A Study of Factors and Level of Food Quality Management in The Bakery Sector

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ABSTRACT

The major responsibility of bakeries is to make excellent bread. This can only be achieved by maintaining strict batch control over all materials used in production. Nihans data categorization method was used for statistical data treatment, data grouping, and data analysis. Datamining, a mix of methods that creates information from huge data sets, might be used to this data to extract relevant information on physical, chemical, biological, or allergic substances linked with a food product from harvest to the consumer's hand. The primary objective of this study is to review the current research on quality management systems.

Keywords Quality Management, Food Safety Management, Critical Success Factors, Food Industry, food law

INTRODUCTION

The state has made measures to establish and maintain a product quality management system in response to rising concerns about food safety and the country's rising prosperity. The formation and growth of the Customs Union is of the utmost importance to the Russian economy. Given these factors, it became important to develop a standardized approach to managing the quality of produced goods, with the goal of identifying and fixing manufacturing flaws before they reach consumers. The HACCP-based method has proven to be the most effective so far.

The study's overarching goal is to aid academics and food industry managers in decision making and action prioritization by compiling and ranking the essential success criteria that impact quality management systems and food safety management systems in a worldwide setting.

The World Health Organization (WHO) reports that international trade in food is growing rapidly, which raises the possibility that pathogens and contaminants will travel across national boundaries, presents new difficulties for the authorities, and heightens the importance of global sharing of information about food safety. However, climate change may be a contributor to the rise in the prevalence of certain food-borne illnesses due to the accelerated growth of micro-organisms in foods and water at higher temperatures. This, in turn, can lead to the spread of toxins to previously unaffected regions and an overall increase in the prevalence of pathogens in food.

The plant's failure to meet both broad and narrow standards for cleanliness is to blame for many of the reported safety issues with the finished product. Inadequacies in the bakery product

manufacturing industry include the difficulty in acquiring skilled technical people, the high startup costs associated with establishing a new bakery, and the high rate at which existing bakeries are sold or shut down. The ability to learn from food contamination episodes and foodborne disease outbreaks is a crucial feature of a genuinely preventative food safety system. To stay up with the ever-evolving threats, technology, and food production, processing, and distribution systems in a world where food is increasingly sourced from across the globe, the methodologies used to investigate cases of foodborne disease have evolved throughout time. However, food companies, regulatory agencies, academic institutions, and other major stakeholder groups have not yet standardized their investigative methodologies for pinpointing the origins of food contamination.

LITERATURE REVIEW

Maria Królak et.al (2022) Companies with a high level of innovation also tend to create new products for the firm, for the customer, and in terms of packaging. The primary reason for introducing new items to the market was to accommodate changing customer preferences. Therefore, the findings point to a consumer orientation toward innovation as the norm. The bakers questioned said fiber-enriched bread was a healthy option with positive effects on the planet. Our findings provide new insight into what motivates sustainable innovation in the food sector and have real-world consequences for bakeries that want to differentiate themselves via eco-friendly methods of production. Findings from the research highlighted the significance of listening to customers while thinking of new bakery offerings. An approach focused on the needs of consumers has the potential to benefit everyone involved by increasing the variety of items available for a diet that is both healthy and sustainable while also making use of byproducts from the food processing industry, such as fiber waste.

S. Özçakmak (2019) From the time of harvest until the time it reaches the hands of the customer, any number of physical, chemical, biological, or allergic substances might have contaminated the food processing. The use of HACCP principles guarantees the safety of manufactured goods. Though many producers may receive a HACCP certificate with no trouble, they may not use the comprehensive food screening systems at every step of production. The researchers in this study set out to assess how well Samsun, Turkey, residents understand food safety and the laws that govern it, as well as how well HACCP is implemented in the roll bread production line. The HACCP group inspected the roll bread factory's verification processes, documentation, and production flow and made adjustments to the HACCP chart as a result. The CCPs were established by following the decision tree of the procedure outlined in ISO 22000:2005. A questionnaire administered in-person assessed workers' knowledge of sanitation and food safety standards. The manufacturing facility saw cooling (stage 10) as CCP despite the fact that it occurred at the end of the whole process. Procedures for monitoring and averting disasters, as well as any necessary software applications, will be developed. Product labeling was also reviewed and updated to reflect the current state of manufacturing. We found that the staff was not well-versed in food hygiene procedures and quality control applications; informing the staff and providing them with technical assistance would improve this situation and help them maintain internal control.

Kholmamatov Diyor Haqberdievich (2022) Understanding the variables that influence the demand for bread and bakery goods in Uzbekistan is crucial at a time when global food security is improving. Because of this, a survey was designed to gauge consumer interest in bread and baked goods. This article presents some of the findings from this research.

Humiras Hardi Purba (2019) Before deciding whether or not to purchase a product or service, buyers place a high value on the product's quality. The needs and wants of potential buyers, which may include specific quality characteristics, form the bedrock of the innovation process. The primary goal of this research was to prioritize the development of product qualities like bread and chocolate cake. Eleven different qualities of chocolate bars were ranked, including their flavor, smoothness, scent, visual appeal, quantity, selection, healthiness, sustainability, cost-effectiveness, and affordability. Consumers' opinions on the most important characteristics of the bread and chocolate cake products were gleaned via surveys they filled out on the products' relative significance and performance. According to the findings of an important performance study, the quality of the product's flavor, texture, scent, appearance, variety, freshness, healthiness, and packaging should be a top priority.

Aina Nindiani (2018) The purpose of this study was to assess the quality of a Bekasi-based bakery's operations based on the opinions of its customers. The technique used was an Importance-Performance Analysis (IPA). The purpose of the IPA was to track the development of quality-of-life indicators for products and services. To aid management in making strategic decisions using this information. According to the data, enhancing the product's flavor should be a top goal. In contrast, the politeness indicator is the service quality's top goal, placing in Quadrant A. The bakery should focus on these indicators as improvement objectives.

METHODOLOGY RESEARECH

Bakery description

Two MDD mixers fed a single division, check weigher, rounder, and intermediate proover in the bakery. Two different moulders, one for each side of the 6x2 tin straps, processed the dough bits into two parallel streams of dough/bread. After being divided into three different pools for slicing, the dough/bread was first proved, cooked, and chilled in two separate batches. It was hard to trace individual dough pieces or loaves through the process since the number of streams changed from one to two to three, and the sequence of the tin straps entering and exiting the oven was reversed.

Data collection

The bakery's data was gathered utilizing four portable computers outfitted with data gathering gear and software and a single data logger. Measurements from the PLC control system and digital photographs were stored with PC-recorded divider check weight, proof height, loaf height, and other data (Table 1). Some numbers had to be recorded manually since not all the bakery's equipment was connected to the PLC system (data logger, bakery paperwork and some manually). Mixer data (including but not limited to: flour and water amounts, water and flour temperatures, total labor input, mixer efficiency, mix duration, recipe number, dough temperature, and divider level) could not be recorded due to computer limitations.

Table 1. Bakery properties with measuring method and time between measurements

Property	Measuring method	Time between measurements
Flour report	Manual	~ daily

Dough temperature	Manual	30 mins
Dough piece weight	Check weigher	0.6 secs
Proover temperature, humidity	Data logger	5 mins
Proof height	Laser triangulation	1.2 secs
Oven temperature (3 zones)	PLC*	1 min
Cooler temperature, humidity (in/out)	PLC	1 min
Bread room humidity, exhaust temperature	PLC	1 min
Bread despatch temperature	PLC	1 min
Loaf height, top collapse	Rotary encoder	1.2 secs
Loaf quality shape, colour, four piecing	Manual from photo	~2 mins**
Loaf quality score texture, holes, cores, temperature	Manual from loaf	30 mins
Loaf weight	Check weigher	0.6 secs
Outside temperature, humidity, pressure, wind	Internet	Daily

** In order to keep the information superhighway from crashing, * PLC data were recorded once each minute, but items were read one at a time with a one-second delay between them. Many of the 48 attributes read, such as set points and counter values, were not really utilized in the study.

**

Every 125 loaves, with at least 25 loaves in between shots, will have a random photo taken (to allow the flash to recharge). The snapshot was used to manually rate the properties.

About 2.5 months were devoted to the study, during which time data was gathered on Thursdays and Fridays. Each week, at the close of business, the bakery's files were transferred to a network where the photographs were graded and the data was cleaned and processed.

Data cleaning and preparation

All the raw data from the various sources (PLC, data loggers, sensors) was connected together with a unique identity, and outliers were deleted and gaps were filled in. To better track the several processes involved in making a product, numerous tables were constructed (e.g., proover, oven or slicers). Tables were developed to display the characteristics of batches of

dough pieces and loaves as a function of time, with values typically average over 100 (6000 loaves/hr) as a result of averaging over 1-minute intervals. Each phase of the bread-making process has its travel time estimated (and assumed constant throughout a day). The characteristics and processing factors of the dough cluster were averaged across these times (Table 2). Cluster identification traits and parameters were then created in a table (Table 3). As a further step, we analyzed the whole dataset (Table 2). Observed patterns in clustering

Table 2. Properties and parameters versus cluster identifier

ClusterID	Time	ProoverIn	ProoverOut	OvenIn	OvenOut	CoolerIn	CoolerOut	SlicersIn
3710	3:55:21	4:03:28	5:02:13	5:04:30	5:26:43	5:29:58	7:00:01	7:14:20
3711	3:56:21	4:04:28	5:03:14	5:05:31	5:27:43	5:30:58	7:01:01	7:15:20
3712	3:57:22	4:05:29	5:04:15	5:06:32	5:28:44	5:31:59	7:02:02	7:16:21
3713	3:58:23	4:06:30	5:05:16	5:07:33	5:29:45	5:33:00	7:03:03	7:17:22

Table 3. Properties and parameters versus cluster identifier

9148	2	816.5	40.3	87.5	157.0	229.2	37.9	108.9	1.9	715.2
9150	2	813.0	40.5	87.4	159.4	229.4	37.9	121.3	2.7	715.0
9290	2	808.8	41.9	76.2	179.8	225.6	39.1	131.2	5.1	702.6
9291	2	810.4	41.6	75.4	178.5	225.6	39.1	131.5	4.8	702.4

The use of standard process times to determine what stage the bread had reached in the process meant that the data was only valid when the plant was running without stoppages. This was determined by looking at the values of the dough piece/loaf counters with data being marked as invalid if the counter rate dropped significantly below the standard production rate.

Selected data were extracted from the database using SQL queries. Extracted data were then converted to the correct format for loading into the WEKA data mining workbench (Witten and Frank 2000).

DATA ANAIYSIS

Overview

The information was analyzed in two different ways. Before anything else, we looked at the time series for each production stage in which individual dough pieces or loaves were measured. With this information, trends could be identified that indicated how well certain factors such as the location of the tin straps and the oven performed. Second, the data was averaged over 1-minute intervals to provide typical conditions for each 1-minute chunk of dough/bread as it went through the facility.

Time series analysis

Data on every dough/loaf was measured by the divider check weigher and half the loaves by the proof height and loaf height sensors. Because of the way the conveyors operate in the bakery the gap between loaves was set by the equipment. The divider drops five dough pieces on the conveyor at a time, and there is a small delay before the next five are dropped. By looking at the

time between dough pieces it was possible to determine what pocket a dough piece came from. A similar situation existed for tin strap position at the proof height sensor, and oven position and tin strap position at the loaf height sensor.

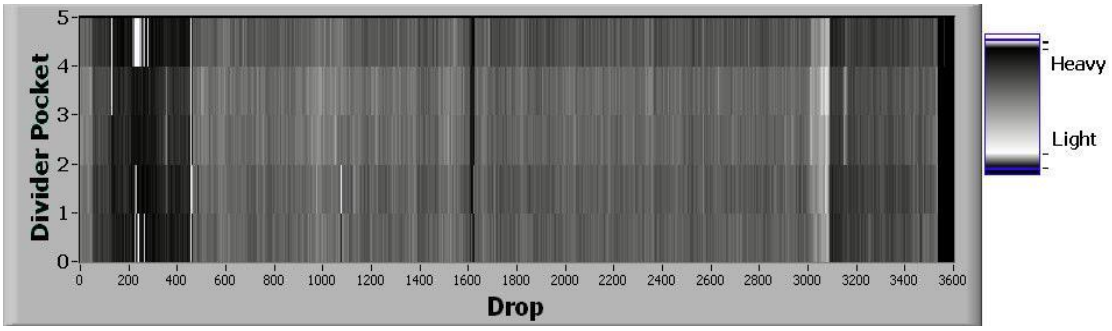

Figure 1 Dough piece weight by divider pocket and drop where the greyscale indicates the relative weight.

See Figure 1 for an example of how this data is put to use. There is a large discrepancy between the weights generated by pockets 1, 2, and 5 and those created by pockets 3 and 4. By laying out the data in this way, the engineer gains insight into how to adjust the weight in each pocket. It's possible that dealing with loaf height and top collapse may be approached in the same way. Both displayed patterns suggestive of the influence of cooking environment.

Data mining

The analytical method was to employ classification and visualization to seek for trends in the data. Neural networks, regression, closest neighbor, and decision trees were among the algorithms used.

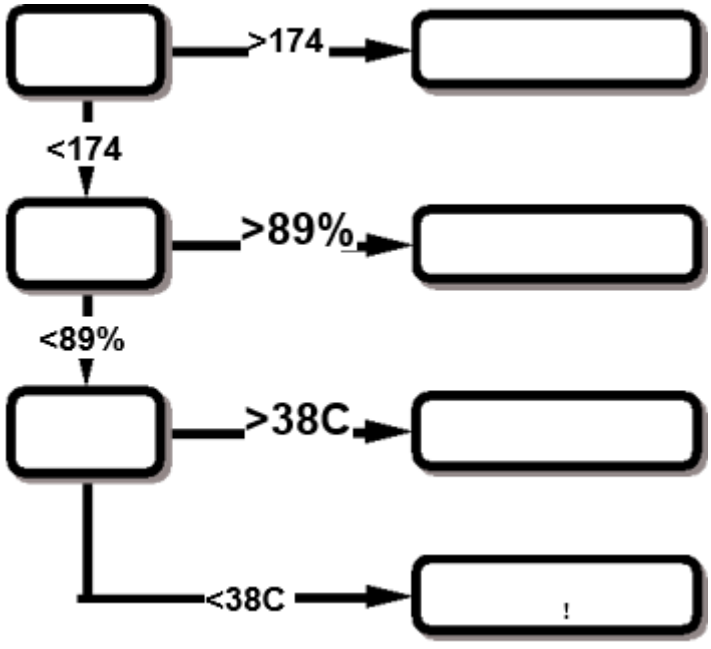

Figure 2. Top collapse predicted from processing parameters using a tree classifier

Top collapse data analysis raises two problems. Predictions made at the outset are not always reliable. About 80% precise here. For the purposes of process control, this could be enough.

Furthermore, it's possible that some crucial detail was overlooked. Larger sample size experiments would demonstrate this. Second, processing factors that didn't shift substantially throughout the experiment have nothing to add to a model of top collapse. A significant parameter may have no discernible impact on the data. An example of this is oven temperature, which did not alter, but is likely to have an influence on top collapse.

Totaling 319 scientific aspects, this article's investigation uncovered them all. After using semantic analysis, we were able to classify these elements into 61 essential success variables that have an impact on SGQSA's rollout and upkeep.

Table 4 displays the results of our estimates of cut-off values for Nihans categorization after semantic analysis and clustering of the essential elements mentioned in the literature.

Table 4. Cut-off numbers for the classification of critical factors

Nihans Index	
Ranking/ Prioritization	Cut-off numbers
A	18
B	8
C	3
D	1

Using this method, we were able to categorize the essential criteria of success that impact the smooth implementation and administration of a QFSMS into four groups (Tables 5, 6, and 7).

Table 5. Ranking and prioritizing critical factors of success for QFSMS. Classe A.

Critical Factors of Success	Frequency (X)	X^2	Ranking/ Prioritization
Management of the people (Knowledge, skills, training and education, etc.).	56	3136	A

Management of the customers / Clients	20	400	A
Control, measurement and performance	19	361	A

Table 6. Ranking and prioritizing critical factors of success for QFSMS. Classe B.

Critical Factors of Success	Frequency (X)	X^2	Ranking/ Prioritization
Quality management and continuous improvement	17	289	B
Supplier management	17	289	B
Commitment of top management	15	225	B
Quality assurance, audits, verification, validation and certification	11	121	B

Financial resources	9	81	B
Organizational culture	9	81	B
Organizational strategies	9	81	B
Management by processes	9	81	B
Teamwork	8	64	B
Government and legislation	8	64	B
Employee commitment	8	64	B

Table 7. Ranking and prioritizing critical factors of success for QFSMS Classe C.

Critical Factors of Success	**Frequency (X)**	**X^2**	**Ranking/ Prioritization**
Time	6	36	C
Behavior	6	36	C
Leadership	6	36	C

Production	5	25	C
Market	5	25	C
Project of products/services	5	25	C
Infrastructure	5	25	C
Communication and integration	4	16	C
Benchmarking	4	16	C
Results	3	9	C
Exports	3	9	C
Information systems	3	9	C
Motivation	3	9	C
Cost and waste	3	9	C
Environmental condit. (Internal or external)	3	9	C

Since these 14 important success elements have such an impact on the quality management and food safety systems as a whole, they have been categorized and prioritized as A and B in this study. As such, they may have an impact on the business's success and the organization's performance if they are well-crafted and contribute to the company's overall goals.

In this light, a company's human resources are crucial in carrying out people-management initiatives. Companies that use TQM in their HR department to get certified typically make significant changes to the company and their HR department's role, with the goal of improving management practices and HRM performance, employee satisfaction and well-being, employee development and advancement opportunities, employee rewards and recognition, recruitment and selection, and HR planning.

CONCLUSION

Many of the inconveniences identified in the safety of the final product are due to the inadequacy of general and specific hygiene requirements of the plant, so this study set out to examine the

existing literature on quality management systems and food safety management, grouping and prioritizing critical success factors that affect the implementation of these systems, when implemented in an integrated manner. The bakery business has developed documentation and a reporting system to assure the consistent delivery of high-quality, risk-free goods. The data mining technique may be used to determine the correlations between the many baking variables. These connections may aid in process management, troubleshooting, and training, and when combined with other quality data (such as customer complaints), they provide another another resource for catering to consumers' preferences. The primary goal of this study was to analyze and organize the literature on quality management systems and food safety management in order to identify, categorize, and rank the most important crucial success criteria that influence the successful integration of these two systems.

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