

Challenges Facing the Food Industry

Examples from the Baked Goods Sector

Zaza Nadja Lee Hansen
DTU Management Engineering
Technical University of Denmark
Lyngby, Denmark
znlh@dtu.dk

Peter Jacobsen
DTU Management Engineering
Technical University of Denmark
Lyngby, Denmark
peja@dtu.dk

Abstract—This paper investigates the challenges in the food industry, illustrated by a case study from the baked goods sector in Denmark. The paper proposes key elements this sector needs to address in order to limit waste improve productivity and increase profitability.

Keywords—food industry; case study; management science; operations management

I. INTRODUCTION

Agriculture is the oldest industrial sector, dating back more than 10000 years [1]. The Industrial Revolution saw the transition to new manufacturing processes from around 1760 to around 1820 or 1840 in all industries, also agriculture.

Agricultural production across the world doubled four times between 1820 and 1975 to feed a global population of one billion human beings in 1800 to 6.5 billion in 2002 [2]. During the same period, the number of people involved in farming in the developed world dropped as the process became more automated [3]. Today in the western world there are few people employed in the sector and very little investment [4]. Employment in the developed world is increasingly in the service industry and the development of intellectual work, whereas citizens in the developing world are still heavily employed in the raw materials industry (including farming, fishing, minerals etc.) [3]. In the developing world employees in agriculture are predominantly female but also here investment in farming is shrinking due to the increased industrialization of the sector [4].

Bread and baked goods have long been an essential part of human diet. Global trends predict that production of cereals increase 1.4% per year with 57% of total growth coming from developing countries from 2013 to 2022 [5]. Thailand is projected to be the leading exporter of rice followed closely by Vietnam while the United States is expected to remain the dominant exporter of wheat and coarse grains [5].

Faced with environmental challenges, financial constraints and an increasingly global customer base, the food industry today need to constantly seek to limit waste and improve productivity; in short to do more with less. This paper analyses the main challenges in the mass-production of baked goods, illustrated by a case study from a Danish producer of such products. The research question is therefore “What are the key challenges in the production of baked goods?”

This paper first presents some key developments and challenges facing the food industry and the baked goods sector in particular. Hereafter, it proposes what key challenges the baked goods sector faces. This proposition is tested using a case study from the Danish baked goods sector. Findings from the case study are presented and hereafter reflections and conclusions are described.

II. LITERATURE REVIEW

A. The food industry

Agriculture has been a key part of human history from the very beginning. The first big changes to agricultural practices in Europe came in the Middle Ages with new or improved tools such as the scythe and plow (the moldboard plow and wheeled plow). Horses began to be used in farming instead of oxen and metal horseshoes were widely adopted. Farming became a business with big farmers selling to shops in addition to families farming for their own needs. In the late Middle Ages, the use of manure as fertilizer increased, which in turn decreased the necessity of regular fallowing of fields.

The next big change in agriculture was the industrialization of the sector. Industrialization of agriculture more or less coincides with the Industrial Revolution in general. With the development of heavy machinery like large tractors and harvesters and chemical advances like antibiotics for animals and pesticides farmers could produce large quantities of grain and meat. Food production became an industry with factories such as large slaughter houses and processing plants for wheat and other raw materials. In the beginning the final stages of supply chain still took place in small local shops like a local bakery and butcher. With advances in chemical engineering and cooling equipment (most noticeable the freezer and refrigerator) it became possible to develop long-lasting food which could be sold directly to the consumers. Developments in shipping networks and transport technology have made long-distance distribution of agricultural produce feasible. A consequence of this is that in many supermarkets in the developed world fruits and vegetables which used to only be available in a certain season (like apples or strawberries) are available almost the entire year round as it is transported in from many different countries.

In the last century food production in the developed world has become increasingly more globalized, automated and

industrialized, with fewer and larger players in the market and a smaller workforce. In the 1930s, 24 percent of the American population worked in agriculture compared to 1.5 percent in 2002; in 1940, each farm worker supplied 11 consumers, whereas in 2002, each worker supplied 90 consumers [2]. The number of farms has also decreased, and their ownership is more concentrated. In the U.S., four companies kill 81 percent of cows, 73 percent of sheep, 57 percent of pigs, and produce 50 percent of chickens [6]. In 1967, there were one million pig farms in America; as of 2002, there were 114,000 [7,8] with 80 million pigs (out of 95 million) killed each year on factory farms, according to the U.S. National Pork Producers Council [2]. According to the Worldwatch Institute, 74 percent of the world's poultry, 43 percent of beef, and 68 percent of eggs are produced this way [6].

B. The baked goods sector

Baking is used not only for bread but also for cakes, pastries, pies, tarts, quiches, cookies, scones, crackers and pretzels. These items are known as "baked goods," and are sold at a bakery or a bakery section of a supermarket, gas station, book store or other shops.

Bread baking began in Ancient Greece around 600 BC, leading to the invention of enclosed ovens [9]. Ovens have been discovered in archaeological digs from Turkey (Hacilar) to Palestine (Jericho), dating from about 5600 BCE [10]. Baking flourished in the Roman Empire. In about 300 BC, the pastry cook became an occupation for Romans (known as the *pastillarium*). A bakers' guild was established in 168 BC in Rome. Eventually, the Roman art of baking became known throughout Europe, and eventually spread to the eastern parts of Asia. Bakers often baked goods at home and then sold them in the streets [9]. Every family used to bake their own bread and bread produce, until baking developed into a trade. With the Industrial Revolution baking became an industry that used heavy machinery and the latest chemical research in order to produce large batches of fresh, long-lasting bread products. The advances in transportation have furthermore meant that baked goods can be transported large distances. Today bread is still baked by local bakeries but also in large industrial batches which are sold to supermarkets and other shops. This project will only focus on the latter.

C. Key challenges facing the baked goods sector

Challenges in the food industry in general include environmental concerns, safety, hygiene, freshness, sustainability and financial constraints. Challenges specifically for the production of baked goods are proposed to include the following elements.

Waste is a main challenge in most production lines, also for the production of baked goods. Waste of food (e.g. dough leftover, faulty products), waste of energy (e.g. heat, electricity), waste of material (e.g. packaging material) and waste of time (e.g. inefficient personal movements or packaging). Lean is a manufacturing philosophy which is concerned with creating more value for less. The elimination of waste is a key focus in lean as is flow [11]. Lean is derived

from the Toyota Production System (TPS) and is also called Toyotism [12] [13].

Furthermore, quality is important as consumers want well-tasting and fresh baked goods. Flexibility, to adjust to seasonal fluctuations (for example baked goods made specifically for Christmas, Easter, Eid) and to meet daily changes in demand quickly are also important.

However, the smoothness sought by lean is contrary to the need for flexibility, which creates a dilemma. Furthermore, the level of quality would need to match with lean principles of zero waste.

We therefore make the following proposition: There are 3 key challenges in the production of baked goods – lean practices, flexibility and quality – which need to be balanced in order to obtain the most financially sound and environmentally correct production of baked goods (see figure 1).

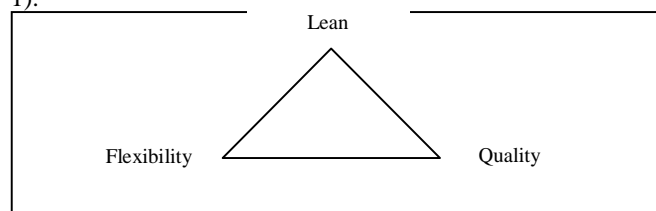


FIGURE 1. THE PROPOSED KEY CHALLENGES IN THE PRODUCTION OF BAKED GOODS.

III. CASE STUDY

A. Methodology

The research focuses on understanding the challenges in the food industry; in particular in the baking sector, something that is not well understood, thus leading this research to use a qualitative approach in order to explore the research question and provide rich, deep data [14]. A quantitative approach is used to analyze the dataset.

This research is case-based and includes three key phases: a theoretical phase, an empirical phase and a reflection on current theory based on new empirical evidence. First, an extensive literature review was carried out. Second, data was gathered from an in-depth case study and these findings were used to reflect on the current situation in the research field. Third, the theoretical and practical implications of the new knowledge were identified.

The explorative nature of the research question allows for an in-depth understanding of the research object which makes the case-study approach was selected the most appropriate research methodology [15]. The case-study approach delivers a rich in-depth study of a phenomenon where limited knowledge or extant knowledge seems inadequate. The case organization was selected based on a number of key parameters including, (i) it being a food organization in the baking industry, (ii) the organization being situated in Denmark, (iii) possible access to management and post-senior management, and (iv) the products are industrially made in large batches to be frozen or to have a long shelf life.

The main method of data collection was through company visits, presentations by the senior staff and documentation. Additional information was collated in the form of company archival documentation, strategy documents and public statements to ensure an accurate representation and enable a triangulation of the findings between different sources of information for improving validity [16].

The case study focused on one of the largest Danish producer of baked goods called Baked Goods A/S (a synonym due to the company's wish for anonymity). Baked Goods A/S was established in 2000 and entered the market in 2001. In 2012 Baked Goods A/S had 103 full time employees. The company focused on increasing its revenue on the domestic market and on developing new export markets, especially in China. The focus on new export markets put a pressure on the 2012 results which declined from DKK 3.1 million in 2011 to DKK 1.7 million in 2012 (after tax) despite a substantial revenue growth. Revenue increased from DKK 159 million in 2011 to DKK 180 million in 2012. The increase primarily derived from the domestic market despite the general downward price development on the Danish market. The focus on export in general, including the Chinese market, has not yet resulted in increasing sales.

Revenue growth primarily derived from increasing sales of convenience products, but also from coffee bread products, including buttermilk horns, which proved successful in 2012. The sale of more traditional sandwich and snack breads has stagnated. This development was expected, and Baked Goods A/S sought to counteract this with a continued considerable price focus and a high innovation level.

B. Findings

Baked Goods A/S gave access to several of their production lines and conveyor belts. One of the most noticeable findings was the amount of food waste (see figure 2).



FIGURE II. Food waste at a conveyor belt at Baked Goods A/S.

Another finding was the lack of organization of tools and equipment as well as the amount of movement of goods which had to take place in order to keep the production line going (see figure 3).



FIGURE III. The trolleys and boxes show the large amount of movement of goods and produce needed to keep the production line going

This was also visible in the planning of production, for example were ingredients to one batch often taken to the production hall and left waiting until it was discovered that the given batch was not to be produced that day after all and then ingredients were taken back to storage and cooling rooms.

It was also noticeable that there was a large amount of leftover ingredients on the floor of the production hall and on the equipment which could cause health issues, accidents and other delays in production (see figure 4).



FIGURE IV. Flour, dough, faulty produce and other ingredients on the floor of the production hall.

Furthermore, many roundabout solutions were created to keep the production line going; for example removing safety covers, recovering covers to allow for overflowing of produce and collection of falling dough in trays (see figure 5).



FIGURE V. Dough falling off the production line. It is collected in a tray.

To summarize, Baked Goods A/S had 7 main challenges:

- Waste in the form of food.

- Waste in the form of faulty produce.
- Waste in the form of movement of goods and people.
- Equipment not used to specifications.
- Leftover ingredients and produce on the floor and equipment.
- Temporal solutions to problems on the production line which increased waste and did not solve the problems.
- Poor planning when changing between batches, creating waste of movement and potentially of produce if the produce stands too long out of cooling areas.

IV. REFLECTIONS AND CONCLUSIONS

Baked Goods A/S's challenges can be categorized into the three categories introduced earlier which supports the proposition:

- Lean challenges in the form of waste as well as equipment not used as specified.
- Quality challenges in the form of faulty produce, ingredients split on the floor and on the equipment and delays in changing batches on the production line.
- Flexibility challenges due to difficulties with changing batches on the production line.

We can therefore address the research question and postulate that while the production of baked goods has similar challenges to other productions, in particular lean challenges similar to those illustrated in the automobile industry [10], there are also differences. The Just-In-Time principle from lean is amplified in this type of production where production lines need to be able to change often daily to produce the kind of products most needed. This need for flexibility will have to be balanced against the demand for smoothness and repetition found in lean. Furthermore, quality needs have to be balanced against the zero waste policy of lean. For example, faulty products or leftover ingredients could perhaps be reused or sold in a budget line?

Further research is needed into how to address these challenges and to find the right balance between the three areas proposed here. Furthermore, it is necessary to test the proposition proposed here on more case companies in the baked goods industry, both in Denmark and abroad. The authors seek to develop this research further in the future and

plan to carry out several additional case studies in the baked goods industry in Denmark throughout 2013.

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