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**Scientific Research**

# Identifying critical control points in the fast-food production process using HACCP principles

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**ABSTRACT**

This study aimed to identify and analyze critical control points (CCPs) in the production process of a fast-food restaurant in order to improve food safety management. This research was conducted with the need for a preventive and systematic approach to prevent potential biological, chemical, and physical hazards in a high-volume food service environment. The methodology was a descriptive-analytical case study conducted at the fast-food restaurant "Krono Pich Yazd". The Hazard Analysis and Critical Control Points (HACCP) framework was applied, which included direct observation, drawing a process flow diagram, risk analysis, and using a decision tree to determine CCPs. Risk Priority Number (RPN) scoring was used to prioritize the identified hazards. The analysis identified eight critical control points in the production chain. Key CCPs included proper washing and sanitizing of raw materials and containers, contamination from metal parts of equipment or broken glass, presence of antibiotic residues in meat, and final inspection of ready-to-eat food for physical contaminants such as hair or packaging materials. This study concludes that the systematic application of HACCP principles is essential for identifying and controlling critical points in fast food production. The findings provide a practical framework for similar establishments to improve their food safety protocols, increase consumer confidence, and prevent health risks. Future research should focus on quantitatively assessing the effectiveness of HACCP implementation in different fast-food models.

## 1- INTRODUCTION

The global expansion of the fast-food industry has significantly transformed modern food consumption patterns and has raised increasing concerns regarding food safety and public health. The high-volume and rapid nature of fast-food operations, characterized by extensive movement of raw materials and complex preparation processes, creates multiple points at which biological, chemical, and physical hazards may arise [1]. Failures in food safety protocols within this sector can lead to foodborne illnesses, resulting in serious health consequences for consumers, economic losses for businesses, and damage to brand reputation. In an era of growing consumer awareness, the establishment of robust and preventive food safety management systems has evolved from a voluntary practice into a critical operational necessity to ensure public well-being and maintain business viability in the competitive food service landscape.

A central framework for addressing these challenges is the Hazard Analysis and Critical Control Points (HACCP) system. HACCP is a preventive, systematic, and science-based approach designed to identify, evaluate, and control hazards that are significant for food safety [2]. Although studies such as [3] indicate that the application of HACCP practices is generally maintained in fast-food restaurants, the same research also suggests that the system may be perceived by some stakeholders as lacking importance, highlighting the need to promote and demonstrate its tangible benefits. Unlike traditional end-product testing, HACCP emphasizes prevention by concentrating control efforts on specific points within the production process where potential hazards can be prevented, eliminated, or reduced to acceptable levels. The system is built upon seven fundamental principles, beginning with hazard analysis and culminating in the establishment of verification procedures and documentation. As explained in [4], its application can significantly improve food safety outcomes. The effectiveness of HACCP in reducing microbial risks and enhancing quality control across various sectors of the food industry has been widely documented, making it a globally recognized standard that is often integrated into broader certification schemes such as ISO 22000.

Successful implementation of a HACCP plan depends on the accurate identification of Critical Control Points (CCPs). A CCP is defined as a step at which control can be applied and is essential to prevent or eliminate a food safety hazard or reduce it to an acceptable level [2]. These are not merely important control points but represent the final barriers against unacceptable health risks. Identifying a true CCP requires careful analysis, often facilitated by tools such as decision trees. Control at these points must be measurable, with critical limits established for parameters such as time and temperature, and must be supported by robust monitoring and corrective action procedures. The precision with which CCPs are identified and managed directly determines the overall effectiveness of the HACCP system in protecting the final product.

Numerous studies have examined the application of the Hazard Analysis and Critical Control Points (HACCP) system in the food industry. For example, a study on the implementation of HACCP in yogurt production demonstrated that this system, as a scientific and systematic approach, can ensure the safety of the final product by identifying potential hazards at different stages of production and determining critical control points. In that study, the stages of raw milk reception, pasteurization, packaging, and storage were identified as stages with the highest risk of contamination and were therefore considered critical control points. The results emphasized that effective implementation of HACCP and continuous monitoring of these points can play a significant role in preventing contamination and improving the safety of dairy products [5]. In another study, the possibility of using Failure Mode and Effects Analysis (FMEA) as a complementary tool to strengthen the HACCP system in a food processing plant in Poland was investigated. In this research, the production process of canned meat in glass jars was selected as the case study, and data were collected through employee interviews, value stream analysis, and examination of non-conformity reports. The results indicated that several non-conformities with varying levels of impact on product quality and the production process existed within the manufacturing process. The findings suggested that the application of the HACCP system can contribute to improved risk management, enhanced quality control, and increased safety in food production, providing considerable benefits for food industries in different countries [6]. Furthermore, a case study conducted in a cake manufacturing company in Dhaka, Bangladesh, examined the development and implementation of a HACCP management system. In this research, all production stages were analyzed for biological, chemical, and physical hazards, and a comprehensive HACCP plan was designed in accordance with regulatory requirements. To reduce certain risks before the start of production, prerequisite programs were also established, which helped simplify the implementation of the HACCP plan. The results showed that one critical control point (CCP) and two operational prerequisite programs were identified during the production process. This study demonstrated that implementing the HACCP system can assist process engineers and quality control specialists in designing effective control measures and improving the safety of food products [7].

Despite the proven effectiveness of the HACCP system, relatively few studies have examined its practical implementation in small and medium-sized fast-food establishments, particularly in developing countries. Existing literature often focuses on large-scale food manufacturing industries or export-oriented sectors [8], while studies addressing the practical and step-by-step implementation of HACCP in local fast-food restaurants remain limited. This lack of applied research has resulted in an incomplete understanding of how HACCP can be effectively implemented in small food service environments, including the challenges encountered, common errors, and the identification of actual critical control points. Findings from several case studies, including an investigation conducted at the Arjuna Resto Chakra hotel restaurant, indicate that effective HACCP implementation in such establishments faces numerous practical challenges [9]. A more recent study has empirically confirmed these challenges, including the shortage of trained personnel, the complexity of documentation, and insufficient understanding of analytical procedures [10]. This gap highlights the need for targeted, case-based research that demonstrates the process of CCP identification in a real-world fast-food environment and provides a practical model for similar businesses.

The present study aims to identify the critical control points (CCPs) in the production process of a fast-food restaurant in Yazd and to analyze the major hazards at each stage. The research questions guiding this study are: (1) What significant biological, chemical, and physical hazards exist at each stage of the fast-food production process? and (2) Which stages of the process constitute actual critical control points? This research adopts a descriptive–analytical case study approach, utilizing direct observation, process flow diagrams, hazard analysis, and decision tree analysis to systematically identify critical control points. The following sections of this paper describe the methodological approach in detail, present the findings of the hazard analysis and CCP identification, and discuss the practical implications for improving food safety management in the fast-food industry, concluding with recommendations for future research and implementation.

## 2- Theoretical Framework

This study is situated within the critical domain of food safety management and specifically examines the application of systematic and preventive control systems in the fast-food industry. The scope of the research is defined by the operational processes of a fast-food restaurant, ranging from the receipt of raw materials to the final serving of meals to customers. The significance of this topic is underscored by the persistent global challenge of foodborne illnesses and the unique vulnerabilities of the fast-food sector, where high operational throughput, complex preparation procedures, and time pressures can compromise traditional and reactive hygiene practices [1].

The theoretical importance of this research lies in addressing the gap between established food safety principles and their practical, context-specific implementation in small- to medium-sized food service enterprises, which often receive less scholarly attention compared with large-scale food manufacturing industries [11]. Consequently, this study engages with an important conceptual area by examining how theoretical hazard-control models can be operationalized within a real-world, high-risk environment. The primary theoretical objective of the study is to construct a conceptual model for hazard identification and control using the internationally recognized Hazard Analysis and Critical Control Points (HACCP) framework.

This research is not merely descriptive; rather, it seeks to demonstrate the analytical process of decomposing a complex food production system into its constituent stages in order to systematically evaluate risks. The guiding theoretical framework is the Codex Alimentarius HACCP system, which provides a structured, seven-principal approach for ensuring food safety [2]. The potential contribution of this study lies in advancing knowledge on the contextual adaptation of this framework and its transformation from a general standard into a tailored and implementable program. In doing so, the study aims to contribute to the theoretical understanding of how systems thinking and preventive principles can be effectively translated into managerial practice within the logistical and resource constraints typical of fast-food operations.

Several fundamental concepts play a central role in this research. The first is the concept of a hazard, defined as a biological, chemical, or physical agent in food or a condition of food with the potential to cause adverse health effects [2]. The theoretical literature distinguishes between identifying all potential hazards and subsequently determining which hazards are sufficiently significant to require control measures. The second key concept is the Critical Control Point (CCP), defined as a stage at which control can be applied and is essential to prevent, eliminate, or reduce a food safety hazard to an acceptable level. The precise identification of a CCP, as distinct from a simple control point, represents a fundamental analytical exercise often facilitated by a decision tree, which is a logical sequence of questions used to determine whether a specific step constitutes a CCP [4]. Together, these concepts form the core vocabulary of the analytical process.

The theoretical foundation of this study is based on the HACCP system and is supported by the prerequisite framework of risk assessment. HACCP itself represents a comprehensive model built on preventive control rather than reliance on final product inspection. Its key principles hazard analysis, determination of CCPs, establishment of critical limits, monitoring procedures, corrective actions, verification, and documentation provide a sequential model for developing an effective food safety protocol [2]. Complementing this model is the risk assessment framework, which provides the quantitative or qualitative basis for hazard analysis. In this study, this framework is operationalized through the Risk Priority Number (RPN) derived from Failure Mode and Effects Analysis (FMEA), a method that evaluates risk by assessing the severity, occurrence, and detectability of potential failures. This integration enables a more objective prioritization of hazards during the HACCP analysis.

The interrelationship among these concepts and theoretical frameworks forms a coherent and robust foundation for the present study. The comprehensive HACCP framework provides the structural roadmap, while the specific concepts of hazards and CCPs represent the critical analytical nodes within that structure. The risk assessment model, expressed through the RPN, directly informs the “hazard analysis” stage of HACCP by transforming it from a subjective listing of hazards into a prioritized evaluation based on severity, occurrence, and detectability. The decision tree then functions as a logical tool that utilizes the output of the risk assessment to definitively classify a process step as either a CCP or a non-CCP.

Thus, these elements are not independent but functionally integrated: risk assessment quantifies the problem, HACCP principles guide the systematic response, and the decision tree provides the critical logic required to determine precisely where absolute control is necessary. This synergy offers a comprehensive theoretical perspective through which the safety of a food production system can be rigorously examined and strengthened. However, as field studies in the hospitality industry in Saudi Arabia have demonstrated, the level of understanding and prioritization of the HACCP system can vary even among international fast-food chain restaurants [3], highlighting the importance of considering human and organizational factors alongside technical frameworks.

## 3- Materials and Methods

### 3.1. Research Design and Methodology

This study employed a descriptive–analytical case study design to examine food production processes in a single operational fast-food restaurant. The research was conducted in a real field setting Krono Pich Yazd in order to ensure the ecological validity of the findings. The selection of this restaurant as the case study was based on several considerations. First, it is an active fast-food establishment in Yazd with a high sales volume and a relatively diverse menu, encompassing the main processes of food preparation, cooking, and holding. Second, the management of the establishment provided the necessary cooperation for a comprehensive field examination of production processes and the application of HACCP principles, thereby enabling direct access to real operational data. Third, the operational characteristics of this unit in terms of size, equipment, and workforce represent the most common structure of small- to medium-sized fast-food establishments in Iran, making the practical implications of the findings applicable to similar businesses.

The overall approach to data collection was qualitative and observational, guided by the structured framework and seven principles of the Hazard Analysis and Critical Control Points (HACCP) system [2]. The analytical methodology included systematic hazard analysis and the use of a standard decision tree to convert observational data into identified Critical Control Points (CCPs). This design was selected to provide a detailed and context-specific understanding of food safety hazards, in line with the study objective of developing a tailored and practical HACCP-based model.

### 3.2. Study Sample and Materials

The subject of this case study was the entire food production system of Krono Pich Fast Food, Yazd. Purposive sampling was used to select this specific unit due to its operational characteristics, which represent a typical medium-sized fast-food establishment. In addition, the organization of the physical space and the layout of functional areas in the restaurant were considered in light of contemporary studies on HACCP requirements for restaurant environments [12], allowing a more accurate assessment of material flow and potential cross-contamination risks. The products examined included the full range of the restaurant's menu items, including pizza, fried foods, steak, pasta, and sandwiches. The analysis covered all relevant raw materials, ingredients, and semi-finished products used in their preparation. Key characteristics of these materials, such as supplier origin, storage conditions for example, refrigerated or dry storage and preparation requirements, were recorded as inherent variables affecting the hazard analysis.

### 3.3. Data Collection Tools and Instruments

The primary tool for data collection was a structured observation protocol based on HACCP principles, including customized checklists for hygiene and process auditing. The main analytical tool was the decision tree used for CCP identification. For the risk assessment component, the Risk Priority Number (RPN) matrix was used as a quantitative tool to prioritize the identified hazards. This matrix was designed using predefined ordinal scales from 1 to 5 for scoring the severity (S), occurrence (O), and detectability (D) of each potential failure mode. All three indicators were scored on a five-point ordinal scale: severity referred to the potential impact of the hazard on food safety; occurrence referred to the likelihood of the hazard arising during the process; and detectability referred to the likelihood of identifying the hazard before it reached the consumer. On this scale, a score of 1 indicated a low level of effect or probability, whereas a score of 5 represented the highest level of importance or likelihood. No specialized laboratory equipment was used; rather, data collection relied on direct observation, process monitoring, and the systematic application of these structured analytical tools to the observed processes.

### 3.4. Data Collection and Analysis Methods

Data collection was conducted sequentially, beginning with the development of a detailed process flow diagram for each major product category, such as pizza and fried chicken. The researchers then carried out direct observations of all operational stages, from the receipt and storage of materials to preparation, cooking, holding, and service. During the observations, potential biological, chemical, and physical hazards were identified and recorded in the checklists. To prioritize hazards, the RPN matrix was applied using the formula $RPN = S \times O \times D$ where S, O, and D were scored using the five-point scale described above. The RPN threshold was set at 15. This value was selected based on the logic of the five-point scale and with the aim of adopting a conservative approach, such that even hazards with moderate levels of occurrence or severity would be considered for further evaluation and entry into the decision-tree analysis stage. This method ensured a systematic and reproducible procedure for progressing from observation to the identification of critical control points.

### 3.5. Methodological Limitations

Although the proposed approach enables the systematic identification and prioritization of hazards, the results of this study are subject to several methodological limitations. First, the scoring of severity, occurrence, and detectability indicators was based on expert judgment; therefore, the possibility of bias or uncertainty in opinions cannot be excluded. Second, the scope of the study was limited to a single production unit; accordingly, the generalizability of the findings to other production lines or similar food industries may be limited. Third, RPN values only indicate the relative priority of hazards and do not directly predict the actual severity of outcomes. Therefore, future studies are recommended to use larger samples, complementary indicators, or multi-criteria decision-making methods to improve the generalizability and accuracy of risk assessment.

In summary, the methodological approach integrated a case study design with the structured analytical framework of HACCP. The restaurant’s production system served as the bounded case from which process- and hazard-related data were collected through direct observation and checklists. These qualitative data were then systematically analyzed using quantitative RPN scoring for prioritization, followed by the logical and binary filtering process of the decision tree. This coherent process from flow diagram development to hazard identification, risk prioritization, and final CCP determination was implemented to directly address the research questions concerning specific hazards and critical control points in the fast-food production process, while also providing a clear and reproducible protocol for similar studies.

## 4-Implementation Model and Risk Analysis

The implementation of the HACCP system in this study consisted of five sequential and systematic stages, as illustrated in Figure 1. These stages were carried out as follows:

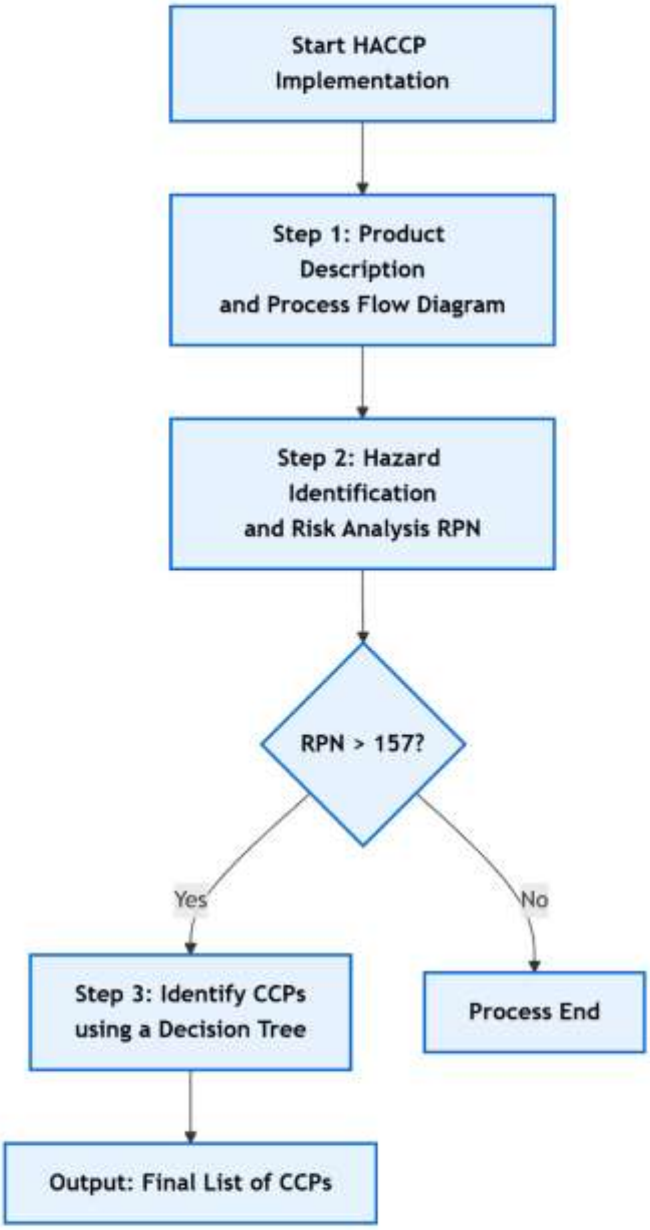


**Figure 1: Steps in implementing the HACCP system in the present study**

### 4.1. Stage 1: Product Description and Development of the Process Flow Diagram

In the first stage, the complete specifications of each main product category pizza, fried items, steak, pasta, and sandwiches were recorded in the form of a product description table (Table 1). These tables included information on ingredients, sensory characteristics, storage conditions, and packaging type.

**Table 1: Description of Krono Pich products**

| Item | Ingredients | Key Characteristics | Consumption Method | Packaging Type | Shelf Life and Storage | Distribution and Sales |
|---|---|---|---|---|---|---|
| Types of Pizza | Pizza dough, pizza cheese, main toppings | Good taste, crispiness of pizza, cheese elasticity, proper baking | Ready-to-eat for the customers | Pizza box | To be consumed on the same day | At the fast-food restaurant, takeaway, delivery |
| Types of Fried Chicken | Chicken, special flour, frying oil | Crispiness, flakiness, proper cooking | Ready-to-eat for the customers | Special box and paper bag | To be consumed on the same day | At the fast-food restaurant, takeaway, delivery |
| Types of Steak | Beef, vegetables, mushroom sauce | Good taste, proper cooking, freshness | Ready-to-eat for the customers | Plastic containers, paper bag | To be consumed on the same day | At the fast-food restaurant, takeaway, delivery |
| Types of pasta | Macaroni, milk, cream, mushrooms, chicken or beef | Good taste, freshness of ingredients | Ready-to-eat for the customers | Plastic containers, heat-resistant up to 120°C | To be consumed on the same day | At the fast-food restaurant, takeaway, delivery |
| Types of Sandwiches | Baguette bread, lettuce, tomato, main fillings | Freshness | Ready-to-eat for the customers | Sandwich paper, box | To be consumed on the same day | At the fast-food restaurant, takeaway, delivery |

Immediately thereafter, a separate process flow diagram was developed for each product. These diagrams schematically and precisely illustrated all production stages, from the receipt of raw materials to service to the customer (Figures 2–6).

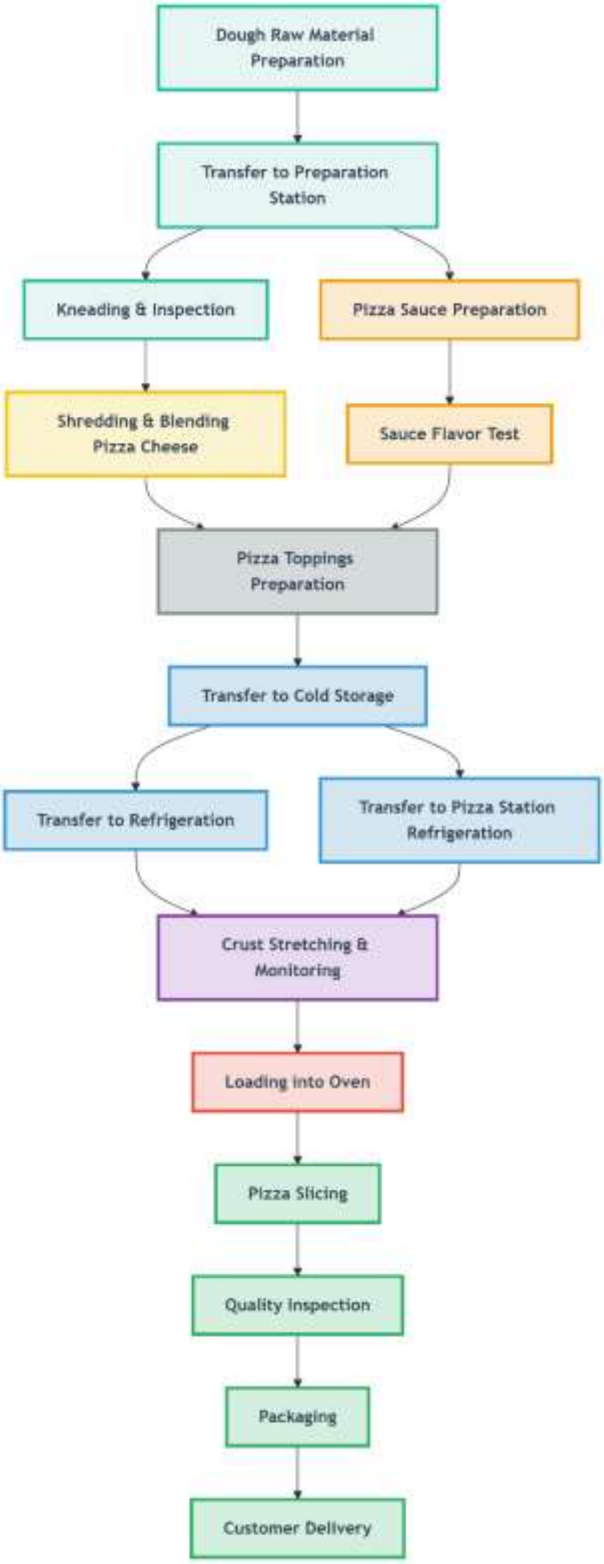


**Figure 2: Pizza process flow chart**

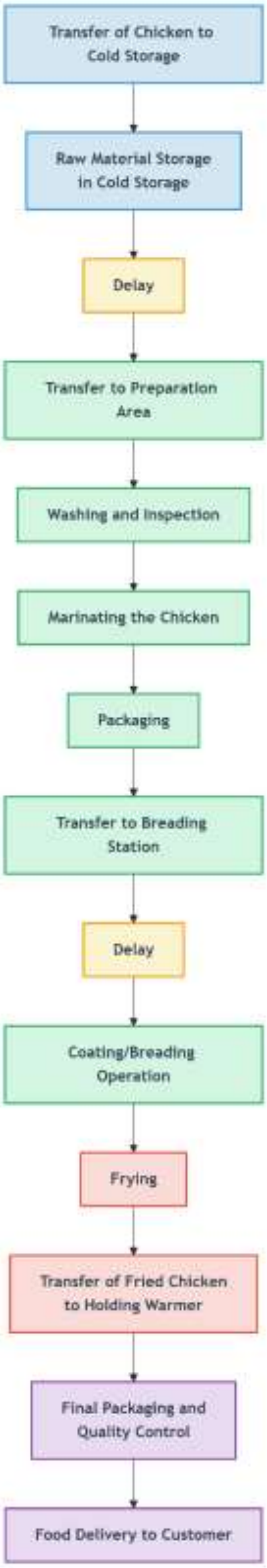


**Figure 3: Breading process flow chart**

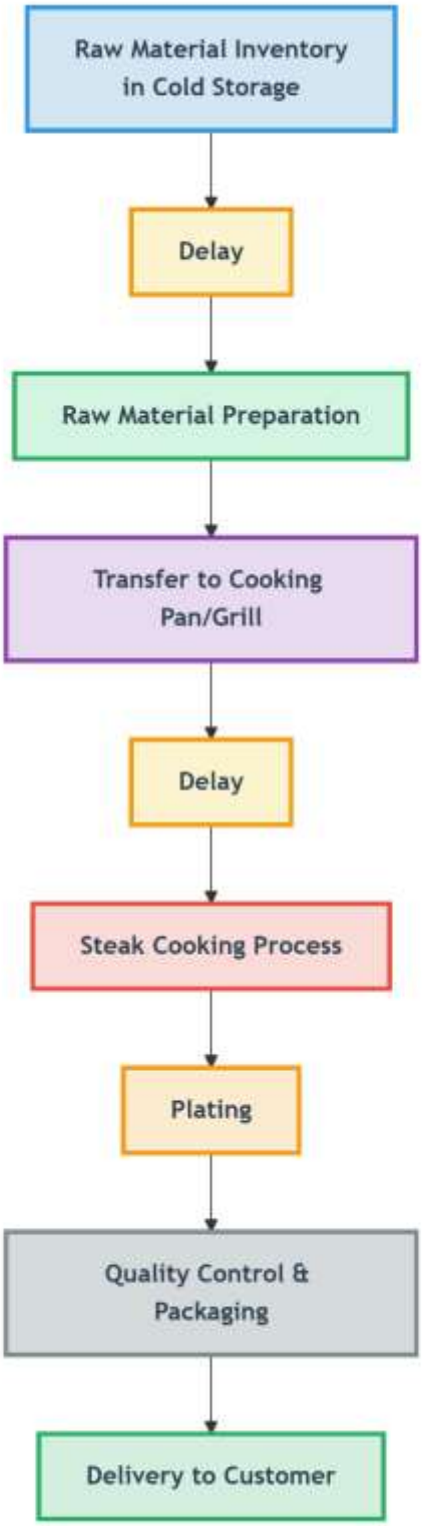


**Figure 4: Steak process flow chart**

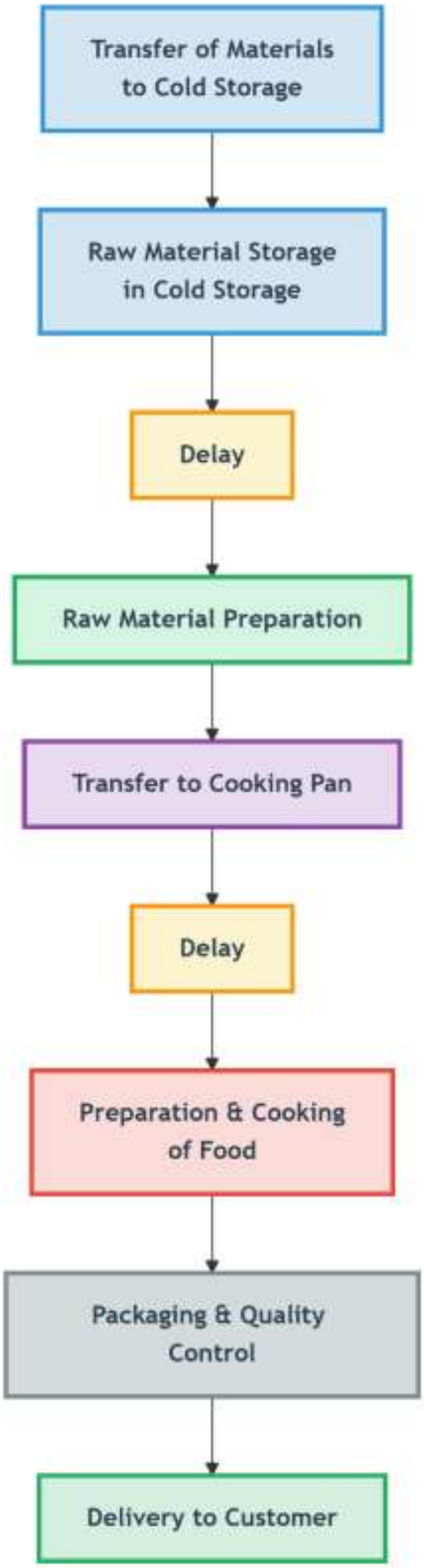


**Figure 5: Pasta process flow chart**

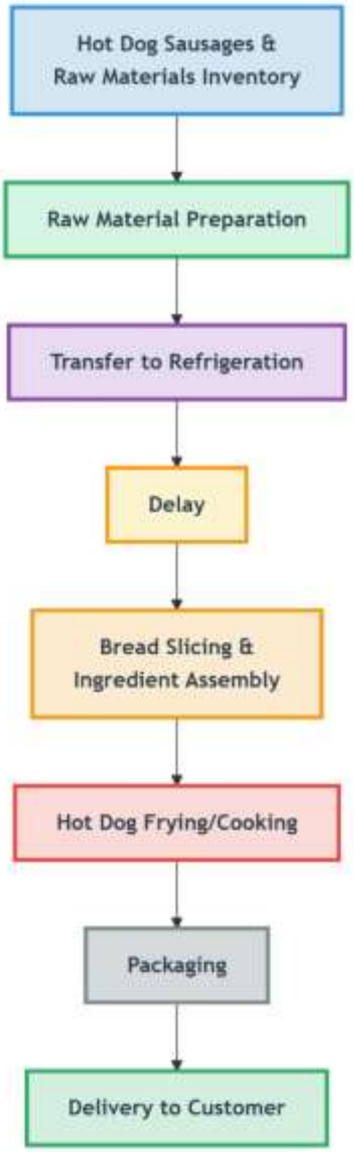


**Figure 6: Sandwich process flow chart**

## 4.2. Stage 2: Hazard Identification and Risk Analysis

At this stage, all potential hazards biological, chemical, and physical were identified at each process step through field monitoring and comparison with the process flow diagrams. To scientifically prioritize these hazards, the Risk Priority Number (RPN) method was applied. Scoring was performed based on three indicators: severity (S), probability of occurrence (O), and detectability (D). Hazards with an RPN value greater than the threshold of 15 were selected as significant, high-priority hazards (Table 2).

**Table 2: Identified hazards and associated risk scores**

| FMEA hazards | O | S | D | RPN |
|---|---|---|---|---|
| Food contamination with Hepatitis A virus due to improper handwashing practices by staff | 2 | 5 | 4 | 40 |
| Contamination in bread and vegetables caused by mold growth and expired shelf life | 3 | 4 | 2 | 24 |
| Contamination in raw meat due to the presence of parasites | 2 | 5 | 4 | 40 |
| Contamination in vegetables caused by residual pesticide chemicals | 2 | 5 | 4 | 40 |
| Contamination in vegetables due to the presence of heavy metals | 2 | 5 | 4 | 40 |
| Contamination in meat caused by antibiotic residues | 2 | 5 | 4 | 40 |
| Contamination in semi-processed materials due to small metallic fragments from kitchen equipment | 2 | 4 | 4 | 32 |
| Contamination in semi-processed materials due to broken glass pieces from containers | 2 | 4 | 4 | 32 |
| Contamination in ready-to-eat food caused by fragments of packaging materials | 2 | 4 | 3 | 24 |
| Contamination in ready-to-eat food due to the presence of hair | 2 | 4 | 3 | 24 |

### 4.3. Stage 3: Identification of Critical Control Points

To accurately determine the Critical Control Points (CCPs), two standard decision trees were used. Hazards associated with raw materials were evaluated using a three-question decision tree (Figure 7), while hazards related to processing and production stages were assessed using a five-question decision tree (Figure 8).

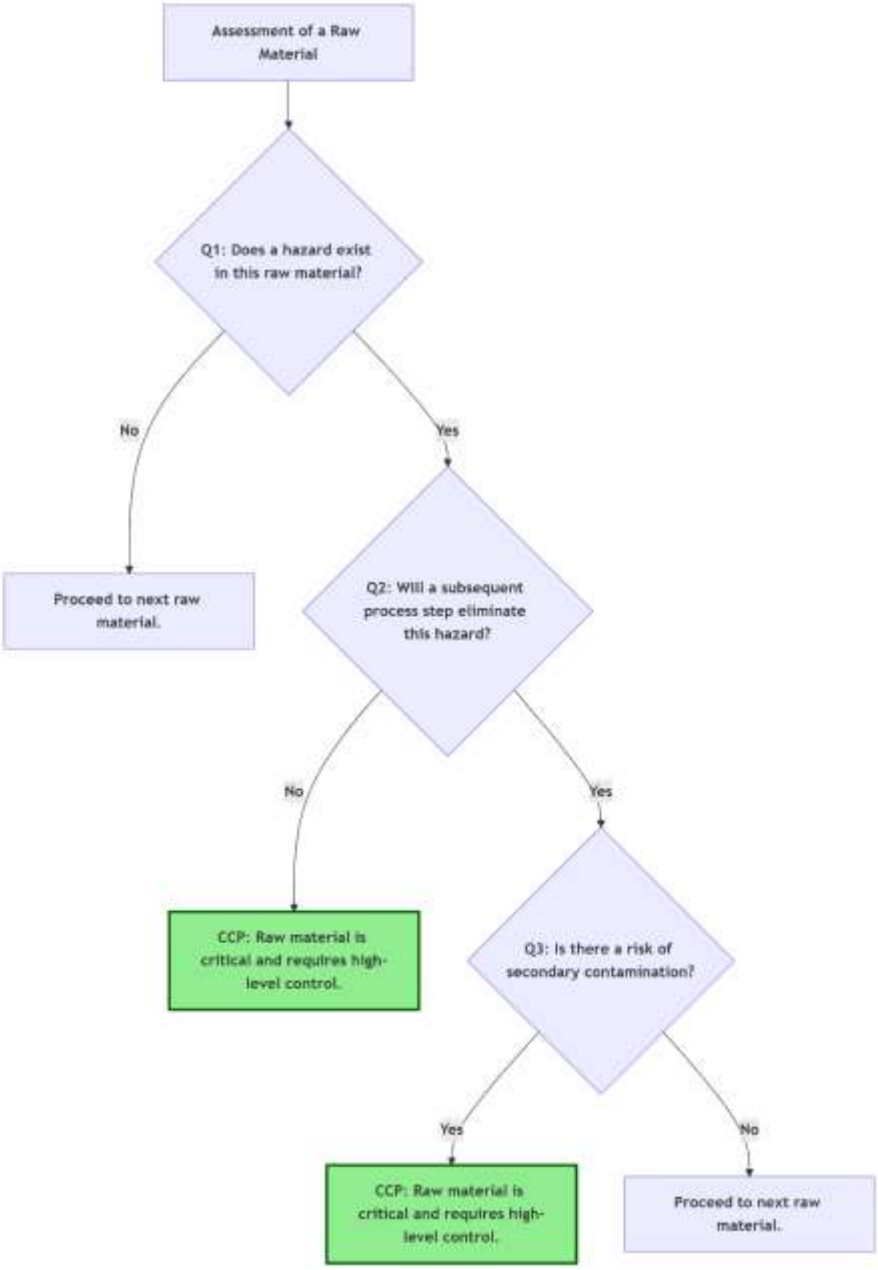


**Figure 7: Three-question decision tree for raw materials** [2]

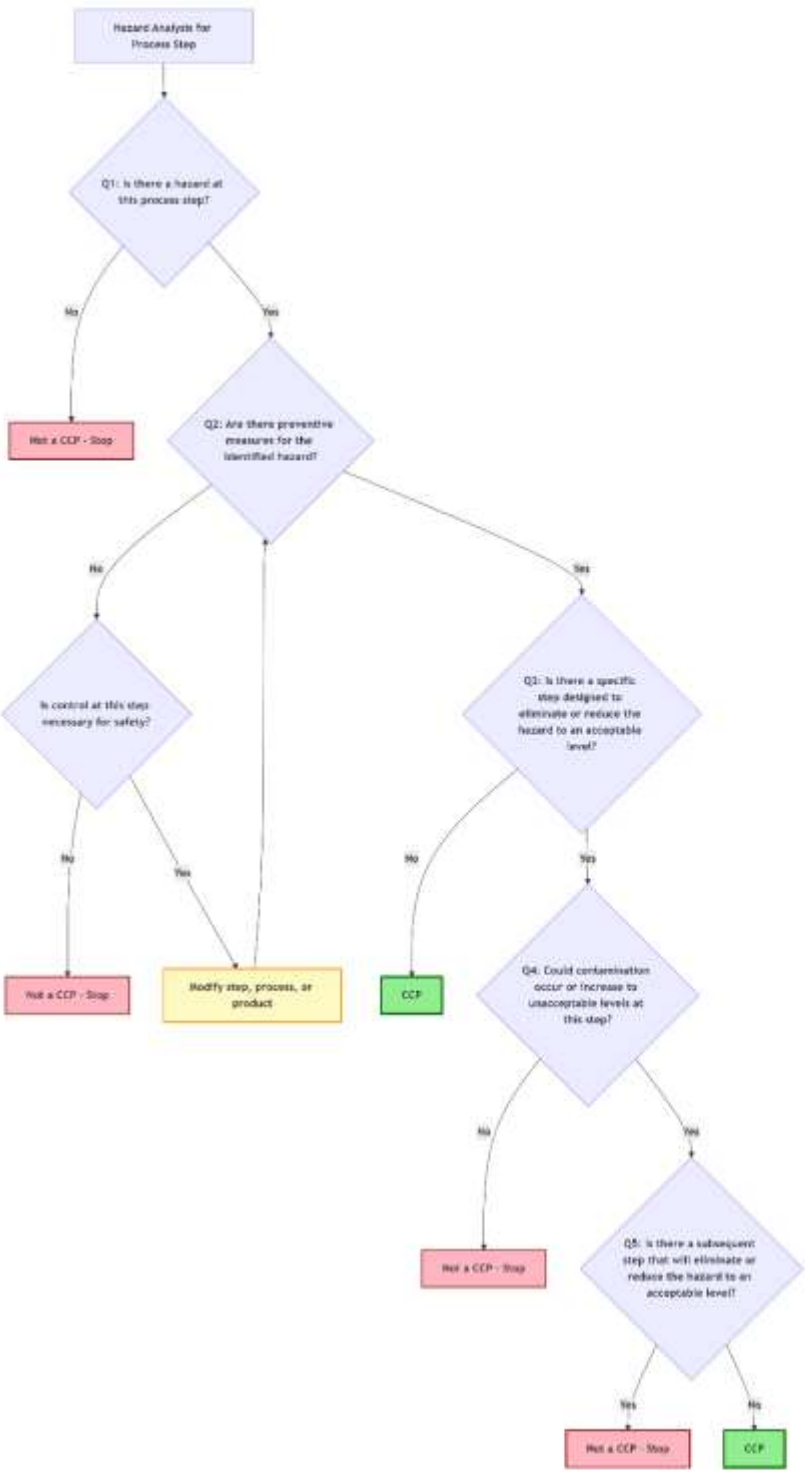


**Figure 8: Five-question decision tree for processing and production stages** [2]

The output of this stage was the final list of points at which control was deemed essential and critical for eliminating hazards or reducing them to an acceptable level, as presented in Table 3.

**Table 3: List of Critical Control Points (CCPs) identified in the production process**

| ID | Critical Control Point (CCP) | Hazard type |
|---|---|---|
| 1 | Contamination of preparation materials due to improper cleaning and washing practices | Chemical / Biological |
| 2 | Contamination of raw and semi-processed materials caused by inadequate washing of utensils | Chemical / Biological |
| 3 | Contamination of raw or semi-processed materials due to lack of washing | Chemical / Biological |
| 4 | Contamination in meat caused by antibiotic residues | Chemical |
| 5 | Contamination in semi-processed materials due to small metallic fragments from kitchen equipment | Physical |
| 6 | Contamination in semi-processed materials due to broken glass pieces from containers | Physical |
| 7 | Contamination in ready-to-eat food caused by fragments of packaging materials | Physical |
| 8 | Contamination in ready-to-eat food due to the presence of hair | Physical |

Based on the results obtained from the HACCP decision-tree analysis, eight Critical Control Points (CCPs) were identified in the process under study. For the first three cases, which were related to raw materials and preparation stages, the three-question decision tree was applied. In these cases, a “No” response to the second question of the decision tree “Is the subsequent step capable of eliminating the hazard or reducing it to an acceptable level?” indicated that no effective control measure existed in the following stages of the process to eliminate or reduce the hazard. Therefore, these stages were designated as Critical Control Points. This situation was observed in cases such as contamination of prepared materials due to inadequate washing (CCP1), contamination resulting from incomplete washing of utensils (CCP2), and failure to wash raw or semi-processed materials (CCP3).

For the remaining cases, which were related to product processing and preparation stages, the five-question decision tree was used. At these stages, a “No” response to the fifth question of the decision tree “Is the subsequent step capable of eliminating this hazard or reducing it to an acceptable level?” was considered the main criterion for determining a CCP. The results showed that for hazards such as antibiotic residues in meat (CCP4), the presence of metal fragments originating from kitchen equipment (CCP5), glass fragments originating from utensils (CCP6), packaging fragments in the ready-to-eat product (CCP7), and the presence of human hair in the final product (CCP8), the subsequent step of the process was not capable of eliminating the hazard or reducing it to an acceptable level. Consequently, control at these stages was deemed essential for ensuring product safety, and they were therefore identified as Critical Control Points.

## 5-Results

The systematic application of the HACCP framework to the fast-food production process at the Krono Pich fast food resulted in a clear mapping of significant hazards and the identification of critical control points. Hazard analysis revealed numerous potential biological, chemical, and physical contaminants across all stages of production, from raw material reception to final service. One key overall outcome was the successful prioritization of these hazards using the Risk Priority Number (RPN), which provided a quantitative basis for focusing control efforts. The subsequent application of the decision tree to high-priority hazards led to the definitive identification of eight distinct stages in the production process that were classified as Critical Control Points (CCPs), indicating where control is essential to prevent, eliminate, or reduce a food safety hazard to an acceptable level.

The first research question, which sought to identify significant hazards at each stage of the production process, was addressed through a comprehensive hazard analysis. This analysis identified 27 distinct potential hazards. The Risk Priority Number (RPN), calculated as the product of severity (S), occurrence (O), and detectability (D) scores, was used to prioritize these hazards. The results showed a wide range of RPN scores, from 5 to 48. A predetermined threshold value of 15 was applied, and 18 of the 27 identified hazards (66.7%) exceeded this threshold and were therefore classified as significant. These high-priority hazards included, but were not limited to, contamination due to antibiotic residues in meat (RPN = 40), the presence of metal fragments originating from equipment (RPN = 40), and contamination with norovirus resulting from inadequate hand hygiene (RPN = 40).

The second research question, focusing on the identification of actual Critical Control Points (CCPs), was addressed by applying the decision tree to the 18 high-priority hazards (RPN > 15). The results of this analysis indicated that eight of these significant hazards were associated with stages classified as CCPs. For instance, the hazard "food contamination due to the presence of hair" (RPN = 24) was confirmed as a CCP because no subsequent processing step could eliminate this physical contaminant. Similarly, the hazard "contamination of materials due to inadequate washing and disinfection" was also confirmed as a CCP. In contrast, other hazards with high RPN values, such as contamination with Salmonella due to undercooked chicken (RPN = 40), were not classified as CCPs because a subsequent controlled cooking step capable of eliminating the hazard was identified.

Further analysis of the results revealed the distribution of the eight identified CCPs across different hazard types and process stages. The CCPs were not limited to a single stage but were found in stages including preparation (e.g., washing of raw materials and utensils), processing (e.g., the potential presence of metal or glass fragments), and final preparation prior to service (e.g., final inspection for physical contaminants). A notable finding was that all CCPs associated with physical contaminants (e.g., originating from packaging, hair, or equipment) required control measures based primarily on visual inspection and strict adherence to operational procedures, since no subsequent elimination step existed to remove such hazards. The complete set of eight CCPs provides a targeted framework for implementing control measures with defined critical limits, monitoring procedures, and corrective actions.

## 6- Discussion

The identification of eight Critical Control Points (CCPs) in the fast-food production process highlights the importance of a preventive and structured approach to food safety management. The findings demonstrate that significant hazards are not confined to a single stage but are distributed throughout the entire production chain, from receiving and preparation to final assembly. This distribution emphasizes the inadequacy of relying solely on a final inspection point such as the cooking stage to mitigate all hazards. The fact that several CCPs, particularly those related to physical contaminants such as metal, glass, and hair, were identified in post-processing stages is especially noteworthy. The findings indicate that investment in continuous training and the development of a strong food safety culture among staff, as emphasized in study [13], constitutes a fundamental prerequisite for the effective control of such hazards. This also suggests that for certain hazard categories there is no subsequent "elimination step," and therefore preventive control through rigorous standard operating procedures and environmental monitoring becomes the only feasible defense [2]. In addition, the study by Comets et al. emphasizes the critical importance of the design and organization of the restaurant's physical environment, including the layout of functional areas, in preventing cross-contamination and facilitating effective monitoring of critical control points [12]. These results confirm the core HACCP principle that control must be applied at specifically identified and scientifically determined points in order to be effective.

These findings both align with and extend the existing literature on HACCP implementation. For instance, studies conducted in food service environments have shown that implementing HACCP leads to the identification of multiple critical control points across different stages of food preparation and production [1]. The results of the present study are consistent with these findings, as eight CCPs were identified at various stages including raw material reception, preparation, and final assembly. However, this study provides a more nuanced perspective by highlighting the particular vulnerability of fast-food operations to post-processing contamination an issue less frequently emphasized in studies focused on large-scale industrial food production. Furthermore, the use of a quantitative Risk Priority Number (RPN) threshold to prioritize hazards before applying the decision tree represents a methodological refinement. By introducing a more objective and risk-based prioritization stage, this approach addresses a common challenge noted in the literature the subjective nature of hazard analysis within HACCP frameworks [8]. Consequently, it bridges the gap between the qualitative principles of HACCP and quantitative risk assessment tools, thereby enhancing the precision of the initial hazard analysis stage.

Compared with previous studies, the findings of this research reveal both similarities and notable differences in terms of the nature of CCPs and the approach to hazard analysis. In many studies conducted in food service units, the primary CCPs have typically been identified at stages such as raw material reception, temperature-controlled storage, and cooking processes, with the main focus on controlling microbial and chemical hazards [1,13]. While the present study confirms the importance of these stages, it also demonstrates that several CCPs in a fast-food operation are distributed throughout the production chain. Moreover, a significant portion of the identified CCPs relates to physical hazards occurring during post-cooking and final assembly stages, an aspect that has received less emphasis in research focusing on large-scale industrial food production. This difference suggests that the operational characteristics of fast-food establishments—including rapid service, frequent employee contact with the final product, and spatial limitations—create a distinct pattern of hazard exposure. In addition, whereas many previous studies have conducted hazard assessment within the HACCP framework primarily through qualitative evaluation and expert judgment, the use of the Risk Priority Number (RPN) in this study to prioritize hazards before decision-tree analysis provides a more quantitative and structured approach. Thus, while the study supports the broader literature regarding the effectiveness of HACCP in improving food safety, it expands current knowledge by emphasizing the role of post-processing physical hazards in fast-food operations and by integrating a quantitative risk assessment tool.

Despite its contributions, this study has several limitations that should be considered when interpreting the findings. As a single case study focused on one fast-food restaurant (Krono Pich Yazd), the generalizability of the eight identified CCPs is limited. Operational procedures, supplier networks, and physical layouts of other establishments will inevitably differ, requiring the development of customized HACCP plans for each case. Moreover, the assignment of scores for RPN calculation (severity, occurrence, and detectability) was based on observational data and expert judgment within the specific context of the study, which—although systematic—contains an inherent degree of subjectivity. Future research should seek to validate these findings through multi-site case studies across different fast-food brands and operational models in order to identify common and transferable CCPs.

Furthermore, there is a significant opportunity for future studies to quantitatively evaluate the effectiveness of the control measures implemented at these CCPs. This could be achieved, for example, through the definition and monitoring of specific performance indicators. Such indicators may include reductions in microbial and physical contamination levels in product samples, decreases in the number of non-conformities recorded in internal hygiene checklists, and trends in customer complaints related to food quality and safety. In addition, measuring employee compliance with hygiene procedures—such as the correct rate of handwashing or the use of personal protective equipment—as well as the results of periodic microbiological testing of the environment and food-contact surfaces could provide a clearer understanding of the long-term effectiveness of the HACCP system.

## 7-Conclusion

This study successfully addressed its principal research questions through the systematic identification of significant hazards and the determination of Critical Control Points (CCPs) in the production process of a fast-food restaurant. The empirical investigation, conducted within the HACCP framework, revealed a range of biological, chemical, and physical hazards, 18 of which were considered significant based on the Risk Priority Number (RPN) threshold. The subsequent application of a standard decision tree identified eight distinct stages as actual CCPs. These points were located primarily at stages where control constitutes the final barrier against contamination, particularly in relation to physical hazards and issues arising from inadequate hygiene. The main contribution of this research is the provision of a validated, context-specific, and actionable set of CCPs that establishes a clear empirical foundation for targeted food safety interventions in the setting under study.

The implications of these findings extend beyond the immediate case study and offer a replicable model for strengthening food safety protocols in the broader fast-food and small- to medium-sized food service sector. In practice, the identified critical points provide managers with a framework for allocating resources more efficiently and for concentrating monitoring and corrective actions on the stages most crucial to preventing food safety failures. Successful implementation of such a system not only ensures safety but, as indicated by study [14], may also improve overall staff performance through process structuring and increased awareness. This study therefore contributes to the HACCP literature by demonstrating both the practical adaptability of HACCP and the value of integrating a risk-prioritization step, such as RPN scoring, into the hazard analysis process. For future research, this study provides a foundation for several important directions, including the quantitative validation of control measures at identified critical points through microbiological testing, comparative analysis of CCPs across different fast-food operational models to identify broader transferable principles, and examination of the economic impact of targeted HACCP implementation on waste reduction and accountability.

### Data Availability

The authors confirm that all data generated or analyzed during this study are included in this article.

### Conflict of Interest

The authors declare that they have no financial conflicts of interest or competing interests related to this study.

### Funding Statement

The authors declare that no funding was received for this study.

### Author Contributions

All research activities were carried out by the authors.

## 8-Resources

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مقاله علمی_پژوهشی

# شناسایی نقاط کنترل بحرانی در فرآیند تولید فست فود با استفاده از اصول HACCP

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**چکیده**

این مطالعه با هدف شناسایی و تجزیه و تحلیل نقاط کنترل بحرانی در فرآیند تولید یک رستوران فست فود به منظور ارتقاء مدیریت ایمنی مواد غذایی انجام شد. این تحقیق با نیاز به یک رویکرد پیشگیرانه و سیستماتیک برای جلوگیری از خطرات بالقوه بیولوژیکی، شیمیایی و فیزیکی در یک محیط خدمات غذایی با حجم بالا انجام شد. روش شناسی یک مطالعه موردی توصیفی-تحلیلی بود که در رستوران فست فود "کرنوپیچ یزد" انجام شد. چارچوب تجزیه و تحلیل خطر و نقاط کنترل بحرانی به کار گرفته شد که شامل مشاهده مستقیم، ترسیم نمودار جریان فرآیند، تجزیه و تحلیل خطر و استفاده از درخت تصمیم گیری برای تعیین نقاط کنترل بحرانی بود. از امتیازدهی عدد اولویت ریسک برای اولویت بندی خطرات شناسایی شده استفاده شد. این تجزیه و تحلیل هشت نقطه کنترل بحرانی را در زنجیره تولید شناسایی کرد. نقاط کنترل بحرانی کلیدی شامل شستشو و ضدعفونی مناسب مواد اولیه و ظروف، آلودگی ناشی از قطعات فلزی تجهیزات یا شیشه های شکسته، وجود باقیمانده آنتی بیوتیک در گوشت و بازرسی نهایی غذای آماده برای آلاینده های فیزیکی مانند مو یا مواد بسته بندی بود. این مطالعه نتیجه گیری کرد که کاربرد سیستماتیک اصول HACCP برای شناسایی و کنترل نقاط بحرانی در تولید فست فود حیاتی است. این یافته‌ها یک چارچوب عملی برای موسسات مشابه فراهم می‌کند تا پروتکل‌های ایمنی مواد غذایی خود را بهبود بخشند، اعتماد مصرف‌کننده را افزایش دهند و از خطرات سلامتی جلوگیری کنند. تحقیقات آینده باید بر ارزیابی کمی اثربخشی اجرای HACCP در مدل‌های مختلف فست فود تمرکز کنند.