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Implementation of TRIZ Method to Improve Paving Production Process (Case Study: Industrial Engineering Department Workshop, UNDIL)

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***Abstract*— the purpose of this study is to improve the quality and efficiency of road pavement products to meet consumer expectations. To achieve the quality of road pavement products in this study, the Theory of Inventive Problem Solving (TRIZ) method will be applied. The data used in this study are primary data obtained directly from operators in the Industrial Engineering Department, such as observation data in the design and data in the form of information on the quality of road pavement product production. While secondary data is obtained from books, newspapers, the internet or other media that support the study. From the results of the data analysis, contradictions were finally determined such as Not according to composition / not standard Measurement accuracy (28) vs Loss of time (25), Perforated Pot (29) Manufacturing accuracy vs (25) Loss of time, Lack of knowledge 33 (Ease of operation vs 35 (Adaptability, versatility of manufacturing quality) (29) fabrication) vs 11 (Stress or pressure) and Bad Mal (11) Volume of moving objects vs Difficulty detecting and measuring (37). Alternative Solution for Perforated Pot: In the production process, there are always obstacles to Perforated Pot, for this reason, producers must add clamps to the wind pipe so that they can control wind power. Alternative Solution: Lack of Knowledge because so far there has been no provision or training regarding the production process.**

Keyword: TRIZ, Quality, Pavement, Product.

I. INTRODUCTION

In an era of globalization and increasingly fierce market competition, product innovation is a key factor in achieving competitive advantage. Companies across various industrial sectors face the challenge of continuously improving product quality and value while maintaining cost and time efficiency. In this context, finding effective, innovative solutions is crucial. One method that can be used to achieve this goal is TRIZ (Theory of Inventive Problem Solving)[1].

TRIZ was developed by Genrich Altshuller in 1946, based on the analysis of hundreds of thousands of existing patents and innovations[2]. This method offers a systematic approach to solving engineering and design problems, using innovation patterns that have proven successful across various disciplines. TRIZ focuses not solely on solutions but rather on sustainable and innovative problem-solving, which can be adapted and applied in a variety of contexts[3].

One of TRIZ's strengths is its ability to identify and resolve contradictions that often arise in the product design process. In many cases, designers encounter situations where improving one aspect of a product can result in a decline in the performance of another aspect. Through the use of TRIZ tools, such as the Contradiction Matrix and the Innovation Principles, designers can find solutions that not only meet current needs but also create opportunities for greater innovation in the future.

Applying TRIZ methods to the product design process can help companies optimize their products more efficiently and effectively. By understanding and applying TRIZ principles, companies can accelerate the product development process, improve quality, and reduce production costs. This will positively impact customer satisfaction and ultimately increase company profits.

On the other hand, although TRIZ has been used in various industries, challenges remain in its widespread adoption. Many companies still lack understanding of how to systematically use TRIZ in their design processes[4]. Therefore, this study aims to explore the application of TRIZ methods to product optimization and identify concrete steps companies can take to effectively adopt this method in their practices. It is hoped that this research will contribute to the development of knowledge in the field of product innovation and serve as a reference for industry practitioners exploring the potential of TRIZ to enhance the competitiveness of their products.

II. RESEARCH METHOD

The type of research used in this study is a qualitative method. The data collected is in the form of words and images, not numbers. The purpose of this descriptive study is to make systematic, factual, and accurate observations about the facts and characteristics of a specific population or region. This study

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aims to determine how the application of the TRIZ method can optimize pavement products in the design process[5].

The purpose of this research is to obtain a clear, complete, and accessible picture and information for the researcher to conduct observations. Therefore, the author determined the research location to be the workshop of the Department of Industrial Technology, UNDIL.

Data collection methods are techniques or methods used by researchers to collect data, while data collection instruments are also the instruments selected and used by researchers in their data collection activities to make the process systematic and easier. In this study, researchers used instruments or procedures to collect data, such as: (1) observation, (2) interviews, and (3) documentation.

Data analysis in this study occurs simultaneously with the data collection process. These three stages are data reduction, data presentation, and verification. Qualitative data analysis involves processing, organizing, grouping, and analyzing data into manageable units, maintaining consistency, identifying patterns, determining what is important and what can be learned, and making decisions.

Analysis involves reviewing data obtained from the field by organizing it into categories, dividing it into units, selecting what is important and what will be learned, and drawing conclusions that are easily understood by one person and another.

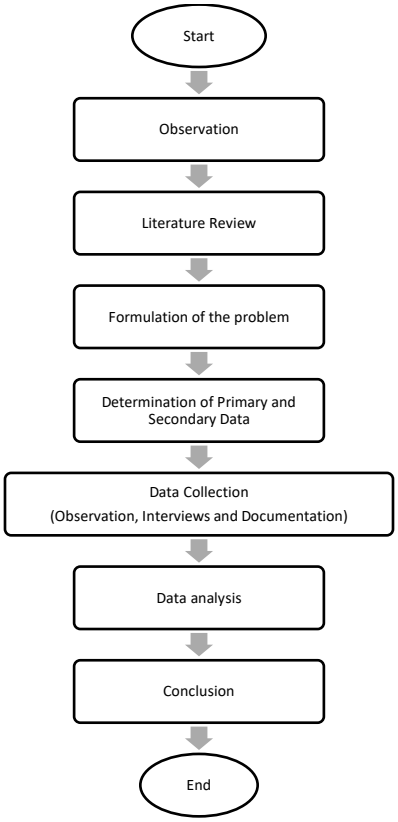

Fig. 1. Research Flowchart.

III. RESULT

Problem identification is the initial phase of TRIZ implementation. As an application of these principles, the tools contained in the TRIZ method for innovative problem-solving are used in this phase to identify and resolve contradictions in systems, products, or processes with the goal of finding effective, creative, and innovative solutions.

This initial product design aims to describe the model and quality of the road pavement material/product.

1. The initial road pavement product design aims to reengineer the road pavement product production process to improve quality.
2. The initial road pavement product design aims to reengineer the road pavement product composition production process to ensure a warranty period.

Fig. 2 Initial Pavement Product Design.

An operational process map, often referred to as an operational map, is a service map used to create an organized service graphic, making operational elements more clearly visible[6]. The process in this section aims to be more systematically organized.

Table 1.
Pavement Operation Process Map

Duration	Process	Activity
30 Minutes		Collecting plastic waste
1 Minute		Filling the plastic waste into the trash can
1 Minute		Filling the gas tank with oil
1 Minute		Turning on the gas stove that uses oil
1 Minute		Placing a pan on the gas stove to cook the plastic waste
30 Minutes		Cook and wait for the plastic to melt
20 Minutes		Stir the plastic until it melts before pouring it into the mold
1 Minute		Pouring the cooked molten plastic into the mold
2 Minutes		Pressing the paving product into the mold
15 Minutes		Soaking the paving product in water
2 Minutes		Unscrewing/removing the cooled paving product
1 Minute		Storing/placing it in a storage area

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An operational process map is a diagram that can depict the flow of a service process relevant to raw materials related to organize operational and inspection activities. From initial processes to production results, this map can also generate the information needed for ongoing analysis of time spent, equipment and materials used, and all facilities. Therefore, the writing and design of an operational map also include operational activities, transportation, inspection, and safe storage.

The initial design analysis of the material related to the Reengineering Process for road pavement products, along with the diagram, is as follows:

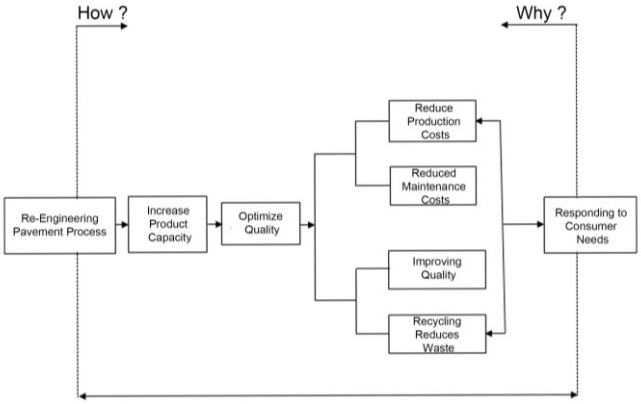

Fig. 3 FAST method diagram of pavement products.

In the analysis phase, including conducting analysis using a cause and effect diagram (fishbone diagram), where the results of these factors are translated into technical parameters, then creating a contradiction matrix for which the inventive principle is sought, and then these solutions will be used for each product defect problem that occurs.

A cause-and-effect diagram (fishbone diagram) helps identify factors that lead to product defects and provide recommendations for improvement[7]. A cause-and-effect diagram for this product is shown below.

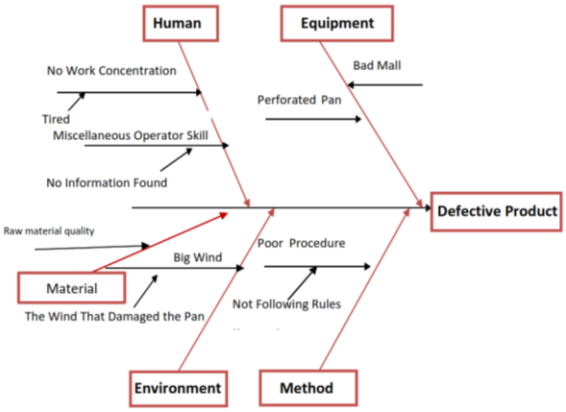

Fig. 4 Defect Cause Diagram.

Through the diagram above, the causes of material, human, equipment, environmental and method factors are as follows:

1. Humans
   Problems arise from human factors such as labor, lack of knowledge about product production, due to a lack of training in road pavement production.
2. Raw Materials
   This problem is caused by poor quality raw materials (mixed plastic waste). Therefore, manufacturers must pay attention to raw materials, as they are the initial step in the process that is transferred to subsequent processes.
3. Methods
   One of the main factors contributing to poor quality road pavement products is the composition of raw materials that does not meet standards.
4. Equipment
   One cause of poor quality road pavement products is the poor quality of the MALL used for production.

In the pavement production process, there are contradictory problems that make it difficult to minimize defects. The results of the analysis of the causes of defects that will become contradictions will be resolved using the TRIZ method[8]. Contradictions will be resolved by brainstorming, the results are ineffective so that the TRIZ method is needed to make decisions based on data. The way to apply the TRIZ method is to define the contradiction parameters into 5 categories: Not according to composition/non-standard, Perforated Pan, Lack of knowledge, Poor quality of raw materials, and Poor Mal. Then, the contributing factors (other parameters that are considered to influence the solution of the problem) are described and sought so that the decision making can include all parameters that influence the problem.

Table 2.
TRIZ Contradiction Parameters

No.	Causal Factors	Contradiction		
		Fix Parameter	><	Bad Parameter
1	Non-composition /non-standard	Measurement accuracy (28)		Loss of time (25)
2	Perforated Pot	Accuracy Of Manufacturing (29)		Loss of time (25)
3	Less Knowledge	Ease of operation (33)		Adaptability Or Versatility (35)
4	Poor quality raw material	Accuracy of manufacturing (29)		Stress or pressure (11)
5	Bad Mall	Volume moving object (11)		Difficulty of detecting and measuring (37)

After identifying the contradiction, find a solution to the contradiction that aligns with TRIZ principles. The principle is to generate new, creative ideas from existing alternative solutions, then select the most feasible solution to use as a solution to the problem. To find alternatives, use a tool from the TRIZ website (http://www.triz40.com/), which also has a section for inputting data and results, called an interactive matrix.

Table 3.
Alternative Solutions

Improvement Needs	Contradiction	Alternative Solutions
Non-composition /non-standard	Measurement accuracy (28) vs Loss of time (25)	Preliminary Action (10)
Perforated Pot	Accuracy Of Manufacturing (29) vs Loss Of Time (25)	Copying (26)
Less Knowledge	Ease of operation (33) vs Adaptability Or Versatility (35)	Discharging and recovering (16, 34)
Poor quality raw material	Accuracy of manufacturing (29) Vs Stress or pressure (11)	Adaptability of versatility (35)
Bad Mall	Volume moving object (11) vs Difficulty of detecting and measuring (37)	34, 2, 6, 10

IV. CONCLUSION

In relation to this research, the researcher finally wants to conclude the research results, as follows:

1. After the analysis, the following contradictions were found: Inappropriate composition / non-standard Measurement accuracy (28) vs. Lost time (25), Perforated pan (29) Manufacturing accuracy vs. (25) Lost time, Lack of knowledge 33 (Ease of operation vs. Flexibility of Material, 35 poor quality 29 (Manufacturing accuracy) vs. 11 (Pressure or pressure) and poor Mall (11) Volume of moving objects vs. Difficulty detecting and measuring (37)
2. Alternative solutions for non-standard compositions: In the problem of non-standard raw material compositions, it is necessary to identify each good quality raw material and raw materials that can be used quickly and can be used for a long period.
3. Alternative solutions for perforated pan: In the production process, the perforated pan problem always occurs, therefore the manufacturer must add another valve to the wind pipe to control the wind force. 4. Alternative solutions for lack of knowledge: Because at this time there is no formation or training regarding the product production process.

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