



Sudan University for Science and Technology
College of Graduate Studies



The Impact of Implementation Hazard Analysis & Critical Control Points (HACCP) On Meat Processing

**أثر تطبيق نظام تحليل المخاطر والتحكم في النقاط الحرجة
علي تصنيع اللحوم**

**A thesis submitted in partial fulfillment of the requirements for
the MSc, in Total Quality Management & Excellence**

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بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

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قال تعالى:

وَيَسْأَلُونَكَ عَنِ الرُّوحِ قُلِ الرُّوحُ مِنْ أَمْرِ رَبِّي وَمَا أُوتِيتُمْ مِنَ الْعِلْمِ إِلَّا قَلِيلًا

الإسراء: ٨٥

DEDICATION



*WITH ALL MY LOVE AND APPRECIATION TO: MY
PARENTS, WHOM ALWAYS ENCOURAGED ME
AND PROVIDED ALL THE SUPPORT*

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I am greatly indebted to my supervisor to Prof.Dr.Mohammed Abdelsalam Dean of Post Graduates College in Sudan University of Science & Technology and to Dr Eihlam Haroun the quality and food safety manager of AL-Goussi meat industry in Sudan for his invaluable support and advice.

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المستخلص

يركز هذا البحث كله على دور ومساهمة عملية تحليل المخاطر في صناعة اللحوم بولاية الخرطوم . كما يهدف هذا البحث على معرفة أثر ودور تنفيذ نظام تحليل المخاطر والتحكم في النقاط الحرجة على سلامة الغذاء، ومعرفة الفرق بين نظام تحليل المخاطر والتحكم في النقاط الحرجة لمصنعين لصناعة اللحوم بولاية الخرطوم احدهما مطبق لهذا النظام والأخر غير مطبق له .

تم جمع البيانات من خلال استبيان منظم من 86 عينة. وكان تصنيفها أن 28 من مجموع العينات جمعت من المنشأة التي التي لم تطبق نظام تحليل المخاطر والتحكم في النقاط الحرجة بينما جمعت 58 عينة المتبقية من المنشأة التي تطبق نظام تحليل المخاطر والتحكم في النقاط الحرجة لصناعة اللحوم داخل ولاية الخرطوم. ومن جدول الارتباط الاحصائي ومن خلال تحليل الارتباط ومن البيانات التي تم جمعها في المنشأة المطبقة لهذ النظام كانت النتيجة حوالي 0.895 اي انها أكبر من مستوى 0.05 والتي تشير بوضوح على أن كل المتغيرات تقريبا هي كبيرة.

. ومن تحليل البيانات التي تم جمعها لوحظ أن جميع المتغيرات لديها تأثير كبير على عملية تحليل المخاطر والتحكم في النقاط الحرجة .

ومن تحليل معامل الارتباط من البيانات التي تم جمعها يكشف أن عملية تحليل المخاطر لديها تأثير مباشر على برنامج السلامة في صناعة اللحوم بولاية الخرطوم. وان الصناعات التي تطبق هذا النظام لديها العديد من البرامج لمراقبة سلامة الغذاء بخلاف تلك الصناعات التي لم تطبق هذا النظام .

خلص البحث والتحليل إلى أن نظام تحليل المخاطر والتحكم في النقاط الحرجة له أثر بالغ ومهم في عملية صناعة تصنيع اللحوم داخل ولاية الخرطوم.

ABSTRACT

This entire research concentrates on role and contribution of Hazard Analysis Critical Control Point process in the meat processing industry in Khartoum State.

The research aims identifying the Impact of Implementation of Hazard Analysis Critical Control Point on food safety for the processors of the meat industry in Khartoum state, find out the difference between two meat industries in Khartoum state, one is HACCP implemented & the other one is non implemented.

Data were collected through a structured questionnaire of 86 samples. It was classified as 28 samples of the total samples collected from the facility not applied the hazard critical control point, while the remaining 58 samples collected from the facility which applied the hazard critical control Point over the meat industry in Khartoum State.

From statistical correlation table and through the correlation coefficient analysis on the data collected from 58 samples in the facility applied the hazard analysis and critical control point, the result of a correlation coefficients significant level was about 0.895, which are greater than a level of 0.05 which clearly indicate that all variables were significant.

From the analysis of the collected data, it was observed that all the variables had a significant impact of the process of Hazard Analysis of Critical Control Point

An analysis of the correlation coefficient from the data collected reveal that the Hazard Analysis process has a direct impact upon the safety program in the meat industry in Khartoum state. The industries that apply this system have several programs to monitor food safety, other than those industries have not started this system did not apply it.

Thus through research and analysis concluded that the Hazard Analysis of Critical control point has a great and important impact on the meat processing industry within the state of Khartoum.

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INTRODUCTION

HACCP was a preventive system for the production of safe food products. It was based on technical and scientific principles applicable to every step of the food production chain, from growing breeding activities, to production and distribution systems, to the moment the food reaches the final consumer (ICMSF (1991)).

HACCP systematic analysis identifies raw materials and processed foods that may contain toxic substances or agents that were potential sources of contamination. It may also determine the possibility that microorganisms survive or grow during food production, processing, storage, and preparation (ICMSF (1991)).

HACCP was developed by Pillsbury Company, after a request from the National Aeronautics and Space Administration in the 1960s, to ensure the safety of foods used in the American space program. The system had its own specifications concepts and terminology, as follows (Bryan (1993))

– *Hazard* : unacceptable biological (growth or survival of microorganisms), chemical(pesticides, antibiotics, heavy metals, cleaning products), or physical (pieces of glass, metal, or other materials) contamination, rendering the food unfit for consumption.

– *Severity* : magnitude of the hazard or of the consequences to the health of consumers. Diseases may be classified, in terms of severity, as lethal, chronic, or mild.

- *Risk* : probability that the hazard will occur. Risk levels may be high, moderate, or low, and may vary according to the situation.

– *Critical control point (CCP)*: a place, practice, procedure, or process that may be controlled to prevent, eliminate, or reduce the hazard to acceptable levels.

– *Critical limit*: physical (e.g., time, temperature), chemical (e.g., pH), or biological(e.g., sensorial, microbiological) attribute or value determined for each CCP, which indicates that the operation was controlled.

- *Monitoring*: measurement of time/temperature, pH, or acidity, or visual observation of CCPs in order to assess whether critical limits were met; if they were not met, the CCP was not controlled and corrective actions were necessary.
- *Corrective action*: immediate and specific procedures to be followed whenever critical limits were not met.
- *Verification*: additional tests and/or review of monitoring records in order to confirm whether the HACCP plan was working as designed. Verification may cause some of the steps of the process to be changed in order to ensure food safety.
- *Decision tree*: logical sequence of questions that enable the identification of a raw material, step in the process, or ingredient as a CCP. Motarjemi and Käferstein (1999)

HACCP had changed and developed over the years. In 1991, the National Advisory Committee on Microbiological Criteria for Foods published a report determining the basic principles of the system as it was known today Almeida (1998) .

General Objectives of this Study

- ☞ To analyze the impact of HACCP implementation in industries for secured food production process in food chain.

Specific objectives of this Study

- To study the impact of HACCP on food safety.
- To identify food safety difference between HACCP implemented and non-implemented companies.
- To emphasize industries to implement HACCP process for effective food safety.

CHAPTER ONE

LITERATURE REVIEW

1.1 Hazardous Analysis during HACCP implementation

El-Hofi.(2013) examined HACCP for providing assured quality production for food safety in Egypt, In this research hazard oriented with food safety were measured for providing efficient manufacturing with improved efficiency and with reduced wastage. This research was carried out in Egypt in industries of Milk, food and Mansoura with improved food safety. Among various selected industries necessary data for quality improvisation was studied in the selected were. Hazards were analyzed in each and every part of the production process of food chain. Further in this research critical control points were examined which was found that there were 7 critical factors in cheeses production process. In this research to overcome hazards and critical factors chart was developed to overcome hazards in the food production industry for HACCP process. Also in this research it was concluded that CaCl₂ and NaCl must be set properly for efficient pasteurization.

Wallace, (2014) examined control methods for preventing or reduce various hazards to acceptable level in food chain through HACCP process. For effective corrective measurements necessary steps were need to be considered through monitoring various hazards factor to minimize loss of food. Hazard control was the essential step for preventing food wastage with minimized loss with acceptable level. This document examined need for hazard analysis in food safety with enhanced improvisation of hazards in process management. This document concluded that HACCP provides assured food safety with minimized wastage. While analyzing food safety acceptability factors like biological, chemical environment were need to be considered for enhanced food safety.

Wallace et al. ((2014) investigated about various key elements in HACCP process flow for efficient food production process in multinational companies. Conduct a Hazard Analysis, forms a central pillar of any HACCP plan since hazards need to be identified, analyzed and understood before effective control measures can be specified. However limited guidance was available to HACCP teams on

exactly how to approach the application of this principle. This research demonstrates that combination of plan and knowledge about HACCP provides significant hazard identification of errors also. Finding of this research reveals that there must be significant hazard analysis for safe production of food process. Hazards were need to be evaluated using well trained, experience personnel for various risk evaluation in food production process.

Orriss and Whitehead (2000) analyzed food assurance in each stage of Food quality assurance systems of one sort or another were necessary at every segment of the food chain and in every sector of the food industry to ensure the quality and safety of food. On the one hand governments had the responsibility of establishing the standards, legislation and enforcement programs necessary to control food quality and safety. On the other hand industry had the responsibility on implementing quality assurance systems, including HACCP, where necessary to ensure compliance with the standards and legislation. The challenge to governments was to ensure that the sanitary measures applied were effective in ensuring food quality and safety at all levels of the food chain and were consistent with the obligations under the World Trade Organization Agreements on the Application of Sanitary and Phytosanitary Measures and Technical Barriers to Trade.

Dereje et al. (2011) proposed a HACCP plan for mycotoxigenic hazards associated with dry-cured meat production facility. Mycotoxigenic hazards that could emerge at each stage of the production were described. Pathogenic yeasts, toxic secondary metabolites of toxigenic moulds were identified as the potential hazards. Smoking and the dry-ripening stages of production were the critical control points identified. Critical limits for the critical control points were set based on scientific premises and recommendations set by legislative authorities. The status of the critical limits at the identified critical control points need to be monitored, verified and recorded. Summaries of hazards, CCP and the HACCP plan with critical limits and corrective actions. However, the successful implementation of this HACCP plan depends on the correction of the deviations in the prerequisite programs. The basic conditions and activities that maintains good hygienic and production practices and reduce product contamination by fungi should be in place. The full commitment of the management and the employees was also required. The commitment of the management to convey a positive message at all levels of the operation in both words and actions were important. Training of personnel at the two

about the importance of food safety hazards was important for the effective implementation of this HACCP plan. Any concerns or weaknesses in these should be addressed to ensure product safety.

Kyung .R. et al. (2013) described a new analytical method for simple beta and triangular probability distributions to improve the hazard analysis stage of the HACCP plan. Plan was developed in the Microsoft spreadsheet program for calculating probability of risk level. At a 50% percentile value in probability distribution, the highest risk was a biological hazard (e.g., food borne pathogens growth) in the packaging steps with probability of 5.5 to 10. The lowest risk was a physical hazard in the packaging steps at a probability of 1.4 to 10.3. Despite certain shortcomings, this model, with further improvements, could be expected to increase the effectiveness of HACCP in controlling food safety. At present, conducting complete hazard analysis seems to be difficult for most food industries. This study overcomes this limitation by introducing an original methodological approach to carry out a structured hazard analysis in HACCP development. A simple pork-cutting procedure was taken as an example in the case study.

Hurst (2013) examined food processors around the world had applied the principles of HACCP (Hazard Analysis Critical Control Point) as prevention- based approach to food safety. In 2005, the International Organization for Standardization (WASO) issued the WASO 22000 standard, which incorporated HACCP into its food safety management system. An inherent weakness of HACCP was that there was no advanced warning when a critical control point (CCP) will exceed its critical limit (CL) safety zone. However, Statistical Process Control (SPC) was a proven tool that can signal when a CCP was in danger of going out of control. First, it will bring about a culmination to any nut processor's HACCP plan in that statistically valid control charts will demonstrate to customers evidence of product safety. Thus it can serve as a powerful marketing tool to any nut handler or processor. Second, it will provide an on-going and continuous improvement of all processes which can had a positive impact on the company's bottom line in terms of production efficiency and lower costs. Third, it will satisfy government regulations that mandate that a nut handler or processor be able to document compliance with product performance standards.

1.2 Hazardous Analysis during HACCP implementation

Cerf et al.(2011) suggested a horizontal complement to the Guides to GHP that would consider only the application of the Step 6 and Principle 1 of the HACCP system amended as follows: "List all potential hazards transferred from one activity to another activity within the farm, conduct a hazard analysis, and consider any measures to control identified hazards". An outline in two parts was proposed. The first part would help at checking if all generic GHP were in place; the second part would help at disclosing interactions between farm specific activities. Detected hazard transfers could then be controlled with measures that were already described in existing guides. The horizontal complement would benefit from being drafted at the European Community level. The trial demonstrated low awareness of the Hygiene Package of most interviewed farmers, and lack of awareness of existing guides or the non application of them when they were known.

Untermann (2014) determined about philosophy based approach for first it determine the need for action and then to define suitable preventive measures, was not new and naturally applies to all whereas where faults should be avoided, including basic hygiene measures. A reflective approach to hygiene was urgently required. However, the application of terms or notions borrowed from the HACCP system, e.g., for basic hygiene measures or in other areas where the seven principles were not wholly applicable, leads to a dilution of the aims and efficacy of the HACCP concept. Further components were a sufficient separation of production steps and production lines to avoid cross contamination, and, finally, personnel hygiene. The 'roof' of the house was made up of product- and production-specific preventive measures based on a specific hazard analysis according to the HACCP principles to avoid specific health hazards for the consumer.

Collins (2014) studied various principles in HACCP process where the HACCP team needs to prepare a list of hazards that reasonably should be expected to occur at each process step. A hazard analysis was then carried out to assess which of these hazards were significant. Significant hazards were those that were "of such a nature that their elimination or reduction to acceptable levels was essential for the production of safe food." These hazards should be addressed in the HACCP plan, and appropriate

measures to control those hazards should be determined. It was also important to include the source or the cause of the hazard during the hazard analysis as this will help the HACCP team to determine the appropriate control measures. When the first principle was completed, the CCPs then need to be determined by the HACCP team. Correct identification of CCPs requires a logical approach and may be aided by the use of a decision tree. Each step in the process must be considered in turn for each of the identified significant hazards. Care needed in the use of decision trees. A number of decision trees had been published, some of which had been concerned specifically with the raw materials and ingredients. The decision tree used and the answers should be recorded within the HACCP plan.

1.3 Failure mode and Effect Analysis

Wojciech (2014) designed a HACCP system audit method which allows precise assessment of the system functioning in practice. The method was based on specially elaborated audit questionnaire, covering all HACCP steps and principles, associated with analysis of audit findings by failure mode and effect analysis. External third party audits were carried out in two medium-size bakeries located in Poland. The method allowed precise identification of high and critical risks in HACCP areas of verification and recordkeeping. In view of the obligatory of HACCP system in food industry and periodically emerging food safety scandals in the EU and other countries, it appears advisable to strength control and use methods enabling precise identification of the risk. The designed method was ready to use in all types food enterprises.

Psomas and Kafetzopoulos (2015) determined the differences between the ISO 22000 certified and non-certified dairy companies with regard to the HACCP (Hazard Analysis Critical Control Points). The HACCP effectiveness was defined in the present study as the degree of the achievement of the system objectives (identification, assessment and the control of food borne safety hazards). A research study was carried out in 74 Greek dairy companies using a structured questionnaire. The differences between the ISO 22000 certified and non-certified dairy companies (both implementing HACCP principles) with regard to HACCP effectiveness were determined through non parametric tests such as the Chi-square Test and the Mann-Whitney Test. The ISO 22000 certified dairy companies significantly outperform the non-certified with regard to the HACCP effectiveness, in other words to the degree to which the objectives of HACCP were achieved. Thus, managers of dairy taking advantage of the

structured organization and the documented procedures provided by the ISO 22000 standard can increase the level of achieving the objectives of the HACCP, in other words HACCP effectiveness. In doing so, can set the foundations in order to optimize the conditions under which safe food was provided, minimize the possibility of food non-conformities and scandals, increase market share and consequently withstand the current downturn.

Julia and Pavel (2015) analyzed HACCP gaps in hazard control; likewise, there shouldn't be gaps between neighbouring producers. However, gaps do exist, mostly due to lack of motivation. After initial HACCP establishing the motivation drops and the system(s) may deteriorate to a GMP level. It's vital to monitor status of HACCP(s) implementation and motivation level(s) on local and national level(s) to analyze changes and draw conclusions about their impact on the food safety management system at the national level, thus providing feedback for the national food protection system. From the presented results it was obvious that there was lack of motivation in respect to the HACCP. All of them had HACCP established but it seems that its efficiency was degrading and the system had trend to fail the consumers. Communication between producers and controlling authorities becomes thus even more important. It was imperative to understand the open concept of HACCP and enforce the legal requirements without bureaucratic refusal of creativity. Discrepancies may and should be resolved by means of audits. Ignoring the fact that HACCP evolves will lead to loss of control over it and jeopardize its functionality, not only on the local level but on the national level too.

1.4 Developments in HACCP validation and verification

Surak (2015) valid and verifies many methods for economical food safety process. Validation and verification principles square measure important to the event of a sturdy food safety system. Sadly, several food safety professionals get the 2 terms confused. this might be caused by the phrasing of the Hazard Analysis and important management Points (HACCP) documents revealed by each the Codex Alimentations Commission (Codex) and also the National consolatory Committee on the Microbiological Criteria (NACMCF). Codex delineates HACCP Step eleven (Establish verification procedures), within the following way: 'Where doable, validation activities ought to embrace actions to verify the potency of all components of the HACCP system.' NACMCF delineate HACCP Principle six (Establish verification procedures), within the following manner: 'verification was outlined as those activities, apart from watching, that verify the validity of the HACCP arrange which the

system was working in step with the plan'. (NACMCF, 1998) additionally, the food safety skilled might come across the term 'HACCP system'.

1.5 Impact of HACCP in numerous food industries

Taylor (2007) conferred an explanation and use of a replacement methodology of applying Codex HACCP principles designed specifically for caterers. It charts the method by that the tactic was developed by setting against the scene of international efforts to present support to initiatives that a lot of fittingly meet the wants of little and fewer developed businesses. The tactic was extensively piloted, evaluated and valid by the united kingdom Food Standards Agency and deemed compliant with 2006 EU HACCP needs. The initial 'Salford Model' was extended and revealed as Menu-safe with a system which will be employed by business businesses of all sorts and sizes. This analysis by trial and error develops a food safety management system for caterers. It remains the sole adaptation of the 'classical' methodology that had been incontestable to own utility to businesses and conjointly contribute to enhancements in food safety management. specifically, the output demonstrates that there square measure valid alternatives to the 'classical' Codex methodology which businesses will adjust to HACCP principles while not ever having to 'hear' or 'use' the HACCP jargon. The removal of technical deciding from the business with the outputs, derived and valid outwardly, integrated into the system, was additionally shown to be the simplest way forward for businesses with marginal technical data.

Ema et al. (2014) relatively analyzed concerning numerous factors like incentives, costs, difficulties and edges of Chinese in Mexican meat-exporting enterprises associated with food safety management systems implementation. A form was applied to spot the most factors concerned in HACCP implementation. Information were collected among thirty two Chinese and forty two Mexican firms and analyzed victimisation the SAS package. The implementation of the HACCP system was crammed come in all mercantilism meat industries. The results indicated that the key incentives were associated with rising product quality for each country, while rising management of the method was the primary motivation within the Chinese trade and access to new foreign markets was the primary motivation within the Mexican one. Additionally, each country's industries reported

that employees coaching were the foremost necessary implementing price, whereas product testing was the key expense. The difficulties found throughout HACCP implementation and operation activities were related to accessibility of personnel for alternative tasks for China and prices of certification for Mexico. The reported edges were relevant for the 2 countries, attributable to the power to scale back micro-organism counts and inflated access to foreign and domestic markets.

Dzwolak, W. (2014) analyzed concerning hazards in frozen dessert production victimization important management Points in food production method. The biological, chemical, and physical hazards that will exist in each step of chocolate frozen dessert production were known; additionally, the important management points were elect and also the important limits, monitoring, corrective measures, records, and verifications were established. The important management points, that embrace pasteurization and freeze, were identified. Implementing the HACCP system in food producing will effectively assure food safety and quality, expand the market, and improve the manufacturers' management level. The results of this study showed the extent of the positive effects that a HACCP system introduced in a very chocolate frozen dessert industrial plant had on each the microbiological quality of the ultimate product and on the whole quality/hygiene management. The applying of the HACCP system provides food makers with effective preventive ways to ensure food safety and improve management.

To boot, the documentation and records generated within the HACCP system will simply facilitate in tracing the origin of contamination, therefore preventing additional production of substandard product and lower the consumption of personnel, material, and monetary resources. At present, HACCP was tough to implement in some producing plants owing to technical and monetary obstacles. Though most of the key makers had applied HACCP for frozen dessert production, the issues come back from the purpose of sale. As retailers in night markets, that square measure a singular feature of Taiwanese culture, might lack enough data of hygiene, leading to the contamination of the frozen dessert. Therefore, this live needs government support for its wider application.

Holt, G., & Henson, S., (2000). surveyed 24 makers of able to eat meat merchandise were given an one hygiene audit. Afterward, the technical or owner manager of the corporate was interviewed. Analysis of the standard management systems operated and assessed was compeered with the International Life Sciences Institute (ILSI) model for quality assurance management. Findings demonstrate that while there stay deficiencies in quality management systems in tiny businesses, significantly with regard to the shortage of technical experience, the tendency of active management ought to even be recognized. The analysis supports the read that WASO two and Total Quality Management (TQM) philosophies were instructive frameworks for the implementation of quality assurance management inside the tiny food sector. The results of the study recommend that little firms do want a additional formal framework for quality assurance management. Audited business standards, however, ar pricey to the tiny business and contain structural recommendations that at the moment legal necessities. WASO and TQM may offer these frameworks. Food consultants trained in these strategies will so offer a helpful service by locating technical aspects of quality management into an abstract framework for the tiny food business. While food consultants not trained in these techniques may usefully begin to base their HACCP coaching on WASO and TQM principles. This may facilitate HACCP understanding and implementation and conjointly foster a uniformity of standards across the business, which might successively facilitate examination.

1.6 Impact of HACCP on food safety

Stevenson (1990) During the past decades, the quest for safety has been challenged by important changes in food production, such as innovations in manufacturing processes, reduced intervals between production and consumption, increased product shelf life, and increased prevalence of some micro-organisms.

Motarjemi and Käferstein 1999 As the food chain became global, FBDs are seen in a new dimension and now represent one of the greatest health problems worldwide, affecting millions of people a year Germano (2003) and leading to significant economic and social consequences Ruegg 2003 ; Silva (1999) . Data from the World Health Organization show that, in 2005, 1.8 million people died of gastroenteritis caused by contaminated food and water (World Health Organization 2007) . In spite of the

technological progress in food production and control, the occurrence of these diseases has recently increased, even in developed countries Franco and Landgraf (2003) .

Food hazards or contamination may come from primary production, still on the farm, from inadequate handling or storage in the food industry, or from errors during preparation at home or in other places where the food is consumed. Although they have not recently become an issue, FBDs have become increasingly important lately, both in terms of magnitude and in terms of health consequences for the general population. Factors related to the supply chain, demographic

situation, lifestyle, health system infrastructure, and the environmental conditions of each country influence the prevalence, increased frequency, and consequences of these diseases Motarjemi and Käferstein (1999) .

When all these facts are taken into account, HACCP is an important tool in modern quality management in the food industry, ensuring the integrity of the product, preventing FBDs, and protecting the health of the consumer Mortimore and Wallace 1998 .

However, HACCP will only become effective when its principles are correctly and broadly applied in all stages of the food production chain. Some of the reasons for the recent increase in FBD frequency all over the world may be failures in implementation or limited application of HACCP, mainly in small companies; lack of knowledge of the final consumer, keeping inadequate food handling practices alive; and low rates of HACCP adoption in developing countries, where most of the FBD outbreaks occur.

1.7 The cost/Benefit of the system

Maldonado et al. 2005 In general, companies find it difficult to clearly picture the costs and benefits of HACCP). Lack of knowledge of the principles, and of how the plan works, makes it difficult to identify and separate HACCP expenses from production costs Buchweitz and Salay 2006 ; Donovan et al. (2001) . Therefore, as they are basically interpreted by the perception of the managers, they may be overestimated

HACCP generally involves high fixed costs related to the creation of the plan, training of the workers, and acquisition of equipment, requiring an economy of scale Unnevehr and Roberts(1996) . Maldonado et al. (2005) emphasized the importance of evaluating the magnitude of costs before the system is implemented. However, this is quite uncommon, as confirmed by Henson et al. (1999) , who showed that less than 15% of the companies estimated the costs involved before they began HACCP implementation.

Total relative costs of HACCP involve the sum of all resources made available at the different stages. The technological level of the individual plant and non-compliance with prerequisite programs contribute to greater costs in the implementation of the system McAloon (2003) ; Suwanrangi (2000) . Prerequisite programs determine adequate implementation of good manufacturing practices, and make adoption of the program easier owing to the reduction of the number of CCPs (Bata et al. 2006 ; Henson et al. 1999) . A great number of CCPs make management difficult and make auditing procedures too time-consuming (Wallace and Williams 2001) . In the initial phase of the plan, the main costs are related to the use of external consultants (when required), and to the use of the HACCP team in other positions, different from their routine ones (Bata et al. 2006) . In the implementation stage, costs are related to training of employees and adjustment to prerequisite programs and specific HACCP items, such as new equipment, laboratory analyses, and adjustments in the process and in the structure of the plant. During the maintenance phase, costs are mainly related to time consumed in monitoring CCPs and recording corrective actions (recordkeeping procedures), as well as to hiring people to monitor CCPs (Motarjemi and Käferstein 1999 ; Roberto et al. 2006 ; Donovan et al. 2001 ; Caswell 2000) . According to Henson et

al. (1999) , although difficult to measure, the cost related to the time consumed filling in forms and records is generally greater than expected.

In terms of human resources, lack of trained personnel to develop and implement all aspects of HACCP make most of medium-sized companies use external consultants(Bata et al. 2006) , increasing the cost of the system. In relation to employee training, the following costs should be considered: external costs incurred by the HACCP team, including trips, transportation, meals, and

loss in productivity caused by team members being away from regular positions, 32 S. Cusato et al

or when all employees have to be trained, and by a complete interruption in the production cycle (Donovan et al. 2001) . Staff training is the basis of the plan and is the key element for the motivation of the team, including plant staff, managers, and supervisors, normally cited as the main obstacles to HACCP implementation in the companies (Henson et al. 1999 ; Maldonado et al. 2005) . The greater or lesser impact of these elements on total HACCP costs depends, however, on the particular characteristics of each plant (Bata et al. 2006) . Implementation of the system may take from some months to several years, and depends on the qualification of the employees, the complexity of the production process (Donovan et al. 2001) , the number of CCPs, and the initial condition of the plant.

As for the advantages attributed to the HACCP system, there are several recognized benefits, many of them of an intangible nature or difficult to quantify. The main beneficiary is the consumer, because the system may ensure food safety and lead to the production of higher-quality products (Caswell 2000 ; Bauman 1995) . Benefits to the public sector are related to the reduction in costs for public health services and sick leaves, besides making it easier for regulatory agencies to monitor processes and products, saving time in audits and decreasing costs in analyses(Donovan et al. 2001 ; Unnevehr and Roberts 1996) . However, the companies are beneficiaries of most of the advantages of HACCP implementation, by becoming aligned with governmental regulations, and reducing the number of incidents related to the production of unsafe food (Bauman 1995) .

Economic advantages are related to better control of the process, less reprocessing of products, decrease in raw material and finished product losses, reduction in microbiological counts and

consequent increased shelf life of the products, and gains in production efficiency (Henson et al. 1999 ; Donovan et al. 2001 ; Maldonado et al. 2005) .

Hajdenwurcell (2002) demonstrated other advantages, such as the reduction in the number of laboratory analyses necessary for the finished product, reduction in sampling plans to control the process because of preventive control of CCPs, and reduction in the number of noncompliant products. Hajdenwurcell (2002) also observed that human operational errors may be less frequent owing to better training and greater awareness of the handlers. After HACCP was implemented in Cargill, McAloon (2003) reported that the system enabled better control of the process, reduced losses and reworks, increased food safety, and improved employee commitment. Besides, McAloon (2003) reported increased productivity and lower production costs. Marthi (2003) showed that when HACCP was implemented in the fishing industry in India, productivity increased owing to fewer interruptions in the production process and to better quality of raw materials.

The use of HACCP increases exporting possibilities, because the system enables harmonization with international trade requirements (Unnevehr and Roberts 1996) and contributes to a positive image of the company, improving consumer confidence and reducing the possibilities of product recall (Ehiri et al. 1995 ; Motarjemi and Käferstein 1999) . According to Bauman (1995) , the high costs of recalls are related to destruction of the products, momentary decreases in sales, and reduction in future sales caused by negative repercussions. Besides, legal actions and financial responsibility should also be considered, as well as costs that are difficult to measure, such as damaged company image and effects on the sales of other products Implementation of Hazard Analysis and Critical Control Points System In a study among fish-processing industries in Brazil, Donovan et al. 2001) showed that HACCP led to better quality of raw materials owing to greater control of suppliers and, consequently, to final products of higher quality.

The advantages of HACCP related to company image are more difficult to assess. They are, however, undeniable, because the system improves competitiveness and leads to longer permanence in the market, greater consumer confidence, better product/ service compliance (Bata et al. 2006) , and lower

rates of consumer complaints(Motarjemi and Käferstein 1999) . In the present, highly competitive market, these gains may make the difference between commercial success and failure.

Reduction in microbiological counts of the products, the ability to attract new clients and to keep existing consumers satisfied were recognized as the greatest benefits of HACCP implementation in dairy factories in the UK (Henson et al. 1999) . However, Maldonado et al. (2005) observed that the perception of the benefits by the consumers depended on their awareness of food safety issues. Khatri and Collins (2007) reported the benefits of HACCP implementation in meat industries in Australia, such as the reduction in losses and reworks of noncompliant products, besides reduction in the number of consumer complaints, improved hygienic conditions of the products, and increased market shares for the companies. The greater the number of studies that demonstrate the costs and benefits of HACCP to food industries and discuss the elements that make them up, the greater the number of companies that will be motivated to adopt the system (Henson et al. 1999) .

1.8 HACCP and the Environment

Tanimoto et al. 2008 The present integrated economy increasingly demands a more proactive environmental posture from the production sector, making companies reevaluate their competitive strategies. The search for sustainable development demands a review of traditional standards of waste production, manufacturing procedures, and environmental management systems, including practices aiming at waste management and efficient use of non-renewable resources.

As new concepts are brought into this discussion, present consumption and production standards must be reviewed and aligned with increasingly clean and sustainable productive processes. "Clean production" involves the use of technologies that enable the use of fewer natural resources, such as water, energy, and raw material, as well as the reduction in waste production and in environmental impacts. Other measures related to production and consumption are also involved. In "clean production," such as good operational practices and reduction in losses, adequate storage and discard of residues, redesign of products and production processes, and minimal and efficient use of raw material and energy (Andrade et al. 2001).

Although HACCP was originally conceived to ensure food safety, there are other recognized benefits related to the use of the system, such as reduction in losses during food production. Better trained employees and monitored procedures are responsible for this benefit, because systematic monitoring of some steps of the process leads to immediate responses when critical limits are exceeded, in a way that hazards are controlled without delay, preventing errors and losses during the process. Therefore, fewer failures in the process lead to fewer noncompliant products, that is, fewer products that are rejected and discarded. In the lack of strict control of the process, as proposed in the HACCP system, errors are only identified in the finished product, making reprocessing impossible most of the times, and leading to even greater losses.

Discard of finished product implies added costs for the company and for the environment, mostly related to the necessary treatment of the material before it is discarded, such as the use of energy, water, and chemical products, as well as the cost of the discard process per sec . For example, residual waters of food industries, such as dairy or meat plants, contain blood, fat, meat residues, whey and amounts of milk, cheese, yogurt, dairy drinks, and butter. Treatment of these residues involves large amounts of water and produces large volumes of effluent that still have high concentrations of organic material and should be adequately treated before being disposed of into natural water bodies (Chaves 2006) . Therefore, HACCP contributes to the reduction of losses in all steps of the process, and has a positive impact on environment conservation.

Packaging material is often discarded together with the products, and it is a waste of natural goods. Although materials such as cardboard, plastic, and cans may be reused after recycling, they are not always recycled and may overload landfills. According to Marinho and Kilperstok (2000) , prevention of environmental pollution is a positive attitude that minimizes and may even prevent waste production by means of changes in the types of materials used, or in the production processes.

The use of high-quality raw materials, obtained from reliable companies and stored in adequate conditions, is an indispensable requisite for the quality of the final product (Góes et al. 2001 ; Ehiri et al. 1995) . These issues are approached and foreseen by the HACCP system, as part of the reception of ingredients and raw materials in the food industry, and are important CCPs (Forsythe 2002) . Many of the raw materials delivered to the food industry come directly from primary production (i.e., from farms), where levels of contamination, mainly chemical contamination, may pose serious risks to the health of the consumer, especially in developing countries. Thus, this CCP requires critical limits for the presence of chemical contaminants, ensuring quality control of raw material, and leading to greater environmental awareness and responsibility of the suppliers, by means of controlled and rational use of pesticides and drugs of veterinary use. Ehiri et al. (1995) and Mortimore and Wallace (1998) showed that auditing suppliers Implementation of Hazard Analysis and Critical Control Points System... 35 problems that would only be identified at the moment of reception of the materials in the food industry, and enables the evaluation of quality standards of the suppliers In this context, HACCP contributes to stimulating the responsibility of the industries in relation to food safety and quality, and environmental protection.

CHAPTER TWO

MATERIALS AND METHODS

2.1 Study area

Study area considered for this research was Al-Goussi Meat Factory in Khartoum State of SUDAN which was considered to be one among the biggest meat processing factories in SUDAN. Which was located at Omdurman Area in Khartoum State. Al-Goussi Meat factory awarded and implemented HACCP system since 2010.

2.1.1 Study population

The total population of the employees in this factory was around 763 employees where the workers and the labours constitute and represent the main division around 541. Where the rest of employees around the 222 were professionals.

2.2 Study Design

Data was collected as the part of the study of haccp process flow in algoussi meat processing factory study was carried out during February 2016 to estimate the impact of the hazard analysis and critical control point in food safety and differentiate between the haccp implementers facilities and non implementers facilities random sampling was designed based on: demographic Information., haccp process in industry, employee medical status, general Process in Industry, policies in industry, records of Industry.

2.2.1 Sample Size

The sample size of the study was determined by using formula given for sample random sampling methods. The relevant formula for 95% confidence and 5% precision was:-).

$$\text{Sample Size} = \frac{\frac{z^2 \times p(1-p)}{e^2}}{1 + \left(\frac{z^2 \times p(1-p)}{e^2 N}\right)}$$

Population Size = N | Margin of error = e | z-score = z

e was percentage, put into decimal form (for example, 3% = 0.03).

The z-score was the number of standard deviations a given proportion was away from the mean. To find the right z-score to use, refer to the table below:

Desired Confidence Level	z-score
80%	1.28
85%	1.44
90%	1.65
95%	1.96
99%	2.58

Desu. (1990)

The sample size for HACCP implemented industry had population size was 71 and the confidence level 95 % where as the margin errors in 5% the calculated sample size was 61 sample . From this out of 61 samples 3 samples were invalid for analysis. The rest of 58 samples were valid for the analysis. For HACCP not implemented industry had the population size as 34 and the confidence level was 95% where as the margin errors was 5% the calculated sample size will be 32. Out of 32 samples 4 samples were not valid for the analysis and the rest 28 samples was valid for analysis..

DATA COLLECTION

In data collection, quantitative data were sought for this research. In this research secondary data alone collected through reports and records of HACCP implemented industries study area, from two food industries of Al-Goussi Meat factory and another meat factory in Khartoum state. The sample size for HACCP implemented industry had population size was 71 and sample size was 61. From this out of 61 samples 3 samples were invalid for analysis. The rest of 58 samples were valid for the analysis. For HACCP not implemented industry had the population size as 34 and the sample size was 32. Out of 32 samples 4 samples were not valid for the analysis and the rest 28 samples were valid for analysis..

2.3 DATA ANALYSIS

The data analysis was made to answer such key questions as:

1. Why were these data collected, and what were the answers the study was trying to seek?
2. What type of 'reliable' data was needed to construct this research?
3. Where can we obtain these data and who can give the reliable data information?
4. How should the data be collected cost effective and without error?
5. How should future researchers or studies be enhanced by this research work?

The descriptive analysis was basically the term provided to analyzing of data. describe show. The various tools of descriptive data analysis like frequency and percentage data analysis were. The various tools of inferential data analysis like correlation, and regression, analysis was conducted to test statistical hypothesis.

These statistical estimates formed in SPSS were the level of significance was set at $p \leq 0.05$..

2.4 VERIFYING DATA ACCURACY

In the study, a combination of all the Qualitative data accuracy verification was done by mainly cross-checking this research against previous research.

2.5.1 Reliability

The results of the reliability test conducted in SPSS 19.0 reflected the Cronbach alpha value of 0.872 which reflects that the measuring instrument was highly reliable in determine the responses and quantitative analysis.

CHAPTER THREE

RESULTS

3.1 PERCENTAGE ANALYSIS OF COLLECTED DATA:

This research aims to investigate the process flow difference between the HACCP implemented and HACCP non-implemented meat industries in Khartoum state. The data had been collected from 86 working professionals in Khartoum state. among those samples 28 respondents were working in HACCP non-implemented meat industries and 58 samples were working in HACCP implemented industries in Khartoum state. In this section demographic variable related to HACCP non-implemented and HACCP implemented industries percentage calculation were stated.

3.2 MEASUREMENT OF THE STUDY VARIABLES

Table 3.1 shows the study variables and its scaling.

Table 3.1 Study Variables and Its Scaling

VARIABLE	SCALES	SCORING
SOCIO-DEMOGRAPHIC FOR HACCP NON-IMPLEMENTED INDUSTRIES		
Gender	Male	0
	Female	1
Age Group	18-25 years	0
	25 – 35 years	1
	Above 35 years	2

Annual Income	less 12000 24000-48000 48000 – 60000 more than 60000	0 1 2 3
Occupation	Meat Cutter Meat Process Worker Microbiologist production manager production supervisor Process Worker qc supervisor Quality manager Sales Manager sales representative sales supervisor sanitation inspector	0 1 2 3 4 5 6 7 8 9 10 11
Year of Joining	2005 2006 2008 2009	0 1 2 3

	2010	4
	2011	5
	2012	6
	2013	7
	2014	8
Experience	Less than 1 year	0
	1 – 2 Years	1
	2-4 years	2
	More than 4 years	3
SOCIO-DEMOGRAPHIC FOR HACCP IMPLEMENTED INDUSTRIES		
Occupation	Meat Cutter	0
	Assistance Meat Manager	1
	Microbiologist	2
	Marketing Supervisor	3
	meat plant production supervisor	4
	Packing Supervisor	5
	Production/project manager	6
	Quality and food safety manager	7
	Quality assurance HACCP coordinator/ Technician/ Manager	8

	Sales Manger	
	Sanitation Technician	9
	Senior Quality Analyst	10
	Store Keeper	11
	Fabrication maintenance	12
Year of Joining	2004	0
	2005	1
	2006	2
	2007	3
	2008	4
	2009	5
	2010	6
	2011	7
	2012	8
	2013	9
	2014	10

Table 3.1 provided clear view of scoring value assigned for individual parameter evaluated in the questionnaire. The data collected through questionnaire was categorized into implemented HACCP industries and non-implemented HACCP industries based on that scoring value had been assigned to the collected data. Among the all variables except designation and year of joining were similar to non-implemented parameters hence other than those parameters scoring values were same for both HACCP non-implemented industries and HACCP implemented industries in Khartoum state.

3.2.1 NON – IMPLEMENTED HACCP INDUSTRIES:

This section provides the percentage analysis of sample demographic profile in HACCP non-implemented industries. Demographic profile of the non-implemented process conswasts of factors like gender, age group, annual income, designation, year of joining in an organization and years of experience.

3.2.1.2 Gender of Sample

In demographic factor analysis primary investigated about the gender of the sample. This was evaluated due to traditional approach but it does not involve any significant contribution for this research.

Table 3.2 Gender of Sample

PARAMETER	FREQUENCY	PERCENTAGE
Male	18	64.28571
Female	10	35.71429
TOTAL	28	100

The above table 3.2 provides the percentage of male and female respondent's from the total available sample.

3.2.1.3 Age Range

This section provides the age range of the sample group among total population in HACCP non-implemented process. The questionnaire consisted of three options for estimating age group of the total sample population. Table 3.3.

Table 3.3 Sample Age Range

PARAMETER	FREQUENCY	PERCENTAGE
18-25 years	8	28.57143
25 – 35 years	13	46.42857
Above 35 years	7	25
TOTAL	28	100

From the table 3.3. percentage calculation it was calculated that 46.42857% of people were belong to the age group of 25 -35 years. For age group of 18 – 25 years percentages were about 28.57143 and for age above 35 years the percentage was about 25.

3.2.1.4 Annual Income

Table 3.4 Annual Income of sample

PARAMETER	FREQUENCY	PERCENTAGE
24000-48000SDG	11	39.28571
Less than 12000SDG	10	35.71429
48000 – 60000SDG	6	21.42857
more than 60000SDG	1	3.571429
TOTAL	28	100

The above table 3.4 described the percentage calculation for the 28 sample. From the percentage calculation of sample it was observed that about 35.715% of population annual income was at the rate of less than 12000SDG. Further annual income at the rate of 24000 – 48000SDG where 39.28571% for the collected sample data. Whereas annual income of 48000 – 60000SDG where at the rate of 21.42857% and more than 60000SDG as annual income for 3.571429% of total sample population.

3.2.1.5 Occupation

In evaluating process flow of the HACCP implemented and non-implemented industries occupation difference were examined.

Table 3.5 Designation of Sample

PARAMETER	FREQUENCY	PERCENTAGE
Meat Cutter	5	17.85714
Meat Process Worker	4	14.28571
microbiologist	4	14.28571
production manager	2	7.142857
production supervisor	3	10.71429
Process Worker	1	3.571429
qc supervisor	3	10.71429
Quality manager	1	3.571429
Sales Manager	2	7.142857
sales representative	1	3.571429
sales supervisor	1	3.571429
sanitation inspector	1	3.571429
Total	28	100

From the table 3.5 it was observed that among the total 28 sample population there existed a 12 different occupation among the total sample population. Among the various occupational preferences most of the sample population where belong to the occupation of the meat cutter whose frequencies were at the range of 5 with percentage of 17.8 and other occupation of sample where meat process worker, microbiologist, production manager, production supervisor, quality manager, sales manager, sales supervisor and Sanitation Inspector were at 14.28%, 7.14%, 10.71%, 3.57%, 7.14%, 3.57% and 3.57% respectively..

3.2.1.6 Year of Joining

In examining the demographic related data related to HACCP non-implemented next question was year of joining of the sample population.

Table 3.6 Sample Joining Year

PARAMETER	FREQUENCY	PERCENTAGE
2005	2	7.142857
2006	2	7.142857
2008	2	7.142857
2009	1	3.571429
2010	3	10.71429
2011	4	14.28571
2012	5	17.85714
2013	7	25
2014	2	7.142857
TOTAL	28	100

The above table 3.6 demonstrated sample population joining data in order to evaluate the knowledge regarding the process flow in meat industry of Khartoum state. it was observed that in the

year of 2013 most of the respondents joined in particular organization with 25%. Since respondents were joined in the particular organization starting from the year of 2005, 2006 and 2008 .

3.2.1.7 Years of Experience

In questionnaire four options were provided in order to investigate the work experience of sample in organization. The below table 3.7 demonstrated the percentage calculation of sample population.

Table 3.7 Work Experience of Sample

PARAMETER	FREQUENCY	PERCENTAGE
Less than 1 year	0	0
1 – 2 Years	6	21.42857
2-4 years	8	28.57143
More than 4 years	14	50
TOTAL	28	100

From the table 3.7 the percentage calculation of total 28 sample it was concluded from table that majority of the sample population handwork experience of more than 4 years since they contribute 50% of the total sample population. People with work experience of 1.-2 years and 2-4years were in the percentage of 21.42857 and 28.57143 respectively.

3.3.1 IMPLEMENTED INDUSTRIES

This section provides the percentage analysis of sample demographic profile in HACCP implemented industries. Demographic profile of the implemented process consists of factors like gender, age group, annual income, designation, year of joining in an organization and years of experience. For analysis data had been collected from 58 sample population and its corresponding data were described in this section.

3.3.1.1 Gender of Sample

Table 3.8 Gender of Sample in HACCP Implemented Industries

PARAMETER	FREQUENCY	PERCENTAGE
MALE	39	67.24138
FEMALE	19	32.75862
TOTAL	58	100

Table 3.8 provides the percentage of male and female respondent's from the total available sample. it was observed that among total sample population 67.2138% of population were male respondents and 32.75862% were female respondents. From the percentage analysis it was concluded that majority of the respondents were male respondents.

3.3.1.2 Age Rang.

Table 3.9 Age Range of Sample in HACCP Implemented Industries

PARAMETER	FREQUENCY	PERCENTAGE
Below 18 years	1	1.724138
18-25 years	23	39.65517
25 – 35 years	21	36.2069
Above 35 years	13	22.41379
TOTAL	58	100

Table 3.9 it was concluded that age group of 25-35 years were highest in numbers and its corresponding percentage. From the percentage calculation it was calculated that 36.2069% of people where belong to the age group of 25 -35 years. For age group of 18 – 25 years percentages were about 39.365517 and for age above 35 years the percentage was about 22.41379.

3.3.1.3 Annual Income

Table 3.10 describes the percentage calculation for the 58 sample. From the percentage calculation of sample it was observed that about 50% of population annual income was at the rate of less than 12000SDG. Further annual income at the rate of 24000 – 48000SDG where 29.31034% for the collected sample data. Whereas annual income of 48000 – 60000SDG where at the rate of 15.51724% and more than 60000SDG as annual income for 5.172414% of total sample population.

Table 3.10 Annual Income of Sample in HACCP Implemented Industries

PARAMETER	FREQUENCY	PERCENTAGE
24000-48000	17	29.31034
less 12000	29	50
48000 - 60000	9	15.51724
more than 60000	3	5.172414
TOTAL	58	100

Annual income of the respondents where illustrated in the figure 3.9 to evaluate the income of the sample population in HACCP non-implemented industries in Khartoum state.

3.3.1.4 Occupation

In evaluating process flow of the HACCP implemented and non-implemented industries occupation difference were examined.

Table 3.11 Occupation of Sample in HACCP Implemented Industries

PARAMETER	FREQUENCY	PERCENTAGE
Meat Cutter	15	5.172414
Assistance Meat Manager	1	5.172414
microbiologist	5	1.724138
Marketing Supervisor	1	5.172414
meat plant production supervisor	2	13.7931
Packing Supervisor	2	1.724138
Production/project manager	3	13.7931
Quality and food safety manager	1	6.896552
quality assurance haccp coordinator/ Technician/ Manager	3	6.896552
Sales Manger	3	12.06897
sanitation Technician	2	22.41379
Senior Quality Analyst	1	1.724138

Store Keeper	1	1.724138
fabrication maintenance	1	1.724138
Total	28	100

From the table 3.11 it was observed that among total 28 sample population there exists a 12 different occupation among the total sample population. Among the various occupational preferences most of the sample population where belong to the occupation of the meat cutter whose frequencies were at the range of 5 with percentage of 17.8 and other occupation of sample where meat process worker, microbiologists, production manager, production supervisor, quality manager, sales manager, sales supervisor and sanitation inspector were at 14.28%, 7.14%, 10.71%, 3.57%, 7.14%, 3.57% and 3.57% respectively. From the analysis it was concluded that among total sample population majority of the people where meat cutter

3.3.1.5 Year of Joining

In examining the demographic related data related to HACCP non-implemented next question was year of joining of the sample population.

Table 3.12 Sample joining year in HACCP Implemented Industries

PARAMETER	FREQUENCY	PERCENTAGE
2004	3	5.172414
2005	3	5.172414
2006	1	1.724138
2007	3	5.172414
2008	8	13.7931
2009	1	1.724138
2010	8	13.7931
2011	4	6.896552

2012	4	6.896552
2013	7	12.06897
2014	13	22.41379
2015	1	1.724138
2016	1	1.724138
OTHER	1	1.724138
TOTAL	58	100

From the table 3.12 it was observed that in the year of 2014 most of the respondents joined in particular organization with 22.41379%. Since respondents were joined in the particular organization starting from the year of 2005, 2006 and 2008 were in the 5.172414% respectively for corresponding three years. In the year of 2009, 2015 and 2016 the percentage was of 1.72138.

3.3.1.6 Years of Experience

Table 3.13 demonstrates the percentage calculation of sample population.

Table 3.13 Work Experience in HACCP Implemented Industries

PARAMETER	FREQUENCY	PERCENTAGE
Less than 1 year	0	0
1 – 2 Years	12	20.68966
2-4 years	14	24.13793
More than 4 years	32	55.17241
TOTAL	58	100

From the percentage calculation of total 58 sample in table 3.13 it was concluded that the majority of the sample population has work experience of more than 4 years since they contribute 55.17241% of the total

sample population. People with work experience of 1-2 years and 2-4years were in the percentage of 20.68966 and 24.13799 respectively.

3.4 HACCP Process in Industry

The second section of the questionnaire consists impact of HACCP process flow in meat industry in Khartoum state. For examining the HACCP in meat industry data had been collected from 86 samples in meat industry where in HACCP implemented industries data were collected from 58 sample population and 28 data sample were collected from HACCP non-implemented industries in Khartoum state.

3.4.1 Risk Management Model

In HACCP process examination questionnaire consist of four questions for predicting standard of the organization. This section contains the questions like whether the organization had risk management system, recall system, company certification and quality management system. The reason behind framing question regarding company certification and quality management was to estimate the HACCP process in the meat industry to evaluate the process flow in supply chain management in the selected food industry.

Table 3.14 Risk Management

Parameter	Is risk management system was exists			
	HACCP non-implemented Industry		HACCP implemented Industry	
	Frequency	Percentage	Frequency	Percentage
Yes	0	-	53	91.3793
No	28	100	5	8.62
Total	28	100	58	100

The table 3.14 comparatively described the risk management system in both implemented and non-implemented meat industry in Khartoum state. The percentage analysis of the implemented and non-implemented system demonstrates that in HACCP implemented industry there was no risk management scheme whereas in HACCP process implemented industries had risk management scheme. From the analysis it was observed that 91.3793% population accepted that risk management scheme had been existed in the HACCP implemented meat industry only 8.62% of population describes that risk management had not been implemented in meat industry.

3.4.2 Product Recall System

Table 3.15 Product Recall System

Product Recall System				
Parameter	HACCP non-implemented Industry		HACCP implemented Industry	
	Frequency	Percentage	Frequency	Percentage
Yes	0	-	58	100
No	28	100	0	-
Total	28	100	58	100

From the table 3.15 it was clearly concluded that product recall system was significantly followed in the HACCP implemented industries. The percentage calculation of product recall system in implemented and non-implemented industries shows that in HACCP industries alone product recall system was effectively followed.

3.4.3 Quality Management System

Table 3.16 Quality Management System

Quality Management System				
Parameter	HACCP non-implemented Industry		HACCP implemented Industry	
	Frequency	Percentage	Frequency	Percentage
Yes	0	-	58	100
No	28	100	0	-
Total	28	100	58	100

Table 3.16 revealed that quality management system had been strictly followed in the HACCP implemented industry alone. From the total sample it was observed that quality management scheme had been followed in HACCP implemented industry alone since about 100% accepted that quality management had been implemented in HACCP implemented industry.

3.4.4 ISO Certification

From the analyzes of the collected data for this section clearly described that HACCP implemented industries had proper risk management, recall and quality management system. Hence from this it was concluded that HACCP implemented industries had effective management of supply chain rather than HACCP non-implemented industry.

3.5 EMPLOYEE MEDICAL STATUS

3.5.1 Diseases in Employee's

The optional questions were used to evaluate the diseases persists in the employee's in meat industry. First question was about whether the employee suffer from any diseases before like typhoid, food borne diseases, Parasitic Infection and Tuberculosis. The second question was about whether the employee had any diseases at present scenario like skin allergies, vomiting, boils, septic and any fluid discharge from ears, eyes and gums and mouth.

Table 3.17 Diseases in Employees

Parameter	HACCP non-implemented Industry		HACCP implemented Industry	
	Frequency	Percentage	Frequency	Percentage
Yes	0	-	0	-
No	28	100	58	100
Total	28	100	58	100

. The table 3.17 demonstrated the data collected from 86 sample population about dwaseases in the working organization. From this it was concluded that employee's health hygiene was not affected by HACCP implemented and non-implemented organization.

3.5.2 Maintenance in HACCP Process

The second section of the employee medical status section was of Linkert scale questions where maintenance in HACCP process in meat industry. This section of the questionnaire contains Linkert scale to check medical health process among employee's in an organization. First question of this section was about whether their was chance if employee suffer from any diseases he/she can inform to their higher officials in the organization.

3.6 GENERAL PROCESS IN INDUSTRY

The section 4 of the questionnaire contains the list of questions to evaluate the HACCP process in implemented and non-implemented industry. This section of the questionnaire consists of five questions to examine the impact of HACCP process on meat industry in Khartoum state. Framed questions were the auditing process in both HACCP implemented and non-implemented industries. As stated above section among 86 total sample population 28 where working in HACCP non-implemented industries and 58 where working in HACCP implemented industries.

3.6.1 Audit in Organization

The first question of this section was whether regular auditing was carried out in the meat industry of Khartoum state. The data collected from the respondents states that in HACCP implemented industry alone having regular auditing in HACCP non-implemented industries auditing was not carried out.

3.6.2 Auditing personnel

Second question of this section states that through which personnel auditing had been carried out in the organization. From the previous question itself it was observed that auditing was carried out only in the HACCP implemented industry alone hence HACCP implemented industries alone had auditing activities. Hence the collected data shows that only 58 respondents described by whom auditing had been carried out. This question had four options to investigate the auditing personal through customers of industry, third party, third – party selected by customers and nill. Among 28 sample of HACCP non-implemented industries opted for nil options only HACCP implemented industry respondent's which 58 sample expressed that auditing in the particular organization was carried out by third party. Through this question it was concluded that auditing in HACCP implemented industry was carried out by third party.

3.6.3 Slaughtered Animals Import from Industry

The third question of this section was to examine the amount of slaughter exported from the particular meat industry. In order to estimate the percentage of slaughter exported from the particular industry the question was fed with five options those were all 10 – 25% of the slaughter, 25 – 45%, 45 – 75 % and above 75% of the total export quantity. Data collected regarding this questions demonstrates that in HACCP non – implemented industry 27 sample expressed that about 10 -25% slaughter was exported from the meat industry only one sample opted that amount of slaughter export was not specific in the organization. While analyzing HACCP implemented industries all 58 sample population expressed that about 10 – 15% of slaughter had been manufactured from the meat industry in Khartoum state.

Table 3.18 Slaughter Manufacturing Rate

Slaughter Manufacture				
Parameter	HACCP non-implemented Industry		HACCP implemented Industry	
	Frequency	Percentage	Frequency	Percentage
None	0	-	0	-
10 - 25%	27	96.428	58	100
25 – 45%	0	-	0	-
45 – 75%	0	-	0	-
Above 75%	1	3.57	0	-
Total	28	100	58	100

Table 3.18 demonstrates slaughter manufacturing percentage in meat industry of Khartoum state and concluded that from any organization amount of slaughter produced from the organization was about 10 – 25% for a year.

3.6.4 Sanitation in Plant

While examining the process flow in the HACCP implemented and non – implemented industries the safety measures play a major role hence in this section examined about the sanitation availability of the industry was examined. From the analysis of the data in HACCP non – implemented industry did not have a specific routine in the industry. In HACCP implemented industry had mandatory to use gloves and sanitation for the entire process of the organization. Hence from the analysis of the collected data states that HACCP implemented organization had significant measurement schemes rather than HACCP non- implemented industry.

3.6.5 Written Policies and Procedures

The final section of the questionnaire in examining about the general process flow in the meat industry conclusion question was whether organization had written policies and procedures in the Organization. The questionnaire was adopted with two choice written policies and procedures were existing in the company policy or not. From the analysis it was observed that in both HACCP implemented and HACCP non – implemented organization had specific written policies and procedures in meat production in Khartoum state.

Table 3.19 Written Policies and Procedures

Written Policies and Procedures				
Parameter	HACCP non-implemented Industry		HACCP implemented Industry	
	Frequency	Percentage	Frequency	Percentage
Yes	27	96.428	57	96.428
No	1	3.57	1	3.57
Total	28	100	58	100

From table 3.19 it was concluded that both HACCP implemented and non-implemented industries had written statement and policies. From the collected data it was concluded that every organization had written policies and procedures since it occupies the highest rate of 96.428% for both implemented and non – implemented industries in Khartoum state.

3.7 POLICIES IN INDUSTRY

The section five of the questionnaire was about to analyze the factors involved in industry policy of the meat industry In Khartoum State. For evaluating the process in meat industry questionnaire was framed based on the three point Linkert Scale. This section consists of 18 questions to measure the process flow in meat industry. The questions were like whether the meat industry had written policies, security management schemes, sanitation standard, pest control programme etc. The collected from the total sample population were listed in table 3.20. Data were listed separately based on the HACCP

implemented and non-implemented standard. From the collected data it was observed that HACCP implemented industries had various programmes for safety measures like pest control programme, food hygiene and safety control programme, recall programme and traceability which frequencies were at the rate of 58 or 57 and it corresponding percentage about 100 or 98.27. From that analysis it could be concluded that HACCP implemented industry had hygiene, pest control, recall programme where while examining about the HACCP non-implemented industries did not having the programme separately for pest control, hygiene control programme, recall, traceability etc.

Table3.20 Industry Policies

PARAMETER	HACCP non-Implemented			HACCP implemented		
	Yes	No	NA	Yes	No	NA
Do you have company written policy	2 (7.14)	4 (14.28)	22 (78.57)	58 (100)	0	0
Was your company perform security risk management scheme	0	6 (21.43)	22 (78.57)	53 (91.38)	0	5 (8.62)
Do you had any food safety plan, program or schemes like HACCP?	0	26 (92.85)	2 (7.14)	58 (100)	0	0
Do you had specific Sanitation Standard Operating Procedures (SSOP's)?	3 (10.71)	5 (17.86)	20 (71.43)	58 (100)	0	0
Was your industry conducts any hygiene program for employees?	11 (39.28)	17 (60.71)	0	58 (100)	0	0
Were personnel trained in food hygiene and safety?	23 (82.14)	2 (7.14)	3 (10.71)	58 (100)	0	0

Does your industry have any pest control program?	1 (3.57)	12 (42.86)	15 (53.57)	58 (100)	0	0
Was cross-contamination risks were control efficiently in your industry	22 (78.57)	2 (7.14)	4 (14.29)	58 (100)	0	0
Do you have a recall program?	1 (3.57)	11 (39.29)	16 (57.14)	57 (98.27)	1 (3.57)	0
Do you have full traceability?	0	11 (39.29)	17 (60.71)	57 (98.27)	1 (3.57)	0
Do you have system for handling customer complaints?	1 (3.57)	19 (67.86)	8 (28.57)	58 (100)	0	0
Have you ever feel any allergens in on-site	0	15 (53.57)	13 (46.43)	14 (74.14)	43	1 (3.57)
Do you have an allergen control program on-site in your industry?	0	6 (21.43)	22 (78.57)	49 (84.48)	9	0
Do you have a supplier approval program?	6 (21.43)	0	22 (78.57)	58 (100)	0	0
Were manufacturing instructions documented?	1 (3.57)	5 (17.86)	22 (78.57)	58 (100)	0	0
Do you carry out any auditing, either internal or external?	0	23 (82.15)	5 (17.86)	58 (100)	0	0
Do you carry liability insurance?	16 (57.14)	5 (17.86)	7 (25)	58 (100)	0	0

Do you had any other food safety controls in place?	0	28 (100)	0	58 (100)	0	0
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From table 3.20 the analysis of the collected data only 2 where expressed that HACCP process non-implemented industry did not had any written statement. In HACCP non-implemented 82.14% of population had food and hygiene programme and 78.57% of population had contamination control programme. Through the analysis of the collected data it was concluded that HACCP implemented industry had significant process flow rather than the HACCP non-implemented industry.

3.8 RECORDS OF INDUSTRIES

The contamination record of the meat industry had been evaluated in the section six of the questionnaire. Section six of the questionnaire was organized based on freezer temperature maintained for transporting meat from the particular industry. This section consists of the following scenarios which were all stated below:

1. Deliveries Temperature Record
2. Fridge & Freezer Temperature Record
3. Storage Temperature Record.

In above section temperature record were evaluated based on weekly progress from Sunday to Saturday. From the collected data it was observed that almost all sample describes the similar record to maintain the temperature for a week.

Table 3.21 Fridge & Freezer Temperature

Cabinet	Target Temperature	Temperature For Week						
		Sun	Mon	Tues.	Wed	Thurs	Fri	Sat
1	-18C ⁰	-18	-18	-18	-17	-17	-18	-18
2	-18C ⁰	-18	-18	-18	-18	-18	-18	-18

Table 3.21 states fridge and freezer temperature record of both HACCP implemented and non-implemented industry. From the analysis of data it was concluded that almost all industry maintained same maintenance record for every week.

CHAPTER FOUR

DISCUSSION

Hazard Analysis and Critical Control Point is a process control system designed to identify and prevent microbial and others hazards in food production. The HACCP system is used at all stages of a food chain, from food production to packaging and distribution.

HACCP include steps designed to identify food safety risks, prevent food safety hazards before they occur, and address legal compliance. They most important aspect is to prevent rather than inspection system of controlling food safety hazards. Prevention of hazards can not be accomplished by end product inspection, controlling the production process with HACCP offers best approach. assured quality production for food safety in Egypt was improved by adopting the HACCP as preventive system , the efficient manufacturing with improved efficiency and with reduced wastage. This research was carried out in Egypt in industries of Milk, food and Mansoura El-Hofi.(2013).

This document concluded that HACCP provides assured food safety with minimized wastage. While analyzing food safety acceptability factors like biological, chemical environment were need to be considered for enhanced food safety. CA Wallace, (2014)

In this study and based on the result obtained it is obviously and clearly the HACCP implemented organizations had significant process flow rather than the HACCP non implemented industry. implementing quality assurance systems, including HACCP, where necessary to ensure compliance with the standards and legislation. The challenge to governments was to ensure that the sanitary measures applied were effective in ensuring food quality and safety at all levels of the food chain. Orriss and Whitehead (2000).

The processes flow in the supply chain aimed of pressuring food safety and quality. Keeping in mind that food product are among most delicate product in the market they require special conditions therefore, various details like temperature. air quality, humidity.. Hence from the analysis of the collected data states that HACCP implemented organization had significant measurement schemes rather than HACCP non- implemented industry.

A reflective approach to hygiene was urgently required. However, the application of terms or notions borrowed from the HACCP system, e.g., for basic hygiene measures or in other word where the seven principles were not wholly applicable, leads to a dilution of the aims and efficacy of the HACCP concept. Further components were a sufficient separation of production steps and production lines to avoid cross contamination, Untermann (2014)

The high level of hygiene had considered and legally regulated during manufacturing and distribution in HACCP implemented facility. In HACCP implemented industry had mandatory to uses the gloves and sanitation for the entire process of the organization which reflected in high percentage 100% in specific Sanitation Standard Operating Procedures (SSOP's) and conducted hygiene program for employees and personnel trained in food hygiene and safety in contrary to HACCP non implemented facility.

HACCP system audit method which allows precise assessment of the system functioning in practice. The method was based on specially elaborated audit questionnaire, covering all HACCP steps and principles, associated with analysis of audit findings by failure mode and effect analysis. Wojciech (2014).

it was observed that auditing was carried out only in the HACCP implemented industry alone hence HACCP implemented industries alone had auditing activities. Hence the collected data shows that only 58 respondents described by whom auditing had been carried out. It was concluded that auditing in HACCP implemented industry was carried out by third party.

Validation and verification principles square measure important to the event of a sturdy food safety system. Sadly, several food safety professionals get the 2 terms confused. this might be caused by the phrasing of the Hazard Analysis and important management Points (HACCP) documents revealed by each the Codex Alimentations Commission (Codex) and also the National consolatory Committee on the Microbiological Criteria (NACMCF). Codex delineates HACCP Step eleven (Establish verification procedures), Surak (2015)

the questionnaire was organized based on freezer temperature maintained for transporting meat from the particular industry. This section consists of the following scenarios which were all stated below:

1. Deliveries Temperature Record
2. Fridge & Freezer Temperature Record

3. Storage Temperature Record.

In above section temperature record were evaluated based on weekly progress from Sunday to Saturday. From the collected data it was observed that almost all sample describes the similar record to maintain the temperature for a week(-18) C (+ -1).

Total Quality Management (TQM) philosophies were instructive frameworks for the implementation of quality assurance management inside the tiny food sector. The results of the study recommend that little firms do want a additional formal framework for quality assurance management. Audited business standards, however, ar pricey to the tiny business. Holt, G., & Henson, S. (2000).

The organization implemented HACCP system had risk management system, recall system, company certification and quality management system. The reason behind framing question regarding company certification and quality management was to estimate the HACCP process in the meat industry to evaluate the process flow in supply chain management in the selected food industry. The percentage of risk management implementer in HACCP implementer was 92% while 8% for HACCP non implementer.

recall system was significantly followed in the HACCP implemented industries. The percentage calculation of product recall system in implemented and non-implemented industries shows that in HACCP industries alone product recall system was effectively followed. The percentage of recall system was 100% in in HACCP implementer while 0% nill percentage was recorded for HACCP non implementer.

The quality management system and ISO certification adopted in HACCP implemented industry had proper risk management, recall and quality management system. Hence from this it was concluded that HACCP implemented industries had effective management of supply chain rather than HACCP non-implemented industry which 100% applied in haccp implemented while 0% nill applied in HACCP non implemented industry.

CONCLUSION

The current study had shown the significance and impact of HACCP implementation on food safety in meat processing factory implemented the HACCP system and HACCP none implemented. To investigate the HACCP implemented and non-implemented industry statistical analysis correlation had been performed. The correlation analysis of the framed hypothesis clearly states that HACCP process in the meat industry had the significant impact on the process flow rather than HACCP non-implemented industry. . In HACCP process implemented industry regular auditing had been carried out in the selected meat industry through the third person in HACCP non-implemented industry, no auditing had been carried out. In order to promote the hygienic environment in meat manufacturing industry, regular awareness program had been organized in the HACCP implemented industry for the selected meat production industry in the Khartoum State. Through the analysis of the variables, it was concluded that HACCP implemented industry had significant process flow rather than the HACCP non-implemented industry in the Khartoum State. The further findings of this research also state that HACCP process had the significant impact on food production process in meat manufacturing industry hence through this research it was an influence that HACCP process need to be implemented in all manufacturing industries to ensure safe and hygienic environment.

RECOMMENDATION

- (1) Establishment of an independent body for the setting up the regulations & legislations concerned with HACCP system in the country.
- (2) Making the HACCP mandatory for all the food processors and manufacturers.
- (3) Full attention and concern should be given to the training for food manufacturers and processors personnel.
- (4) HACCP awareness of advantages and benefits must be realized to the public.

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