Case Study: Use of Grease in Moulding to Prevent Corrosion and Increase Productivity with Fishbone Diagram Method at PT Tuffiadi Semesta

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DOI: https://dx.doi.org/10.47772/IJRISS.2025.903SEDU0331

Received: 10 June 2025; Accepted: 17 June 2025; Published: 16 July 2025

ABSTRACT

Corrosion of *moulding* components is one of the critical problems that has a direct impact on the efficiency of the production process and the quality of the mould. PT Tuffiadi Semesta faces the problem of decreased productivity due to *mould* damage caused by inaccurate use of *grease* as a protective lubricant. This research aims to identify the root cause of corrosion and develop an improvement strategy using the *fishbone diagram* method as a cause-and-effect analysis tool. The research approach used is a case study with qualitative methods through field observations, interviews, and literature studies. The results of the analysis show that the main factors causing corrosion include the mismatch of *grease* type with *mould* specifications, lack of operator understanding of lubrication procedures, and the absence of standard work standards related to *mould* maintenance. After validating the *fishbone* diagram, the company implemented improvements in the form of selecting the appropriate *grease*, training operators, and preparing lubrication SOPs. The implementation of these improvements resulted in a 15% increase in productivity and a 40% decrease in *mould* defect rate. These results show that the *fishbone diagram* method is effective in systematically identifying and resolving operational problems.

Keywords: corrosion, grease, moulding, productivity, fishbone diagram

INTRODUCTION

In the manufacturing industry, corrosion of machine components is one of the problems that is often faced, especially in iron and steel materials. This phenomenon not only reduces tool life, but also has an impact on productivity and operational efficiency. At PT Tuffiadi Semesta, improper use of lubricants can lead to increased maintenance frequency and machine downtime, which in turn disrupts the production process. Although various types of lubricants are available, such as oil, grease, and chemical fluids, there is still a gap in the understanding of the effectiveness of each in preventing corrosion and improving productivity. This led to the question of choosing the most suitable lubricant for the company's moulding application.

Data shows that the use of oil is often insufficient to provide optimal protection against corrosion, especially under extreme environmental conditions. At On the other hand, grease has advantages in adhesion and resistance to high temperatures, making it more effective in preventing corrosion of engine components. Meanwhile, chemical fluids can provide additional protection, but require higher costs and some customers require food-grade seals. Considering this comparison, it is important to identify the most effective lubricant to use at PT Tuffiadi Semesta. The problem statement that arises is: "how can the use of grease in moulding prevent corrosion and increase productivity at PT Tuffiadi Semesta?"

PT Tuffiadi Semesta, a seal manufacturing company, experienced a similar problem in the *moulding* section which often experienced corrosion and damage. These problems directly impacted productivity and increased maintenance costs. Therefore, a systematic approach was needed to identify the root cause of the problem and design an effective solution. In this context, the *fishbone* diagram (cause-and-effect diagram) method was used as an analytical tool to explore the factors that contribute to corrosion.

The purpose of this study is to analyse the effectiveness of grease use in preventing corrosion and increasing productivity in the seal production process at PT Tuffiadi Semesta. This research is expected to provide data-based recommendations regarding the type of lubricant that is most suitable for use, as well as its impact on production performance and efficiency. Thus, the results of this research are expected to assist the Company in optimising the production process and reducing maintenance costs.

LITERATURE REVIEW

Several studies have been conducted by previous researchers that corrosion not only occurs as a result of direct interaction with a corrosive environment, but is also influenced by factors such as material chemical composition, temperature, pressure, and the presence of inhibitors, and makes an important contribution in expanding our understanding of corrosion and developing more effective protection strategies. In addition, the specific objective of this journal review is to compare corrosion rate testing methods based on existing literature studies.

Corrosion is often the main cause of damage to metal components in the manufacturing industry. Several studies have shown that lubricants and anti-rust coatings are essential in preventing corrosion damage in humid or aggressive environments. (*Liu, C. P., et al. 2020)*

There is an increasing demand for lubricants that are suitable for use so that they do not pollute the environment when in contact with water, food or humans. Bio lubricants fulfil these requirements because bio lubricants decompose in the soil more than 90% (biodegradable) so as not to cause pollutants to the environment, unlike mineral and synthetic lubricants, the maximum decomposes only 40% which causes the need for further handling, besides that bio lubricants are nontoxic because they are derived from plant oils (Kuweir, 2010).

According to Scarvada (2004), the main idea of the fishbone diagram is to organise the root of the problem at the core of the fishbone framework. The causal factors of the problem are illustrated on the fins and bones of the fish. The problem origin categories that are often used as starting points are materials (raw materials), machinery and equipment, labour, methods.

Fishbone or Ishikawa analysis is an approach that analyses identifying more structured in- depth causes for and of problems, discrepancies, and differences (Gaspers, V. 2002). The stages that need to be carried out are as follows:

1. Data collection
2. Creation of a causal factor diagram
3. Root cause recognition
4. Recommendation and implementation of solutions.

RESEARCH METHODOLOGY

This research is carried out through a series of systematic stages in order to identify, analyse, and solve problems that occur at PT Tuffiadi.

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS |Volume IX Issue IIIS June 2025 | Special Issue on Education

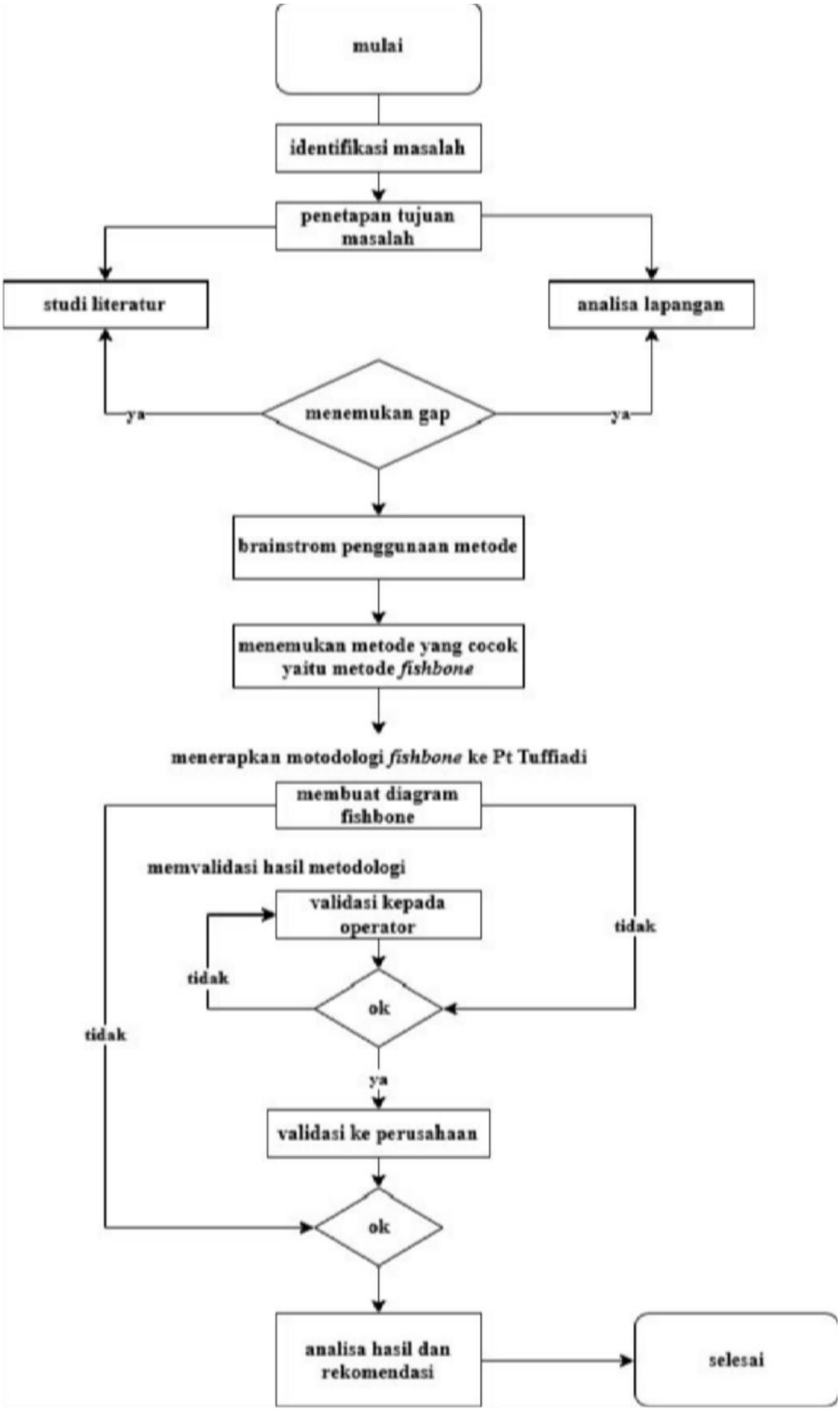

Figure 1. frame of mind

This research began by designing a framework to develop systematic steps in solving the problems faced by PT Tuffiadi. The first stage is to identify the problem to clearly understand the main issues that occur in the field. After the problem was identified, the next step was to set research objectives that were directed at finding the root causes of the problem and developing appropriate solutions.

To support the understanding of the problem, two parallel approaches were taken, namely literature study and field analysis. The literature study aimed to explore relevant theories and methodologies from various scientific references, while the field analysis was conducted to obtain empirical data directly from the work environment concerned. From these two approaches, *gaps* were identified between the actual conditions in the field and the ideal conditions based on the literature.

If gaps were identified, the process continued with brainstorming to determine the appropriate method of analysis. The results of the discussion agreed that the fishbone method or cause- and-effect diagram was the most suitable approach to use. This method was then applied directly to the case at PT Tuffiadi. The first step in applying this method is the preparation of a fishbone diagram that groups various causal factors into main categories such as people, machines, methods, materials, and environment.

After the fishbone diagram was created, the validation process of the analysis results was carried out. Validation was conducted in two stages: first to the operators directly involved in the production process to ensure compliance with real conditions, and second to the company management to obtain approval from the policy and operational side. If the validation results are not suitable, then revisions are made to the diagram until agreement is reached from both parties.

The final stage of the process was to analyse the validated results and develop recommended solutions based on the identified root causes. Thus, this research ends by producing a comprehensive analysis and recommendations that can be implemented by the company for continuous improvement.

RESULTS AND DISCUSSION

This research begins with data collection conducted by the production department to identify problems that often occur, namely downtime caused by the following factors.

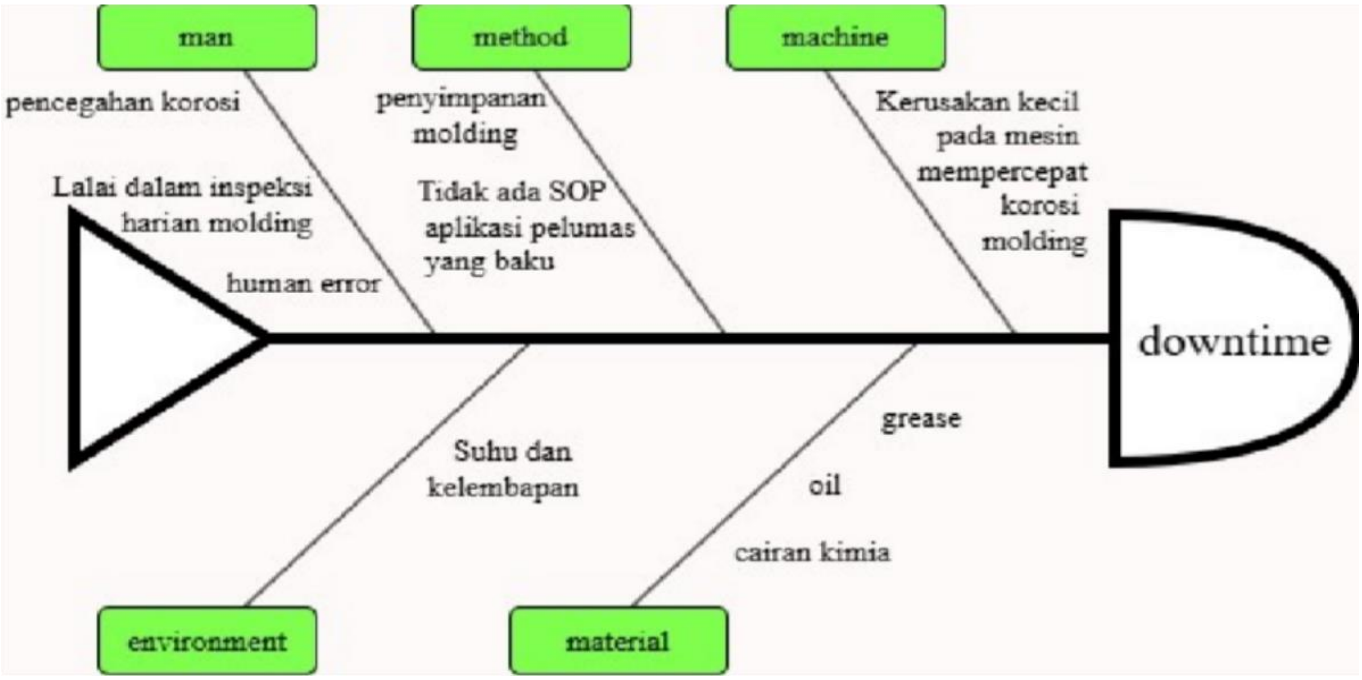

Figure 2. Fish bone

To identify the main causes of the increased *downtime* due to corrosion in the *moulding*, a fishbone diagram or cause-and-effect diagram was analysed. This analysis categorised the causal factors into six main categories: *man*, *method*, *machine*, *environment*, material, and *grease/oil*.

On the human factor (*man*), it was found that operator negligence in conducting daily inspections of the *moulds* was a significant cause. The lack of understanding about corrosion prevention and the high potential for *human error* also exacerbated the condition. Furthermore, in terms of *method*, the absence of a standardised

Standard Operating Procedure (SOP) on lubricant application and improper storage of *mouldings* were the root causes that accelerated the corrosion process.

Machine factors also play a role, where minor damage that is not repaired promptly can accelerate corrosion of the *mould*. Component wear and lubricant leaks also increase the risk of damage. From an *environmental* aspect, uncontrolled temperature and humidity contribute to increased oxidation rates on metal surfaces.

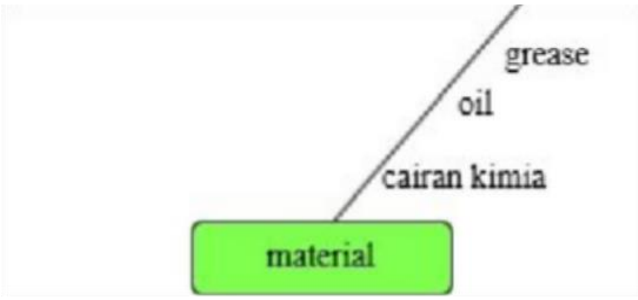

Figure 3. Material

In addition, the lubricating materials used are also a concern, where the types of *grease*, *oil*, and chemical fluids used are not in accordance with technical specifications or conditions.

operational. This mismatch results in sub-optimal lubrication and reduced surface resistance to corrosion.

Thus, the fishbone diagram provides a systematic overview of the various factors causing *downtime* and corrosion in the *mould*. This analysis forms the basis for designing corrective actions, such as the establishment of lubrication SOPs, operator training, work environment control, and evaluation of the type of lubricant used.

In this study, data collection was carried out in the Production Department to identify product defects related to damage to the mold and repairs made to the mold, The required data and information were obtained from employees of the Seal Manufacturing Company. The data collection process carried out to identify this damage was carried out for 44 working days, Data collection regarding the mold repair process was carried out at the Machining Department of the Seal Manufacturing Company. The tools used for the mould repair process are Kerosene, 80-400 grit sandpaper, lathe machine, and dial guage,

This difference in results could be due to the fact that this study focused on the use of lubricants to reduce corrosion associated with mould damage.

Table 1: Types of lubricants

No.	Lubricant Type	Duration
1	Grease	12 Months
2	Oil	6 Months
3	Chemical Liquid (Release)	1 Month

Based on the data obtained, molds that use lubricants experience different corrosion damage, From these results it can be seen that lubrication using grease has the longest durability and is easy when repaired, The process of repairing mold damage starts from disassembling the mold to check the damaged parts. A complete description of each sequence of mould repair steps is presented in the following section:

a) Mould Disassembly The first step that must be done is the disassembly of the mould which is done by separating the core mould and cavity mould using a tool in the form of an iron bar. This is done to identify the damage that has occurred, this process is carried out for 10 minutes.

b) Then polishing is done using a lathe, this polishing process usually takes a relatively short time when the mould has been coated with grease for 20 minutes, and checked again. Thus, the overall time required to repair the mould takes 30 minutes.

CONCLUSION

Based on the results of research conducted at PT Tuffiadi Semesta, it can be concluded that corrosion of moulding components is a major problem that causes a decrease in productivity and an increase in maintenance costs. Through the fishbone diagram approach, it has been successfully identified that the main causes of corrosion include:

1. Mismatch of lubricant type (grease, oil, chemical liquid) with mould specifications and operational conditions.
2. Lack of operator understanding of the correct lubrication procedures, and the absence of a standardised lubrication SOP.
3. Environmental factors such as uncontrolled temperature and humidity.
4. Negligence in routine inspection and maintenance, and late repair o f minor mould defects.

After implementing improvements such as selecting the appropriate type of grease, training operators, and developing lubrication SOPs, the company was able to increase productivity by 15% and reduce mould damage by 40%. Grease proved to have the longest corrosion protection duration (12 months), better than oil (6 months) and chemicals (1 month).

Advice

Based on the results of the analysis and implementation of the solution, the following are suggested:

1. Standardisation of grease usage:

PT Tuffiadi Semesta should set a standard for the use of grease as the main lubricant for lubricating moulds, taking into account technical specifications and the work environment.

2. Preparation and Implementation of lubrication SOPs:

Create a detailed Standard Operating Procedure (SOP) for lubrication and mould maintenance and integrate it into the operator's daily work system.

3. Periodic training for operators:

Organise regular training for production operators on proper lubrication techniques, the importance of daily inspections, and how to detect early corrosion.

4. Periodic monitoring and evaluation:

Conduct periodic audits or inspections of the effectiveness of lubricants used, and evaluate downtime and mould damage data for further decision-making.

5. Work environment control:

Controlling humidity and temperature in storage and moulding production areas to keep them stable to minimise the risk of metal oxidation.

6. Consider using environmentally friendly lubricants:

In the long run, companies can consider using bio lubricants that are biodegradable and non-toxic as a form of concern for the environment.

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