CHAPTER VI
IMPLEMENTATON AND EVALUATION

The FMEA project has been implemented from July 2007 to October 2007. The detail of implementation and evaluation are discussed as following:

6.1 Implementation of The FMEA

Before implementing the FMEA project, a meeting with the FMEA team members was organized in order to illustrate the new documents and working procedures. This meeting aimed to make all of the team members obviously understanding the proposed FMEA.

6.2 Evaluation of The FMEA

After FMEA project was complete, the FMEA team analyzed and revised the RPN score. The severity, occurrence and detection score of failures which had RPN score higher than 100 as mentioned in Table 4.5 (Chapter 4) were reevaluated by using the team judgment. The RPN scores before and after implementation are compared in Table 6.1. %Reduction of RPN score ranks from 71% to 90%. The average reduction of RPN score is 83%. The occurrence and detection scores have been significantly decreased, particularly the detection score, because many new work instructions or modified work instructions and preventive maintenance proposed by FMEA team are quite effective. They are generated in the form of controlled documents and are trained to users who later understand and perform as the instruction with high skill. In addition, the frequency of failures was mostly reduced when people understand and follow the instructions strictly.

Process FMEA (Failure Mode and Effect Analysis)

Process name:
Product name:
Team:

Documented by:
Responsible person:

FMEA Date (Org.):
FMEA Date (Rev.):

Process Function & Requirement	Potential Failure Mode	Potential Effect(s) of Failure	S	Potential Cause(s)/ Mechanism(s) of Failure	O	Current Process Controls	D	RPN	Recommended Actions(s)	Resonsibility & Target Completion Date	Expected			
											S	O	D	RPN
Coating	Contaminates in rice	Machine damage	8	Poor inspection procedure	6	Manual inspection	7	336	Set up work instruction	QC (11/6/07)	8	3	2	48
Coating	Viscosity of paste varies batch by batch	Deviation of coating quality	5	Poor control procedure for paste preparation	8	Loose control	7	280	Set up work instruction	QC (11/6/07)	5	3	2	30
Drying	Long drying time	Products are too dry and more energy consumed	4	Ventilation system in drying rooms is not good	8	No inspection and control	8	256	Check flow rate, set PM for ventilation	Maintenance (22/6/07)	4	4	2	32
Coating	Improper conveyor speed	Off-spec products/ products need quality adjustment	7	Deviation of paste type	7	Indicate in work instruction	5	245	Updating work instruction	Process Eng. (5/6/07)	7	5	2	70
Coating	Inconsistent quality of rice (i.e.moisture)	Deviation of coating quality	5	Different sources, Poor transportation	6	No inspection and control	8	240	Set up work instruction for quality control	QC (6/6/07)	5	5	2	50
Coating	Improper brush speed	Off-spec products/ products need quality adjustment	7	Deviation of paste type	6	Indicate in work instruction	5	210	Updating work instruction	Process Eng. (5/6/07)	7	4	2	56

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											S	O	D	RPN
Coating	Uncleanness of paste mixing tank	Deviation of coating quality	5	Brush for cleaning is not suitable	6	Visual Inspection	7	210	Modify equipment to match with cleaning	Process Eng. (5/6/07)	5	3	2	30
Coating	Solidification of paste	Paste plug in tubes coating process shut down	7	Poor temp control, heat loss during transporting	4	Control only paste mixing tank	7	196	Build insulation around paste line, set up work instruction	Production Eng. (19/6/07)	7	2	2	28
Drying	Poor distribution of coated rice on belt	Products have high humidity (off-spec)	4	Improper design of hopper	8	No control	6	192	Set up PM for hopper & screw conveyor	Maintenance (22/6/07)	4	4	2	32
Coating	Improper brush speed	Off-spec products/ products need quality adjustment	7	Operators don't follow instruction strictly	5	Indicate in work instruction	5	175	Training operators to make them realise the consequence	Production Eng. (8/6/07)	7	2	2	28
Coating	Improper conveyor speed	Off-spec products/ products need quality adjustment	7	Operators don't follow instruction strictly	5	Indicate in work instruction	5	175	Training operators to make them realise the consequence	Production Eng. (8/6/07)	7	2	2	28

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Process Function & Requirement	Potential Failure Mode	Potential Effect(s) of Failure	S	Potential Cause(s)/ Mechanism(s) of Failure	O	Current Process Controls	D	RPN	Recommended Actions(s)	Resonsibility & Target Completion Date	Expected			
											S	O	D	RPN
Coating	Uncleanness of coating brush	Next coating is impossible	5	Cleaning procedure is not suitable	5	Visual Inspection	7	175	Modify coating brush system	Process Eng. (12/6/07)	5	3	2	30
Drying	Non-suitable temp. in drying rooms	Products have high humidity (off-spec)	5	Heat loss of hot air during transportation	7	Insulation around hot air tube	5	175	Design insulation	Process Eng. (13/6/07)	5	2	2	20
Drying	Non-suitable temp. in drying rooms	Products have high humidity (off-spec)	5	Different coated rice feeding	7	Indicate in work instruction	5	175	Updating work instruction for varying drying temp./time according to inlet humidity	Process Eng. (13/6/07)	5	3	2	30
Coating	Uncontrolled moisture in the air	Deviation of coating quality	5	Too much raining can affect moisture in air	4	No control	8	160	Develop system that can control air moisture	Process Engineer (5/6/07)	5	2	2	20
Drying	Deposits on drying belt	Energy loss	4	Cleanness of drying belt	8	Stop drying belt for cleaning sometimes	5	160	Set up schedule for cleaning	Production (21/6/07)	4	2	2	16
Coating	Contaminates of coated rice	Off-spec products	7	Cleanliness of valves, pipes, equipments	3	Visual inspection	7	147	No action	-	7	3	7	147

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FMEA Date (Org.):
FMEA Date (Rev.):

Process Function & Requirement	Potential Failure Mode	Potential Effect(s) of Failure	S	Potential Cause(s)/ Mechanism(s) of Failure	O	Current Process Controls	D	RPN	Recommended Actions(s)	Resonsibility & Target Completion Date	Expected			
											S	O	D	RPN
Coating	Uncleanness of paste mixing tank	Deviation of coating quality	5	Cleaning procedure is not suitable	4	Visual inspection	7	140	Set up schedule and procedure for cleaning	Process Eng. (12/6/07)	5	4	7	140
Drying	Non-suitable temp. in drying rooms	Products have high humidity (off-spec)	5	Low efficiency of blowers	4	No control	7	140	Set up PM	Maintenance (15/6/07)	5	2	2	20
Drying	Non-suitable temp. in drying rooms	Products have high humidity (off-spec)	5	Operators don't follow instruction strictly	5	Indicate in work instruction	5	125	Training operators to make them realise the consequence	Production Eng. (8/6/07)	5	2	2	20
Coating	Inhomogeneous paste in mixing tank	Deviation of coating quality	5	Operators don't follow formulation	6	Instruction in formulation sheet	4	120	Training operators to make them realise the consequence	Production Eng. (8/6/07)	5	2	2	20
Coating	Wrong weighting of raw materials	Off-spec products/ products need quality adjustment	7	Operators do not understand scaling procedure	5	No control	3	105	Set up training for operators	Production Eng. (7/6/07)	7	2	2	28
Coating	Inhomogeneous paste in mixing tank	Deviation of coating quality	5	Stirring time is not suitable	4	Specify into the formulation	5	100	Revise work instruction	Production Eng. (8/6/07)	5	2	2	20

Process FMEA (Failure Mode and Effect Analysis)

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Page: 5 of 5

Process Function & Requirement	Potential Failure Mode	Potential Effect(s) of Failure	S	Potential Cause(s)/ Mechanism(s) of Failure	O	Current Process Controls	D	RPN	Recommended Actions(s)	Resonsibility & Target Completion Date	Expected			
											S	O	D	RPN
Coating	Inaccurate temp. during coating	Deviation of coating quality	5	Poor maintenance, temp. indicator false	5	Periodical check of temp. indicator	4	100	Set up work instruction for calibration	Maintenance (15/6/07)	5	2	2	20
Coating	Inhomogeneous paste in mixing tank	Deviation of coating quality	5	Level of impeller does not match with level of paste	5	Control by setting the level of paste in mixing tank	4	100	No action	-	5	5	4	100
Coating	Inhomogeneous paste in mixing tank	Deviation of coating quality	5	Stirring speed does not suit with paste volume	5	Indicate in work instruction	4	100	No action	-	5	5	4	100

6.2.1 The Way To Revise The Score of Severity, Occurrence and Detection

The FMEA team has revised the score of severity, occurrence and detection of each failure in both coating and drying process that has the RPN > 100. They are indicated in Table 6.1: Comparison of the RPN scores between and after implementation of the FMEA technique. It was found that 23 out of 26 failures are revised. Three failures have not been taken into action since these failures cannot be solved easily. For example, contaminates of coated rice due to cleanliness of valves, pipes and equipments; this requires operation shut down which is already done once every year. The process is continuous and shut down for cleaning valves, pipes and equipments is not easy. The second failure that cannot be solved is inhomogeneous paste in mixing tank due to that the level of impeller does not match with level of paste. Since the level of impeller is non-movable, therefore it can do nothing with the level of impeller. The only possible action is to control the level of paste constantly but this is impossible since sometimes the factory receives extra order in a limited time period. The third failure that has no action is inhomogeneous paste in mixing tank due to that stirring speed does not suit with paste volume. Again the stirring speed of the impeller is non-adjustable, therefore only the control of paste volume that can be performed.

One example on how to revise the scores of severity, occurrence and detection is illustrated.

In the coating process of rice with several kinds of pastes, one of the main critical failure modes which has the highest RPN score is contaminates in rice such as fine sands, stones, metal, or organic compounds. This will have a direct impact on the instruments inside the coating drum; in the worst case, the contaminates can stuck in the machine and cause it shutting down. The detail of this failure is already mentioned in section 4.1.3.1. After FMEA implementation and revision of the RPN scores, it was found that severity is ranked at the same level. The failure mode does not cause any danger to operators or machines or process. According to the criteria of severity given in Table 4.1, therefore, the severity score of 8 is assigned. In terms of detection, after implementation work instruction on how to systematically remove the contaminates is

suggested. This work instruction generated in the form of controlled document is applicable and effectiveness. It was trained to users and the users understand and perform as the instruction with high skill. According to Table 4.2, the detection score of 2 is obtained. In terms of occurrence, after implementation this failure occurred very slightly: in average of 16% of total numbers of production. Therefore the occurrence score of 3 is obtained. As the result, the RPN score after implementation is 8 x 2 x 3 = 48 (86% reduction compared to the original RPN score of 336). This implies that the new work instruction can prevent the failure effectively.

For other failures, the way to revise the score of severity, occurrence and detection is the same as above.

6.3 Comparison Before and After Implementation FMEA Techniques

After implementation, it was found that quantity of broken rice from coating and drying processes and the process time (coating and drying time) are improved. As can be seen from Table 6.2 and Figure 6.1, percentage of broken rice created from coating and drying processes before FMEA implementation in average was 20.7% in the year 2006. After implementation, the percentage of broken rice in average was reduced to 17.9%. When comparing at the same period of time (July - October 2007) in which production capacity is similar, a significant reduction in the percentage of broken rice and process time is observed. Therefore FMEA technique can be used to reduce the average amount of broken rice by 13.8% (from 20.7% to 17.9%). Similarly the process time (coating and drying time) before FMEA implementation in average was 172 minutes but after implementation, the process time is reduced to 141 minutes on average. Therefore the 17.8% reduction of process time is obtained from this FMEA project.

Table 6.2: Comparison in percentage of broken rice from coating and drying processes and the process time (coating and drying time) before and after FMEA implementation

Before FMEA implementation			After FMEA implementation			Reduction of Percentage of broken rice (%)	Process time reduction (minutes)
Month/2006	Percentage of broken rice (%)	Process time (minutes)	Month/2007	Percentage of broken rice (%)	Process time (minutes)		
January 2006	23.8	192	-	-	-	-	-
February 2006	19.3	128	-	-	-	-	-
March 2006	18.8	189	-	-	-	-	-
April 2006	19.4	157	-	-	-	-	-
May 2006	21.7	168	-	-	-	-	-
June 2006	25.5	190	-	-	-	-	-
July 2006	19.7	176	July 2007	18.6	145	1.1	31
August 2006	22.7	173	August 2007	18.8	133	3.9	40
September 2006	18.5	193	September 2007	16.6	157	1.9	36
October 2006	19.9	166	October 2007	17.5	130	2.4	36
November 2006	20.6	179	-	-	-	-	-
December 2006	18.6	150	-	-	-	-	-
Average	**20.7**	**172**	**Average**	**17.9**	**141**	**2.8**	**31**

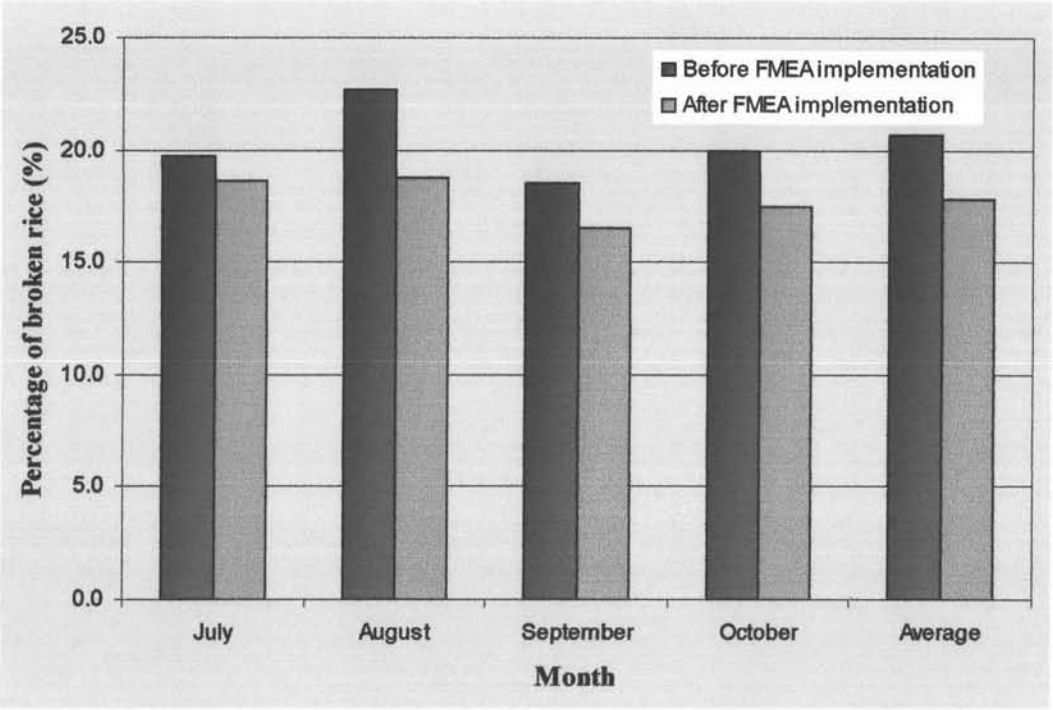

Figure 6.1: Reduction in percentage of broken rice after FMEA implementation

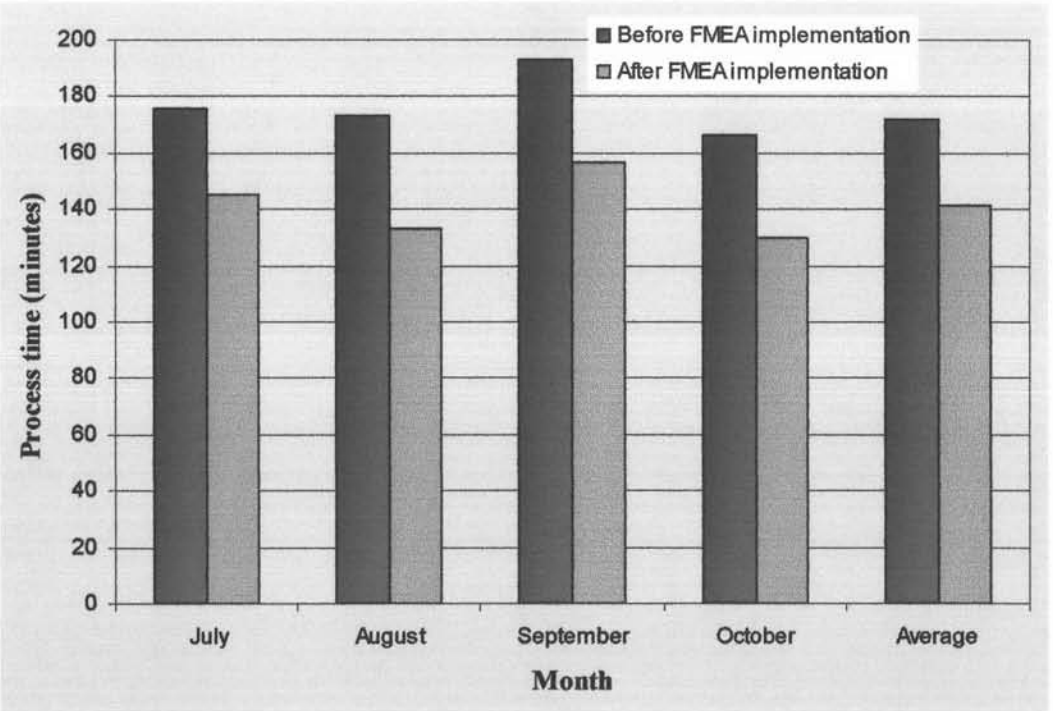

Figure 6.2: Reduction in process time after FMEA implementation