

Design local exhaust ventilation on sieve machine at PT.Perkebunan Nusantara VIII Ciater using design for assembly (DFA) approach with *Boothroyd and Dewhurst method*

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Abstract. PT Perkebunan Nusantara VIII Ciater is a company produced black tea orthodox more or less 4 tons every day. At the production section, PT Perkebunan Nusantara VIII will use local exhaust ventilation specially at sortation area on sieve machine. To maintain the quality of the black tea orthodox, all machine must be scheduled for maintenance every once a month and takes time 2 hours in workhours, with additional local exhaust ventilation, it will increase time for maintenance process, if maintenance takes time more than 2 hours it will caused production process delayed. To support maintenance process in PT Perkebunan Nusantara VIII Ciater, designing local exhaust ventilation using design for assembly approach with Boothroyd and Dewhurst method, design for assembly approach is choosen to simplify maintenance process which required assembly process. There are 2 LEV designs for this research. Design 1 with 94 components, assembly time 647.88 seconds and assembly efficiency level 23.62%. Design 2 with 82 components, assembly time 567.84 seconds and assembly efficiency level 24.83%. Design 2 is choosen for this research based on DFA goals, minimum total part that use, optimization assembly time, and assembly efficiency level.

Keywords: local exhaust ventilation, design for assembly, maintenance process

1. Introduction

PT. Perkebunan Nusantara VIII has a tea plantation area more or less 400 hectares. Tea plantation utilized to produced black tea orthodox. Every day PT PN VIII plucked approximately 10 tons of wet tea leaves and then processed and produced dry tea powder approximately 4 tons. Every industry have a ventilation system to keep circulation of air and to vacuum the contaminants that can cause dangers for workers. PT Perkebunan Nusantara VIII will use local exhaust ventilation as artificial ventilation that will be placed in sortation area specially on sieve machine because sieve machine generate a lots contaminants like dusts that can caused dangers. Local exhaust ventilation [2] need to be maintenance routinely to keep the system well. Maintenance in PT Perkebunan Nusantara is scheduled every 1 months during work hours [4]. Maintenance process approximately 2 hours to checked all of production machines. With additional of local exhaust ventilation can caused extra time for maintenance and will caused production process delayed. So, for this research for designing local exhaust ventilation using design for assembly approach to minimize time of assembly and maintenance. Goals of design for assembly are to minimize parts, minimize time of assembly, optimize efficiency assembly level. To determine assembly time and efficiency assembly level, qualitative methods is needed. In this research use Boothroyd and Dewhurst method to determine assembly time and efficiency assembly level. Hopefully with designing local exhaust ventilation use



design for assembly approach can support maintenance process and will not caused production process delayed.

2. Methods

Structured study with do some observations by researchers in PT PN VIII that expected to determine the problems of the company and provides problem solving for company.

This research directly observe in sortation area and interviews some workers and supervisor to get know what the problem is, based on that observation researchers proposed to implemented local exhaust ventilation to solve the problems. For the design local exhaust ventilation, researchers do some observe from literature, and others media, then designing recommendation proposed design to be analyze in design for assembly approach, and choose the best design.

2.1 Design For Assembly

This method depends on the design that will be evaluated and improve continuously. There are 4 primary expected in design for assembly results [3]:

1. Reduced material cost.
2. Reduce labor and automatic assembly.
3. Reduced assembly cycle time.
4. Higher product quality and reliability.

2.2 Boothroyd and Dewhurst Method

Quantative method to calculate efficiency assembly level, there are 2 steps to analyze efficiency assembly level [1].

$$E = NM. ta/TM \quad (1)$$

Where,

E = Theorical minimum item count
 Ta = Actual assembly process time for the product
 TM = Total assembly process time for all item.

2.3 Local Exhaust Ventilation

Local exhaust ventilation system is artifial engineering control to handle and reduce air contaminants in workplace such as dust, fog, steam and also gases [2].

3. Result and Discussion

3.1 Result

Researchers observe the area on the sieve machine, to decide the proposed design local exhaust ventilation that will be applied. Researchers proposed 2 design in this research then make different assembly methods, and parts, then analyze 2 proposed design then evaluate the design after that choose the best proposed design.

A. Design 1**Figure 1.** Proposed Design 1 Local Exhaust Ventilation

Proposed design 1, determine parts, dimension, and fastener based on benchmarking from literature, and others media.

Table 1. Proposed Design 1 Components

Design 1			
No	Component	Quantity	Description
1	Exhaust Fan	1	Base Part
2	Air Cleaner Pad	1	Base Part
3	Pole Support	6	Base Part
4	Exhaust Fan Pipe	1	Main Parts
5	Support Ring	6	Main Parts
6	Top outlet	1	Main Parts
7	Bottom outlet	1	Main Parts
8	Silinder vertical	1	Main Parts
9	Main Pipe	1	Main Parts
10	Hood	2	Main Parts
11	Flange	5	Fastener
12	Screw 10	12	Fastener
13	Screw 23	40	Fastener
14	Mur 23	16	Fastener

Based on the proposed design 1 there are 14 kind of parts consist of 94 components that needed for design 1. Next step is determine total operation for proposed design 1 that shown in tabel below.

Table 2. Total Assembly Operation Design 1

No	Sub Assemblies	Total assembly operation
1	<i>Exhaust fan</i>	4
2	<i>Air cleaner</i>	3
3	<i>Hood and Main Pipe</i>	8
4	<i>Air cleaner dan exhaust fan</i>	2
5	<i>Pipa Pipe and air cleaner</i>	1
Total		18

Boothroyd and Dewhurst Method for design 1. Total operation time for assembly 647.88 secs with efficiency assembly level 23.62 %

Table 3. Manual Assembly Design 1

Desain 1				
A		B	G	H
ID	Part Name	Number of times the operation carried out	Operation time (TM), Bx(D+F) (sec)	Theoretical minimum part (NM)
1 Assembly Exhaust Fan				
1.1	Exhaust Fan (Base Part)	1	-	-
1.2	Pipa exhaust fan	1	15.5	1
1.3	Screw 23	8	64.48	4
1.4	Tiang Support (Base Part)	1	-	-
1.5	Ring Penyangga	1	12.1	1
1.6	Screw 10	2	16.12	2
2 Assembly Air Cleaner				
2.1	Wadah Air Cleaner (Base part)	1	-	-
2.2	Pipa outlet atas	1	7.1	0
2.3	Silinder vertikal	1	5	1
2.4	Pipa outlet bawah	1	11.6	0
3 Assembly Pipa Exhaust dan Air Cleaner				
3.1	Flange	1	3.5	0
3.2	Screw 23	8	64.48	4
4 Assembly Pipa Utama dan Hood				
4.1	Pipa Utama	1	15.5	1
4.2	Flange Pipa Utama	2	7	0
4.3	Hood	2	19	2
4.4	Flange Hood	2	15	0
4.5	Screw 23	16	56.96	8
4.6	Mur 23	16	128.96	8
4.7	Tiang Support (Base Part)	5	-	-
4.8	Ring Penyangga	5	60.5	5
4.9	Screw 10	10	80.6	10
5 Assembly Pipa Utama dan Air Cleaner				
5.1	Screw 23	8	64.48	4
Total Part		94	647.88	51
Efficiency Formulation			$3 \times (NM/TM)$	
Efficiency			23.62%	

B. Design 2

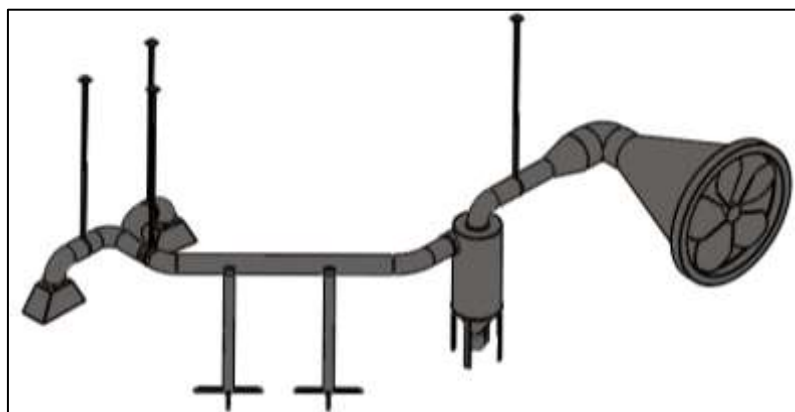


Figure 2. Proposed Design 2 Local Exhaust Ventilation

Proposed design 2, based on design 1 make an improvement from proposed design before like do simplification parts, and reduce fastener components.

Table 4. Proposed Design 2 Components

Design 2			
No	Component	Quantity	Description
1	Exhaust Fan	1	Base Part
2	Air Cleaner Pad	1	Base Part
3	Pole Support	4	Base Part
4	Floor Pole Support	2	Main Parts
5	Exhaust fan Pipe and top outlet	1	Main Parts
6	Support Ring	4	Main Parts
7	Bottom outlet	1	Main Parts
8	Silinder vertical	1	Main Parts
9	Main Pipe	1	Main Parts
10	Hood	2	Main Parts
11	Screw 10	8	Fastener
12	Screw 23	40	Fastener
13	Mur 23	16	Fastener

Based on the proposed design 2 there are 13 kind of parts consist of 82 components that needed for design 2. Next step is determine total operation for proposed design 2 that shown in tabel below

Table 5. Total Assembly Operation Design 2

No	Sub Assembly	Number of assembly operation
1	<i>Exhaust fan</i>	4
2	<i>Air Cleaner</i>	2
3	<i>Hood and Main Pipe</i>	8
4	<i>Air cleaner and exhaust fan</i>	1
5	<i>Main Pipe and air cleaner</i>	1
Total		15

Boothroyd and Dewhurst Method for design 2. Total operation time for assembly 567.84 secs with efficiency assembly level 24.83 %.

Table 6. Manual Assembly Design 2

Design 2				
A		B	G	H
ID	Part Name	Number of times the operation	Operation time (TM), $B \times (D+F)$ (sec)	Theoretical minimum part (NM)
1 Assembly Exhaust Fan				
1.1	Exhaust Fan (Base Part)	1	-	-
1.2	Pipa exhaust fan	1	15.5	1
1.3	Screw 23	8	64.48	4
1.4	Tiang Support (Base Part)	1	-	-
1.5	Ring Penyangga	1	12.1	1
1.6	Screw 10	2	16.12	2
2 Assembly Air Cleaner				
2.1	Wadah Air Cleaner (Base part)	1	-	-
2.2	Silinder vertikal	1	5	1
2.3	Pipa outlet bawah	1	11.6	0
3 Assembly Pipa Exhaust dan Air Cleaner				
3.1	Screw 23	8	64.48	4
4 Assembly Pipa Utama dan Hood				
4.1	Pipa Utama	1	15.5	1
4.2	Hood	2	19	2
4.3	Screw 23	16	56.96	8
4.4	Mur 23	16	128.96	8
4.5	Tiang Support (Base Part)	3	-	-
4.6	Ring Penyangga	3	36.3	3
4.7	Screw 10	6	48.36	6
4.8	Tiang Support Lantai	2	9	2
5 Assembly Pipa Utama dan Air Cleaner				
5.1	Screw 23	8	64.48	4
Total Part		82	567.84	47
Efficiency Formulation			$3 \times (NM/TM)$	
Efficiency			24.83%	

3.2 Discussion

Table 7. Comparison

Comparison			
No	DFA Goals	Design 1	Design 2
1	Total Components (piece)	94	82
2	Total Assembly Time (sec)	647.88	567.84
3	Efficiency (%)	23.6%	24.8%

The comparison proposed design between both design changes with design 1 with 94 components can be reduced until 82 components in design 2 and assembly time 567.84 sec with efficiency level 24.8%. Its believed that design 1 is the best design to implemented in PT Perkebunan Nusantara with minimum assembly time for maintenance process. With minimize assembly time for local exhaust ventilation, its hoped that maintenance process for all machine in PT Perkebunan Nusantara VIII will not caused extra time for maintenance process, and production will continue without delay.

4. Conclusion

Based on the results of comparison proposed design, that design 2 is choosen as the best design to be implemented in sortation area for supporting maintenance process based on research problem in PT. Perkebunan Nusantara VIII. Design 2 required 82 components with assembly time 567.84 sec with efficiency 24.8%. Design 2 is fulfill DFA goals and its hoped can achieve of this research.

5. References

- [1] Boothroyd and Dewhurst 1994 *Product Design for Manufacture and Assembly*. (New York: Marcel Dekker, Inc).
- [2] Health and Safety Authority 2014 Local and Exhaust Ventilation Guidance. (Ireland: Health and Safety Authority).
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