APPLICATION OF SIX SIGMA TECHNIQUE FOR REDUCING PERCENTAGE OF INTERNAL REWORK (IR) IN SMOKED CHICKEN FRANKFURTER PROCESSING

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ABSTRACT: Six sigma technique consisting of five phase i.e. define, measure, analyze, improve and control was applied in smoked chicken frankfurter processing of the case study factory to reduce the IR. Result from preliminary data shown that the main problem affecting the organization's business goal and customer demand is non-internal rework products. The amount each month of IR was 3.4% of total smoked chicken frankfurter products, which was higher than the target (3.0%). The most of internal rework is over length sausages. After analysis on the processing and cause of over length sausages IR come from after cooking then using process mapping (KPIVs), pareto diagram and FMEA technique. There were 18 factors affected such internal reworks. Those factors could be classified into 2 groups i.e. group-1 which are factors that can be readily improved 14 factors and group- 2 which are factors that need to be tested for statistical significant consist of 4 factors**.** It was then considered based on technical feasibility and investment to select only factors from over length sausages IR**,** in group-2 there was 1 factor i.e. changing a new casing. The result from improve phase of those factors were used to control and operating condition such as daily inspection, preventive maintenance after finish production, changing a new casing which is suitable for cooking process as well as proper setting before starting the production. It was found that, the quantity of over length sausages IR reduced from 3.4% to 1.8% of total smoked chicken frankfurter products.

KEYWORDS: *Six Sigma, Sausages, Internal rework (IR).*

1. INTRODUCTION

Six Sigma is a system which primarily can improve the quality and consequently the time management of projects. The Six sigma system has already been implemented in different industry sectors. And fortunately it has brought about benefits. It has brought about benefits. It has improved the time, quality and cost management in the projects, according to the Six Sigma body of knowledge, which consists in the process called DMAIC (Define, Measure, Analyze, Improve and Control). However, Six Sigma focuses on detecting the errors in the project, with which it then can create a database to improve the process of the project.

In part of food industry is important of economy of the country, especially the frozen food industry which is highly competitive both quality and product price. The productivity, speed and services are necessary to meet customer demand. The frozen food industry has been profiting into Malaysia hundreds thousands of dollars a year. Once of frozen food is chicken sausages frozen with of neighboring countries such as Brunei, Indonesia, Singapore and etc. as an important export market and also sausages frozen industry will be made income into local and foreigner people those who work in Malaysia.

The case study factory is one of sausage frozen products manufacturer located in the west of Malaysia. After processing, that showed in Fig.1. There were many problems occurring in the processing such as the percentage of internal rework (IR) higher than target, raw material losses, machine downtime and production costing increasing. After analysis and discussion with the factory manager base on the impact to organization's goal and customer demand, it was found that the major impact is the higher percentage of internal rework (IR) than target. The objective of this study was to implement six sigma technique in smoked chicken frankfurter processing of factory to reduce percentage of internal rework (IR).

(Jakrin, 2012) The study were to explore and analyze the electroplating process, find root causes that affect the electroplating process, and to reduce defects from the electroplating process by using Six Sigma techniques the result from improvement was to reduce damaged strip frame from 193 to 40 parts per million, which was 79.3 percent. (Monthri, 2016) Study the causes and solutions to the problems of waste materials in

compound rubber production process by applying DMAIC. It was found that the amount of the weight of the waste materials in the production process fell from 0.09 to 0.07 percent. This meant that the loss was reduced by 22.22 percent. (Sumporn, 2011) The Application of Six Sigma Technique for Defects Reduction in the Injection Molding Process the result shows that the defects problem in the injection molding process can be deceased to 4,064 DPPM or 0.41 percent defect which equal to 78.66 percent defect decreased.

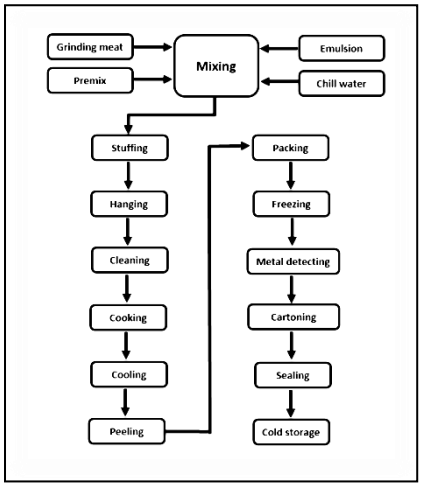

Figure 1: Smoked chicken frankfurter flow process.

2. METHODOLOGY

Only one production line base on the availability and which process that made internal rework during production was chosen as prototype of case study. The six sigma technique approach consisted of define, measure, analyze, improve and control phase was carried out as follows:

2.1 Define phase: the necessarily preliminary data on smoked chicken frankfurter processing of case study factory was collected. All problems impact to the organization's business goal and customer demand were analyze.

2.2 Measure phase: the data of quantity and type of the internal rework were collected from daily production report.

2.3 Analyze phase: it was started from brainstorming to analyze the production process and cause of over length IR after cooking by process mapping. Then, identify key process input variables (KPIVs) in each step of processing which can cause over length IR. All of KPIVs were screened by pareto diagram and failure mode and effect analysis (FMEA) and provided risk priority number (RPN). After screening, some factors were selected for statistical significant testing.

2.4 Improve phase: the appropriated solution considered from investment, technical feasibility and availability were applied for improving the smoked chicken frankfurter processing.

2.5 Control phase: finally this phase was provided to control the appropriated solution. The process will be monitor in order to sustain the gain.

3. RESULT AND DISCUSSION

3.1 Define phase

The important problem from the preliminary survey that had impact higher than other problems is higher quantity of internal rework (IR) than target. According to specification the percentage of internal rework not more than 3.0% of total smoked chicken frankfurter product.

The quantity of internal rework (IR) each type in the sample collected from prototype production line was shown in Fig. 2**.** It was clearly found that over length sausage IR was the major IR, about 3.4% of total tested products. So, the important impact highest IR is over length sausages IR.

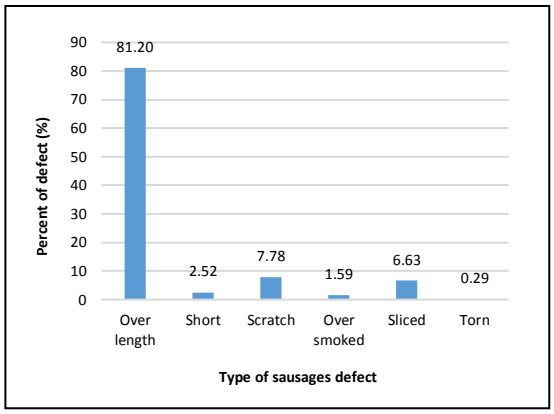

Figure 2: Percentage of internal rework (IR) each type

3.2 Measure phase

The quantity of internal rework (IR) that out of specification from five months Fig. 3 showed the average value 3.4% of total manufactured smoked chicken frankfurter products.

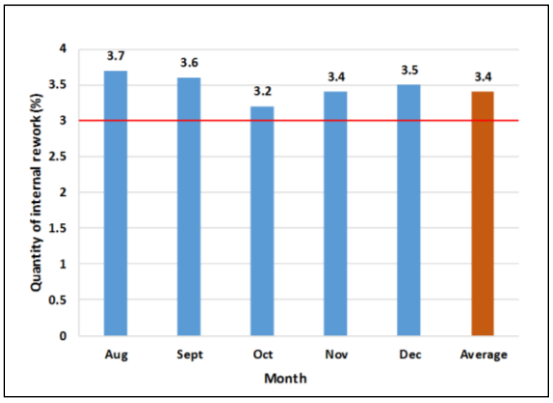

Figure 3: Overall percentage of internal rework (IR)

3.3 Analyze phase

After brainstorming, the main cause of over length sausage IR occurred in smoked chicken frankfurter processing were identified. There are many aspect such as short sausages, scratched sausages, over smoked sausages, torn sausages, etc. those causes could occur in different 4 steps i.e. stuffing, after cooking, after peeling and during packing.

Then, the key process input variables (KPIVs) in those steps were considered. Total 41 factors were found in 4 steps. All factors were screened by failure mode and effect analysis (FMEA) and provided risk priority number (RPN). In traditional FMEA, risk priority number (RPN) could estimate by multiplying of occurrence (O), severity (S) and detection (D) of failure mode as in formula, RPN = O × S × D

Step	KPIVs	Potential failure mode	Potential failure effect	S	Potential cause	O	Current Control	D	RPN
Cooking	Casing	Casing cracking and untwisted during cooking.	Sausages become internal rework (IR).	5	Casing properties not suitable for cooking temperature.	5	Appearance inspection.	5	125

*Casing cracking and untwist during cooking made sausages become over length sausages IR.

Table 1. Failure mode and effect analyze on cooking step.

It was found that the possible factor within 80 percent accumulation consisted of 18 factors which possibly affect the internal rework (IR) on smoked chicken frankfurter product. The result of failure mode and effect analysis in cooking step showed in table 1. Then RPN score from 41 KPIVs were plotted into pareto diagram. From the pareto diagram (Fig. 4). Those 18 factors allocated in stuffing 7 KPIVs, cooking 3 KPIVs, peeling 4 KPIVs and packing 4 KPIVs

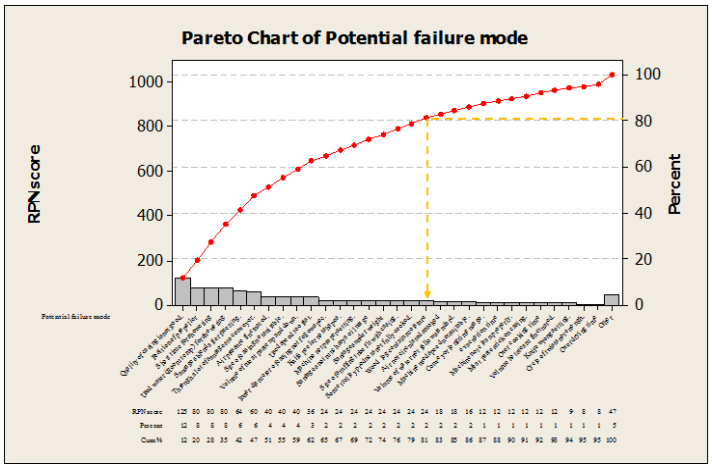

Figure 4: Pareto chart of RPN ranking.

Then, the appropriate factors based on the technical feasibility and investment were selected. The most appropriate factor related to the over length sausage IR were selected 1 factors from cooking step to further study i.e. type of casing (statistical significance testing).

The result statistical significance testing: compared casing 2 suppliers (Supplier A&B)

Hypothesis test: T-test

H_0 : Casing supplier A & B does not make the difference quantity of over length sausages IR

H_1 : Casing supplier A & B makes the difference quantity of over length sausages IR

The result is P-value = 0.001 so accepted H_1 shown that casing supplier of each supplier makes the difference quantity of over length sausages IR after cooking.

Casing specification Supplier A and B

Casing supplier A (Existing casing) dry casing and tolerance cooking temperature not exceed 80 ºC if compare with casing supplier B (New casing) pre-moisturized casing, tolerance cooking temperature not exceed 250 ºF/121 ºC (The current process of products cooking temperature ≥ 83 ºC because of core temperature of products reaches ≥75 ºC.)

3.4 Improve phase

To improve the condition of air blower and smoked generator inspection in cooking step and also changing a new casing

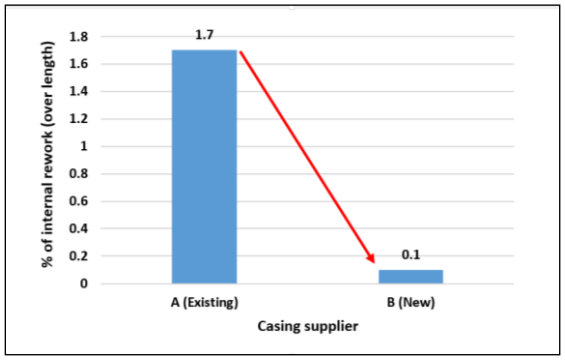

Figure 8: Percentage of over length sausages IR compared casing supplier A and B

3.5 Control phase

The last phase of six sigma technique approach was to provide the maintenance of the improved process. The process will be monitored in order to sustain the gain. After the factors in cooking step is improved.

4. CONCLUSION

The problem of high impact to business goal and customer demand of case study factory is the higher quantity of internal rework (IR) than target. The most of internal rework (IR) is over length IR. After brainstorming and factors screening using pareto diagram, FMEA and RPN techniques, there were only 18 factors affecting to over length IR. Base on technical feasibility and investment, the important selected 1 factors is changing a new type of casing. The result showed that the quantity of over length sausages IR after cooking reduced 1.6% (from 1.7% to 0.1%) of total tested products. More understanding total overall percent of internal rework reduced from 3.4% to 1.8%. Therefore, this study revealed the successful implementation of six sigma technique in smoked chicken frankfurter processing.

5. ACKNOWLEDGEMENT

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