

## **CAUSES OF AND STRATEGIES FOR REDUCING FOOD WASTE IN POST FARM SUPPLY CHAINS**

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### **ABSTRACT**

About 1/3 of food produced for human consumption is lost and wasted. Considering resource efficiency and environmental impacts, the need for reducing food waste levels is urgent. This case study illustrates the potential and great possibilities to deal with the food waste challenge by proper root cause analysis and the methodology of Lean Six Sigma. A production line of a dough-based product was targeted, and the practical work resulted in a 50% reduction of waste.

### **INTRODUCTION**

Every actor in the different parts of the food chain needs to reduce their amount of waste due to environmental consequences and pressure from politicians and authorities to contribute to the reduction of the environmental impact from the food chain. Preventing waste is one option that contributes to cost reduction as well as increasing profits.

However, waste reduction is a complex objective which demands time and involvement of staff at different levels of the managerial hierarchy, from the production line to the top managerial level. Root causes of waste may vary significantly, based on physical and human resources and technical solutions and are highly dependent on how the whole process is designed and managed. In many cases, there may be a combined effect from a number of driving influences which make the improvement more difficult (Carlos and Ozgur, 2011) since the food supply chain is complex.

A very important part of waste reduction work is the diagnosis, a correct identification of the causes that can be considered as drivers of the major waste quantities in the system studied and to which the measures taken should be addressed. However, this identification process is very complex since there can be hundreds of ideas on possible causes for a single production line at the start of the identification work. The question is how to find the needle in the haystack.

The aim of this case study was to adapt a stepwise method inspired by Lean Six Sigma (George, 2002) to deal with the reduction of food waste. Within the Lean Six Sigma methodology, Pareto charts are often used to illustrate which factors influence a given outcome the most (George, 2002). The Pareto Principle is also known as the "80/20 Rule". If valid and applied to food waste in a given system, about 20% of the causes would generate

80% of the waste. The Lean Six Sigma methodology has earlier been applied to identify waste generating-causes in two different Swedish food industries, and the results indicated that a major part of the waste in these food production systems was generated by quite few causes (Gunnerfalk, 2006; Svenberg and Torgå, 2007). Inspired by this methodology, a method for mapping waste within a specified system, identifying the major causes of the waste and root cause identification of the major drivers of waste has been adapted to a case study carried out on a production line of a dough-based product manufactured in Sweden. The process is continuous, with a number of sub-process steps from mixing of ingredients to palletizing of the final product, for example dough mixing, baking, cooling, packing and palletizing. All sub-processes have potential to generate waste if not efficiently run.

## **METHODS**

The first step of the method is to map the product flow in detail throughout the chain and measure the waste quantities at different points along the chain studied. The points where the major waste quantities are detected are thereafter identified as the waste hotspots in the system, but it does not show the cause(s) of that waste.

The second step in a mapping method is to investigate the hotspots in greater detail to identify possible causes to the waste detected here. In the third step, a root causes analysis is performed to yield the detailed information needed to identify actions suitable for eliminating the root cause.

In some cases, root causes may be associated with activities in other management zones of the production line aside from the hotspot of waste occurrence. Therefore it is of importance to be open-minded to a very high degree of complexity in the analysis and avoid pre-assumptions that waste is necessarily caused at the site of its occurrence. For example machinery stoppage can be a cause of waste in a bakery production line. It can result in a cascade effect where machine stoppage at one specific point of the process line will generate cascades of waste occurring at several points of the line. Therefore interviews and gathering of facts from the staff that are running the process daily are of major importance to understand the detailed complexity since it is these persons who have the best knowledge of what incidents frequently occur at the same time as waste is generated at the hotspots in the actual process line.

## **RESULTS**

Based on the method explained above, the amount of waste throughout the production line had been measured for a couple of months. The highest amount of waste was detected in the sub-process of baking in the oven, leading to the conclusion that the oven was the hotspot for waste on this process line.

For the deeper study of possible causes to the waste detected in the baking step, the oven was thoroughly studied under production conditions to gather information directly from the center of coincidences that actually resulted in waste. In addition, the oven operator was interviewed to identify critical information about waste generation in the sub-process of baking. The result was that waste generation often could be associated with the dough properties; especially, the occurrence of stickiness was regarded as a parameter related to waste generation. It was also concluded that the dough properties were determined in one or more sub-processes from the

oven and upstream to the very beginning of the process line. Based on these findings, the focus was shifted to the dough making sub-processes in order to find the root cause(s) for stickiness of the dough.

Possible causes of the dough's stickiness were the subject of a brainstorming session held with experienced production staff where a large number of ideas on possible causes of stickiness were identified. Thereafter, available options in the different sub-processes on how to control these different causes (factors) were identified. The analysis of information from the brainstorming session highlighted a few factors, as being more likely to affect the stickiness of the dough and also possible to control.

Due to practical reasons, sets of at most three factors could be investigated. The three factors assessed as more likely to cause major quantities of waste were selected. In full scale trials, it was statistically validated that one of these factors, the resting time of the dough, significantly affected the stickiness and that a longer resting time was correlated to less stickiness.

To validate the result that a longer resting time of the dough would decrease the waste amounts from the actual process line, the process parameter settings were changed during a test period of 6 weeks out of 18 weeks project time. Waste generation before and after the changed settings and implemented improvement was monitored.

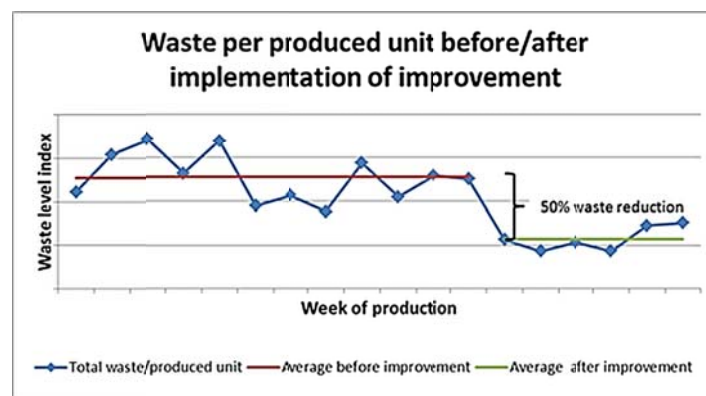


Figure 1. Waste per produced unit before/after implementation of improvement

During the test period, the average waste generation of the process line was reduced by 50% as shown by Figure 1. It was concluded that the root cause for 50% of the waste in the actual line had been properly identified and also that it was possible to control this factor over a longer time period. It was furthermore concluded that the correct identification of this major root cause simultaneously enabled not only a lower environmental impact from waste but also cost reduction.

## DISCUSSION

In accordance with previous studies (George, 2002; Zhen, 2011; Gunnerfalk, 2006; Svenberg and Torgå, 2007), this case study indicates that the 20/80 rule may be roughly applied to food waste issues.

Improvement activities for increasing efficiency require the investment of human resources and management to adjust their activities to the best practices. By a correct identification of

quite few root causes and implementing actions towards these, the waste reduction potential may even exceed 50% for a specific line. In this specific case, a 50% reduction of waste from the actual process line could be achieved by taking one single action.

Nonetheless, this is not the end point of waste reduction as there are still causes with lesser effects which can be dealt with, respective to their priority. The cost reduction gained by actions that result in waste reduction can be proactively used as an investment in continuous improvements aiming for further waste reduction activities.

The results achieved in this case study cannot be generalized and validated for all bakeries as the root cause of waste may vary between production lines, even when the lines are producing quite similar products. This is due to differences in the ingredients and actual machinery used but also based on how physical and human resources work separately and together and depending on how the whole process is managed.

The root cause of waste can vary significantly case by case, therefore setting standards by generalizing for the whole of the food industry or even the bakery industry may be too much simplification. However, a guideline may be defined on how to map waste to identify the hotspots along the part of the food chain studied and the root cause(s) associated with the hotspots. Based on this type of analysis, effective waste prevention activities for food chains can be identified.

## CONCLUSIONS

A mapping methodology for reducing food waste has been adapted and successfully applied to a dough-based product line. The case study illustrates that the potential and great possibilities to deal with the food waste challenge can be exploited through proper root cause analysis and adaption of the methodology of Lean Six Sigma. As such, the result of this study is not merely about a better use of a technology it also shows the importance of maintaining the gained knowledge within the company to achieve long lasting effects of the waste prevention work. This highlights the influence of management on food waste levels at each specific food production plant.

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