JOURNAL OF AUTOMOTIVE AND MECHANICAL APPLIED TECHNOLOGY

Vol. 1 No 1, 2024, pp. 53-58 https://journal.uny.ac.id/publications/jamat https://doi.org/10.21831/jamat.v1i1.814

Design of Hino Series Wheel Bearing Grease Filling Tool to Improve Efficiency Performance at Hino MPM Solo

Alfian Bagas Pramuditya[1], Moch Solikin[1], Yoga Guntur Sampurno[1*]

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

*Corresponding author: yoga_gs@uny.ac.id

ARTICLE INFO

Article history:
Received 05.11.2024
Revised 27.11.2024
Accepted 05.12.2024

Keywords:
Design; Manufacture; Grease bearing filling tool; Hino 500

ABSTRACT

Efficiency in the vehicle maintenance process is a major concern considering that it can have an impact on saving time, improving accuracy and minimizing operational costs. The use of innovative tools is expected to increase efficiency in the vehicle maintenance process. The current manual lubricant filling process proves to be time-consuming, requires extra labor, and is prone to inconsistency, which can lead to bearing damage. This research focuses on the design and manufacture of a lubricant filling tool for wheel hub bearings on Hino Series vehicles, which aims to improve maintenance efficiency at Hino Mitra Pratama Mobilindo Solo. The tool is designed using the ADDIE model, which includes needs analysis, design, development, and testing stages. The tool consists of a frame, arm holder, lubricator housing, and pressure plate, all of which are designed to ensure proper lubrication and minimize contamination. Tests show that the tool significantly reduces lubricant filling time, with a 418% increase in efficiency compared to the manual method. It also delivers more consistent results, improving work efficiency and productivity.

1. Introduction

Vehicle preventive maintenance is an important part of the transportation industry [1], [2]. It helps to avoid serious damage, prolong the life of vehicles, save fuel, and ensure the safety of drivers [3]. For cargo vehicles, this is even more crucial because they often carry heavy loads and work at high intensity. Good maintenance not only keeps the vehicles running well and safe but also helps the company run smoothly and control costs.

Hino Mitra Pratama Mobilindo Solo, as an aftersales service center for vehicle sales and maintenance, plays an important role in providing quality service to customers. This service center does not only repair and maintain vehicles but also makes sure that every process is efficient and meets customer needs. However, there are some challenges in the maintenance process, especially in the wheel section, that need to be addressed.

Field observations show that the grease replacement process on the wheel hub of Hino Series vehicles is still done manually, which causes various problems. This manual process requires a long time, extra labor, and a low level of accuracy, so it often hampers technician productivity. In addition, this inefficiency has an impact on increasing operational costs, both in terms of processing time and the use of human resources. In practice, technicians must apply grease in stages using conventional tools, which is not only time-consuming but also has the potential to cause discrepancies in the quantity of grease used. This can result in faster bearing damage due to non-optimal lubrication. This ineffectiveness is a major challenge for the company, especially as current customer and industry demands increasingly prioritize efficiency and speed of service without compromising on quality. Therefore, a solution is needed that can overcome this problem while meeting operational standards more effectively and efficiently.

To overcome these difficulties, novel solutions are required to improve vehicle maintenance efficiency. One proposed approach is to create a more practical and effective grease filling tool for wheel hub bearings. This technology is intended to help technicians do routine maintenance, save time, increase accuracy and minimize operational cost.

This study focuses on the design of a grease filling tool for wheel hub bearings on Hino Series vehicles, with the goal of increasing technician work efficiency at Hino Mitra Pratama Mobilindo Solo while also evaluating its effects on overall operational effectiveness. The findings of this study are likely to have a significant impact on the automobile sector by improving the efficiency of vehicle maintenance systems.

2. Methodology

This research uses a product development approach with the ADDIE model (Analyze, Design, Develop, Implement, Evaluate) as a guide to create an effective design. The ADDIE model is one of the most widely used models in the field of learning design[4], [5]. This research begins with a needs analysis to design a tool that can simplify the grease filling process on Hino 500 Series and R 260 vehicles. At the needs analysis stage, the first step is to identify the shortcomings of the old method and design a new method, then determine how the tool works and select the tools and materials needed in the manufacturing process.

Inventor software was used to create the frame, arm holder, and grease bucket components. In the development phase, the metal was cut using an angle grinder, and the parts were welded together. After that, the tool was tested in the field to assess its performance and gather feedback from technicians for further improvement. To measure its effectiveness, we used a Guttman scale, which is simple to use but still provides a clear evaluation[6]. The criteria for evaluation included whether the tool could lubricate the bearings properly, prevent contamination of the grease and bearings, and reduce the labor involved in the lubrication process.

To assess efficiency, we compared the grease lubrication process using the new tool with the manual method. The two methods were compared based on the time it took to lubricate the bearings. The test was repeated five times to ensure the results were reliable and accurately reflected the efficiency of both methods.

3. Result and Discussion

The results and discussion will be carried out on two aspects which include product results and evaluation of the product. Product results will discuss the manufacturing stages clearly and testing is needed to carry out feasibility and see the level of efficiency of the products made.

3.1 Design and Manufacture product

The design process is the initial stage in tool manufacturing. For its implementation, Inventor 2023 student version software was used to design the tool. The designed tool has a manual working system and consists of four main components: frame, holder, pressure plate, and grease housing, whose detailed specifications can be seen in Table 1. The frame serves as a support for other components, such as the holder, pressure plate, grease housing, and wheels. The frame is designed using angle carbon steel with a thickness of 4 mm and a size of 40 x 40 mm, and is 70 cm long, 30 cm wide, and 40 cm high. The pressure plate serves to press the bearing to be lubricated with grease. This component has a diameter of 10 cm and a height of 20 cm, made of a 2 mm thick carbon steel plate, which is connected to three carbon steel rods that are fused to the arm holder circle. The arm holder functions as a lever that presses the pressure plate and moves the spring inside the grease house. The material used for the arm holder is a 2 mm diameter carbon steel pipe with a length of 70 cm, equipped with a return spring to facilitate the return of the arm holder after pressing. The grease house functions as a grease storage area for bearings, equipped with CVT springs, CVT funnels, axles, and mounting plates. The grease housing is designed based on the size of the wheel bearings that have been analyzed and made using carbon steel pipes that match the size of the bearings.

Table 1. Specification of the product

Aspect	Description
Actuator	Manual
Capacity	1.5 Liter
Length	70 Cm
Width	40 Cm
Height	40 Cm
Tipe Bearing	32310,32313,32217,32218 or other types that have the same size

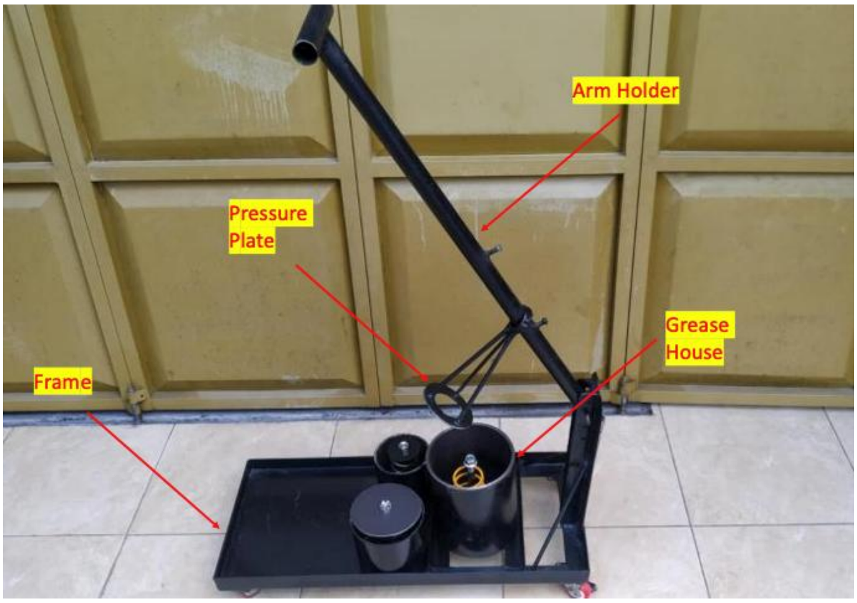

Figure 1. Wheel bearing grease filling tool

Fig. 1 shows the results of the prototype tool that has been made.. The first stage is the manufacture of the frame, which includes collecting tools and materials, cutting the angle carbon steel to size, welding the angle carbon steel, welding the plate on the frame, drilling the arm holder, and welding the arm holder. The second stage is the manufacture of the grease house, which includes collecting tools and materials, cutting carbon steel plates and pipe carbon steel according to the size of the bearing, cutting the motor axle for the center shaft, connecting the motor axle with the plate, connecting the CVT funnel, and connecting the pipe carbon steel with the plate. The third stage is the manufacture of the pressure plate, which includes cutting carbon steel for the pressure plate support, connecting the carbon steel support with the plate, connecting the pipe carbon steel connected to the arm holder, and igniting the welding connection using a grinder. The fourth stage is the manufacture of the arm holder, which includes cutting the carbon steel pipe for the arm holder, connecting the rear end of the arm holder, and drilling the carbon steel pipe for the lever end support. The fifth stage is the finishing stage, which involves caulking, sanding, and painting all the components to smoothen the joints and protect the metal from corrosion. The final step is the assembly, where all the components are put together based on the specifications outlined in the table. This results in a tool designed to fill grease into Hino 500 bearings, with various technical details such as housing capacity, dimensions (length, width, height), holder length, CVT spring, bearing holder, wheel, bearing holder plate, and the type of bearing used.

3.2 Evaluation of Product

The effectiveness of the grease bearing filling tool was tested through a questionnaire assessment to assess product feasibility and performance tests by experts, which included workshop heads, service advisors, and technicians. A total of six experts from Hino Mitra Pratama Mobilindo Solo were involved in this process. The purpose of the test is to evaluate whether the tool functions optimally in filling grease in bearings. The results of the evaluation conducted by the experts are presented in Table 2.

Table 2. Results of product effectiveness survey

Aspect	Indicator	Question item	Answer		Result
			No	Yes	
Technical	Can lubricate bearings properly	1,2,3,4	0	6	Feasible
	Can prevent contamination of the grease and bearings	5,6	0	6	Feasible
	Can reduce the labor involved in the lubrication process	7,8,9	0	6	Feasible

Based on Table 2, the results of the survey of nine respondents show that the tool was rated as effective based on predetermined indicators. The assessment was conducted using a Guttman scale with two answer options, “yes” and “no.” The instrument included two negative statement items, numbers 6 and 8, where a “no” answer to both items was still considered consistent with a “yes” answer to the other positive items and scored.

The survey revealed that the bearing grease filling tool demonstrated effective performance. It was able to optimally fill grease to the bearing intervals, as stated by the six respondents who gave a “yes” answer. In addition, it was also able to distribute the grease evenly, ensuring optimal bearing lubrication. This finding was again supported by six respondents who expressed agreement with the grease distribution capability.

The tool also demonstrated reliability in filling grease in front wheel bearings and rear wheel bearing gaps, with all respondents stating that it is highly effective for use on a wide range of vehicle bearings. In terms of cleanliness, six respondents stated that the tool was able to minimize grease contamination during the filling process, maintaining the cleanliness and quality of the grease to prevent bearing damage due to dirt.

However, some respondents indicated the potential for grease contamination during the use of this tool. This can be seen from the inconsistent answers to questions related to grease cleanliness, indicating the need for further evaluation to address the issue.

On the other hand, the majority of respondents agreed that this tool is able to speed up and simplify the grease filling process compared to manual methods, thereby increasing work efficiency and productivity. All respondents also emphasized that this tool does not require a long time to use, making it superior to conventional methods. Overall, this grease bearing filling tool is considered more effective than the manual method based on survey results involving respondents.

Furthermore, the measurement of product effectiveness and efficiency is also compared with existing products. The effectiveness and efficiency of the grease bearing filling tool compared to the manual method is carried out through measuring the time of implementation of grease filling work between bearings. Time measurements are made using a stopwatch, starting when taking grease and stopping when the bearing has been evenly lubricated. The results of the tool efficiency test are presented in Fig. 2, which contains the filling time before and after using the tool, the percentage of efficiency, and conclusions from each test.

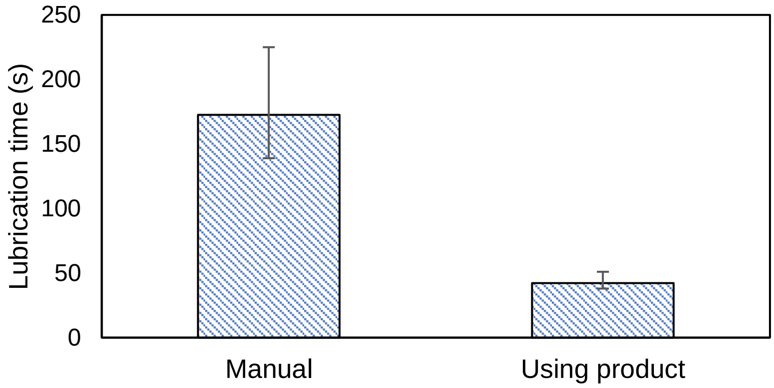

Figure 2. Duration comparison filling grease between manual and use tool

This test was carried out by mechanics with the supervision of the foreman, service advisor, and workshop head. The average manual grease filling time for five trials was 172.6 seconds. After using the tool, the average filling time was reduced to 42 seconds, resulting in an average efficiency of 418% compared to the manual method. The comparison graph of the filling time before and after using the tool shows a significant increase in efficiency. The highest grease filling time with the tool was recorded at 51 seconds, while grease filling with the manual method had the highest time value of 225 seconds.

The analysis results show that the standard deviation of the two grease filling methods has a significant difference. In the manual process, the standard deviation was recorded at 41 seconds, while in the use of tools it was only 5.2 seconds. Standard deviation reflects the level of data variability, where smaller values indicate higher consistency.

Based on these results, manual grease filling tends to have an inconsistent repetition rate, resulting in lower accuracy compared to grease filling using tools. This indicates that the use of tools not only speeds up the process, but also increases the precision and consistency of grease filling results in bearings which is very helpful in calculating work efficiency. These advantages make grease filling tools in bearings an effective solution for workshop needs.

4. Conclusion

This research has successfully made and developed a lubricant filling tool for Hino Series wheel hub bearings through design and manufacturing stages. Furthermore, the prototype that has been made has been tested for functional feasibility where through a survey conducted it is found that the designed tool is suitable for use.

The efficiency value generated from the tool that has been made is measured by comparing the lubrication process manually and with the tool. The test results show that this tool can reduce lubricant filling time by up to 418% compared to the manual method. In addition, it also ensures that the lubricant is distributed more evenly and consistently, reducing the risk of bearing damage.

Finally, it offers a practical and efficient solution to simplify maintenance processes, save time, and reduce operational costs. Hopefully, this innovation can have a positive impact on Hino's operations and the automotive industry in general.

Conflict of interest

The authors declare no conflict of interest.

References

[1] J. Nagy and I. Lakatos, "Predictive Maintenance and Predictive Repair of Road Vehicles—Opportunities, Limitations and Practical Applications," in *SMTS 2024*, Basel Switzerland: MDPI, Nov. 2024, p. 27. doi: 10.3390/engproc2024079027.

[2] Q. Gong, L. Yang, Y. Li, and B. Xue, "Dynamic Preventive Maintenance Optimization of Subway Vehicle Traction System Considering Stages," *Applied Sciences (Switzerland)*, vol. 12, no. 17, Sep. 2022, doi: 10.3390/app12178617.

[3] Y. Liu, Y. Tang, P. Wang, X. Song, and M. Wen, "Reliability-Centered Preventive Maintenance Optimization for a Single-Component Mechanical Equipment," *Symmetry (Basel)*, vol. 16, no. 1, Jan. 2024, doi: 10.3390/sym16010016.

[4] J. C. Tu, X. Zhang, and X. Y. Zhang, "Basic courses of design major based on the addie model: Shed light on response to social trends and needs," *Sustainability (Switzerland)*, vol. 13, no. 8, Apr. 2021, doi: 10.3390/su13084414.

[5] N. Aldoobie, "ADDIE Model," 2015. [Online]. Available: www.aijcrnet.com

[6] L. M. . Uhlaner, *The use of the Guttman scale in development of a family business index*. EIM Business and Policy Research, 2002.