CHAPTER 6
CONCLUSIONS AND SUGGESTIONS

6.1. Conclusions

Based on the case study on the production of raw plywood in PT. Asia Forestama Raya by implementing Lean Six Sigma project, conclusions drawn are as follows:

a. AHP is a well-proven decision-making tool to select major lean waste according to the decision-maker considerations. Obtained results indicate that defect is selected as major lean waste with the percentage of 43%, followed by transportation (18%), inventory (15%), overprocessing (14%), and motion (10%).
b. Most dominant defect found in the production process of 2.7mm LFE raw plywood is uneven core thickness with the percentage of 29.58 % before Lean Six Sigma implementation. Solutions implemented are based on PFMEA highest RPN value and feasibility discussion with team members such as developing Uroko rotary machine setting parameters work instructions (dogging setting, knife cutting angle setting, and pressure bar setting) and socialization in a curriculum-based training. The percentage of uneven core thickness decreased by 3.0% into 26.58% after Lean Six Sigma implementation. Overall defect rate is also decreased by 0.88% from 3.04% to 2.15%

6.2. Suggestions

Several suggestions are given to enhance furher study of Lean Six Sigma as follows:

a. Combination of Andon systems with supervisory control and data acquisition (SCADA) systems to enhance Andon data processing, analysis and its effect towards quality and productivity.
b. Comparison of other decision-making tools to select major lean waste such as paired comparison analysis and the Quantitative Strategic Planning Matrix (QSPM).
c. Implement DMAIC problem-solving methodology in solving other types of lean waste possessed in PT. Asia Forestama Raya production system.
d. Select major lean waste using waste relationship matrix (WRM) methodology.

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APPENDICES

Appendix 1. Interview Results (Data Collection Phase 1)

Materials in the Appendix 1 can be found in the attached compact disc (CD).

Appendix 2. AHP Questionnaire

Materials in the Appendix 2 can be found in the attached compact disc (CD).

Appendix 3. Questionnaire Results (Data Collection Phase 2)

Materials in the Appendix 3 can be found in the attached compact disc (CD).

Appendix 4. AHP Evaluation (Criteria)

Materials in the Appendix 4 can be found in the attached compact disc (CD).

Appendix 5. AHP Evaluation (Alternative)

Materials in the Appendix 5 can be found in the attached compact disc (CD).

Appendix 6. Consistency Evaluation Summary

Materials in the Appendix 6 can be found in the attached compact disc (CD).

Appendix 10. Rotary Machine Operator Training Module

Materials in the Appendix 10 can be found in the attached compact disc (CD).

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Appendix 7

Lean Waste Ranking

Criteria	Weight Value	Transportation (W1)	Inventory (W2)	Motion (W3)	Overprocess (W4)	Defect (W5)
		Global Weight	Global Weight	Global Weight	Global Weight	Global Weight
Output (C1)	0.343	0.057	0.059	0.032	0.042	0.153
Production Cost (C2)	0.257	0.086	0.051	0.015	0.031	0.075
Grade Result (C3)	0.400	0.041	0.039	0.051	0.069	0.199
Total Score		0.184	0.150	0.098	0.141	0.428

Lean Waste	Global Weight	Ranking
Transportation (W1)	0.18	2
Inventory (W2)	0.15	3
Motion (W3)	0.10	5
Overprocess (W4)	0.14	4
Defect (W5)	0.43	1

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Appendix 8

2.7 mm LFE Raw Plywood Grading Results

Table 1. Plywood Grading Result in January 2017 to January 2018 (Monthly Basis)

2.7 mm LFE Raw Plywood (2.7 x 1220 x 2440 mm)																	
Month	**U (pcs)**	**D (pcs)**	**Defect Type**														
			A1	**A2**	**A3**	**A4**	**B1**	**B2**	**B3**	**B4**	**C1**	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**
January 2017	41,623	1093	0	104	0	237	0	0	0	137	262	70	0	0	26	177	80
February 2017	15,455	381	0	39	0	84	0	0	0	58	88	18	0	0	9	54	31
March 2017	20,673	515	0	41	0	116	0	0	0	66	122	20	0	0	14	88	48
April 2017	30,551	769	0	78	0	172	0	0	0	100	148	45	0	0	16	116	94
May 2017	3,621	91	0	13	0	19	0	0	0	10	13	3	0	0	3	14	16
June 2017	8,704	174	0	20	0	37	0	0	0	21	24	6	0	0	7	36	23
July 2017	14,585	218	0	25	0	49	0	0	0	34	36	7	0	0	6	25	36
August 2017	7,072	172	0	21	0	33	0	0	0	27	31	4	0	0	5	24	27
September 2017	8,882	237	0	29	0	57	0	0	0	31	43	4	0	0	5	33	35
October 2017	21,628	539	0	63	0	134	0	0	0	68	108	13	0	0	14	77	62
November 2017	33,505	849	0	76	0	170	0	0	0	115	158	39	0	0	36	148	107
December 2017	17,607	463	0	47	0	94	0	0	0	62	88	16	0	0	16	83	57
January 2018	17,105	1288	0	36	0	879	0	0	0	54	41	242	0	0	0	0	36

Note:

A1: Core lap

A2: Short core

A3: Rough Core

A4: Uneven core

B1: F/B Lap

B2: *Lipat Luar*

B3: Rough F/B

B4: Fragment

C1: Pressmark Hot Press

C2: Hot Press Damage

C3: Delamination

C4: Blister

C5: Miscut

C6: *Termakan sander*

C7: Edge Damage

Table 2. Plywood Grading Result on March (Daily Basis)

2.7 mm LFE Raw Plywood (2.7 x 1220 x 2440 mm)																	
Date	**U (pcs)**	**D (pcs)**	**Defect Type**														
			A1	**A2**	**A3**	**A4**	**B1**	**B2**	**B3**	**B4**	**C1**	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**
March 1, 2018	1,894	56	0	4	0	16	0	0	0	3	27	0	0	0	0	4	2
March 2, 2018	4,303	102	0	19	0	36	0	0	0	8	11	0	0	0	0	19	9
March 3, 2018	1,485	52	0	0	0	17	0	0	0	3	9	0	0	0	0	18	5
March 5, 2018	1,646	100	0	2	0	29	0	0	0	3	5	0	0	0	55	6	0
March 6, 2018	4,450	146	0	11	0	47	0	0	0	8	28	0	0	0	0	43	9
March 7, 2018	3,376	84	0	9	0	23	0	0	0	9	12	0	0	0	0	24	7
March 8, 2018	3,132	105	0	8	0	34	0	0	0	7	42	0	0	0	8	4	2
March 9, 2018	4,700	82	0	5	0	20	0	0	0	9	13	4	0	0	5	12	14
March 10, 2018	1,406	34	0	1	0	11	0	0	0	1	4	13	0	0	0	4	0
March 12, 2018	1,489	37	0	2	0	9	0	0	0	3	16	0	0	0	0	5	2
March 13, 2018	696	10	0	0	0	3	0	0	0	3	3	0	0	0	0	1	0
March 14, 2018	1395	53	0	3	0	14	0	0	0	3	0	0	0	0	14	15	4
March 15, 2018	726	24	0	2	0	7	0	0	0	0	5	2	0	0	0	3	5
March 16, 2018	916	30	0	0	0	9	0	0	0	3	8	0	0	0	0	8	2
March 19, 2018	1153	34	0	1	0	8	0	0	0	2	1	12	0	0	0	4	6
March 20, 2018	930	24	0	4	0	8	0	0	0	0	4	0	0	0	2	5	1
March 21, 2018	505	13	0	2	0	4	0	0	0	0	1	3	0	0	1	1	1
March 22, 2018	380	8	0	0	0	2	0	0	0	0	6	0	0	0	0	0	0
March 23, 2018	1504	39	0	0	0	11	0	0	0	5	11	0	0	0	0	12	0
March 24, 2018	765	19	0	3	0	5	0	0	0	1	2	0	0	0	0	5	3
March 26, 2018	1625	15	0	4	0	4	0	0	0	0	7	0	0	0	0	0	0
March 27, 2018	2598	74	0	10	0	17	0	0	0	23	0	0	0	0	0	24	0
March 28, 2018	2674	30	0	3	0	8	0	0	0	1	0	0	0	0	0	18	0
March 29, 2018	686	18	0	1	0	5	0	0	0	3	9	0	0	0	0	0	0
March 30, 2018	1568	26	0	0	0	7	0	0	0	4	0	2	0	0	2	10	1
March 31, 2018	1720	24	0	1	0	5	0	0	0	0	6	0	0	0	1	11	0

Appendix 9

Measurement System Analysis Test Results

Sample Number	Mr. Farizan (Standard)	Mrs. Memet		Mrs. Ida		Mrs. Ratna		Mrs. Lela	
		Trial 1	**Trial 2**	**Trial 1**	**Trial 2**	**Trial 1**	**Trial 2**	**Trial 1**	**Trial 2**
1	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject
2	Accept	Accept	Accept	Accept	Accept	Accept	Accept	Accept	Accept
3	Accept	Accept	Accept	Accept	Accept	Accept	Accept	Accept	Accept
4	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Accept	Accept
5	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject
6	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject
7	Accept	Accept	Accept	Accept	Accept	Accept	Accept	Accept	Accept
8	Reject	Accept	Accept	Reject	Accept	Reject	Reject	Reject	Reject
9	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Accept
10	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject
11	Accept	Accept	Accept	Accept	Accept	Accept	Reject	Accept	Accept
12	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject
13	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject
14	Accept	Accept	Accept	Accept	Accept	Accept	Accept	Accept	Accept
15	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject

Appendix 11

Implementation Documentations

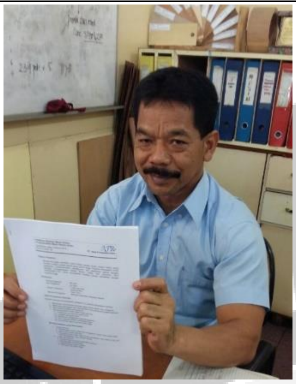


Figure 1. Training Module Handover for Management Review

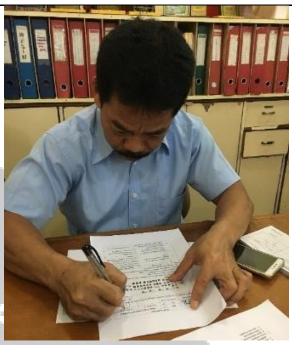


Figure 2. Approval of Uroko Rotary Machine Training Module and Uroko Rotary Machine Setting Work Instruction

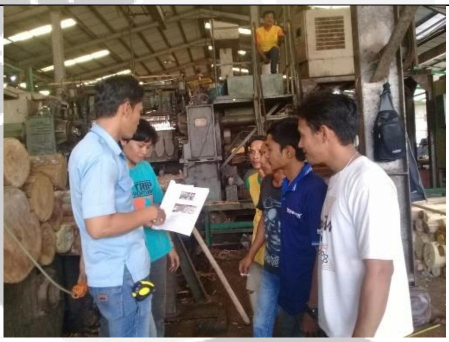


Figure 3. Training Conducted by Supervisor and Foreman to Rotary Machine Operator

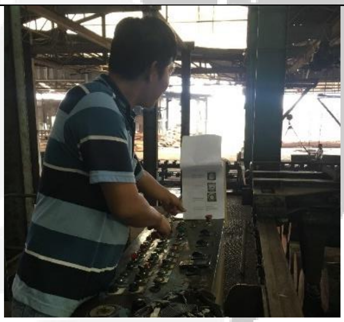


Figure 4. Position of Uroko Rotary Machine Training Module and Uroko Rotary Machine Setting Work Instruction

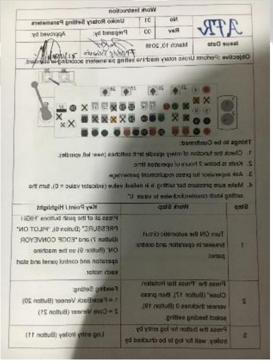
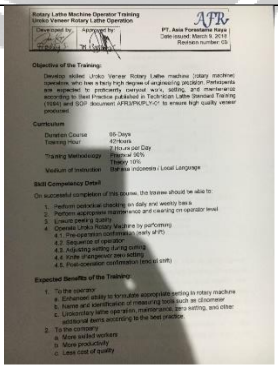


Figure 5. Production Manager Approval on Uroko Rotary Machine Setting Work Instruction



Rotary Lathe Machine Operator Training
Uroko Veneer Rotary Lathe Operation

Developed by:	Approved by:

AFR
PT. Asia Forestama Raya
Date issued: March 9, 2018
Revision number: 00

Objective of the Training:

Develop skilled Uroko Veneer Rotary Lathe machine (rotary machine) operators, who has a fairly high degree of engineering precision. Participants are expected to proficiently carryout work, setting, and maintenance according to Best Practice published in Technician Lathe Standard Training (1994) and SOP document AFR3/PK/PLY-01 to ensure high quality veneer produced.

Curriculum

Duration Course	06-Days
Training Hour	42Hours 7 Hours per Day
Training Methodology	Practical 90% Theory 10%
Medium of Instruction	Bahasa Indonesia / Local Language

Skill Competency Detail

On successful completion of this course, the trainee should be able to:

1. Perform periodical checking on daily and weekly basis
2. Perform appropriate maintenance and cleaning on operator level
3. Ensure peeling quality
4. Operate Uroko Rotary Machine by performing
    - 4.1. Pre-operation confirmation (early shift)
    - 4.2. Sequence of operation
    - 4.3. Adjusting setting during cutting
    - 4.4. Knife changeover zero setting
    - 4.5. Post-operation confirmation (end of shift)

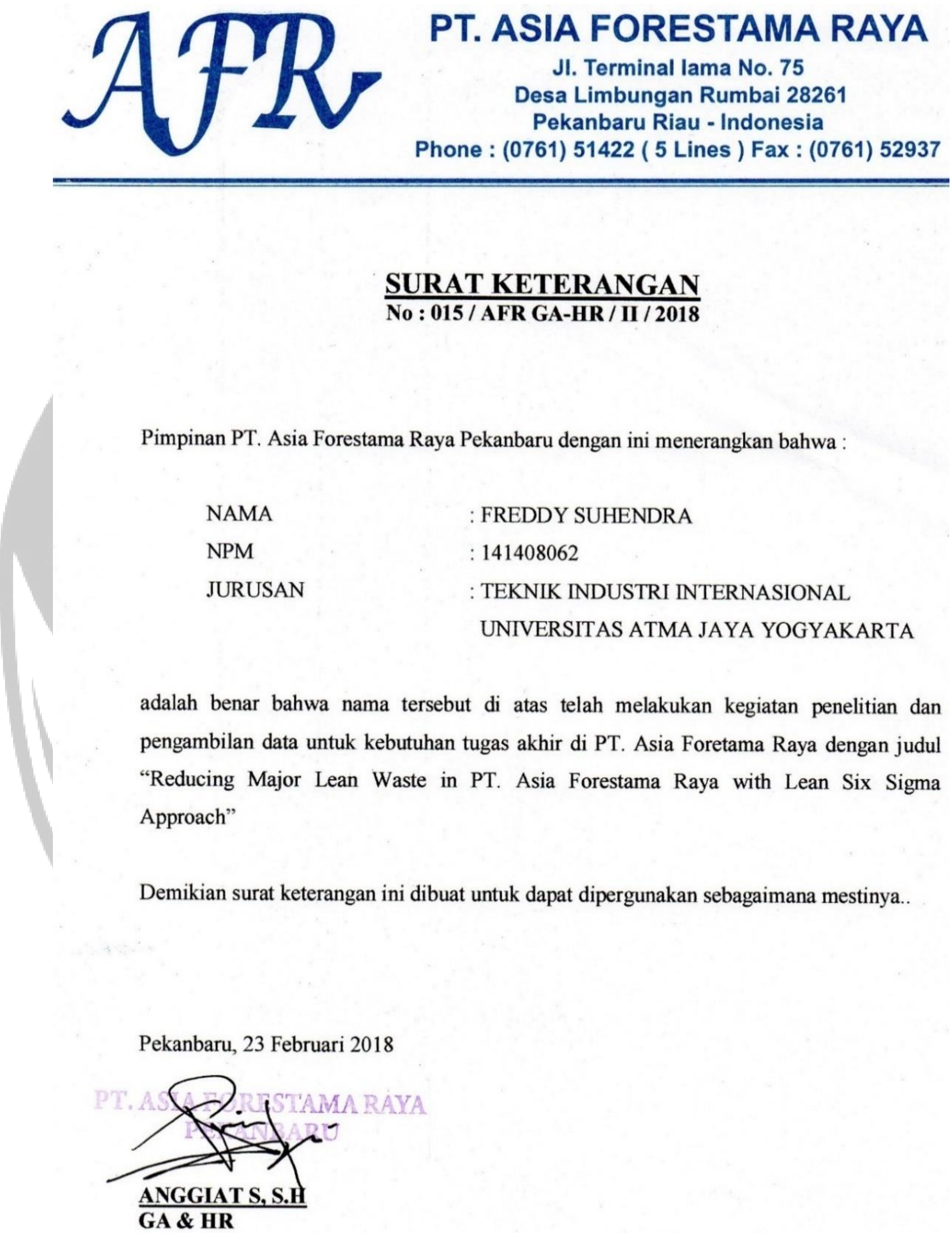
Expected Benefits of the Training:

1. To the operator
    - a. Enhanced ability to formulate appropriate setting in rotary machine
    - b. Name and identification of measuring tools such as clinometer
    - c. Urokorotary lathe operation, maintenance, zero setting, and other additional items according to the best practice.
2. To the company
    - a. More skilled workers
    - b. More productivity
    - c. Less cost of quality

Figure 6. Production Manager Approval on Uroko Rotary Machine Training Module

Appendix 12

Research Evidence



AFR

PT. ASIA FORESTAMA RAYA
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Phone : (0761) 51422 (5 Lines) Fax : (0761) 52937

SURAT KETERANGAN
No : 015 / AFR GA-HR / II / 2018

Pimpinan PT. Asia Forestama Raya Pekanbaru dengan ini menerangkan bahwa :

NAMA : FREDDY SUHENDRA
NPM : 141408062
JURUSAN : TEKNIK INDUSTRI INTERNASIONAL
UNIVERSITAS ATMA JAYA YOGYAKARTA

adalah benar bahwa nama tersebut di atas telah melakukan kegiatan penelitian dan pengambilan data untuk kebutuhan tugas akhir di PT. Asia Foretama Raya dengan judul "Reducing Major Lean Waste in PT. Asia Forestama Raya with Lean Six Sigma Approach"

Demikian surat keterangan ini dibuat untuk dapat dipergunakan sebagaimana mestinya..

Pekanbaru, 23 Februari 2018

PT. ASIA FORESTAMA RAYA
PEKANBARU

ANGGIAT S, S.H
GA & HR