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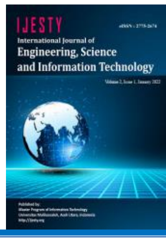

Measurement of Human Work Reliability Using Systematic Human Error Reduction and Prediction Approach and Human Error Assessment and Reduction Technique Method

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Abstract

CV. Raja Hati is a company that is engaged in the process of refinishing tires that have been bald into new ones. The tire retreading process has a relatively high percentage of defects, such as 14.8% Printing Process, 12.3% Surface Leveling, 8.6% Tire Curing, and so on. The problems in this study are the factors that cause defects in terms of human aspects, the types of errors that most often occur in the production process, and the value of human error probability (HEP) in the production process at CV. Raja Hati. This study aims to determine the factors that cause defects in terms of human aspects, the types of errors that most often occur in the production process and the value of human error probability (HEP) in the production process. The research was conducted using the SHERPA and HEART methods. The SHERPA method's study results show that the types of errors that often occur in the tire retreading process are many wrong operator actions. Still, on the proper object (A7), the operator is wrong in dividing the time in doing work (A2), and the operator is not suitable for doing his job (A5). This study concludes that the factors that cause product defects in the tire retreading process are the absence of a procedure for correcting errors by 21.63%, the need for different techniques in doing work to facilitate operators by 27.04%, inexperienced operators by 12.36%, and inexperience and independent inspection has a percentage of 12.36%. The results of the calculation of the HEP value show that the average HEP value in the tire retreading process is 0.8552 or 85.52%, while the operator reliability value is 14.48%.

Keywords: *Reliability, Human Error, SHERPA, HEART.*

1. Introduction

The era of globalization and free trade has changed the business world in Indonesia. One of the impacts of the changes for the domestic industry is the increasingly fierce competition that must be faced. Companies must compete with local companies and compete with foreign companies. The company must have an advantage in product and service quality compared to its competitors. Companies must also have competitive prices to obtain maximum profit and maintain the company's survival. The strategies used by the company to increase profits include increasing sales volume, selling product prices that are cheaper than the market price or equal to the market price, and providing exemplary service to customers or consumers [1].

CV. Raja Hati is a company that processes tire retreading, which has been bald to become new—of course, check the tires first, whether they are suitable for retreading or not. By reinstalling the new rubber tread on the tire casing, the first inspection of the tire is carried out semi-automatically. Namely, the machine used is not fully automatic—still, human participation in operating the machine undergoing operations on the retreading process at CV. Raja Hati still encounters work mistakes on Human Error operators, so it causes tire defects or does not match what is desired in work or often called human error [2].

The method used in this study is SHERPA (Systematic Human Error Reduction and Prediction Approach), a human reliability method developed by Embrey in 1986. The SHERPA method identifies errors in each task performed by the operator based on a predetermined taxonomy of human error. Another method used in this research is HEART (Human Error Assessment and Reduction Technique). This method is designed to be simple and easy to understand in identifying the main influences in human performance that cause errors. The HEART method has a good level of accuracy to measure human reliability [3].

2. Literature Review

2.1. Ergonomics

Ergonomics comes from the Greek Ergon, which means work, and Nomos, which means rules/laws. So ergonomics can also briefly tell the rules/regulations at work. In general, ergonomics is defined as a static branch of science to utilize information about the nature, abilities, and limitations of humans in designing a working system so that people can live and work on the system properly, namely achieving the desired goals through the work effectively, healthy, convenient, and efficient. Not only related to tools, but ergonomics also includes the study of interactions between humans and elements of other work systems, namely materials, the environment, even methods and organization [4] [5].

Ergonomics has various definitions. In Indonesia, it is agreed that ergonomics is a science. Its application seeks to harmonize work and the environment with people or vice versa to achieve the highest productivity and efficiency through optimal human utilization. Ergonomics includes examining the physical abilities of workers, the workplace environment, and the task being completed and applying this information to the design of models of tools, equipment, and work methods required for the overall job safely [6].

2.2. Human Errors

Human error is a failure to complete a specific task or job (or perform an unauthorized action) that may disrupt the operating schedule or damage objects and equipment. Human error can be classified into several categories, namely [7]:

1. Error in the operation process
2. Error in the assembly process
3. Error in the design process
4. Error in the inspection process
5. Error in the installation process
6. Error in the maintenance process

2.3. Systematic Human Error Reduction and Prediction Approach (SHERPA)

Embrey developed the Systematic Human Error Reduction and Prediction Approach to predict human errors, analyze tasks, identify potential solutions for mistakes in a structured manner. This technique is based on the human error taxonomy, and in its original form, it determined the psychological mechanisms involved in errors [8]–[10]. The procedures that must be followed in using the SHERPA method are as follows:

a. Hierarchical Task Analysis (HTA)
   The first step to using the SHERPA method in analyzing human error is to compile the entire job liant into an HTA diagram to make the worstudiedanalyzed more detailed and systematic. Information on HTA has been discussed in the previous section.
b. Job classification
   Each job list that has been described in the HTA diagram is further classified into several types of errors. The types of errors used in the SHERPA method are as follows:
   a. Action (action), for example: pressing a button, pressing a switch, opening a door.
   b. Retrieval (acquisition or search): obtaining information from the screen or manually through paper.
   c. Checking (checking), for example: performing an inspection procedure.
   d. Selection, for example: choosing one alternative among several available alternatives.
   e. Information (information), for example: communicating with other people.
c. Identification of human errors
   The error identification procedure is to compile a list of jobs that have been classified into several types of errors in the previous stage according to the appropriate category.
d. Consequence analysis
   At this stage, a list of the operator's most likely consequences of a job is performed is included in the error type.
e. Recovery analysis
   Recovery, in this case, refers to actions that can be taken to correct errors. The recovery column generally indicates whether the operator continues his work or performs other alternative positions, attempting to correct the mistake.
f. Ordinal error probability assessment
   The ordinal probability value used in the SHERPA method is low, medium, or high.
g. Critical level analysis
   If the consequences of the error are critical (e.g., resulting in intolerable losses), then the work item being analyzed must be marked as an essential work item. The sign used as an indication that the error of the work item being analyzed is vital is an exclamation point (!). In contrast, for mistakes that are not critical, a dash (-basic necessary level of error in a work item can be seen from its impact on the production floor, facilities, processes, products, or operators doing the work.
h. Strategies to fix errors
   The next stage in the SHERPA method is to develop a strategic plan and the actions that need to be taken to reduce the mistakes [10].

2.4. Human Error Assessment and Reduction Technique (HEART)

The first function of the HEART calculation process is to group tasks into general categories and nominal level values for human unreliability according to the HEART generic categories table [11] [12] [13]. The next step is to identify the conditions that cause errors (Error Producing Conditions, EPCs) shown in the form of scenarios that negatively impact human performance [14]. So HEART is part of the reliability calculation, which is defined as how much the operator makes an error in the task that should be done [15], [16]. The steps taken to determine the value of Human Error Probability (HEP) using the HEART method are as follows [17]:

1. Identify all types of work to be performed by the operator. This can be done by observing, interviewing, and recording operator job descriptions so that researchers can fully understand the tasks that operators must do.

2. Categorize each work item into one of the eight categories in the Generic Task Type (GTT) table. Each categorized work item must be strictly matched. Therefore, direct interviews with supervisors or experienced people are needed. In addition, the little human error probability can still be adjusted based on interviews.
3. Identify Error Producing Conditions (EPCs) according to the scenarios in the HEART EPCs table.
4. Determine the proportion of effects or Assessed Proportion of Effect (APOE) and calculate the value of the Assessed Effect (AE) of each EPCs that have been identified.
5. Calculating the total value of AE
6. Perform calculations on Human Error Probability (HEP) value.

3. Method

The research was conducted at CV. Raja Hati, Ule Pulo Village, Dewantara District, North Aceh Regency. In this study, researchers used two types of data as research material: primary and secondary data.

1. Primary data
   Primary data is data obtained directly from the source through review, observation, and recorded matters relating to this research. Preliminary data were obtained from interviews about the manufacturing process, now recording the defects of each product and seeing firsthand the conditions of the work environment.
2. Secondary Data
   Secondary data is obtained from company or organization documents, newspapers, magazines, or other publications. Secondary data was obtained from records such as the number of productions.

3.1. Operational Variables

The operational variable is a definition of variables formulated based on the characteristics of the observed variables[18], [19]. Some operational purposes were used in this study area [20].

1. Defective product
   Products produced in the production process are not by the established quality standards, but economically defective products can still be repaired by spending a certain amount of money.
2. Work procedure
   A series of work procedures that are interconnected with one another, where it is seen that there is a sequence of steps and paths that must be taken to complete a product.
3. Work error
   Mismatches or errors can occur in making that can disrupt the production process.

3.2. Analysis Method

The data obtained is completed by following the following steps:

1. SHERPA Method (Systematic Human Error Reduction and Prediction Approach)
   The steps to analyze using SHERPA are as follows:
   a. Hierarchical Task Analysis (HTA)
   b. Job classification
   c. Identification of human errors
   d. Consequence analysis
   e. Recovery analysis
   f. Ordinal error probability assessment
   g. Critical level analysis
   h. Strategies to fix errors
2. HEART method (Human Error Assessment and Reduction Technique)
   The steps in using the HEART method are:
   a. Identify all types of work to be performed by the operator. This can be done byintoerving, inte, reviewing, and recording operator job descriptions so that researchers can fully understand the operators' tasks.
   b. Categorize each work item into one of 8 categories in the Geberic Task Type (GTT) table. Each categorized work item must be strictly matched. Therefore, direct interviews with supervisors or experienced people are needed.
   c. Identify Error Producing Conditions (EPCs) according to the scenarios in the HEART EPCs table. EPCs are factors that can affect the operator's failure rate or, in other terms, called Performance Shaping Factors (PSFs).
   d. Determine the proportion of effects or Assessed Proportion of Effect (APOE) and calculate the value of the Assessed Effect (AE) of each EPCs that have been identified.
   e. Calculates the total value of AE.
   f. Perform calculations on the value of Human Error Probability (HEP)

4. Results and Discussion

4.1. Description of Retreading Tire Processing

The following is the sequence of the production process carried out in the Retreading Tire process:

1. Tire Material Selection Process
2. Tire/Tread Leveling Process
3. Tire Scraping Process
4. Tire Cleaning Process
5. Tire Rubber
6. Checking

7. Print/Vulcanization Process
8. Final stage and examination

4.2. Analysis of Human Errors that Occur with the SHERPA Method

1. Hierarchical Task Analysis (HTA)
   The first step to using the SHERPA method in analyzing human error is to compile the entire job list into an HTA diagram to do the work to be studied more detailed and systematic.

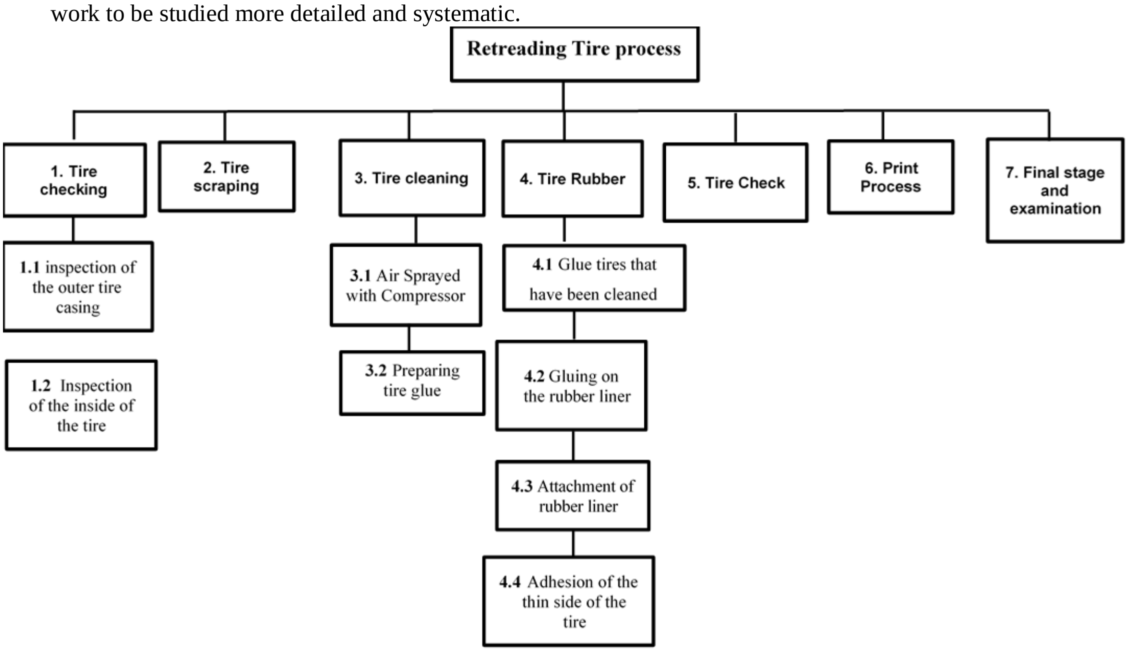

Fig 1. Hierarchical Task Analysis (HTA) diagram

2. Job Classification
   a. Action, for example: grinding that does not cover the machine
   b. Checking, for example, Inspection of the inside of the tire
   c. Selection, for example: Preparing tire glue

   List of jobs for tire retreading process in detail:

Table 1. Work Classification of Tire Retreading Process

Code	Job description	Classification
1.1	Inspection of the outer tire casing	Checking
1.2	Inspection of the inside of the tire	Checking
1.3	Mark the tires	Action
2.1	Tires that have been scraped are brushed	Action
2.2	Non-machine grinding	Action
2.3	Patching in wet places	Action
3.1	Air Sprayed with Compressor	Action
3.2	Preparing tire glue	Selection
4.1	Glue tires that have been cleaned	Action
4.2	Gluing on the rubber liner	Action
4.3	Attachment of rubber liner	Action
4.4	Adhesion of the thin side of the tire	Action
4.5	Envelope Installation	Action
6.1	Cooking tires in the oven	Action

3. Human Error Identification (HEI)

Table 2. Identification of Work Errors in the Tire Retreading Process

Code	Classification	Category	Description
1.1	Checking	C2	The operator is not careful in checking the outside of the tire.
1.2	Checking	C2	The operator is not careful in checking the inside of the tire.
1.3	Action	A7	The operator gives a sign that does not match
2.1	Action	A2	The operator was too hasty to clean the wound on the surface so that the character was still scraping.
2.2	Action	A2	The operator neglects the grinding time that the machine does not cover so that it is still visible and has not been ground.
2.3	Action	A7	The operator was not careful when patching, so the holes in the tires were still visible.
3.1	Action	A1	The operator rushed to spray air on the brushed tires leaving small stones remaining.
3.2	Selection	S2	The operator was too hasty in preparing the rubber glue, so the bond was lacking.
4.1	Action	A7	The operator was negligent when applying glue to the tire surface so that the bond was not evenly distributed on the tire surface.

Code	Classification	Category	Description
4.2	Action	A7	The operator was negligent when applying glue to the sole of the liner so that the glue did not flatten the surface of the liner.
4.3	Action	A5	The operator was negligent when installing the palm liner so that the palm liner was not neat.
4.4	Action	A7	The operator is negligent in time. I am attaching the thin side of the tire so that the edge of the tire is not neat.
4.5	Action	A7	The operator was negligent when installing the envelope on the tire that he wanted to put in the oven.
6.1	Action	A5	Operators are in a hurry and don't focus on cooking the tires in the oven.

4. Consequence analysis

Table 3. Analysis of Work Consequences on Tire Retreading Process

Code	Error Desc.	Description of Error	Consequence
1.1	C2	The operator is not careful in checking the outside of the tire	An error occurred when checking the tire surface
1.2	C2	The operator is not careful in checking the inside of the tire	An error occurred when inspecting the inside of the tire
1.3	A7	The operator gives a sign that does not match	Lack of careful marking time
2.1	A2	The operator was too hasty to clean the wound on the surface so that the character was still scraping.	Work is hampered because it has to be reworked.
2.2	A2	The operator neglects the grinding time, which is still visible, does not cover the machine.	Repetition of work
2.3	A7	The operator was not careful when patching, so the holes in the tires were still visible.	There is the repetition of work.
3.1	A1	The operator rushed to spray air on the brushed tires leaving small stones remaining.	The work is hampered because it has to be reworked.
3.2	S2	The operator was too hasty in preparing the rubber glue, so the bond was lacking.	Not as expected, so there is repetition.
4.1	A7	The operator was negligent when applying glue to the tire surface so that the bond was not evenly distributed on the tire surface.	Lack of imperfect glue, resulting in repetition of work.
4.2	A7	The operator was negligent when applying glue to the sole of the liner so that the glue did not flatten the surface of the liner.	Lack of imperfect glue, resulting in repetition of work.
4.3	A5	The operator was negligent when installing the palm liner so that the palm liner was not neat.	The unification of the liner with the tire is not perfect, so there is the repetition of work.
4.4	A7	The operator is negligent in time. I am attaching the thin side of the tire so that the edge of the tire is not neat.	Not as expected so that it repeats
4.5	A7	The operator was negligent when installing the envelope on the tire that he wanted to put in the oven.	There is the repetition of work.
6.1	A5	Operators are in a hurry and don't focus on cooking the tires in the oven.	Items are not suitable for use.

5. Ordinal error probability assessment

Table 4. Ordinal Error Probability of Tire Retreading Process

Code	Description of Error	Probability Error
1.1	The operator is not careful in checking the outside of the tire	M
1.2	The operator is not careful in checking the inside of the tire	M
1.3	The operator gives a sign that does not match	L
2.1	The operator was too hasty to clean the wound on the surface so that the character was still scraping.	H
2.2	The operator neglects the grinding time, which is still visible, does not cover the machine.	M
2.3	The operator was not careful when patching, so the holes in the tires were still visible.	H
3.1	The operator rushed to spray air on the brushed tires leaving small stones remaining.	M
3.2	The operator was too hasty in preparing the rubber glue, so the bond was lacking.	L
4.1	The operator was negligent when applying glue to the tire surface so that the bond was not evenly distributed on the tire surface.	M
4.2	The operator was negligent when applying glue to the sole of the liner so that the glue did not flatten the surface of the liner.	H
4.3	The operator was negligent when installing the palm liner so that the palm liner was not neat.	M
4.4	The operator is negligent in time. I am attaching the thin side of the tire so that the edge of the tire is not neat.	M
4.5	The operator was negligent when installing the envelope on the tire that he wanted to put in the oven.	H
6.1	Operators are in a hurry and don't focus on cooking the tires in the oven.	M

6. Critical level analysis

The sign used as an indication that the error of the work item being analyzed is critical is an exclamation point (!), while for mistakes that are not critical, a dash (-). The essentiabasicf tire retreading process work results can be seen in Table 5 below.

Table 5. Critical Level of Tire Retreading Process

Code	Consequence	Critical Level
1.1	An error occurred when checking the tire surface.	!
1.2	An error occurred when checking the inside of the tire.	!
1.3	Lack of careful marking time	-
2.1	Work is hampered because it has to be reworked.	!
2.2	Repetition of work	!
2.3	There is the repetition of work.	!
3.1	The work is hampered because it has to be reworked.	!
3.2	Not as expected, so there is repetition.	!
4.1	Lack of imperfect glue, resulting in repetition of work.	!
4.2	Lack of imperfect glue, resulting in repetition of work.	!
4.3	The unification of the liner with the tire is not perfect, so there is the repetition of work.	!
4.4	Not as expected so that it repeats	!
4.5	There is the repetition of work.	!
6.1	Items are not suitable for use.	!

7. Strategies to fix errors

Table 6. Strategic Plan for Tire Retreading Process

Code	Consequence	Ordinal Error Probability	Critical Level	Strategic Plan
1.1	An error occurred when checking the tire surface	M	!	Improve operator Accuracy
1.2	An error occurred when checking the inside of the tire	M	!	Improve operator Accuracy
1.3	Lack of careful marking time	L	-	Improve operator Accuracy
2.1	Work is hampered because it has to be reworked	H	!	Improve operator Accuracy
2.2	Repetition of work	M	!	Improve operator Accuracy
2.3	There is the repetition of work	H	!	Improve operator Accuracy
3.1	The work is hampered because it has to be reworked	M	!	Improve operator skill
3.2	Not as expected, so there is repetition	L	!	Improve operator Accuracy
4.1	Lack of imperfect glue, resulting in repetition of work	M	!	Improve operator Accuracy
4.2	Lack of imperfect glue, resulting in repetition of work	H	!	Improve operator accuracy
4.3	The unification of the liner with the tire is not perfect, so there is the repetition of work.	M	!	Improve operator skill
4.4	Not as expected so that it repeats	M	!	Improve operator skill
4.5	There is the repetition of work	H	!	Improve operator accuracy
6.1	Items are not suitable for use	M	!	Improve operator accuracy

4.3. Calculation of the Probability of Human Error Occurrence with the HEART Method

The category of each work item in the Generic Task Type (GTT) category followed by the Nominal Human Error Probability value can be seen in the following table.

Table 7. Category of Work Items and Nominal Value of Human Error Probability in Tire Retreading Process

Task Number	*Task*	*Generic Task Type* (GTT)	Nominal *Human Error Probability*
1.1	Inspection of the outer tire casing	H	0,00002
1.2	Inspection of the inside of the tire	H	0,00002
1.3	Mark the tires	H	0,00002
2.1	Tires that have been scraped are brushed	G	0,0004
2.2	non-machine grinding	E	0,02
2.3	Patching in a wet place	C	0.16
3.1	Air Sprayed with Compressor	G	0,0004
3.2	Preparing tire glue	G	0,0004
4.1	Glue tires that have been cleaned	C	0.16
4.2	Gluing on the rubber liner	C	0.16
4.3	Attachment of rubber liner	C	0.16
4.4	Adhesion of the thin side of the tire	E	0,02
4.5	Envelope Installation	C	0.16
6.1	Cooking tires in the oven	C	0.16

1. Identify Error Producing Conditions (EPCs)
   Based on the results of direct observations and interviews, it can be described that the EPCs that affect the operator's work failure rate in the tire retreading process are as follows.
   a. Category I
      - EPCs 10 requires specific knowledge transfer in every work carried out without any missing or reduced information.
      - EPCs 9 requires a different technique (way) than usual.
      - EPCs 15, namely inexperienced operators (operators who have fulfilled the requirements for their work but are not yet classified as experts).
      - EPCs 20, i.e., an independent inspection of the output (results) little or maybe not checked.
      - EPCs 17, i.e., Independent examination of the output (results) is slight and maybe not

b. Category II
- EPCs 20, namely the operator's education level, is not according to the actual work needs.
- EPCs 22 is a little time to train the mind and body while working.
- EPCs 26, i.e., there is no clear way to maintain or increase supervision while doing work

2. Determine the proportion of effects or Assessed Proportion of Effect (APOE) and calculate the value of the Assessed Effect (AE) of each EPCs that have been identified.
Assessed Effect (AE) value is determined using:
AEi = ((Max. *Effect* -1) x APOE) + 1 (1)
The value of the Assessed Proportion of Effect (APOE) and the calculation of the value of the Assessed Effect (AE) can be seen in Table 4.9 below:

Table 8. Value of Proportion (APOE) and Calculation of AE on Tire Retreading Process

Table EPCs	EPCs	*Max. Effect*	AP-PLE	AE
10	There needs to be a specific transfer of knowledge in every job done, but without any information being lost or diminished	5,5	0,4	2.8
9	It takes a different technique (way) than usual in doing work	6	0,5	3.5
15	Inexperienced operator (operator who has fulfilled the requirements in carrying out his work but is not yet classified as an expert)	3	0,3	1.6
20	Operator education level does not match job requirements	2	0,2	1.2
17	Operator education level does not match job requirements	3	0,3	1,6
22	Little time is given to training the mind and body while doing work	1,8	0,2	1,16
26	There is no clear way to maintain or increase supervision during work	1,4	0,2	1.08

3. Calculating the total value of AE
Where n is the number of AEs identified as factor EPCs. The calculation of the total AE value for the operator in the tire retreading process is as follows. The total value of the Assessed Effect (AE) is calculated using the equation:
Total AE = AE_1 x AE_2 x AE_3 x ... x AE_n (2)
Total AE = 2.8 x 3.5 x 1.6 x 1.2 x 1.6 x 1.16 x 1.08 = 37.716
4. Calculating the value of Human Error Probability (HEP)
The HEP value is calculated using the equation:
HEP = HEP Nominal x Total AE (3)
The HEP value for each task in the tire retreading process can be seen in the following table:

Table 9. HEP Value in Tire Retreading Process

Task Number	*Generic Task Type* (GTT)	Nominal *Human Error Probability*	AE Total	HEP
1.1	H	0,00002	37,716	0.7543
1.2	H	0,00002	37,716	0.7543
1.3	H	0,00002	37,716	0.7543
2.1	G	0,0004	37,716	15,086
2.2	E	0,02	37,716	0,754
2.3	C	0.16	37,716	6,034
3.1	G	0,0004	37,716	15,086
3.2	G	0,0004	37,716	15,086
4.1	C	0.16	37,716	6,034
4.2	C	0.16	37,716	6,034
4.3	C	0.16	37,716	6,034
4.4	E	0,02	37,716	0,754
4.5	C	0.16	37,716	6,034
6.1	C	0.16	37,716	6,034
		Total		39,974
		Average		0,8552

4.4. Measurement of Human Reliability with SHERPA Method

Based on the analysis results that occurred in the tire retreading process, it was found that the error probability is included in the high category (often happens) and has a critical level of 2.3, 4.1, 4.2, 4.3, 4.5, and 6.1. The results of the SHERPA method for the high and essential level error probabilities can be seen in Table 10.

Table 10. SHERPA Results for High and Critical Level Categories

Code	Job description	Category	Critical Level
2.3	Patching in a wet place	High	!
4.1	Glue tires that have been cleaned	High	!
4.2	Gluing on the rubber liner	High	!
4.5	Envelope Installation	High	!
6.1	Cooking tires in the oven	High	!

The method used to overcome these human errors can be overcome by providing exceptional training to improve the control system and operator skills.

4.5. Measurement of Human Reliability with HEART Method

The percentage of each EPC factor in the tire retreading process can be seen in the following table:

Table 11. Rate of EPCs Factors for Tire Retreading Process

Serial Number	EPCs	AE	Percentage (%)
10	There needs to be a specific transfer of knowledge in every job done, but without any information being lost or diminished	2.8	21,63%
9	It takes a different technique (way) than usual in doing work	3,5	27,04%
15	Inexperienced operator (operator who has fulfilled the requirements in carrying out his work but is not yet classified as an expert)	1,6	12,36%
20	Operator education level does not match needs	1,2	9.27%
17	Independent checks of the output (results) are few and may not be checked	1,6	12,36%
22	Little time is given to training the mind and body while doing work	1,16	8,96%
26	There is no clear way to maintain or increase supervision during work	1,08	8,34%
	Total	12,98	100%

Based on the calculations in the table above, the average HEP value for all tasks that cause errors is 0.8552. This result shows that the probability of error made by the operator is 85.52%, so it can be seen that the reliability value of the operator in the tire retreading process is 14.48%.

Meanwhile, based on the percentage value in the table above, the percentage of causes of defects in the tire retreading process is the absence of a procedure for correcting errors, which is 21.63%, the need for a technique (way) that is different from usual in doing work to facilitate the operator, which is 27.04 %, the operator is inexperienced. Hence, the percentage is 12.36%, the operator's education level is not by the needs that are 9.27%, simple and a little independent inspection both have a rate of 12.36% At least the time given to the operator when carrying out work so that it has a percentage of 8.96%. There is no clear way to increase the supervision of operators by 9.09%.

5. Conclusion

Factors that cause product defects in the tire retreading process are the absence of a procedure for correcting errors, which is 21.63%, the need for a different technique (way) in doing work to make it easier for the operator, which is 27.04%, the operator is inexperienced. Hence, the percentage is 12.36%. The level of operator education does not match their needs, which is 9.27%, inexperience and a little independent inspection both have a percentage of 12.36%, At least the time given to work operators so has a rate of 8.96%. There is no clear way to increase operator supervision by 9.09%. Based on the results of human error identification, it is known that the type of error that often occurs in the tire retreading process is an action error, with the most error codes being a lot of wrong operator actions. Still, on the proper object (A7), the operator is wrong in dividing the time in doing work (A2), and the operator is not fit to do his job (A5). The results of the calculation of the HEP value show that the average HEP value in the tire retreading process is 0.8552 or 85.52%, while the operator reliability value is 14.48%.

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