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Quality Management and Risk Analysis of Product Defects at Bakers King

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ABSTRACT

This study aims to analyze quality and risk management related to product defects in dry cakes produced by Bakers King. The research was conducted through a three-month survey (February–April 2022), covering a total production of 10,646 units, with 564 defective products identified. The three main types of defects were overflow (54.4%), burnt (23%), and crumbled (22.5%). Analytical methods used in this study included a P-chart for statistical quality control, a fishbone diagram to identify root causes, and Failure Mode and Effect Analysis (FMEA) to evaluate potential risks in the production process. The FMEA results indicated that the highest risks stemmed from inconsistent recipe use (RPN 240) and data recording errors (RPN 224). Proposed mitigation strategies included regular staff training, digitalization of data recording, implementation of standard operating procedures (SOPs), and regular equipment maintenance. Meanwhile, risk transfer strategies were carried out through quality contracts with suppliers and product insurance. This study recommends a comprehensive improvement in quality management systems to reduce product defects and enhance customer satisfaction.

Keywords:

quality, defect, fmea, p-chart, risk

Introduction

In the highly competitive food industry, product quality plays a critical role in determining a company's sustainability and competitiveness. Modern consumers demand not only delicious products but also consistency, hygiene, and compliance with food safety standards. In this context, quality management becomes an essential aspect that cannot be overlooked. Companies must ensure that every product meets established specifications in order to satisfy customer expectations.

At the same time, production processes are inevitably exposed to various risks that can affect product quality. These risks may include technical issues, such as machine failures, process errors, or inconsistent raw material quality, as well as managerial challenges like inaccurate data recording or insufficient employee training. If these risks are not properly managed, they can lead to product defects, customer complaints, and even significant financial losses. In the food sector, even minor errors in quality control can have major consequences. Defects such as irregular texture, unexpected taste, or visually unacceptable conditions can result in customer dissatisfaction, product returns, and a decline in brand reputation. Therefore, companies need effective strategies to identify potential issues, analyze root causes, and implement corrective measures.

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Quality management is a systematic approach to ensuring that products and services meet predefined standards. In the food industry, this approach involves controlling raw materials, managing production processes, ensuring proper packaging, and monitoring distribution. One common tool for quality control is statistical process control (SPC), such as the P-chart, which helps monitor process variation and detect any out-of-control conditions. On the other hand, risk management is used to identify, assess, and control potential risks that may disrupt production. A widely used method in this regard is Failure Mode and Effect Analysis (FMEA), which evaluates risks based on three parameters: severity, occurrence, and detection. The resulting Risk Priority Number (RPN) helps organizations prioritize actions to address the most critical risks first.

The integration of quality management and risk management is vital in the food industry, as both complement each other. While quality management ensures products consistently meet specifications, risk management addresses the underlying causes of potential failures, thereby reducing the likelihood of defects. By combining these approaches, companies can achieve both operational efficiency and customer satisfaction.

Bakers King is a bakery company established in 2015. The company has positioned itself as a leading producer of premium-quality bread and pastries, emphasizing the use of natural ingredients and hygienic production processes. Bakers King’s product range includes traditional white bread, sweet bread, and specialty products such as whole wheat and gluten-free bread, catering to health-conscious consumers. The company’s vision is to become a market leader in Indonesia’s bakery industry by providing high-quality, nutritious products for its customers. To achieve this, Bakers King continually innovates and collaborates with cafés, restaurants, and supermarkets to ensure its products are widely accessible.

However, as the company expands and production volumes increase, maintaining consistent quality becomes increasingly challenging. Higher production capacity brings greater variation in processes, which can lead to product defects if not properly controlled. During the period from February to April 2022, Bakers King recorded significant occurrences of product defects, particularly in its dry cookie line. The three main defect types identified were “luber” (overflowed dough due to excessive fermentation or inaccurate ingredient proportions), “hangus” (burnt products resulting from improper baking time or temperature), and “remuk” (crumbled cookies during packaging caused by low humidity or improper dough kneading).

Data collected over the three-month period revealed a total of 564 defective units out of 10,646 products, representing a defect rate of approximately 5.3%. Among these, the most dominant defect was “luber,” accounting for 54.4% of all defects, followed by “hangus” at 23% and “remuk” at 22.5%. These figures indicate the need for a comprehensive evaluation of the company’s quality control systems and risk management practices. Furthermore, the presence of such defects not only affects product quality but also impacts production costs, customer satisfaction, and brand reputation. If these issues remain unaddressed, Bakers King risks financial losses and potential erosion of its market share.

Given these conditions, this study aims to conduct a thorough analysis of product quality and associated risks at Bakers King, with a focus on its dry cookie product line. The research employs statistical tools and risk assessment techniques, including P-charts for monitoring process stability, fishbone diagrams for identifying root causes, and FMEA for prioritizing risks. By applying these methods, the study seeks to determine the key factors contributing to product defects and propose targeted strategies for improvement.

The significance of this research lies in its practical implications. For Bakers King, the findings will serve as a foundation for implementing corrective actions and enhancing operational efficiency. For the academic community, this study provides a real-world example of how quality management and risk analysis techniques can be applied in the food industry. For consumers, the ultimate benefit is the assurance of receiving products that meet high standards of quality and safety.

The scope of this research is limited to analyzing defect data for dry cookie products produced between February and April 2022. The analysis focuses on the calculation of defect proportions, process control using P-charts, root cause identification via fishbone diagrams, and risk prioritization through FMEA. Areas beyond the production process, such as distribution or marketing, are not covered in this study.

In conclusion, ensuring consistent product quality while managing production risks is essential for companies operating in the food industry, particularly those striving for market leadership like Bakers King. Through this research, the company is expected to gain valuable insights into the sources of product defects and the associated risks, enabling it to implement effective quality improvement measures. By doing so, Bakers King can reduce defect rates, enhance customer satisfaction, and strengthen its competitive advantage in an increasingly demanding market.

Method

This study applied a quantitative and qualitative approach to analyze the quality issues and operational risks in the dry cookie production process at Bakers King. Data collection was conducted through direct observation and documentation of production outputs over a three-month period (February–April 2022). The team recorded daily production quantities along with the number and types of defective products, which included three primary defect categories: overflow, burnt, and crumbled. The data served as the foundation for identifying trends, calculating defect proportions, and selecting areas for deeper analysis.

To evaluate process stability and monitor the proportion of defective products, the team used P-chart analysis (Proportion Control Chart). This statistical quality control method was employed to determine the average defect rate (p-bar), and to calculate control limits (CL, UCL, and LCL) for each day of production. The P-chart helped visualize whether the production process was operating within acceptable quality limits or if variations indicated potential problems requiring corrective action.

In addition to statistical analysis, the team employed Fishbone Diagrams (Ishikawa Diagrams) to identify root causes of each defect type by examining factors related to materials, machines, methods, manpower, measurements, and the working environment. Following this, Failure Mode and Effect Analysis (FMEA) was used to assess risks based on severity, occurrence, and detection scores. The Risk Priority Number (RPN) was calculated for each failure mode to prioritize corrective actions. Finally, a risk treatment strategy was developed, including mitigation and risk transfer plans, aimed at reducing defect rates and improving overall production quality.

Result and Discussion

The analysis of defect data collected from Bakers King over a three-month period revealed significant variations in product quality, highlighting the need for improved process control. During February, March, and April 2022, the company produced a total of 10,646 units of dry cookies, of which 564 units were identified as defective. This represents an overall defect rate of 5.3%, which, although seemingly small, is substantial in the context of large-scale bakery production where consistency is essential for maintaining customer satisfaction and brand reputation.

Summary of Monthly Defects

The monthly defect distribution is presented in Table 1.

Table 1. Monthly Production and Defects

Month	**Total Production**	**Total Defects**	**Percentage (%)**
February	3,284	144	25.5
March	3,783	224	39.7
April	3,579	196	34.8
Total	**10,646**	**564**	**100**

From this table, it is evident that the highest defect rate occurred in March, which contributed 39.7% of the total defects during the observed period.

Distribution by Defect Type

Defects were categorized into three main types: "Luber," "Hangus," and "Remuk." Table 2 shows the breakdown.

Table 2. Defect Types and Percentages

Defect Type	**Number of Defects**	**Percentage (%)**
Luber	307	54.4
Hangus	130	23.0
Remuk	127	22.5
Total	**564**	**100**

The dominance of the "Luber" defect highlights the need for improved fermentation and ingredient measurement controls.

Proportion Analysis and Control Chart

The overall defect proportion was calculated as:

$$p = \text{Total Defects} / \text{Total Production} = 564/10{,}646 = 0.053$$

Based on this, the P-chart control limits were computed for individual subgroups. For example:

- CL (Central Line) = 0.053
- UCL (Upper Control Limit) ≈ 0.093 – 0.12 (depending on subgroup size)
- LCL (Lower Control Limit) values included negative results, which were rounded to zero.

A sample of subgroup data is presented in Table 3.

Table 3. Sample P-chart Data for February

Date	Inspected Units	Defects	Proportion (p)	CL	UCL	LCL
01/02/22	126	11	0.087	0.053	0.093	0.000
02/02/22	123	1	0.008	0.053	0.094	0.000
03/02/22	105	7	0.066	0.053	0.098	0.000
...	...	...	...	...	...	...

The control chart indicated several points outside the upper control limit, confirming that the process was not fully stable during the observed period. This instability suggests a need for stricter monitoring and process adjustments.

Root Cause Identification and Risk Assessment

To determine the causes behind these defects, a fishbone analysis was conducted, revealing six major categories: Man, Machine, Method, Material, Environment, and Measurement. Factors included inadequate training, improper machine maintenance, lack of standardization in ingredient measurement, inconsistent raw material quality, and environmental variations such as temperature and humidity.

The risks were then prioritized using Failure Mode and Effect Analysis (FMEA). The evaluation of severity, occurrence, and detection produced the Risk Priority Numbers (RPN) shown in Table 4.

Table 4. Risk Priority Number (RPN) Analysis

No	Failure Mode	Severity	Occurrence	Detection	RPN
1	Inconsistent recipe usage	5	8	6	240
2	Data recording errors	8	4	7	224
3	Low-quality raw materials	6	5	7	210
4	Lack of employee training	6	3	5	90
5	Machine breakdown during production	2	5	5	50
6	Unstable temperature and humidity levels	2	4	6	48

The highest RPN was associated with inconsistent recipe usage (240), followed by errors in data recording (224) and poor raw material quality (210). These findings underscore the importance of standardizing recipes, implementing digital data management systems, and improving supplier quality assurance.

The dominance of the "Luber" defect points to weaknesses in fermentation control, which could be addressed through improved SOPs, regular monitoring of dough conditions, and enhanced employee training. Similarly, the occurrence of burnt products highlights the need for preventive maintenance of ovens and the adoption of automated temperature control systems to minimize human error. The issue of crumbled cookies indicates the necessity of maintaining proper humidity levels in storage areas and ensuring that kneading techniques meet established standards.

Digitalization presents a significant opportunity for quality improvement. Implementing an integrated data management system could reduce recording errors and enable real-time monitoring of critical parameters. Automated alerts for deviations in temperature, humidity, or fermentation time would allow for immediate corrective action, reducing the incidence of defects.

Finally, human factors remain critical. Continuous training programs should be implemented to enhance employee competence in ingredient measurement, fermentation control, and baking. Training should emphasize adherence to SOPs and accuracy at every stage of production. Certification programs and performance monitoring can reinforce accountability and encourage a culture of quality within the organization.

In summary, these results confirm that Bakers King's defect issues primarily arise from process inconsistencies and inadequate risk management practices. By addressing these root causes through preventive maintenance, process standardization, digitalization, and employee training, the company can significantly reduce defect rates, improve product quality, and enhance its competitive position in the market.

Conclusion

This study examined the quality management and risk factors associated with product defects in the dry cookie production process at Bakers King. The analysis of three months of production data revealed a total of 564 defects out of 10,646 units, representing an overall defect rate of 5.3%. Among the identified defects, "luber" was the most prevalent type, accounting for 54.4% of all cases, followed by "hangus" at 23% and "remuk" at 22.5%. The P-chart analysis demonstrated that the production process exhibited points outside the control limits, indicating a lack of statistical stability. This suggests that variations in critical parameters such as fermentation, baking temperature, and humidity were not effectively controlled. Further analysis using fishbone diagrams revealed that the root causes of these defects included human factors, machine conditions, inadequate methods, material inconsistencies, environmental variations, and measurement errors. Failure Mode and Effect Analysis (FMEA) identified inconsistent recipe application (RPN: 240), data recording errors (RPN: 224), and poor raw material quality (RPN: 210) as the most critical risks. These findings indicate the urgent need for improvements in process standardization, digitalization, and quality assurance practices.

To address these issues, several corrective strategies are recommended. First, the implementation of strict standard operating procedures (SOPs) for fermentation, baking, and ingredient measurement is essential to minimize variability. Second, preventive maintenance of ovens and other machinery should be prioritized to ensure consistent operating conditions. Third, adopting digital systems for data recording and real-time process monitoring will reduce human error and enable proactive interventions. Finally, ongoing employee training programs should be conducted to enhance operational skills and reinforce adherence to quality standards. By implementing these measures, Bakers King can significantly reduce the rate of product defects, improve operational efficiency, and enhance customer satisfaction. In the long term, these improvements will strengthen the company's competitive advantage in an increasingly demanding market, ensuring sustainable growth and maintaining its reputation for quality and reliability.

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