing high-quality results. Based on testing, this brake bleeding tool has proven highly effective in improving operational efficiency and reducing work time.

In the brake maintenance industry for vehicles, particularly at PT. UMC Suzuki Ahmad Yani Surabaya, brake bleeding work is one of the complex technical challenges. Before the development of the brake bleeding tool, mechanics at the PT. UMC Suzuki Ahmad Yani Surabaya workshop typically relied on traditional bleeding tools. Although these tools appear simpler, they have several drawbacks.

Bleeding with this old tool has several disadvantages: it takes a long time to complete, requires additional manpower from other mechanics, and can cause leaks in the bottle, which can damage parts of the car if brake fluid from the bottle spills onto them. This means that brake bleeding takes longer, ultimately affecting the vehicle's operational productivity. The following is an image of the tool commonly used by mechanics at the UMC Suzuki Ahmad Yani Surabaya workshop to perform brake bleeding on cars:

Figure 1. Tool comparison

As an alternative solution, the brake bleeding tool offers advantages not found in current tools. This tool is designed with a minimalist shape, is lightweight, easy to use when moving between locations, and certainly simplifies the bleeding process, making it suitable for mechanics to perform their work. This tool also ensures greater safety and security when used for brake bleeding work.

The availability of this brake bleeding tool at PT. UMC Suzuki Ahmad Yani Surabaya can help mechanics shorten the brake bleeding maintenance process on vehicles and reduce the need for assistance from other mechanics, thereby minimizing disruptions to the mechanic's work. Overall, the development of this tool represents a significant step forward in enhancing the efficiency and effectiveness of vehicle maintenance at PT. UMC Suzuki Ahmad Yani Surabaya. This tool not only offers an alternative solution but also provides greater ease of use and safety than previous tools.

Figure 2. Innovation in car brake bleeding tools

4. Conclusion

The design of the car brake bleeding tool, from analysis through design, development, implementation, and evaluation, has resulted in a specialized tool that improves mechanics' work efficiency at the PT. UMC Suzuki Ahmad Yani Surabaya workshop. This tool helps mechanics perform car brake bleeding more quickly and accurately, thereby saving time and ensuring a safer, more comfortable work environment. The design of this tool also considers ease of access, allowing mechanics to work comfortably while performing their tasks. The development of this brake bleeding tool has proven to be very effective in streamlining the brake bleeding maintenance process at the UMC Suzuki Ahmad Yani Surabaya workshop. With this tool, manual bleeding tools are no longer necessary, and work becomes more efficient without requiring additional manpower. This tool makes the brake bleeding process

more accurate and reliable, providing consistent quality assurance and thereby improving the overall productivity and operational effectiveness of the workshop. Work efficiency after using the brake bleeding tool at the UMC Suzuki Ahmad Yani Surabaya workshop has significantly accelerated the time required to complete vehicle maintenance tasks. Before using this brake bleeding tool, mechanics needed 17 minutes. However, after using this brake bleeding tool, mechanics can complete the task in just 9 minutes.

Conflict of interest

The authors declare no conflict of interest.

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