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Maintenance Planning Tobacco Vibrator Machine With Reliability Centered Maintenance Method, And Failure Modes And Effect Analyze
[Planning Maintenance Machine *Tobacco Vibrators* With Method *Reliability Centered maintenance* , And ~~*Failure Modes And*~~ *Effect Analyze*]

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Abstract .

UD Tobacco Vibrator machines are used by Jati Wasesa, a tobacco processing firm. The issue that arises when a machine breaks down is that it disrupts the company's production. Downtime reduces output, increases operating expenses, and impacts customer service. Using tools like Failure Modes and Effects Analysis (FMEA) and Reliability Centered Maintenance (RCM), we want to dissect the machine's system. The process involves analyzing component damage data from the tobacco machine. A Pareto chart is then used to match this data with downtime data, with the highest frequency identified using FMEA and the RCM method. Based on the findings of this investigation, the electromotor, lower and upper nozzle, and roller components are completely reliable. Knowing what maintenance intervals the company must follow to ensure the engine keeps performing well and increases reliability figures for components is necessary because the reliability results on components show that each component needs maintenance action to restore engine performance and improve engine performance. After that, a maintenance system is suggested based on the outcomes of the component-specific maintenance time intervals in order to keep the electromotor engine running smoothly. When it's time for maintenance, the technician or engineer may take a closer look at each part of the machine to see whether it has to be replaced or if it only needs some temporary fixes. In order to get the engine running smoothly again, it is possible to do further checks such as relocating components that have moved, tightening their positions, and applying lubrication to prevent excessive wear on the components. There is a maintenance period of 27 days for the electromotor, 160 days for the lower and upper nozzles, and 330 days for the roller. Preventing damage to vital components, which may lead to lengthy downtime, is possible with this maintenance interval period. Firms have the option to establish a policy. upkeep to prolong a part's useful life

Keywords *– FMEA; Maintenance; Reliability Centered Maintenance*

Abstract .

UD Tobacco Vibrator machines are used by Jati Wasesa, a tobacco processing firm. The issue that arises when a machine breaks down is that it disrupts the company's production. Downtime reduces output, increases operating expenses, and impacts customer service. Using tools like Failure Modes and Effects Analysis (FMEA) and Reliability Centered Maintenance (RCM) [1], we want to dissect the machine's system.

This study employs RCM and FMEA methodologies to assess component degradation in the company's tobacco machines. When it comes to scheduling maintenance for machines, the RCM approach is useful since it offers priority tracking that is relevant to design. Simultaneously, the goal of the FMEA approach is to enhance safety and reliability by identifying possible manufacturing process problems. In this study, the dependability level of the electromotor components was found to be 50.8%, the lower and upper nozzles to be 21%, and the roller to be 29.4%. A drop in dependability is shown by the following values: electromotor reliability (0.51) after 27 days of operation, lower and upper nozzle reliability (0.21) after 160 days of usage, and roller reliability (330 days). At this period, the technician or engineer may do further examinations on each part to determine whether they need replacement or if they can be temporarily repaired. This is one kind of preventative maintenance. Tightening components that have moved or loosening their grip, as well as lubricating parts to prevent excessive wear and get the engine running smoothly again, are other possible checks. There is a maintenance period of 27 days for the electromotor, 160 days for the lower and upper nozzles, and 330 days for the roller. Preventing damage to vital components, which may lead to lengthy downtime, is possible with this maintenance interval period. Businesses may increase a component's useful life by instituting a program of routine maintenance.

Keywords *– FMEA; Maintenance; Reliability Centered Maintenance*

I. INTRODUCTION

A. Background

One company that employs Tobacco Vibrator machines is UD Jati Waseso, which processes tobacco. When it comes to sorting tobacco, the Tobacco Vibrator machine is crucial for maximizing efficiency and preserving product quality. But the Tobacco Vibrator machine might be damaged if used continuously outside of operating hours.

The Tobacco Vibrator machine has issues, such as a significant amount of downtime (up to 90 minutes) that occurs twice weekly, adding up to 180 minutes each week. The manufacturing of tobacco is disrupted, the quality of the tobacco produced drops, and there is a possibility of financial losses caused by machine downtime. Because of equipment failure, the daily output of 400 kg of tobacco, which is 50 kg per hour, is lowered. When machines break down, it may have a negative impact on a business's productivity. This is because downtime reduces production, increases operating expenses, and impacts customer service. The Yilmak Machine Laundry has a high rate of downtime, reaching 9,180 minutes, according to the conducted data. In most cases, production times are extended due to breakdowns, which lead to this circumstance. Accumulated start delays exceeding two or three shifts simultaneously are the consequence of manufacturing process disruption caused by excessive downtime. The purpose of this study is to examine the machine's system through the lenses of Failure Modes and Effects Analysis (FMEA) and Reliability Centered Maintenance (RCM). At [3]the Tenayan Raya PLTU, the Tenayan PLTU Conveyor system has seen 71 interruptions in the last three years. Because of this, there are a lot of CM tasks, which might raise maintenance expenses, downtime, and the possibility of losses. Prior research from [4]case studies also indicates that the Sungai Niru Business Unit of PT. Perkebunan Nusantara VII (Persero) has a high rate of engine breakdowns. Studying this challenge and proposing a system maintenance machine that uses the Reliability Centered Maintenance (RCM) strategy will help you solve it. The SEYI SN-110 Ton press machine has a high rate of downtime, according to previous research from [5]case studies at PT. Padma Soode Indonesia. Collecting data reveals a crucial proportion of 77% and 40 instances of internal engine damage in a year. Because of this damage, productivity takes a significant hit; on a typical day, production lasts 8 hours each shift, and downtime levels might exceed 8 hours, thereby canceling out output for the day.

Prioritizing evaluations of system components' dependability and relevance is RCM's maintenance method [6]. The objective is to identify the therapy activity that is both the most effective and the most efficient. Furthermore, this method places an emphasis on preventative maintenance in order to forestall breakdowns and other problems that can interrupt output. FMEA is a technique that attempts to examine the many failure modes of a system with multiple components and how they impact the system's functioning. The Risk Priority Number (RPN) is a relative risk measurement that is also computed using FMEA. By multiplying the values of Severity, Occurrence, and Detection, we get the RPN. The goal is to evaluate the many failure modes of multi-component systems and how they affect system function, as well as to arrange maintenance plans appropriately. From the issues mentioned earlier, it is clear that the organization employs FMEA and Reliability Centered Maintenance (RCM) strategies to reduce machine downtime and optimize maintenance plans.

Study completed with set goals This is to learn how the multi-component system fails and how it affects the system's function so that the best maintenance action can be determined.

II. Method

A. Time and place Study

This research was carried out at UD. Jati Waseso is located in Ketapang Village, Tanggulangin, Sidoarjo, East Java. This research was carried out for 6 months starting from November 2023 to April 2024.

B. Data retrieval

In this research, data collection will be carried out using several methods to complete the case study conducted at UD. Jati Waseso, there are two types of data used, namely primary data and secondary data.

1. Secondary Data: The secondary data required involves literature study, production data, breakdown data, schedule or type of maintenance for the *Tobacco Vibrator machine* at UD Jati Waseso.
2. Primary Data: The following is the primary data needed to obtain the information that is the problem in this research.
   a. Observation

      In order to gather the required information, such as data on the machine's condition and any available maintenance, researchers observe every step of the tobacco chopper's production process, document any machine damage that occurs during production, and finally, identify the object of study.

   b. Interview →

      Employees and partners in the production department were interviewed. Those with first-hand knowledge of the issue under investigation were the ones chosen to participate in the interview procedure. The interviews were carried out five times using a series of questions, and the data gathered from these interviews

was considered relevant. Machine performance, breakdowns, and damage history from the six months beginning in November 2022 and ending in April 2023 are all included in the interview data.

C. Research Flow

research flow diagram showing the stages in the research carried out, the following is a research flow diagram which can be seen in Figure 1.

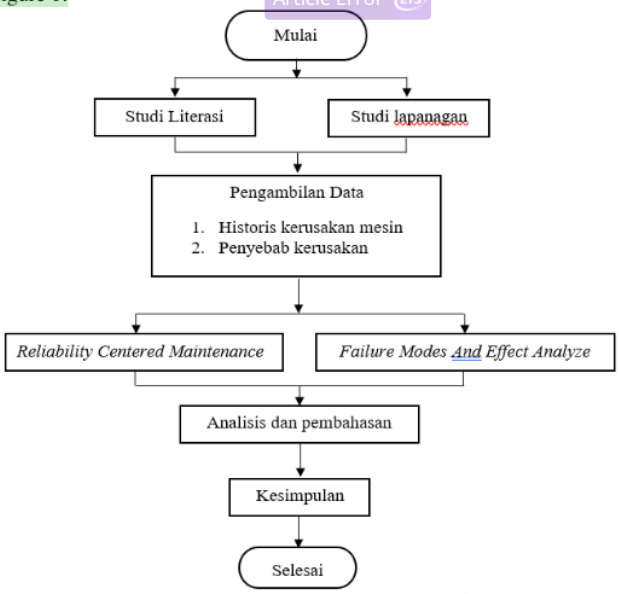

Figure 1. Research Flow Diagram

The steps that can be taken in the data processing process include:

1. RCM is a method that relies on technology to find out what needs fixing so that maintenance plans may be made. The formula employed is: Mark best reliability-based replacement component. Here is the formula to determine the dependability value:

$$R(t) = 1 - F(t) \quad (1)$$

Downtime

$$D(tp) = \frac{Tp.R(tp) + Tf.(1-R(tp))}{(tp+Tp).R(tp) + (M(tp)+Tf).(1-R(tp} \quad (2)$$

Information :

β = shape parameters

θ = scale parameter

t = time (variable)(hour)

e = error value

According to IEC 60300-3-10, the worldwide standard for reliability measurement in RCM, the measurement criteria for determining maintenance-supportive preventative maintenance is no more than 85%. Identifying broken parts of the tobacco machine. You may use a Pareto chart that is suitable for downtime data to identify the damaged components by knowing the greatest frequency.

2. FMEA is a technique that attempts to examine the many failure modes of a system with multiple components and how they impact the system's functioning. The Risk Priority Number (RPN) is a relative risk measurement that is also computed using FMEA. You may calculate RPN by multiplying the values of Severity, Occurrence, and Detection.

Here is a formula for the FMEA calculation, which is :

$$RPN = S \times O \times D \quad (3)$$

Information:

S = Severity

O = Occurrence

D = Detection

The next step in determining the proportion of key components is to identify the parts of the Tobacco Vibrator machine. With a total score of 801, the Electromotor machine is the machine with the highest RPN rating.

3. RCM is a process that users are supposed to carry out within their existing operating circumstances in order to establish what is needed to keep all physical resources in use.As shown in the accompanying graphic, the number of failures often follows a "bath-up curve" and all machines employed have a life limit; this is the core premise of RCM.

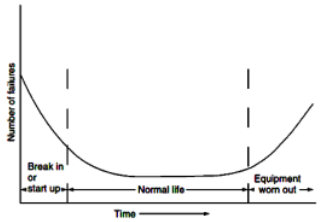

Figure 1 Predictive Maintenance [7]

In a maintenance-based strategy, fixing, maintaining, or replacing equipment doesn't happen until it stops working. The assumption behind this kind of maintenance is that the likelihood of failure in different parts, components, or systems is equal. Infrequent maintenance attempts, a high proportion of unscheduled maintenance tasks, and high component replacement rates are widespread when reactive maintenance is infrequently implemented. Item survival seems to be affected by the reactive maintenance program as well. [8].

4. One must first ascertain the distribution of TTF and TTR data. Each essential part has to guess based on the location of the error level in the distribution as to whether or not the damage data follows the Weibull distribution in order to find this distribution.
   Weibul distribution Probability Density Function formula [9]:

$$f(t) = \frac{\beta}{\theta}\left(\frac{t}{\beta}\right)^{\beta-1} e^{(\frac{t}{\theta})\beta}$$

5. Verifying that the dissemination of flawed data is appropriate. When determining if a suspected data distribution pattern is appropriate for further processing, the quality of the acquired TTF and TTR data is used in checking operations.
6. By using the characteristics of the suitable fault interval distribution, one may compute the time required for maintenance intervals. In order to maximize component utilization while minimizing maintenance and losses

III. Results and Discussion

From the collection of data obtained, it was found that the contribution to damage from the vital elements in the form of:

Table 1 RCM data

RCM II *Decision Worksheet*			SYSTEM: TOBACCO MACHINE OPERATION SUBSYSTEM: TOBBACO MACHINE			*Facilitator:* *Auditors :*		*Date:* *Year :*
No	Component	*Function*	*Potential Failure Mode*	*Potential Effects Of Failure*	*Potential Cause Of Failure*	Consequence failure	Actions Given	Maintenance Actions Taken
2	*Lower and upper nozzles*	Upper and lower nozzles	*Electode* pin ejects splash fire	Experiencing wear on *the electrode pin*	control nozzle section	Operational Consequence	Done inspection and detection potency failure	Recovery Condition Component
				pin *electrode* experiences slack	checking at home dynamo	Operational Consequence	Done inspection and detection potency failure	Recovery Condition Component
			Contactor cable saggy	Resulting bolt fast free	Control part in nozzle housing	Operational Consequence	Done inspection and detection potency failure	Recovery Condition Component
			pressure in *the nozzle housing* No stable	Age use machine reduce	control on the nozzle housing	Operational Consequence	Done inspection and detection potency failure	Recovery Condition Component
				Resulting *nozzle* broken	Done replacement bolt	Operational Consequence	Done inspection and detection potency failure	Recovery Condition Component
			Contact fit dead end	Experience damage to *the contact fit*		Operational Consequence	Done inspection and detection potency failure	Replacement Component
3	*Rollers*	Motion Roller	Top Roller	Experience damage to *the bearing*	replacing rollers	Operational Consequence	Control lubrication in a way scheduled	Recovery Condition Component
				Position *bearing* experience shift	control load on the roller	Operational Consequence	Checking position *bearings* on rollers moved	Replacement Component
			Deep Roller	Damage to the drive *gear teeth*	control roller load	Operational Consequence	Check the drive gear	Recovery Condition Component
				Position *gear* experienced shift				

Based on the results of RCM data collection, it shows that the element that has undergone massive improvements is the Electromotor. These results show that the majority of repairs refer to restoring the condition as a whole, so that component replacement cannot be done directly but rather through light action in the form of welding.

Table 2
Reliability Calculation Results

Component	R(t)	R(t)%
Electromotor	0.50	50%
Lower and Upper Nozzles	0,21	21%
Roller	0,29	29%

A dependability calculation is the next step in determining how dependable the electromotor machine's parts are. In addition to that, it's primary function is to calculate the ideal service life of the electromotor machine's parts. Each component's dependability estimations are summarized in Table 2. These findings indicate that the electromotor component has a degree of dependability of 50.8%, the lower and upper nozzles of 21%, and the roller of 29.4%. A drop in dependability is shown by the following values: electromotor reliability (0.51) after 27 days of operation, lower and upper nozzle reliability (0.21) after 160 days of usage, and roller reliability (330 days). Based on the component reliability results, it is clear that each part needs maintenance to get the engine running well again. To keep the engine running well and even improve its performance, the company needs to determine how often it needs to perform maintenance (see table 4). dependability metrics for parts.

Processing data and doing computations to back the study. Knowing the RPN values—severity, occurrence, and detection—is necessary for the first stage in calculating the Failure Modes and Effects Analysis (FMEA). When damage happens before the set period, the task of establishing maintenance intervals is performed.

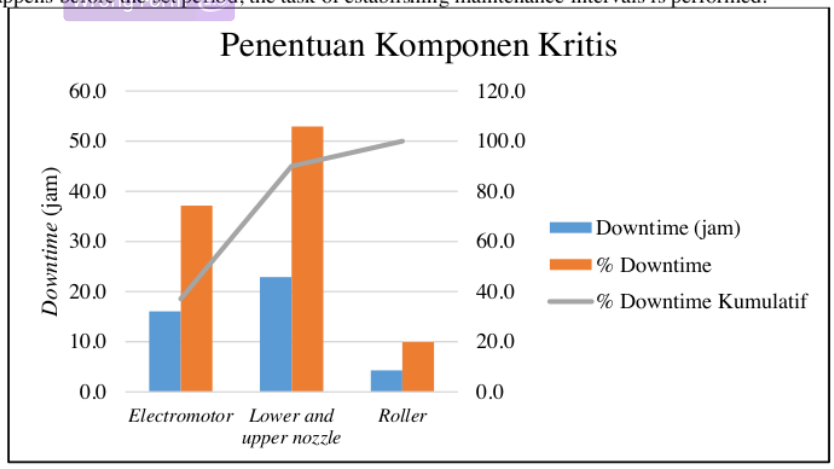

Figure 2 Downtime Value

To ensure that component usage is always optimum and does not lead to excessive maintenance and losses due to replacement, component replacement is carried out when the optimal maintenance life is determined from the previous component replacement maintenance.

Two highly-regarded specialists from UD Jati Waseso's production and engine departments are involved in determining the RPN weight figure. These findings highlight the significance of giving the Electromotor machine top priority when it comes to maintenance. In the electromotor machine, you can find the stator temperature—which peaks at 48 RPN—the nozzle—which peaks at 180 RPN—and the roller—which peaks at 160 RPN. The electromotor machine's vibrator, stator ground, and temperature are the three components that need prioritization according to the RPN findings for each component. support structure. The distribution of repair and damage time data is then determined by carrying out the machine spare parts components. You can see the RPN values for all of the machines in table 3.

Table 3
FMEA Analysis RPN Results

Machine	RPN
Electromotor Machine	714
Nozzles	472
Rollers	368

Source: data processed by researchers, 2024

Determining the appropriate distribution for repair and damage time data can be done using the index of fit calculation across all distributions. Each component of the engine's spare parts will have its distribution type determined by the

next fit index computation, which will take the value of the biggest fit index into account. Table 4 displays data on repair timeframes and damage to important machinery as assessed using the FMEA approach.

Table 4
Machine TTF and TTR data

Data on Repair Time and Machine Damage				
	Damage Date			
Component	Start	Finished	TTR (days)	TTF (days)
Electromotor	01/25/2023 08.53	01/25/2023 13.04	4.18	-
	05/18/2023 08.38	05/18/2023 14.48	6.17	572.57
	06/23/2023 13.20	06/23/2023 16.05	2.75	527.53
	02/08/2023 08.22	02/08/2023 11.20	2.97	377.28
Lower and Upper Nozzles	01/10/2023 09.45	10/01/2023 16.05	6,33	-
	03/30/2023 10.13	30/03/2023 15.20	5,12	731,13
	06/24/2023 10.13	24/06/2023 15.20	5,12	266,88
	02/08/2023 09.45	02/08/2023 16.05	6,33	90,42
Roller	04/03/2023 07.50	04/03/2023 10.44	2,90	-
	22/07/2023 09.20	22/07/2023 10.44	1,40	463,60
	01/11/2023 08.50	01/11/2023 10.44	1,90	439,10

The distribution is chosen using the greatest fit index value, which is computed using the least square curve fitting technique. Exponential, Weibull, and lognormal distributions are some of the distributions used to determine failure time. The next step is to choose a distribution and use it to inform your parameter computations. Table 5 displays the results of manually computing the parameter values for each distribution that was chosen.

Table 5
Calculation of Selected Distribution Parameters (Manual)

Component	Distribution (TTR)	Parameter	Distribution (TTF)	Parameter
Electromotor	Weibull	α=1,51 β =68,74	Weibull	α=4,23 β =540,01
Lower and Upper Nozzle	Eksponensial	λ =0,17	Weibull	α=0,92 β =427,84
Roller	Eksponensial	Λ= 0,48	Weibull	α=23,45 β =459,20

The distribution is chosen using the greatest fit index value, which is computed using the least square curve fitting technique. Exponential, Weibull, and lognormal distributions are some of the distributions used to determine failure time. The next step is to choose a distribution and use it to inform your parameter computations. Table 5 displays the results of manually computing the parameter values for each distribution that was chosen.

Mean Time to Repair (MTTR) and Mean Time to Failure (MTTF) values are computed after getting the parameter values for each distribution of TTR and TTF values. This section summarizes the MTTR and MTTF computations for each component based on the distribution that was chosen.

Table 6
MTTR and MTTF calculation results

Component	MTTR	MTTF
Electromotor	68.74 days	540.01 days
Lower and Upper Nozzles	0.38 days	427.84 days
Rollers	0.48 days	459.20 days

For each component, we can get the results of the manual computation recapitulation of MTTR and MTTF in Table 6. The electromotor part has an MTTR value of 68.74, the lower and upper nozzle parts have an MTTR value of 0.38, and the roller part has an MTTR value of 0.48. Electromotor, lower and upper nozzle, and roller components all have MTTF values of 540.01, 427.84, and 459.20, respectively.

A machine's or component's average time to failure is its MTTF value. The MTTF number indicates the duration of time before the components' performance declines to the point where they may be destroyed or malfunction, leading to production losses. A component's maintenance and repair priorities should be based on its MTTF value; a lower number indicates a higher likelihood of damage.

With an MTTF value of 427.84, the Lower and Upper Nozzle components are the ones with the least MTTF. Companies should pay close attention to component maintenance intervals so that they can fix the Lower and Upper Nozzle components promptly because of the increased likelihood of frequent damage. Find a solution when parts are broken.

A machine's or component's average repair time may be seen by looking at its MTTR value, which is a benchmark. Machine maintainability decreases when MTTR values increase for both components and the whole machine. Based on the distribution parameters used in the preceding calculation results, the MTTR results were achieved. With a value of 68.74 days, the electromotor component had the highest MTTR. This finding indicates that that amount of time is needed to check, fix, and replace components on average during repairs.

Because the firm does not supply replacement components, component work necessitates advance component ordering, which in turn causes the disassembly process to be cautious, which in turn increases the repair time and contributes to the big MTTR value. Preparing all the resources required for maintenance, including new components and equipment, is the appropriate thing for businesses to do to ensure this doesn't happen again. Doing so will further decrease the amount of time needed to repair in the next period, which in turn will decrease the amount of time the system is down. [10].

The next process is to provide maintenance scheduling suggestions for each component. Proposed maintenance scheduling is shown in Table 7.

Table 7
Maintenance Interval Time

Component	Component Maintenance Interval (days)
Electromotor	27
Lower and Upper Nozzles	160
Rollers	330

Table 7 shows the results of the calculations done to determine the recommended maintenance time intervals for each component of the electromotor engine [11]. When it's time for maintenance, the technician or engineer may take a closer look at each part of the machine to see whether it has to be replaced or if it only needs some temporary fixes. Tightening components that have moved or loosening their grip, as well as lubricating parts to prevent excessive wear and get the engine running smoothly again, are other possible checks. There is a maintenance period of 27 days for the electromotor, 160 days for the lower and upper nozzles, and 330 days for the roller. Preventing damage to vital components, which may lead to lengthy downtime, is possible with this maintenance interval period. Businesses may increase a component's useful life by instituting a program of routine maintenance.

IV CONCLUSION

The results of this test show that companies need to pay attention to component maintenance times so that they can immediately deal with them when components are damaged. In order to restore engine performance so that the performance of the engine can be improved, it is necessary to know what maintenance intervals the company must carry out so that the engine continues to perform well and increase the reliability of the components. Maintenance that can be carried out at time intervals is that a technician or engineer can carry out further inspections on each component to see whether there are signs that indicate the machine components need to be replaced or only need temporary repairs. This is to avoid fatal damage, by having maintenance intervals this can prevent damage to critical components which causes long periods of downtime, companies can implement maintenance policies to extend the service life of a component.

THANK-YOU NOTE

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Sp. This word is misspelled. Use a dictionary or spellchecker when you proofread your work.

P/V You have used the passive voice in this sentence. Depending upon what you wish to emphasize in the sentence, you may want to revise it using the active voice.

Missing "," You may need to place a comma after this word.

Article Error You may need to use an article before this word.

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Run-on This sentence may be a run-on sentence. Proofread it to see if it contains too many independent clauses or contains independent clauses that have been combined without conjunctions or punctuation. Look at the "Writer's Handbook" for advice about correcting run-on sentences.

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Confused You have used **lead** in this sentence. You may need to use **led** instead.

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Article Error You may need to remove this article.

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PAGE 4

Wrong Article You may have used the wrong article or pronoun. Proofread the sentence to make sure that the article or pronoun agrees with the word it describes.

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Sp. This word is misspelled. Use a dictionary or spellchecker when you proofread your work.

Dup. You have typed two **identical words** in a row. You may need to delete one of them.

Missing "," You may need to place a comma after this word.

Sp. This word is misspelled. Use a dictionary or spellchecker when you proofread your work.

Proofread This part of the sentence contains a grammatical error or misspelled word that makes your meaning unclear.

Missing "," You may need to place a comma after this word.

Article Error You may need to use an article before this word.

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Garbled Grammatical or spelling errors make the meaning of this sentence unclear. Proofread the sentence to correct the mistakes.

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Wrong Form You may have used the wrong form of this word.

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Article Error You may need to remove this article.

PAGE 7

Possessive You may need to use an apostrophe to show possession.

Sp. This word is misspelled. Use a dictionary or spellchecker when you proofread your work.

Missing "," You may need to place a comma after this word.

Sp. This word is misspelled. Use a dictionary or spellchecker when you proofread your work.

Compound These two words should be written as one compound word.

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Article Error You may need to use an article before this word.

Possessive This word may be a plural noun and may not need an apostrophe.

PAGE 8

Possessive This word may be a plural noun and may not need an apostrophe.

Sp. This word is misspelled. Use a dictionary or spellchecker when you proofread your work.

Article Error You may need to use an article before this word. Consider using the article **the**.

Article Error You may need to use an article before this word.

Missing "," You may need to place a comma after this word.

Article Error You may need to remove this article.

Article Error You may need to use an article before this word. Consider using the article **the**.

Sp. This word is misspelled. Use a dictionary or spellchecker when you proofread your work.

Verb This verb may be incorrect. Proofread the sentence to make sure you have used the correct form of the verb.

S/V This subject and verb may not agree. Proofread the sentence to make sure the subject agrees with the verb.

Sp. This word is misspelled. Use a dictionary or spellchecker when you proofread your work.

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