CHAPTER VII
CONCLUSION AND RECOMMENDATION

7.1 Conclusion

This research is carried out in order to improve the efficiency and productivity (in terms of reduction in energy and fuel cost, drying time, and quantity of products that do not pass the specification) of the case studied factory whose main business is involved with the maize drying process. The aim of the maize drying process is to dry and produce maize seeds that meet specification (humidity) required by customers. The improvement of the process is expected to be achieved by applying the Failure Mode and Effects Analysis or FMEA technique.

The manufacturing process of the studied factory consists of 6 main workstation units as described in Chapter 3. These are loading and inspection workstation unit which is based on the material handling system such as conveyer belts, (ii) drying room workstation unit which consists of 24 identical pattern rooms, (iii) furnace or fuel burner workstation unit that operated by a worker per shift (two shifts per day), (iv) maize milling workstation unit, (v) maize packing workstation unit, and (vi) warehouse unit. The Pareto analysis has proved that drying room workstation unit and furnace workstation unit acquire the greatest energy and fuel cost compared to other units. In addition, drying process is considered to be the most important part of the process that creates the value to the products. Drying directly affects the quality of the maize product since it reduces humidity to the required specification. Insufficient drying can cause off-spec products and cause maize seeds having humidity higher than required and the seeds germinate. This in turn leads to a high quantity of dried maize seeds rejected by the quality control (QC). Therefore FMEA technique is particularly applied to only drying and fuel burner workstation units. In addition, the quality tool named Cause and Effect Analysis is also used for problem identification and analysis.

Before FMEA implementation, the average fuel cost per month was 94.7 thousand baht in 2006, the drying time was 7150 minutes, and quantity of dried maize seeds rejected by QC was 615 kilograms as can be seen from Table 3.2.

Details of application of FMEA technique to problem identification and analysis at drying and furnace workstation units are reported in Chapter 4. The FMEA team were set up which consisted of members with different skills and knowledge from different departments of the studied factory. The team analyzed the problems with FMEA technique and Cause and Effect Analysis (Appendix I and II). The FMEA technique revealed that there were 19 high-risk areas that had RPN scores higher than 100 and they must be addressed (Section 4.1). Recommendation on actions that need to be taken for the failures that have RPN score higher than 100 was then carried out. Departments who have responsibility for each action plan and the due dates to complete action plans were specified in order to make the problem solving success. Responsible department, recommended actions and due date for the completion of FMEA project of drying room and furnace workstation units are summarized in Table 4.13.

Details of improvement and controls in drying rooms and furnace workstation units are explained in Section 5.1 and 5.2 respectively. Such improvements and controls in drying workstation unit include the controlling of temperature in drying rooms to be uniform, improvement in blowers used in drying rooms, the more precision control of drying time according to the varies humidity of maize sheaths, the systematic packing of maize sheaths in drying rooms, insulation at drying rooms and the quality control of raw material and fuel as mentioned in Section 5.1. For furnace workstation unit, improvements include modifying the heating system, work instruction for insulation at furnaces and connections between furnaces and drying rooms, control feeding of fuel, and control stock of fuel feed as described in Section 5.2. To assist these improvements, several work instructions are created and adjusted as reported in Appendix III.

After FMEA implementation between May-September 2007, FMEA team members were called for meeting and revised the RPN scores. It was found that RPN scores were reduced between 60.0-84.8% as shown in Table 6.1. This is because the Occurrence and the Detection scores were significantly decreased while Severity score was maintained due to that:

(i) New work instructions and some modification in drying rooms and fuel burner workstation units are created to control the potential failure mode. They

have also increased the capability to detect both of potential causes of failures and subsequent failure modes. In addition, the new heat exchanger is another important unit that can help to increase temperature before reused into the boiler and it can be used in the system for a long term. The total investment cost is approximately 200,000 baht for this new instrument with installation cost but it is worth to increase temperature in the drying process for a shorter drying time. Furthermore, the stable temperature in the system can save time and energy of drying in the drying room as well. The results are both to improve the productivity and efficiency for the factory.

(ii) People are the key factor for project implementation. Therefore training these people involved in both drying room and furnace workstation units for new work instructions and preventive maintenance plans could lead to a significant reduction of Occurrence score.

Such implementation of FMEA technique and the reduction in RPN scores also leads to an improvement in fuel cost saving and a reduction in drying time. Significant improvements in terms of a reduction in monthly fuel cost and the drying time were observed but a slightly decrease in the quantity of maize seeds rejected by QC was noticed as shown in Figures 6.1-6.3. The average fuel cost per month is reduced by 10% (from 94.7 thousand baht before FMEA implementation to 84.9 thousand baht after FMEA implementation), drying time 8% (from 7,150 to 6,580 minutes) from the ability of increasing the temperature at 2 to 3 degree Celsius higher, and 0.05 ton increasing of dried seeds per Kilowatts-hour. Therefore the objectives of this research have been achieved. However there are some issues that can be improved in the future. These are mentioned in the following section.

7.2 Recommendations

7.2.1 Team members

The FMEA team is one of the most important factors to the success of FMEA implementation, for example, the scores rating depends on the judgement of the team members, recommendation actions also depends on the team opinions. Team members should come from staffs who have different backgrounds and experiences. In this research, none of the team members have experienced FMEA technique before. Therefore it will be better if one of the staff has ever been familiar with this

technique. Next implementation of FMEA technique to this studied factory should perform better since the team can gain knowledge and experience from this first-time FMEA implementation. In addition, team members should include staff from financial departments who are concerned with the cost. This research has not taken the cost of FMEA implementation for consideration yet. Cost analysis should be carried out. Although the fuel cost was reduced, but this reduction is worth for the increased cost generated from FMEA implementation.

7.2.2 Continuous improvement of FMEA

It is certain that FMEA technique needs to be continuously performed and updated. FMEA is an engineering technique to identify potential and known problems and reduce such problems. It is the dynamic tool for continuous improvement after it has been started. Some problems might be found in the future while others can be eliminated. Therefore continuous application of FMEA is necessary. Another suggestion is that the RPN score criteria of risks might be reduced from 100 to 50; an increase from 90% to 95% confidence. More potential failures therefore have to be addressed. This of course leads to a reduction of the problems occurred in the process and an improvement in the process operation.

7.2.3 Consistent acquisition of information

External and internal sources of information are also critical to the success of the FMEA. For example, customers' complaints and/or supplier information can provide important data about problems that must be addressed. Internal sources of data are also needed. FMEA team members might need to listen to their under-controlled staff about the problems they encounter. Operation staff might report data which bring to light potential or actual failure modes and possibly guide the solution. FMEA software can be useful for the data analysis but it comes with the higher cost.

7.2.4 Expansion of FMEA technique to other workstation units

To reduce the quantity of products that do not pass the specification, FMEA technique can be expanded to upstream and downstream processes. It is certain that in terms of energy cost, drying and fuel burner workstation units are main causes of the problem. But for quality of products other workstation units can affect, for example, inefficient maize milling workstation unit can cause maize seeds oversized and cannot be

classified into the sizes that customers require. This in turn causes a longer processing time and, in the worse case, the rejection of the products from the customers. Quality control in raw material is also important to the overall process. I therefore recommend the application of FMEA technique to loading and inspection workstation unit, maize milling workstation unit, and maize packing workstation unit.

7.2.5 Training

Since people are found to be the key factor for the FMEA project implementation as mentioned in Chapter 5, therefore proper training of relevant personnel should be consistently carried out. General training to all entry staff should be provided. Then special trainings of a particular process should be designed and given to the staffs who work in that process. Of course staffs who work for loading and inspection workstation unit require different tasks and skills from those for drying workstation unit.

7.3 Difficulties and limitations

7.3.1 Difficulties

The main difficulty the researcher has encountered in carrying on this study is working with several types of people. It is certain that FMEA technique requires teamwork. Therefore it is unavoidable to work with different people who have different opinions. Arguments occurred sometimes and they need to be solved out logically in order to proceed this research. In addition to the FMEA knowledge, the researcher needs to learn how to work with other people and this requires social skill.
Other difficulty includes the data collecting process. Since the studied factory is a medium-sized factory in which the working system is not well organised. It takes a lot of time to find out some data, particularly those recorded in the paper form. It will be much easier if the system is more computer-based. Moreover some data needs to be asked for authorization before use in this research. Some data is confidential and cannot be published due to the agreement with the mother company.

7.3.2 Limitation

Several limitations are found in this research. Time limitation is the first one. The results after FMEA implementation receive from only 5-month based data. This might not be enough and requires longer time to ensure that the FMEA technique is

absolutely effective. There might be other parameters contributing to the improvement in productivity and energy and fuel cost saving, and these parameters might not be completely controlled.

Human limitation is also observed. No any of the FMEA team members in this research has experienced FMEA technique before. For example, rating severity, detection, and occurrence scores are based on the team judgement and these scores of course change with the different team members. Also the scores were approved by the company executives who had no FMEA experience.

Finally some recommendations are not performed because it acquires significant cost, for example, blowers and insulation which is old and not so efficient. But to replace this with new ones requires significant investment although operating cost (from energy saving) can be reduced.