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THE FACULTY OF ENGINEERING AND THE
BUILT ENVIRONMENT

DEPARTMENT OF QUALITY AND OPERATIONS
MANAGEMENT

TITLE:
IMPLEMENTATION OF HACCP FOOD SAFETY SYSTEM AT
ANHEUSER-BUSCH INBEV TRADITIONAL AFRICAN
BEVERAGES PLANTS
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Co-supervisor: Mr NS Madonsela

THE UNIVERSITY OF JOHANNESBURG

APRIL, 2018
Declaration

I hereby declare that this Masters of Technology Thesis with the title “Implementation of HACCP food safety system at Anheuser-Busch InBev (AB-InBev) Traditional African Beverages plants” was carried out by myself under the guidance and supervision of Dr Sobiyi, Faculty of Engineering and the Building Environment, Department of Quality and Operations, University of Johannesburg, RSA. The interpretations put forward are based on my understanding of the literature reviews. The journal articles, books and website materials which I have consulted and read for the purpose of this research are cited at the relevant places in the text and acknowledged fully under the reference section.

For the present thesis, which I am submitting to the University of Johannesburg, no prior qualification or degree has been conferred on me prior to this submission, either in this or in any other university in the world.

Leutle Radingoane, 809911395

Signature………………………….

Date……………………………….
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Their support and love made it possible for me to move forward. This accomplishment would not have been possible without them.

Thank you God of Major 1 for giving me power and strength during this challenging time, your presence is heavens to me. I will forever praise you for the blessings.
## Abbreviations and Acronyms

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<thead>
<tr>
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<th>Full Form</th>
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<tbody>
<tr>
<td>AB-InBev</td>
<td>Anheuser-Busch InBev</td>
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<tr>
<td>BRC</td>
<td>British Retail Consortium</td>
</tr>
<tr>
<td>BSE</td>
<td>Bovine Spongiform Encephalopathy</td>
</tr>
<tr>
<td>CAC</td>
<td>Codex of Alimentarius Commission</td>
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<tr>
<td>CAPIN</td>
<td>Capital-Investment (plan)</td>
</tr>
<tr>
<td>CCPs</td>
<td>Critical Control Points</td>
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<tr>
<td>CL</td>
<td>Critical Limit</td>
</tr>
<tr>
<td>COA</td>
<td>Certificate of Analysis</td>
</tr>
<tr>
<td>FAO</td>
<td>Food Agricultural Organization</td>
</tr>
<tr>
<td>FDA</td>
<td>Food and Drug Administration</td>
</tr>
<tr>
<td>FMCG</td>
<td>Fast Moving Consumer Goods</td>
</tr>
<tr>
<td>FSMS</td>
<td>Food Safety Management System</td>
</tr>
<tr>
<td>FSSC</td>
<td>Food Safety System Certification</td>
</tr>
<tr>
<td>GAPs</td>
<td>Good Agricultural Practices</td>
</tr>
<tr>
<td>GFSI</td>
<td>Global Food Safety Initiative</td>
</tr>
<tr>
<td>GHPs</td>
<td>Good Hygienic Practices</td>
</tr>
<tr>
<td>GMPs</td>
<td>Good Manufacturing Practices</td>
</tr>
<tr>
<td>HACCP</td>
<td>Hazard Analysis Critical Control Point</td>
</tr>
<tr>
<td>IFS</td>
<td>International Food Safety</td>
</tr>
<tr>
<td>ILSI</td>
<td>International Life Science Institution</td>
</tr>
<tr>
<td>ISO</td>
<td>International Organization for Standardisation</td>
</tr>
<tr>
<td>KPI</td>
<td>Key Performance Indicator</td>
</tr>
<tr>
<td>LDC</td>
<td>Less Developed Countries</td>
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<tr>
<td>LIMS</td>
<td>Laboratory Information Management System</td>
</tr>
<tr>
<td>LSE</td>
<td>London Stock Exchange</td>
</tr>
<tr>
<td>NACMCF</td>
<td>National Advisory Committee on Microbiological Criteria for Foods</td>
</tr>
<tr>
<td>NAS</td>
<td>National Academy of Science</td>
</tr>
<tr>
<td>NASA</td>
<td>National Aeronautics and Space Administration</td>
</tr>
<tr>
<td>OPRPs</td>
<td>Operational Prerequisites Programmes</td>
</tr>
<tr>
<td>PDCA</td>
<td>Plan, Do, Check and Act</td>
</tr>
<tr>
<td>PET</td>
<td>polyethylene terephthalate</td>
</tr>
<tr>
<td>PRPs</td>
<td>Prerequisite Programmes</td>
</tr>
<tr>
<td>QA</td>
<td>Quality Assurance</td>
</tr>
<tr>
<td>QC</td>
<td>Quality Control</td>
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<tr>
<td>QMS</td>
<td>Quality Management System</td>
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<tr>
<td>SABMiller</td>
<td>South African Breweries Miller</td>
</tr>
<tr>
<td>SME</td>
<td>Subject Matter Expert</td>
</tr>
<tr>
<td>SPC</td>
<td>Statistical Process Control</td>
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<tr>
<td>SSOPs</td>
<td>Standard Sanitation Operation Procedures</td>
</tr>
<tr>
<td>TAB</td>
<td>Traditional Africa Beverage</td>
</tr>
<tr>
<td>TQM</td>
<td>Total Quality Management</td>
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<tr>
<td>VPO</td>
<td>Voyager Plant Optimisation</td>
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<tr>
<td>W.H.O</td>
<td>World Health Organization</td>
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Abstract

Food trading is one of the biggest emerging and congested businesses in both rural and urban areas of developed and developing nations worldwide and the opportunities for food businesses to be successful are greater than ever. Production of food is a complex process as it involves many different stages, such as receiving, handling and storage of unprocessed materials; the manufacturing process; packaging; storage; transportation; and the consumption of product, along with waste removal and disposal. This means that if the food safety control system of any company producing or handling food is weak or absent, food contaminations or hazards (such as biological, chemical and physical) are expected to happen at any stage of the process, and subsequently to result in unsafe food for consumption.

Food safety is a confirmation that foodstuff cannot be detrimental to the end users if it is prepared, handled, served and consumed as per the instruction. However, a significant number of individuals worldwide still suffer from food-related illness owing to the availability of food safety hazards in the food network. In most parts of Africa, owing to high levels of unemployment and illiteracy, the majority of people have resorted to traditional and unsafe food and beer, which is produced and sold on the street. This has prompted AB-InBev Africa (formerly SABMiller) to produce and market traditional beer (Opaque), which is produced in a hygienic controlled environment as a way of migrating opaque beer drinkers from unsafe homemade beer to safe beer. However, the nature and viscosity of the opaque beer make the analytical and microbial capability to detect quality and food safety issues a challenge. A food safety system that is able to anticipate and manage the risks associated with food proactively and effectively needs to be installed in the processing plant. The whole intention of the study is to acquire a deep understanding into understanding of the process of implementation, quantify the challenges related to the implementation and subsequently tailor a model for the implementation of an HACCP food safety system at Traditional Africa Beer (TAB) and food manufacturing industries.

A literature review employed to gain insights and understanding from the knowledge and findings emerging from previous research food safety and related studies. The literature review identified and defined the HACCP system as an effective and proactive plant- and process-based food safety programme for managing, analysing and eliminating food safety hazards before they enter products. The HACCP was found to be effective and efficient, if it gained the support of the top leadership of the organisation and was built on the solid foundation of effective prerequisite programmes (PRPs).

Food safety systems that are based on HACCP principles are regarded as flexible and compatible with other international food safety standards such as International Organisation of standardisation (ISO) 22000 and 9000. Literature alerts us to the fact that the adoption and implementation of the food safety system is based on knowledge, expertise and understanding of the food manufacturing steps, current and probable food safety hazards and contaminants related to the production process, the HACCP principles and implementation steps, and installation of adequate PRPs. Prerequisites, which are based on the hygienic condition of the plant, play a critical role in reducing the number of hazards associated with the process and allow the HACCP to control critical control points (CCPs).

The literature reviews also highlighted challenges and barriers to the HACCP food safety system implementation as results of poor seriousness by top management, lack of motivation by employees and insufficient and absence of resources, skills and training programmes, and no buy-in from employees. This study was guided by the theory of operation management, which addresses the planning, management and improvement of the manufacturing process to produce a safe food product. The literature was also used to explain the concepts of behavioural systems thinking and attribution theory as
important to consider when adopting a food safety system. These concepts are relevant to the adoption of an HACCP food safety system as the implementation of this type of system involves the right personnel, and that all necessary systems are in place.

This research study followed the phenomenological paradigms and interpretivist/constructivist approach in understanding people’s perception of and perspective toward the implementation of a food safety system at AB-InBev Africa breweries. This research fulfilled the requirements of the qualitative approach, where the researcher was not interested in the numerical collection of data but in understanding and gaining the insights of the real environment and the social behaviour and human activities in the subject under investigation. An exploratory research design as a plan for the gathering, measurement and analysis of qualitative data was deemed fit for this study, owing to its flexibility and ability to use non-probability sampling and unstructured instruments for data collection. A single case study was conducted at AB-InBev Africa breweries and the purposive sampling technique was considered to be suitable for the study, where individuals with known levels of expertise were selected for the study. Owing to geographical distance, an electronic (email) mode of conducting interviews was employed to collect data and the respondents’ original data were recorded in the question document sent to them. Secondary data were obtained from documents sourced from the participating AB-InBev Africa plants. Qualitative data from the respondents were coded into different categories and compared and consolidated to make concepts.

The findings of the research study suggested that the installation of an HACCP food safety programme is essential for addressing the hazards associated with process and foodstuff. However, the involvement and commitment of the top management can achieve the results and motivate all employees to adopt the system. The findings revealed that the challenges experienced were mainly lack of training, employee and management commitment and involvement. In addition, the study found a lack of skills such as consultation skills, technical skills and leadership skills, and inadequate resources such as financial, human resources and appropriate equipment. The lack of education and understanding by the operators was also found to impede the implementation of the system; people need to be educated or skilled. On the other side, the implementation of the system was found to benefit the company immensely, with increased customer and consumer satisfaction, improved product safety, reduced customer complaints and the preservation of the company’s reputation.

This research proposes a tailor-made model for the installation of an HACCP based food safety system in the AB-InBev Africa plants. The model consists of four implementation phases. The first phase, the initial phase, incorporates the requirements of the customers, consumers and legislation. The second phase, which is the planning phase, involves the top management in planning a food safety system, appointing the HACCP team, and allocating the resources. The third phase is the execution phase or operations management system phase and incorporates the HACCP design, planning and selection of appropriate PRPs and is coupled with training to facilitate knowledge and skills. The fourth phase of the model is the KPI phase, which is also the result of the implementation; customers and customer feedback base this on the evaluation of the system.

It is concluded that implementing an HACCP food safety system is do-able and achievable, if top management is committed to the concept of food safety and has a clear understanding of what needs to be achieved, the process of implementation, and the challenges encountered. They should then provide the resources, skills and training to all levels within the organisation and ensure that the documentation-and record-keeping system is in place and sound. After this, the system can be fully entrenched. Training
programmes need to be in place to address the skills and knowledge gaps, which are impediments to the installation of the HACCP system.

The research recommends that the food safety system model based on the HACCP, which consists of four phases, be implemented in food manufacturing companies in Africa and continually evaluated and improved formally by means of customer and consumer feedback and audits. It is also recommended that more studies be conducted in future to assess the effectiveness of food safety systems in the food manufacturing sector to strengthen the model. This can be achieved by choosing a different methodology to quantify the effectiveness of the system by collecting data from different companies or by duplicating the study using a different sampling technique to cover everyone in the business irrespective of their position or skill.
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1 Introduction

A food system is a link between food producers and consumers; it encompasses different aspects of food production, such as processing, packaging, distribution, marketing, consumption and waste-disposal processes (Peterson, Sefla and Janke, 2010; Chase & Grubinger, 2014). According to Chase and Grubinger (2014), a food system is not linear or circular, but is extremely complex, involving webs of people, their behaviours and resources. Chase and Grubinger (2014) define a food system as an interrelated net of actions, means, resources and individuals that spreads across all spheres involved in providing human nourishment and sustaining health.

Food safety is the notion that food will not be detrimental to its end-users when it is handled, stored, cooked and served according to its anticipated instructions. Unnevehr (2003) argues that unsafe food contains harmful agents with potential to cause harm to people. Such impurities are either leaked into food at different stages of the food system or occur naturally or as a result of poor production and handling practices. Ucar, Yilmaz and Cakiroglu (2016) argue that food can be rendered poisonous to humans and even deadly when it comes into contact with pathogens, microbes, moulds, germs, bugs and toxic chemicals. Hanning, O’Bryan, Crandall and Ricke (2012) state that food safety authorities focus on food management, production and warehousing that prevent sickness and injury from the consumption of food that has reacted with chemical contaminants, mixed with microphysical particles or been exposed to microbiological pathogens. “Food safety risks include risks from veterinary drugs and pesticide residues, food additives, pathogens, environmental toxins such as heavy metals and persistent organic pollutants and unconventional agents such as prions associated with bovine spongiform encephalopathy (BSE) in cattle” (Buzby, 2011). Along this vein, Ucar et al. (2016) suggest that food safety can be affected by incorrect farming practices, incorrect hygienic practices at any stage of the food system, ineffective preventative and safety assurance during food manufacturing, inconsistent use of chemical substances, use of infected and contaminated raw materials and ingredients, and inappropriate storage and isolation of incoming, processing materials and end-products.

The significance of food safety hazards varies across food production processes and products. Food safety hazards can be aggravated by different factors, such as climate change and weather vagaries and infrastructure along with methods of and recipes for food production and consumption. A lack of food safety contributes to the high number of cases of sickness and deaths worldwide from food and waterborne diseases. Food safety hazards seep into the food chain at any point in the production process and, if not detected as early as possible, can be detrimental to the health of consumers. Food safety therefore remains a key health concern for consumers, governments and non-governmental organisations in both less advanced and more advanced countries.

Unnevehr (2000) states that developed countries understand food safety hazards better than developing countries, and that adherence to food safety laws in developing regions is difficult and often a hindrance to achieving food safety. Food organisations need to adopt and ensure compliance to international and national regulations and standards governing food safety and ensuring an effective and accurate control of food safety hazards such as insecticides and bacterial contamination, drug residues, bugs and mycotoxins in many agricultural products such as maize, sorghum, wheat and rice (which can enter animals through ingestion of contaminated feeds and animal products), cyanide in cassava plants and adulteration by chemicals.
Lokunarangodage, Wickramasinghe and Ranaweera (2016) argue that a food safety assurance control system is needed for food manufacturing organisations to guarantee safety in their food chain and that compliance to statutory and regulatory and customer requirements is paramount. Rotaru, Sava, Borda and Stanciu (2005) argue that food safety assurance is an obligatory requirement for any food business or industry that produces food. This assurance can be achieved by implementing an organised, efficient, scientific and managerial-based structure with food-managing actions, such as practices, protocols, procedure and resources that meet fil-for-purpose criteria and sanitation and cleanliness requirements. Sulieman, Siddeg and Salih (2013) maintain that food safety is designed in accordance with the location and manufacturing plant to improve the quality and safety of the food product. Arvanitoyannis and Kassaveti (2009) state that planning and understanding of safe food products should incorporate the elements of Good Manufacturing Practices (GMPs) and Hazards Analysis Critical Control Points (HACCP), and should include any food safety law requirements appropriate to the organisation and its production and handling protocols.

Private food markets often fail to invest in the analysis and assurance of food safety owing to the cost and complexity of testing, with companies aware that food safety features are not always easily noticed by consumers. This has resulted in food producers or retailers failing to ascertain the safety of foods, given the wide range of microbial and chemical agents and their probable threat to food. Unnevehr and Jensen (1998) argue that the lack of incentive to install food safety control measures means that food manufacturers or handlers struggle to manage the products returned from trade.

Furthermore, it is understood that quality control systems currently employed by many companies in Africa and other developing regions in the world are blind, unreliable, ineffective and incapable of controlling and eradicating food safety risks in the food chain (Unnevehr et al.,1998). To maintain and increase the confidence of customers, it is, therefore, essential for food establishments to adopt and implement a globally recognised food safety assurance system that is based on HACCP and GMPs.

Unnevehr and Jensen (1998) argue that the HACCP food safety system offers a logical and systematic approach to controlling and eliminating food safety risks for food processing organisations. Rippen (2007) finds that the HACCP is proactive in nature and does not rely on end-product analysis; food safety hazards are identified and controlled before they are able to seep into the final product. This system also accurately identifies problematic areas and installs correct control and preventative measures during the production and handling of food products. Unnevehr and Jensen (1998) and Rippen (2007) both acknowledge that the HACCP is a widely recognised as an effective food management system in the food chain owing to its effectiveness in establishing good production and ensuring sanitation and good manufacturing practices that produce safe and wholesome food products. The HACCP establishes process control through identified critical points in the production process that need to be monitored. Moreover, the HACCP system is effective and efficient if it is installed on a concrete and sound prerequisite programme (PRP) that is able to control the general operation and condition issues and also supplement the HACCP system. PRPs are protocols and procedures (including GMPs) that address operational environments and provide a concrete installation of the HACCP system. Certain programmes and activities such as GMP, Good Agricultural Practice (GAP) and Good Hygienic Practice (GHP) are essential and must be implemented effectively if an HACCP programme is to be effective and sound (Rippen et al., 2007).

Populations around the world, particularly in Africa, are increasingly concerned about their safety and well-being in relation to the food they consume. This means that food and beverage companies worldwide are under immense pressure to guarantee that food products are safe, wholesome and of good quality.
Anheuser-Busch InBev (AB-InBev) Traditional Africa Beverage (TAB) is no exception as it supplies the majority of low-income populations in Africa and is under pressure to implement the HACCP food safety system to assure its customers that the traditional beers it produces are safe for drinking and the quality guaranteed. During the manufacturing of TAB products, the potential for food safety hazards (chemical, biological and physical) surfaces at certain points and this could have an adverse impact on the products and the organisation itself. To address these food safety concerns, the acceptance and installation of a food safety assurance system which is based on the HACCP standards and that follows structured and scientifically implemented steps and well-defined principles are important. The adoption of a food safety HACCP system needs to be further explored to provide new direction to eliminate hazards by developing an HACCP implementation model.

AB-InBev is rated number one global beverage and brewing organization worldwide with global head office in Leuven, Belgium and with additional zone offices in London, New York City, São Paulo, St. Louis, Mexico City, Johannesburg and others. The organization was extended in October 2016 when AB-InBev acquire SABMiller and complete a merger agreement of the both entities (Brown, 2017).

Brown (2017) points out that AB-InBev was the world’s biggest brewer and marketer of alcoholic and non-alcoholic beverage even before the procurement of SABMiller and is viewed as one of the biggest fast-moving consumer goods (FMCG) organization on the planet. The yearly deals for the organization in 2017 were US$56.4 billion; preceding the merger, AB-InBev had acknowledged US$45.5 billion in income in 2016. As such AB-InBev can be considered a large enough organisation to be researched. The researcher believes that the findings and knowledge acquired from AB-InBev employees will contribute positively to the research study and the knowledge and insight gained can be generalised to and implemented by other food safety organisations.

The research study is structured into six chapters. First chapter, which is the opening chapter of the research, presents the research context and background of the study, outlines the problem statement, sets the purpose and objectives of the research, presents the formulated primary and secondary questions that need to be answered, and explains the rationale and importance of the research. Second chapter presents the review of the literature, and the conceptual framework and theory that manage and guide the investigation. Third chapter, exhibits the research methodology and paradigm, procedure and method, employed to address and answers the questions identified by the study and accomplish the research goals. Fourth chapter, exhibits and discusses the research findings and results. Fifth chapter introduces a tailor-made model for the execution of a food safety which based on HACCP system. The chapter clarifies the ideas and segments of the model. Lastly, sixth chapter concludes the research study and provides the recommendations for further studies.

1.1 Research context: background

As food safety becomes an important public health issue with increasing food safety problems and rising consumer concern, governments worldwide are trying harder to improve food safety (Enne and Serrantoni, 2010). It appears that in order to address food safety issues, a system that effectively controls and mitigates food safety hazards should be adopted and implemented by food industry organisations.

Enne et al. (2010) write that the “farm to fork” method has been implemented in food manufacturing sectors with the aim of detecting and focussing efforts on the critical steps of the food process where contamination is most likely to happen or ablest to be prevented. To diminish issues of food and water-
borne diseases, this study aims to address the challenges and to build a food safety system model that can effectively manage the food supply chain in the manufacturing food industries.

The AB-InBev Africa Zone was approached to participate in this study to provide experience and knowledge regarding the topic researched and to enable the company to learn from the study. AB-InBev is a leading global manufacturer and marketer of alcoholic and non-alcoholic beverages. As mentioned earlier, it bought SABMiller in 2016. SABMiller was founded by Charles Glass in 1894, in Johannesburg as a Castle brewery, where beer was manufactured and delivered to miners and prosperous customers by horse wagon. Following two years, it turned to be the one of the first South African company to be recorded on the Johannesburg Stock Exchange (JSE) and the year after (1898) it was recorded on the London Stock Exchange (LSE). In 1950, Castle Brewing moved its base camp and control from London to South Africa. In 1955, Castle Brewing acquire Ohlsson's and Chandlers Union distilleries, and the company was renamed South African Breweries (World of Beer, 2012). Today SABMiller (AB-InBev) operates all over the world, with more than 30 breweries in Africa and two headquarters in Johannesburg, Republic of South Africa. AB-InBev Africa Zone, apart from manufacturing clear beer, spirits and non-alcoholic and flavoured alcoholic beverages, is also a manufacturer and marketer of Traditional African Beverages (TAB), which are categorised as traditional beer (Chibuku) and nourishment beverages (Maheu). According to Mawonike, Chigunyeni and Chipumuro (2017:16), “TAB is the most popular opaque and nutritional beer brewed in Africa and there are more than 20 breweries that produce over 420 million litres of the beer each year.” Currently, AB-InBev TAB plants operate in the African countries of Zambia, Botswana, Malawi, Swaziland, Zimbabwe, Mozambique, Tanzania and Uganda.

Chibuku and Maheu are opaque, short-shelf-life drinks made with special traditional African raw materials such as maize and/or malted sorghum, depending on local taste, and packaged into mainly cartons and polyethylene terephthalate (PET) bottles. They are consumed within a shorter period of time than other drinks. The acquisition and expansion of TAB by AB-InBev Africa Zone (formerly SABMiller) have been part of the strategy to make beer and nourishing drinks more attractive and affordable for the majority of lower-income consumers across Africa. The implementation and integration of a food safety system should assure product safety and also be a driving factor in migrating consumers from unsafe home-brewed beverages to safe TAB categories.

AB-InBev has a policy of no compromise regarding food safety and quality. Brito (2017) argues that the company is driven by its customers and actively seeks their feedback, as it helps to improve company processes. Brito concludes that if the company provides consumers with consistently high quality and safe products, they are more likely to share positive feedback.

The selection of AB-InBev Africa Zone for participation in this study was guided by the fact that the majority of clear beer plants have already implemented a successful HACCP-based food safety system. The researcher hoped to use the knowledge and experience gained from this clear beer category in developing a model that can be used by the TAB categories and other food companies.

1.2 Problem statement

Many studies have been published globally on subjects linked to the adoption and execution of the HACCP system, based on HACCP steps and principles in production lines. In Africa, mainly in developing African regions, much research has been conducted on the issues, barriers and challenges that these regions face regarding food safety and how their consumers suffer as a result of the lack of food safety practices. However, limited research in the developing world, including Africa, has been published on the
adoption and implementation of a food safety system that incorporates HACCP steps and principles and GMP or a PRP into a single system. Failure in Africa has been attributed to poor environmental conditions without looking at other factors such as leadership commitment and lack of education and training on and knowledge of food safety.

For most developing African countries, including those where TAB beverages (opaque Maheu and Chibuku) are brewed, the majority of the consumers have low income, are unemployed and uneducated, and have no knowledge of food safety. TAB products are the main source of refreshment, because they are easily accessible, cheaper and a good source of carbohydrates. According to Mawonike, Chigunyeni and Chipumuro (2017), the production process of opaque beer products is highly exposed to food safety risks, which makes consumers vulnerable and exposes them to food-borne diseases caused by food safety hazards.

The brewing process of obscure chibuku beer and nutritional Maheu suffers from an absence of basic control measures and basic measuring and monitoring equipment and hygienic measures. Breweries of these products experiences inconsistent in viscosity, cleanliness and quality of the product. This variety is caused by inconsistency in the manufacturing process and inputs/ingredients employed in the brewing process (Mawonike et al., 2017). This inconsistency in manufacturing process, the lack of advanced analytical and microbial measurement practices and poor hygienic practices are detrimental to the health of consumers. This suggests that controlling and improving the quality and safety of the opaque beverages in their production lines should become an important business strategy for opaque beer manufacturers, since the analysis of these products and their viscosity is impossible at present.

There is a notion that many traditional and industrialised opaque beers brewed in developing African countries are inferior in quality and are unsafe to consumers of these products, because of the nature of production. Mawonike et al. (2017) suggest that this problem is caused by incomplete fermentation and high percentages of solids and microorganisms. The production of opaque products involves a complex process of steps, which are likely to be exposed to higher food safety risks (biological, physical and chemical). These risks can be aggravated by a lack of food safety controls in receiving raw materials, monitoring the production process, inspecting packaging material, providing adequate storage space and conditions, and ensuring a proper transportation system.

It is the directive of AB-InBev Africa Zone as a producer of traditional beer to protect its consumers by ensuring that the correct food safety measures are in place and all unhygienic areas are sealed. Karombo (2016) writes of traders who sell unfit products to the public and report that in Malawi poor sanitation practices have pushed the government of Malawi to close down operations at AB-InBev TAB plant. According to Mawonike et al. (2017), TAB plants experience inconsistencies in the texture and taste of TAB beer products. This variation is believed to come from differences in the manufacturing processes, amounts and types of inputs used in the brewing process, and uncontrolled hygienic practices. It is therefore believed that a recognised food safety system such as the HACCP, which is based on a solid foundation of PRP, would benefit TAB production.

AB-InBev Africa Zone plants that produces clear beer complies to internationally recognised and auditable systems that govern the safety of food such as HACCP and ISO 22000 in place, with some plants moving towards the adoption of Global Food Safety Initiative (GFSI) benchmark schemes such as the Food Safety System Certification (FSSC) 22000 and the British Retail Consortium (BRC) scheme. However, an integrated food safety system in the production plants of opaque beer products is lacking. Such as system is necessary to diminish the risk associated with the production process and subsequently with products in most developing regions of Africa. The risk is aggravated by countries’
poor sanitation and personal hygiene, inadequate GMP infrastructure, and deficient road, storage and transportation systems.

This research study intends to comprehend and investigate the effect of the adoption and execution of an HACCP-based food system in the TAB categories of AB-InBev Africa zone and other relevant food and beverage organisations. It additionally addresses the difficulties and shortcoming associated with the implementation process of the current food safety system. In addition, it inform organisations wishing to adopt the food safety system about the benefits associated with implementing this type of system. Ultimately, this study proposes a tailored-made implementation model for the adoption of a food safety framework that is based on HACCP principles to be adopted and implemented in TAB plants and other related food organisations.

1.3 Aim of the study

The research study aimed to explore and understand the process of the implementation of the HACCP-based food safety system at Anheuser-Busch InBev (AB-InBev) Africa Zone clear beer plants, with the aim of proposing the implementation process of an HACCP food safety system at AB-InBev TAB plants. Subsequently, the principal aim of the study was to propose a tailored-made model to advance the implementation of an HACCP food safety system for AB-InBev TAB plants. This study highlights factors that affect the implementation of the system by outlining and addressing potential challenges encountered and indicating the benefits associated with the post-implementation process.

1.4 Research objectives

The study has the following research objectives:

- To determine challenges and benefits linked to the execution and installation of the food safety which is based on a HACCP system.
- To determine the significant factors affecting and impacting on the installation and execution of an HACCP system.
- To propose a tailored-made model for the implementation of an HACCP food safety system for the AB-InBev TAB categories.

1.5 Primary research question

As indicated in the preceding sections, it is evident that the concept of food safety in developing regions is not well understood. This may be the result of different factors, which the researcher attempts to discover in this study, with the aim of developing a model to inform companies on how best to implement an effective food safety system.

With this in mind, the principal research question is stated as follows:

What are the significant factors and challenges that hinder the implementation process of an HACCP-based food safety system in food manufacturing organisations, with the main focus on the Traditional Africa Beverage sectors?
1.6 Secondary research questions
In order to address the principal question, the following supplementary questions were derived to guide the study. Each research question carries the same weight in addressing food safety issues and providing answers for the study. The following are the subsidiary questions:

- What is an HACCP-based food safety system and what is involved in its implementation process?
- What are the challenges and benefits linked with the adoption, implementation and execution of a food safety system based on HACCP standards?
- What are the critical variables that influence the implementation of a food safety system which is based on HACCP standards?
- What is the appropriate model or framework for the effective implementation of food safety system which is based on international HACCP standards?

1.7 Rationale and significance
The lack of an internationally recognised food safety system at TAB manufacturing plants and most food manufacturing companies in Africa prompted the researcher to conduct a study to understand and explore the process of implementing an HACCP-based food safety system. The study focused on the process of implementing such a system and addressed the potential challenges associated with the implementation and the benefits that companies enjoy post implementation. It also highlights factors that affect the implementation process. The study is important for all African food companies, irrespective of their size and the nature of their processes, as it focuses on ensuring the safety of products from early in the process (receiving of raw materials) to the final consumption of the products.

The study uses the service and experience of the AB-InBev Africa Zone breweries to acquire real insights into the food safety system used by these breweries. From the insights gained here and from the literature reviewed, it proposes a tailored-made model for the implementation of an HACCP food safety system for the TAB categories and other relevant food companies in African countries. A tailored-made model is developed and proposed for food manufacturing sectors. It is noted that very little information about the food safety concept and the HACCP food safety system is available in the TAB plants and other companies in Africa’s developing countries. The model is intended to serve as a comprehensive food safety system with an emphasis on the commitment of the top management of the organisation and incorporating legal and consumer requirements on food safety. Finally, the model can be adopted and applied by other food and beverages companies.

1.8 Scope and demarcations
This study focuses on the steps and model to implement a food safety system that incorporates the HACCP principles. It addresses the following issues: factors that affect the implementation of an HACCP-based food safety system, and challenges and barriers that prevent companies from implementing food safety systems that are based on the HACCP. It proposes a tailored-made model for organisations in the food industry to adopt and implement. A case study involving AB-InBev breweries was conducted with the sole intention of addressing the above-mentioned issues. It was considered that the findings and insight obtained from AB-InBev could be generalised to other companies, as the company has extensive experience and knowledge in the process of the installation and execution of its food safety system.
2 Literature review

2.1 Introduction

The literature review plays an important role in research processes that make up qualitative, quantitative and mixed research studies (Onwuegbuzie, Leech & Collins, 2012). According to Kumar (2011), the literature review is the mainstay of every study conducted and provide a guidance and contribute immensely on the knowledge of the subject investigated. It gives, enhances and merges information and can be utilized to incorporate the investigation discoveries with the current assortment of learning.

Cooper (1989) emphasise the aim of literature reviews as to highlight what the previous researcher done so far in the field of interest and how finding relate to earlier research. The review of the literature indicates, approaches to take, methods to follow, variables used and statistical procedure applied. Kumar (2011) narrows down the functions to review the literature as to, arrange the theories to the study; building up the connections between what the researchers are proposing to analyse and what has just been contemplated; and empowering the researchers to indicate how the discoveries and findings of their investigations have added to the current assortment of information in their profession.

Rocco and Plakhotnik (2009) report that a literature review is carried out to demonstrate the need for a research study. The researcher uses the reviewed literature to produce the problem statement, which uses the literature to argue that the purpose of the study is important. Onwuegbuzie et al. (2012) argue that the literature review is a written document that gives a soundly discussed investigation that depends on a thorough understanding of the current state of knowledge about the point of study. This debated case sets up a generous theory to answer the study’s research question.

Keeping Kumar (2011) viewpoints regarding the literature review’s functions and accomplishments in mind, the researcher approached this study using the existing knowledge and empirical findings of a literature review related to the research topic. The literature review focused on finding out what the different theories and preceding findings revealed about the research questions. As mentioned above, Rocco and Plakhotnik (2009) indicate that to exhibit how any study propels knowledge, a literature review must be employed to present existing knowledge to construct a case that clearly shows the gap in what is known that the study will address. Section 2.10 of the literature review, which deals with the conceptual framework, analyses the theories informing this framework so as to respond to the research question, while the sections on related literature review the most recent findings concerning the identified questions. The researcher reviewed literature to develop a theory and acquire knowledge regarding the adoption and execution of a food safety system in the manufacturing and beverage sector with the intents of developing a customised and tailor-made model.

2.2 Food safety

Naresh, Merchant and Dhuldhoya (2006) argue that food safety is about guaranteeing that food for human utilisation is safe and wholesome and it does not degrade the life of consumers. To guarantee a safety of food, companies producing or selling food must ensure that food safety contamination points are known and preventative measures are installed at each point to remove the impurities and risks. Youn and Sneed (2003) define quality and safe food as food that is selected, prepared, cooked and served, and presented in a manner that retains its natural flavour, identity and nutritious value and makes it free of unsafe microbiological and chemical contaminants.
Marques, Matias, Teixeira and Brojo (2012) argue that most transferable and non-transmittable sicknesses that affect the general population in the world, for example, hypertension, cholesterol, diabetes, certain growths and cancers or even HIV/AIDS, are disturbed by the food we eat. Unnevehr (2003) argues that food is rendered unsafe when it contains hazardous agents or contaminants with the potential to make people sick. Such contaminants can leak into the food system at different points in the food production process or can occur naturally from inputs material used or as a result of poor production practices. Arvanitoyannis and Kassaveti (2009) support the ISO 22000:2005(E) (2005) assertion that food safety is an assurance that food is rendered safe for consumption if it is cooked, served and stored in the condition according to its intended use. However, these authors state that if food is not treated, handled, processed or preserved as intended, nutrients can be substituted by food safety hazards and can render the food unsafe and detrimental to the health of the consumers.

The World Health Organization (WHO, 2005) states that an overwhelming weight of food-borne sicknesses forces significant financial misfortunes on people, family units, wellbeing systems and whole countries because of food trades being rejected in light of an absence of food safety. In addition, “Food borne illnesses contribute to decreased worker productivity, disability, and even premature death, lowering incomes and access to food” (FAO/WHO, 2005). Ofolaranmi, Hassan, Bello and Misari (2015) warn that food safety risks are bigger in developing African countries, where poverty, lack of infrastructure, bad sanitation systems, and insufficient drinking water pose greater risks to human health than in developed countries.

Food-borne ailments fuel human enduring in the African area as they cause a high frequency of diarrhoeal maladies, assessed to be 3.3 to 4.1 scenes for every kid every year. Diarrhoeal diseases cause 800,000 children in Africa to perish each year (FAO/WHO, 2005). Cusato, Tavolaro and de Oliveira (2012) emphasise that as food-borne diseases are a common health concern worldwide, food safety has started to receive attention, with public health agencies and governments looking for more capable ways of monitoring food production chains. Food safety hazards are closely related to personal hygiene and factory sanitation, water supply, food preparation and handling, and marketing of food. Cusato et al. (2012) alert that because food safety is the result of wide range of activities involved in the food chain, it might be hard to address food safety issues independently from food security, wellbeing of people, nutritional, and food production practices and marketing issues. All of these need to be managed in a concerted and holistic manner (Cusato et al., 2012).

Hanning et al. (2012) argue that food safety is an umbrella that incorporates many aspects of food processing to prevent illness and injury as a result of food safety danger. As indicated in the introduction to this dissertation, Ucar et al. (2016) list the factors that affect food safety along the supply chain as (1) erroneous in farming practices, (2) poor neatness at any phase of the food system, (3) absence of preventative controls amid handling and planning of the food, (4) incorrect utilization of chemical materials, sullied crude materials and food and (5) improper capacity and isolation of crude and preparing materials and finished foods. Lokunarangodage et al. (2016) argue that food safety assurance is needed for manufacturing organisations to ensure the safety of food in their supply chains and compliance with statutory and regulatory and customer requirements. Rotaru et al. (2005) indicate that to assure safe food, it is a mandatory requirement for the food industry to demonstrate its ability to adopt a systematic organisational structure and to control activities, processes, procedures and resources according to the standards that form the basis of their quality and hygiene systems.

Sulieman et al. (2013) maintain that food safety is designed in accordance with the setting and processing of the plant in order to improve the quality and safety of the product. Arvanitoyannis and Kassaveti (2009)
express that arranging and acknowledgement of safe products consolidate the components of GMP and HACCP, including any administrative prerequisites appropriate to the association and process. Food safety plays a significant role in effective food security, as the consumption of unsafe food and drinking of contaminated water can significantly worsen malnutrition in human health.

Unnevehr (2000) writes that management of food-borne in the production line and handling process is part of the trend towards greater quality management to meet highly specialised product specifications and high global trade demands.

Examples of food safety management systems (FSMSs) and standards are:

1. Total Quality Management (TQM), which provides confirmation to consumers that products or service supplied will meet legislation and quality requirements;
2. ISO 22000, which is an internationally recognised FSMS standard intended to confirm that food borne in all food companies are kept at the lowest acceptable level that will not pose a risk to the health of end users; and
3. The HACCP system, which is based on well-defined international principles is applied to every step of the process from farm to consumption of the product.

Food safety standards need to be in place to control food safety hazards such as pesticides and microbial contamination in agricultural products; microbes in meat, poultry, fish and eggs; mycotoxins in plants and animal products via contaminated feeds; and adulterants.

Marques et al. (2012) alert us to the issues of Bovine Spongiform Encephalopathy (BSE), which is transmissible to humans; the use of hormones in meat production; the use of antibiotics to aid animal growth; traces of insecticide in plants and animals products; the presence of nitrates in water; the presence of caustic in cleaning detergents; the fears associated with genetically modified organisms; and the cases of avian influenza in humans, all of which reduce consumer confidence in the safety of food. However, most developed countries set stringent rules and standards for exporting companies to comply with. The USA has already instructed MacDonald’s fast food company to terminate the use of antibiotics and artificial growth hormones in their products to strengthen the well-being of consumers. Cusato et al. (2012) demonstrate that food safety has transformed into a serious worrisome around the world, causing a general health organisation bodies and law makers of a several countries to search for more viable approaches to screen food chain.

These authors (2012) express that the monetary conditions and worldwide economic meltdown have driven organizations to search for approaches to fabricate aggressiveness by enhancing food production process, lessening production costs and upgrading product quality. Concerning food ventures, two elements ought to be incorporated: (1) the need to guarantee food safety and (2) the need to ensure customers and consumers wellbeing. Unnevehr (2003) argues that upgrading food safety is a principal component of maximising food security, which occurs when everybody has access to sufficient and wholesome food.

The Food Agricultural Organization (FAO) and WHO (FAO/WHO, 2005) report that practices aimed at improving food safety reduce food losses due to prior and post-harvest and food waste during cooking and preparation and handling and increase food availability, accessibility and utilisation. Countries that are able to ensure safe food can take advantage of international and national trade opportunities and can in this way increase income levels, create jobs and alleviate poverty. The 1996 world food summit plan of action recognised the importance of food safety to food security, which it defined as existing “when all people at all levels have access to sufficient, safe, quality and nutritious food” (FAO/WHO,
The aim of this summit was to halve the hunger rate by 2011. However, a significant number of people living in developing world are still living in hunger and destitute. This recommends the requirement for a preventive way to deal with food safety in which food producers look at each basic phase of the procedure, recognize the fundamental techniques and ensure that procedure measures and parameters stay steady. This can be accomplished by setting up and keeping up a nourishment wellbeing program in these associations.

2.3 Management systems

Rotaru et al. (2005) state that, amongst other existing Quality Assurance (QA) systems, there are a number of systems that are appropriate for food safety management, such as GMPs, GAPs, GHPs, TQM, the systems associated with the ISO 9000 and ISO 22000 standards, GFSI and HACCP. However, food producers need to choose a suitable system that satisfies both the safety and quality criteria of their products. With various options for quality management systems (QMS) and food safety management system (FSMS), food organisations ought to settle on the most suitable system for their specific activity and should create, write and apply effective systems for controlling quality and safety of the products. The systems can be arranged by the degree of the exercise they cover. They include: (1) fundamental safety systems (prerequisites for systems such as GMP, GHP and GAP); (2) propelled safety systems such as the HACCP; (3) incorporated FSMS, for example, ISO 22000; and (4) essential and progressed QMSs, for example, ISO 9001 and ISO 9004.

2.3.1 Quality Management System (QMS)

The ISO 9001:2008 standard defines a QMS as “the managing structure, responsibilities, procedures, processes and management resources to implement the principles, as well as the action lines needed to achieve the quality objectives of an organization” (ISO 9001:2008). Ramphal and Simelane (2009) note that the QMS facilitated by the ISO 9001 standard was initially the only standard available to food manufacturers for standardisation. Rotaru et al. (2005) define a QMS as a set of harmonised exercises for directing and controlling an organisation in order to recurrently increase the effectiveness and efficiency of its performance. Food quality is a difficult idea to quantify and can be evaluated only in relation to food safety. However, for food to be viewed as safe for human utilization, it must meet legislation laws and customer’s requirements, technical criteria, cleanliness and handling requirements, and intended use criteria. Rotaru et al. (2005) argue that the relationship between the concepts of food quality and safety is complex, and therefore safety cannot be autonomous from quality.

Ramphal and Simelane (2009) write that the introduction of the HACCP system and more recently the promotion of ISO 22000 has created anxiety for food manufacturers as to which standard to implement, with some replacing their ISO 9001 with ISO 22000 and others adding the HACCP standard, SANS 10330:2007, to their current ISO 9001. For food organizations, applying a HACCP framework inside an ISO 9000 QMS structure can result in an effective food safety system that is more powerful than applying the ISO 9001 standard and HACCP standards independently. The accentuation of the both systems is preventative as opposed to correction of issues or deficiencies after they happen. However, a company that implements an HACCP system does not have to comply with ISO 9001, although this is desirable. The principles of HACCP can be integrated with ISO 9001:2000 requirements.
2.3.2 Food Safety Management System (FSMS)

Rotaru et al. (2005) state that the ISO 22000 is an FSMS standard that was developed in accordance with the ISO 9001 approach specifically to manage food safety in any organisation, irrespective of size, nature and type of product produced. Ramphal and Simelane (2009) point out that the ISO 22000 was released in 2005 as the result of a project initiated by the Danish Standards Association to harmonise all relevant national food and food safety standards internationally.

In 2005, the International Organization for Standardization (ISO) created the FSMS based on ISO 22000:2005, with the aim of reducing the distance between ISO 9001:2000 and the HACCP. Davids (2011) defines the FSMS as an international and auditable food safety standard that defines the HACCP’s role and prerequisites programs. Davids (2011) explains that an HACCP-based FSMS must be supported by the solid foundation of PRPs. The ISO 22000 series incorporates the standards or principles of the HACCP with PRPs (GMP and GHP), subsequently to guarantee that there are no weakest links in the food network system (Kok, 2009).

Davids (2011) adds that FSMSs are applied throughout a product’s whole life cycle and are applicable to product suppliers and service providers of food products.

Figure 1 illustrates the generic global food supply network, which is relevant to all food and beverage sectors. Davids (2011) explains that for companies or business to produce safe food, food safety regulations, codes of practice, examination regimes and risk-reduction approaches such as HACCP and ISO 9001-based management systems must be set up. Davids (2011) argues that FSMS is a complicated system because it involves the control of the complex steps of food production; the variety of raw materials concerned and the variability of different factors; restricted shelf life; and the large range of chemical, physical and microbial processes. This suggests that for FSMS to be successful it must contain the components of a QMS or comply with the relevant ISO standard, GMPs and HACCP.

2.3.3 Total Quality Management (TQM)

TQM can be used to improve the quality of the product and to drive down the costs of production. Muniza (2013) and Scott (1992) argue that TQM plays a significant role in increasing the strength of companies’ competitiveness. TQM can be complemented by HACCP programmes, which can be used to better assure food safety. These management philosophies can be implemented in a holistic way to produce
safe, superior-quality food products while keeping manufacturing costs reasonably low and ensuring continuing improvements in food production efficiencies and product safety (Scott et al., 1992).

The HACCP works most effectively in an environment where TQM is used as a base from which to operate. According to Kok (2009), the HACCP is most operative when applied with other control systems such as TQM and standard operating procedures to improve product safety, product quality and plant productivity. The TQM system operates on the principle that the quality of products and process is the responsibility of everyone who is involved with the production or the services of the organisation (Rotaru et al., 2005). For TQM and HACCP systems to work, therefore, senior management needs to take responsibility for educating employees regarding their jobs and the companies' goals and for motivating employees to use their talents to help improve product safety and quality. The HACCP is a management philosophy that relies on the commitment of senior management, disciplined operator control and teamwork, which are three of the hallmarks of TQM. It is, therefore, important for companies to educate and empower employees regarding the culture of TQM prior to assuming the responsibilities of an HACCP system.

Hoolasi (2005), in a study on yoghurt manufacture, found that using TQM that encompass HACCP and effective document control create a significant framework within which food quality and safety requirements could be communicated effectively and in a way that could be demonstrated and audited. Dhanakumar (2002) found the application of the HACCP system in a food business to be compatible with the implementation of TQM systems.

2.3.4 Global Food Safety Initiative (GFSI)

The GFSI, according to Crandall, Mauromoustakos, O'bryan, Thompson, Yiannas, Bridges and Francois (2017), was developed in 2000 after a few prominent food-borne sickness flare-ups had caused consumer confidence in food supply network to drop to an all-time low. For many years, food experts from retailers, food manufacturers and consumer groups have continuously updated the GFSI guidance document to be relevant and effective for addressing current and emerging food issues. The GFSI is a foundation that was set up by large, leading retail companies across the world. The main objectives in establishing the GFSI were the benchmarking of food safety standards when certifying food production, the development of competence and capacity in food safety systems, and ensuring that these systems were more consistent, uniform and effective (Crandall et al., 2017). Crandall et al. (2017) added that the GFSI document has become the benchmark against which private third-party food safety auditing schemes are certified as being equivalent. The GFSI recognises several standards worldwide, among them the BRC, International Food Safety (IFS) standard, the FSSC 22000 and the Dutch HACCP Standard (Crandall et al., 2017).

The GFSI was not made to set up a solitary standard to regulate all food safety, but instead to empower advancement and improvement of various standards that meet a common foundation of requirements set up by the GFSI. The GFSI does not do any affirmation exercises and its day by day administration is undertaken by the Consumer Goods Forum (Nordenskjöld, 2012). At the point when a formal acknowledgment has been given to a standard by the GFSI, the purpose is that it ought to be perceived worldwide and acknowledged by universal and local retailers and providers. Valder (2009) states that the BRC is the accredited, certifiable standard and was the first to be endorsed by the GFSI in 2000.
2.4 Food safety systems

A food safety system is a set of procedures for producing safe, healthy and hygienic food products at all times. It includes an extensive investigation of a process, keeping in mind the end goal to identify and analyse the potential risks that could make the food created harmful to eat (Naresh et al., 2006). This procedure includes people working in the food companies to produce safe and hygienic food in the production, processing and distribution stages of the product, so that food safety problems can be spotted before they happen. According to Rotaru et al. (2005), food system can be grouped by the degree of the exercise they cover in basic safety systems such as prerequisites (GMP, GHP and Standard Sanitation Operation Procedures or SSOPs) and advanced safety systems such as the HACCP. Lokunarangodage et al. (2016) state that food safety assurance control systems are needed for food businesses to guarantee food safety and to demonstrate their compliance with all food laws and regulations along with incorporating customer and consumer requirements in the food chain.

Rotaru et al. (2005) argue that an HACCP-based food safety system ensures food control at the source or point of production, product planning and process control. It ensures the application of GHPs and GMPs during production processing, handling, distribution, storage, sale, preparation and use of the final product. Afoakwa, Mensah-Brown, Crentsil, Frimpong and Asante (2013) indicate that food safety hazards can occur at any step of food fabrication. For this reason, adequate food safety control throughout the food chain is essential and can be ensured through the combined efforts of all the parties participating in the food chain. Rotaru et al. (2005) emphasise that safe food production and the assurance of safe food products are obligatory requirements for any food business that produces products for human and animal consumption; these can be accomplished by adopting a quality and hygiene systems which are able to assure the quality and safety of food products.

According to Arvanitoyannis and Kassaveti (2009), the outline of a plants food safety system is affected by various elements, in particular food safety hazards, the product provided, the process employed and the size and the structure of the organisation. According to Sulieman et al. (2013), food safety systems are designed on the basis of the building location and manufacturing processing plant in order to increase the quality and safety of the product.

The FAO/WHO (2005) state that the prevention and control of food contamination and food-borne diseases make use of the basic principles of three lines of defence.

The first line of defence expects to improve the hygienic quality of agricultural materials by adopting the standards of good agricultural practice (GAP) and animal husbandry and by improving the ecological conditions under which animals and plants are grown. The second line of defence utilise food-processing technologies such as pasteurisation, sterilisation, irradiation and fermentation to prolong the life span of food products and ensuring the safety by reducing microbe contamination. The use of sound and effective system such as HACCP should be employed to deal with natural and unplanned contaminations during the processing (FAO/WHO, 2005). The third line of defence install to enforce the training and education on food handlers on a good practice to handle food in a safe manner (FAO/WHO, 2005).

Food safety systems are widely categorised into two main systems:

“Traditional and science-based food safety systems” (Unnevehr, 2003; Kalekidan et al., 2014). Kalekidan et al. (2014) define the traditional food safety system as a reactive in nature, with the main accountability lying with the government. This type of food safety system involves no structured and systematic hazard analysis; instead, it believes in testing and inspecting the final product to understand the level of hazards in the products. In contrast, Kalekidan et al. (2014) define scientific or risk based food safety system as
a proactive in nature and it incorporate the prerequisite programs such as GAPs, GHPs, GMPs and the HACCP.

Ropkins and Beck (2000) define the characteristics of the traditional food safety system as reactive, passive and reliant on the final product testing. A significant proportion of a foodstuff has to be sub-sampled for analysis to ensure that it is representative of the whole population and this resulted in the depletion of a high volume of the product. Ropkins and Beck (2000) added that with traditional food safety system, the food safety is only ensured with regard to tested hazards. The limitation with regard to this system is that the food safety testing procedures applied to confirm food safety are probably going to be costly, tedious, complex and difficult to interpret data; control of hazards is reactive; responsibility for food safety is shifted to small element of the business mainly laboratory personnel and quality function; and food safety and quality can only be confirmed during testing. However, traditional food safety assurance plays a very important role in the food business and households in most rural areas in Africa. To assure the safety of food produced, sold and consumed, systems such as boiling, fermentation, drying and winnowing are still used and effectively control food hazards.

Ropkins and Beck (2000) outline the attributes of the science-based food safety system as: the use of a proactive HACCP framework; the identification and evaluation of all hazards related with the final foodstuff before they happen; the identification of the stages within food production at which these hazards may be controlled, reduced or eliminated at critical control points (CCPs); the implementation of monitoring procedure at these CCPs; and the proactive control of hazards.

The ISO 22000 is defined as an “assurance and control measure which involves actions or activities that can be applied to prevent or eliminate food safety hazards or reduce them to an acceptable level” (ISO 22000:2005(E), 2005). This definition is general and can be used to describe virtually any action, step, activity, job, task, process or procedure that has the intention of addressing a food safety hazard. Therefore, according to Stanley, Knight and Bodnar (2011), control measures are categorised into three types of measures to reduce food safety hazards in a process. Each of these measures requires attention to be given to specific production steps, as outlined below.

1) Prerequisite programmes (PRPs): are mainly associated with lower risk in the production sites. According to a study conducted by El-Hofi, El-Tanboly and Ismail (2010) on the introduction of an HACCP for a UF White Cheese line, at Misr Milk and Food, Mansoura, Egypt, PRPs are used to ensure safety and good quality food products. In this study, PRPs were used to deal with hazards before the production of the product to simplify the HACCP plan. The study concludes that in the absence of sound PRPs, HACCP plans are ineffective in dealing with CCPs.

El-Hofi et al. (2010) outline the PRPs implemented at UF White Cheese as: Buildings and facilities programmes, equipment maintenance, personal hygiene, sanitation programmes, pest-management programmes, trade recall and traceability procedure.

2) Operational prerequisite programmes (OPRPs): are mainly associated with higher-risk hazards and are essential for managing the multiplication of food safety hazards in the production lines.

An OPRP is “a control measure identified by the hazard analysis as essential in order to control the likelihood of introducing food safety hazards and/or contamination or proliferation of food safety hazards in the product(s) or in the processing environment” (Merican, 2000). El-Hofi et al. (2010) add that while an OPRP control measure is essential for reducing the introduction of hazards, it is not an intrinsic step in the process as CCPs are. Even with the removal of OPRPs from the production line, a company can still produce safe products. An OPRP does not have a specification or critical limits as CCPs do.
(3) CCPs: are essential for eliminating food safety hazards. The ISO 22000 defines CCPs as a stage at which control can be applied and as fundamental for preventing or eliminating a food safety hazard or decreasing it to a tolerable level. Merican (2000) states that CCPs relate specifically to a step in the food production and handling process, e.g. cooking, cooling and freezing, and are not a general activity or action. Furthermore, as CCPs are defined as a step at which control can be applied, this implies that if a CCP cannot apply control, it cannot be considered to be a CCP. Merican (2000) additionally adds that another factor relating to CCPs is the risk posed by the food safety hazards, should the control not be exercised effectively. For example, salmonella in cooked meat will pose a significant risk to the consumer if the cooking is not carried out to adequate temperature and time specifications. In this case, control is critical and is designed specifically to control the hazard.

Ei-Hofi et al. (2010) write that UF White Cheese followed HACCP principles and ensured that all necessary quality control procedures were checked for completeness and to establish whether they were being implemented to the required standards. The first step was to conduct a hazard analysis to identify potential hazards that might occur in the production cycle. Secondly, CCPs were established to control the hazards identified. CCP signs were then made visible on the factory floor and awareness was promoted across all levels of the organisation. Fourthly, critical limits were established at each CCP, based on scientific data and, fifthly, corrective actions were taken when monitoring indicated deviation or loss of control. After this, verification procedures were established to confirm that the HACCP system was working effectively. Lastly, documentation concerning all procedures and records was established and the HACCP was integrated with ISO 9000 under one management system.

2.5 Operations Management System
Wallace (2014) defines an operations management system as an overall FSMS that encompasses the design and planning of safe products, with an HACCP and PRPs. Such a system, therefore, focuses on the operation part of the process, from understanding potential hazards in the process and how the HACCP can be used at each step where hazards prevail to the installation of PRPs to remove contamination effectively. An operations management system can be considered successful if total food safety is achieved, which involves knowledge of the process and the hazards that might be present: planning and implementation of HACCP principles and steps; and choosing and implementing PRPs to support the HACCP.
Figure 2: Operations management system (adapted from: Wallace, 2014)

2.5.1 Safe product design/planning

2.5.1.1 Understanding of food safety hazards

“Hazards associated with foods may be defined as anything related to the food that might cause harm to the consumer” (USDA/FSIS, 1997). The FAO/WHO (2009) define a food safety “hazard” as a biological, chemical and physical agent or impurity associated with food that has the potential to cause an adverse health effect. “Hazards refer to agents in or conditions of food that can cause illness, injury or death of a person” (Canadian Food Inspection Agency (CFIA), 2014). According to Lammerding and Fazil (2000), a “hazard” refers to an unwanted agent; that is, the microorganism and/or its toxin that has the potential to cause an adverse health effect. Food safety hazards are any impurities or contaminants that appear in the form of physical, chemical or biological agents and react or come into contact with food and have the potential to cause a food to be unsafe for human consumption (Duan, Zhao & Daeschel, 2011).

Unnevehr (2000) contends that many food safety hazards such as microbiological pathogens (e.g. Salmonellae, Listerials, E-coli) are expensive and time-consuming to test for and have the potential to pass into the food products at numerous points in the production process if safety management is not fully in place. However, documented good production practices, which are certified to prevent and control hazards, are becoming accepted as the most economical means of reducing food safety hazards in the production and food handling outlets. It is difficult, expensive and time-consuming to obtain microbiological analysis, due to the sophisticated level of technical expertise required for conducting this analysis. Stanley et al. (2011) argue that the HACCP food safety system is a system that easily identifies specific hazards that adversely affect the safety of food and specifies measures for their control. This
system requires collective involvement of all stakeholders from top management to shop floor and extensive knowledge of the process and the hazards associated with the process.

Figure 3. Mode of occurrences of food incidences (Adapted from. Ndiaye et.al 2018: 377)

Ndiaye, Cissé, Bonne, Sene, Kane and Montet (2018) alluded that food safety hazards occurs at different points, such as lack of health control during recruitment at operator level, contamination due to lack of hygiene in control and handling of foodstuff and germs coming from environments (premises, machinery, pest and raw materials). Lack of control of Physico-chemical parameters such as temperature, water activities and time will develop hazards. Loss of toxification is due to lot of flora and diseases carrying germs. Each point in the process need to be closed and control to ensure that germs responsible for hazards growth are prevented.

The hazards are usually categorised as biological, chemical or physical.

Physical hazards (P)

Duan et al. (2011) and the Canadian food inspection agency (2014) define a physical hazard as any extraneous object or foreign matter that is visible in a food item that may cause illness or physical injury to consumers of the food. “Sources for such contaminants include raw materials, badly maintained facilities and equipment, improper production procedures, and poor employee practices” (Duan et al., 2011). According to Afoakwa et al. (2013), physical hazards are foreign bodies in the product that may cause physical injury, such as choking and mouth or throat cuts. Foreign bodies can be defined as intrinsic or extrinsic. An intrinsic foreign body is associated with the food itself and therefore stringent controls need to be in place to monitor and control any foreign particles that have seeped into the product (e.g. a metal detector can be used to detect any metals in a product). An external foreign body is introduced from external sources, such as glass, metals, wood, plastic, insects and human hair. This is associated with raw material and the organisation needs to have a strict quality control procedure to check the state of raw material, verify it with a certificate of analysis and emphasise strict good acceptance criteria. Food manufacturing companies must identify the sources and types of materials that can be physical hazards in foods and the regulations regarding physical hazards and must determine the types of controls needed to minimise the potential for physical hazards in food.

Chemical hazards (C)

Duan et al. (2011) define a chemical hazard as a poisonous substances or any other compound that may render a food unsafe for consumption and may lead to acute food-borne illness, chemical poisoning or
food allergy. According to the Canadian food inspection agency (2014), chemical hazards contain those caused by molecules that are naturally derived from plants or animals such as mycotoxin, or those that are purposely added to the food during growth as a catalyst or during processing as an ingredient or cleaning agent on the production lines and the residual of those chemical can contaminate the food and cause sickness or death to consumers. It is therefore important for the organisation to develop an acceptable limit of the chemical hazards in their process or products. Afoakwa et al. (2013) state that chemical hazards have two main sources: (1) the contamination and adulteration of agricultural material, water source and air pollution and (2) Chemical contamination as a results of cleaning the processing lines and equipment, detergents used. Contamination of agricultural products are potentially affected by a number of impurities such as heavy metals, plant mycotoxins and residual insecticides. The process can be easily contaminated by cleaning residue in the form of caustic substances and nitrates from water and oil and grease from oil-powered machinery and forklifts. Riswadkar (2000) states that chemical hazards include naturally occurring elements (such as mycotoxin from mould), plant toxins and chemicals added during food processing (such as pesticide residues, food additives and lubricants). Pun and Bharro-Beekhoo (2008) state that contamination of chemical hazards can take place from farm to consumption.

Duan et al. (2011) suggest that successful chemical control programmes include training of employees to follow safe chemical handling; use of protective equipment; and applying procedures for sanitation, maintenance or control of pesticide chemicals. In addition, organisations should make use of standard practices for staff to properly clean and remove all chemical residues from food contact surfaces; should store chemicals in designated areas away from food products, ingredients, packaging and food contact surfaces; should receive incoming material and raw ingredients from reputable suppliers that effectively control chemical hazards; should ensure that restricted ingredients and additives are correctly measured; and should follow good storage practice.

**Biological hazards (B)**

Microbiological contamination is a major hazard in food production (Marques et al., 2012). Riswadkar (2000) states that microbiological hazards are bacterial, viral or enteric parasitic organisms and pathogens. According to the Canadian food inspection agency (2014) and Duan et al. (2011), biological hazards are caused by microorganisms (bacteria, virus, parasites and moulds). These hazards are often associated with the failure of a process step, where pathogens survive because of improper time/temperature applications during pasteurisation. Afoakwa et al. (2013) believe that microbial hazards are mainly introduced during the incoming of raw materials, insufficient temperature control during processing and storage, and improper handling.

Duan et al. (2011) suggest that basic food safety principles should include good personal hygiene, keeping “cold foods cold and hot foods hot” and preventing cross-contamination between food, people and the environment. To protect customers and provide consumers with the assurance that the products are the safest possible, free of microbial pathogens and safe to be eaten, food processors must take the necessary steps to prevent or eliminate potential food safety hazards from their operations by putting in place control measures from receiving to final consumption of products. In Pun and Bharro-Beekhoo (2008) study, the HACCP decision tree approach was used for the team to look at the products, with the intention of identifying microbiological hazards.
2.5.1.2 Knowledge of the manufacturing process

Top management of a food-producing company is the main driver of food safety efforts throughout the planning and implementation process, and organisations that are planning to adopt a food safety system need to gain full commitment from top management and ensure proper allocation of resources. Management of any food business must have the knowledge of the manufacturing process that allows it to develop food safety objectives, goals and policy; define responsibilities; delegate authority; and assign resources (Mortimore, 2001; Pun & Bharro-Beekhoo, 2008).

As the understanding of hazards, intrinsic and extrinsic factors, and the knowledge of the manufacturing and packaging process is essential to facilitate the planning and design of a safe product, Mortimore (2001) emphasises that the selection of HACCP team members and the team leader should be based on their knowledge of incoming processing materials, products, process and potential hazards involved.

The HACCP team must be multidisciplinary and must have a whole business overview. Above that, the team must be equipped with detailed training in food safety regulations and principles of HACCP and with added training and understanding of the special skills that underlie the application of these principles. The team should have knowledge that enables it to identify and report on the FSMS to management for review and improvement.

Organisations must conduct gap or baseline audit analyses to evaluate existing resources and practices and compare these observations against the requirements of the food safety HACCP system before putting together a project brief for an HACCP plan (Pun & Bharro-Beekhoo, 2008; Mortimore, 2013). Moreover, organisations must understand the current and potential food safety hazards associated with the production process and be able to outline the intrinsic and extrinsic factors. Mortimore (2001) argues that to conduct a gap audit analysis, organisations should answer two questions: firstly, what resources and practices, including PRPs, must be in place for an HACCP system to work effectively? Secondly, what are the existing resources and practices?

Mortimore (2013) argues that the most effective and practical way of identifying gaps is to perform a self-assessment or baseline gap audit of current food safety and quality-management practices. This can be achieved by using auditors or experienced employees with knowledge of the standards, procedures and systems required to support the HACCP. Pun and & Bharro-Beekhoo (2008) add that a thorough gap analysis can be used to examine objectively the current QMS in place and related operations and compare them to the requirements of the HACCP system. Operations would include material handling and storage, maintenance and equipment performance, personnel training, sanitation and personal hygiene, and health and safety recall procedures. It is evident from this that the results of a baseline audit and gap analysis can assist organisations to compile a list of areas for improvement and develop action plans and deadlines.

2.5.2 Hazard Analysis Critical Control Point (HACCP)

The main aim of any food business is to produce superior quality and safe foods for its consumers. To guarantee the safety of their food, organisations should establish a solid system based on continuous management that includes TQM, good hygiene and GMPs. With this in mind, the HACCP system should be examined as “an effective system based on Good Manufacturing Practices (GMP) and Standard Sanitation Operation Procedures (SSOP), for providing safe and healthy foods” (Ergönü & Günsç, 2004).
The National Advisory Committee on Microbiological Criteria for Foods (NACMCF) (1998) defines the HACCP system as a management and scientific food safety system in which food safety is addressed through the anticipation of food risk by analyses and control of biological, chemical and physical hazards from purchasing of incoming material, in-putting of ingredients, serving, storage delivery and ingestion of the finished product. “HACCP is known as combined system of microbiology, quality control and risk assessment” (Karagozlu, Karagozlu & Ergonul, 2009). Through implementation of the HACCP system, hazards in any step of the manufacturing chain can be identified and risks can be classified and lessened. The HACCP system uses a methodical, organised methodology to identify existing and potential hazards and the likelihood of their occurring and proliferation at all stages of food production. It then defines preventative measures to mitigate the likelihood of these hazards by applying immediate remedial task to ensure the safety of the food products. This has been shown to be a very effective method of ensuring food safety (Marques et al., 2012). Rotaru et al. (2005) state that the HACCP system can be integrated into other food safety and quality systems such as QMS, TQM and FSMS. For example, HACCP standards are often integrated with ISO 9001 and/or ISO 22000 or FSSC 22000, to ensure the technical and administration components of food safety and quality systems are realised. Food safety is guaranteed by managing and analysing quality and safety at the source or point of process; product design step and process control step; and the application of GHPs during processing from raw material to consumption, in conjunction with the application of the HACC system (Rotaru et al., 2005).

Khalid (2015) states that HACCP-based management systems have a deep-rooted place in managing food safety hazards in the food supply process before they happen. HACCP is a system of assurance that is founded on the basis of prevention of food safety problems and is accepted by international food safety authorities as the most effective way of managing food- and water-borne diseases. Mortimore (2001) argues that the HACCP approach in reality offers a practical and major contribution to the way forward in FSMSs, but only if the people in charge of the implementation are involved, knowledgeable, experienced and enthusiastic about applying it effectively. This implies that an operational food safety system that is based on HACCP should be understood by both the leaders and employees of the organisation. “HACCP can be considered as a management tool” (Barron, 1996). It is considered to be a simple but specialised method developed to effectively prevent, remove and manage health food hazards resulting from the consumption of contaminated food.

“HACCP principles are now incorporated into national food safety legislation of many countries, as well as a likely future component of the standardization of international food quality control and assurance practices” (Ropkins & Beck, 2000). NACMCF (1998) believes that the HACCP principles should be standardised to provide consistency in training and allow the HACCP system to be applied by industry and government. The HACCP system must be designed by each food business and tailored to address the individual product, processing and distribution conditions. “The HACCP system is recognized as an important tool in the reduction of foodborne diseases and it is a global reference in terms of food safety control. It is recommended by the World Health Organization, the International Commission on Microbiological Specifications for Foods, the Codex Alimentarius, and food regulatory agencies in various countries” (Cusato et al., 2012).

Basit (2000) states that the HACCP has been recognised worldwide, not only by FOA/WHO through Codex Alimentarius but also by the International Life Science Institution (ILSI). Adoption of the HACCP system is increasingly required for all companies involved in food business, as an effective means of ensuring food safety and quality and as a means of complying with new food safety legislation and laws. However, most organisations in poverty-stricken African regions are still lagging behind in adopting food safety systems.
2.5.2.1 History of the HACCP

“The occurrence of food-borne diseases in the end of the 20th century allowed the emergence of the HACCP system whose role was to ensure food safety. This system is usually applied by large companies and industries, but not by SMBs in the developing world because they are binding, cumbersome and unsuited to their processes” (Ndiaye, Cissé, Bonne, Sene, Kane & Montet, 2018: 376).

According to Khalid (2015), Kamel, Boubaker and Attia (2013) and Gilling, Taylor, Kane and Taylor (2001), the HACCP has a long history, originating as a way of guaranteeing the safety of canned meals produced for the first United States (US) manned space programme in the 1960s. Only in the last decade has it emerged as the primary approach for assuring the safety of the food supply of the global world. It was developed in the 1960s by the Pillsbury Company working alongside the National Aeronautics and Space Administration (NASA) and the US Army laboratories at Natick, and was used as a defect-free program aiming to produce safe foods to be eaten by Aeronautics at zero gravity. The final product analysis was considered a passive way of ensuring food safety, because by the time the laboratory results were available the food would have long been eaten and impossible to trace and recall for re-analysis. Sozen and Hecer (2013) report that the original Pillsbury HACCP food safety procedure was built on three principles to assure safety: firstly, the detection and analysis of all hazards related to the final foodstuff; secondly, the establishment of CCPs; and, thirdly, the implementation of a monitoring procedure at the CCPs established.

WHO/FAO recognised the HACCP system as an effective, proactive and substitute method to final product analysis. It was concluded that conventional final product testing could not effectively assure food safety for a number of reasons. Consequently, the HACCP was developed as a proactive alternative to end-point testing and recommended for the use in commercial food production. The National Advisory Committee on Microbiological Criteria for Foods (NACMCF 1998) reconvened a HACCP working group in 1995, to review the Committee’s 1992 document, comparing it to current HACCP guidance prepared by the Codex Committee on Food Hygiene (see summary below).

“At the end of the 20th century, food borne diseases took a new dimension in their frequency and their impact on population health. However, in many developing countries, public health authorities undertook very few measures to investigate or prevent these diseases and they became an obstacle to the export of their products and the development of local tourism” (Ndiaye et al., 2018). To overcome these problems, Ndiaye et al. (2018) reported that numeral reports and publications related to HACCP emerged in the late 80s and early 90s and integrated into Codex Alimentarius in 1993.

Basit (2000) summarises the evolution of the HACCP as follows:

- 1960 – NASA and the US Military Laboratory to establish risk of Salmonella infection.
- 1971 – HACCP idea took appropriate shape in national conference on food assurance. Pillsbury Company utilised it in US space program to make the food free from food-borne hazards (bacterial and viral) to use it in space.
- 1973 – First far reaching treatise on HACCP was distributed by Pillsbury Company. HACCP standards were created in exceptionally essential shape and Food and Drug Administration (FDA) inspectors were prepared.
- 1985 – HACCP was prescribed by National Academy of Science (NAS) USA.
- 1987 – National Advisory Committee on Microbiological Criteria for Foods (NACMCF) was set up.
• 1989 – NACMCF gave last endorsement for HACCP report and NACMCF distributed HACCP standards to address biological, physical and chemical risks.

• 1992 – Updated version was distributed by NACMCF that was compatible with the Codex Committee Report on Food Hygiene, which was distributed in 1991.

• 1995/6 – HACCP was used in US regulations for the first time.

• 1997 – UN/Codex Alimentarius – the HACCP framework was produced and embraced by US regulatory authorities.

• 2000 – Accepted as a food safety system through legislation in Europe as well as many other areas in the world.

Ropkins and Beck (2000) state that the HACCP remains a relevant, effective and efficient food control system, in spite of the presentation of new food technologies, as a results of its mix of practical components and a flexible way to their implementation. The HACCP is compatible with other food safety systems and is process focused. According to Marques et al. (2012), an application of HACCP became compulsory from January 2006, by European Commission (EC) Regulation no. 852/2004 of April 29, which put down general rules to be implemented by all food businesses in the world. Consequently, food operators must execute self-regulation framework based on the standards of the HACCP that permit the efficient and proactive administration of food safety hazards. As created by the NACMCF, the HACCP has been developed into proactive, sequential process control system used to distinguish, assess and control food safety hazards (Brosseau, 2000).

2.5.2.2 HACCP Study

The HACCP is a successful framework because of its intention to give the data flow to protect and restore actions and can easily be set up on the production lines of a wide range of food. It applied to various plants that create various types of food products. Thus, all production process lines can have different CCPs and HACCP plans (Karagozlu et al., 2009; Ergüni & Günsç, 2004). For the HACCP system to ensure that safe and healthy food products can be served to consumers with limited safety risks, the hazards analysis for each production line must adequately determine CCPs in the process and establish the necessary verification, validation and corrective actions.

The HACCP can be considered a program of risk management that has been created to manage and control safety of food products (Gilling et al., 2001). It is defined as a procedure and product specific, internally arranged system of precautionary control measures that identifies, assesses and controls risks of significance to food safety. The HACCP “addresses the root causes of food safety problem in production, storage, transportation, and is preventative” (Afoakwa et al., 2013). “The HACCP system is a science based and systematic, identifies specific hazards and measures for their control to ensure the safety of food, it is also a tool to assess hazards and establish control systems that focus on prevention rather than relying mainly on end-product testing and inspection” (El-Faki & Eisa, 2008).

Mortimore (2001) indicates that the HACCP system follows a straight forward and systematic approach and each stage needs to be logical and precise. Therefore, for the successful implementation of properly planned, constructed and conducted HACCP programmes, detailed training and education; knowledge of monitoring of CCPs; ability to take action when required; and recording of results are crucial. El-Hofi et al. (2010) state that the HACCP control chart shows all the potential critical hazards that can occur during processing steps. This flow chart is the fundamental to the entire HACCP plan, which specifies the control points in the process steps and how CCPs should be managed.
Mortimore (2013) demonstrates that the structure of the HACCP system relies upon the assignment and types of production processes being applied, along with the status of the quality and food management systems and PRPs that exist in the plant. There are three basic HACCP approaches, as outlined below.

**Linear HACCP plan approach:**
Internationally recognised HACCP standards are installed in each product or process line, starting from receiving of raw materials, through production and ending with the finished product. This is a very simple and straight forward approach and applies to one process or product line. Food safety hazards using this approach can be easily detected and with the correct measures can be eliminated or removed from the process and subsequently the product.

**Modular HACCP plan approach**
This approach is applicable for products produced using a number of basic process operations. This is an adaptable approach that enables HACCP standards to be introduced independently in every one of the essential activities or modules.

These HACCP plans for separate modules are then combined to make up the complete food safety HACCP system. For the modular approach, it is important to know the start and the end of the module, so that no process steps and food safety hazards are missed when they are combined or added together. The modular approach is commonly used in a very complex food operation as it can be arranged and structured. However, this approach requires skilled personnel to operate the system as it can be easily confused and can allow hazards to enter the products. Mortimore (2013) argues that the modular approach is usually the most practical and effective system to apply. "The modular HACCP plan is complete in details for each individual hazard but will often reference more detailed documents and details of procedures" (Rostron, 2012).

**Generic HACCP plan approach**
The generic HACCP approach is built on an organisational approach that is expected to fit into any similar operation where the food product is made or handled. It has limitations because distinctive processes
are not exactly the same, and the HACCP is aimed to be applied to specific processes. The difficulties of applying only generic HACCP plans is that issues that are operation specific may be ignored and result in hazards being overlooked.

2.5.2.3 HACCP implementation

Food safety system which is built on HACCP principles have been successfully applied in food processing plants. According to the NACMCF (1998), seven principles of HACCP implementation have been generally acknowledged by governments and their agencies, trade associations and food industries around the world as an effective and sound system for assuring food safety. Afoakwa et al. (2013) argue that the HACCP principles are clearly defined and are very useful for the proactively identifying and controlling food safety hazards. The Codex of Alimentarius Commission (CAC) recommends five preliminary stages and seven HACCP principles for implementing the system effectively (Ropkins & Beck, 2000). Rostron (2012) argues that the seven principles of HACCP and five HACCP implementation steps provide a format that may give the impression of a clear, logical, step-by-step guide to HACCP development, whereas (as confirmed by the literature review) HACCP development is difficult and methodical and potential challenges occur at every step of implementation. For this reason, knowledge of the system and the product is crucial.

The five implementation steps and seven principles are outlined below.

2.5.2.3.1 Assemble HACCP team

NACMCF (1998) states that the initial activity in formulating an HACCP framework is to build a food safety HACCP team and team leader. These should be individuals with specific knowledge and expertise appropriate to the product, process and hazards associated with production and products. It is the team’s responsibility to develop the HACCP plan. Mortimore and Wallace (2012) indicate that the HACCP program is everyone’s concern in the company, including top management, and it cannot accomplish by individual or single department alone but is rather the result of a multidisciplinary team and every employee from all departments in the company.

CAC/RCP 1-1969 Guidelines for the Application of the Hazard Analysis Critical Control Point System (1993) suggests that the HACCP team should be multidisciplinary and include individuals from departments of the business such as engineering, production, quality assurance and food microbiology. Arvanitoyannis and Kassaveti (2009) add that the HACCP team should have at least four to six members who should be able to provide a leadership, knowledge and experience necessary for the development of successful HACCP plan. The team leader should be a quality officer working as a custodian of safety and quality in the company. The team responsibilities include: (1) Guaranteeing that the FSMS requirements are built up, installed and sustained; and (2) providing a feedback to top management on the performance of the FSMS at prescribed management review meetings or on the routine and ad hoc basis to ensure food safety implementation alignment to policy or standards. (Pun & Bharro-Beekhoo, 2008).

The team leader should be in the leadership role and have extensive knowledge of the manufacturing process, an independent quality mind-set, technical skills and easy access to employees across the board. The team should also incorporate people who are involved in daily activities in the company such as team leaders of the processing line of department; because they may provide information on accuracies and restrictions in the production process and their presence may create a sense of
commitment to the job (Cusato et al., 2012). Ropkins and Beck (2000) stress that the HACCP team must have access to all important data, and additionally the ability to identify all risks, CCPs and critical limits related to the product and process under consideration. The team may also require help from experts who are not part of the company on any biological, chemical or physical hazard that may confront the product or the process (NACMCF, 1998). Mortimore and Wallace (2012) suggest that the top management of the company should assign one member of the HACCP team as team leader, preferably the manager in the Quality department (Quality Assurance manager).

2.5.2.3.2 Describe the products and their distribution
The NACMCF (1998) states that the food safety HACCP team should provide a full description of the food products, consisting mainly of ingredients and processing methods. Mortimore (2001) indicates that the HACCP team must have intensive knowledge production process and product and be able to describe the product by evaluating what makes the food safe. To do this the team needs to consider internal aspects such as pH and water activity and external influences such as temperature conditions for processing, packing and storing the raw material and products.

A complete description of the product should aim to identify any possible hazards that might affect the product and any hazards that the product may cause (Arvanitoyannis & Kassaveti, 2009). Cusato et al. (2012) agrees with the view of the NACMCF (1998) that the HACCP team should have a detailed knowledge of the food product. Cusato et al. (2012) include knowledge such as microbiological, physical and chemical characteristics and attributes; ingredients and formula; packaging materials; specifications for storage and transportation; and retail conditions. They also suggest knowledge of adequate handling procedures, shelf life and the type of consumer. Pun and Bharro-Beekhoo (2008) state that the HACCP team should know the composition and processing of the food and the severity and risk of any hazards. The description of the product requires knowledge of: (1) product characteristics and composition; (2) structure; (3) processing; (4) packaging; (5) storage and distribution conditions; (6) required shelf life; and (7) instructions for use.

2.5.2.3.3 Describe the intended use and consumers of the product
The NACMCF (1998) states that normal expected use of the food should be described along with the intended consumers, who may be the general public or a particular segment of the population. Arvanitoyannis and Kassaveti (2009) state that knowledge about the intended use consists of information on whether the product has to be prepared prior to consumption or can be eaten as it is. Ropkins and Beck (2000) state that the HACCP team should also identify all potential uses by the end-point user or consumer and all the warnings regarding potential hazards should be declared on the label.

2.5.2.3.4 Develop a flow diagram which describes the process
A process flow diagram should be designed by the HACCP team with the involvement of the area-specific team leaders and operators (Arvanitoyannis & Kassaveti, 2009). The NACMCF (1998) explains that the purpose of the flow diagram is to provide a clear, simple outline of the steps involved in the process, indicating the points that require control in the process. Ropkins and Beck (2000) express that the “flow diagram of the production process under consideration should then be prepared to make documentation more available and easily accessible, and to simplify both management and understanding of the HACCP procedure, once it is installed. The flow diagram or schematic plan of the establishment could also help highlight potential areas of cross-contamination” (FAO/WHO, 2009). According to Cusato et al. (2012),
the process flow diagram should define all the steps, identify the equipment and material and also define working conditions such as temperature, pressure and humidity.

Pun and Bharro-Beekhoo (2008) indicate “that team members construct the flow diagram to cover various steps in the operation for easy identification of routes of potential contamination and controls”. Process flow diagrams include: 1) the network and interaction of different steps in the plant; 2) any outsourced activities and subcontracted work; 3) where raw material, ingredients and intermediate products enter the production; 4) where reworking and recycling takes place; and 5) where end products, intermediate products, by products and waste would be removed.

Flow diagrams are the basis for the identification of hazards and preventative measures, and they should be occasionally approved and balanced, where essential (Cusato et al., 2012). Zhao (2003) writes that “flow diagrams are made up of a sequence of steps through the whole process. A concise explanation of each step is given to describe how the final product is made and the diagram is used to document the production and distribution processes and to identify hazards at each step”.

2.5.2.3.5 Verify the flow diagram
The WHO (1999) states that the correctness of the process flow diagram should be agreed by the operators against the actual physical blueprint of the plant and, if needed, modify. Adjustment of the process flow diagram should be done by the HACCP team with the leadership of HACCP team leader and managers of the affected areas and the changes should be written and communicated (Arvanitoyannis & Kassaveti, 2009). Cusato et al. (2012) define a flow diagram as a sequential flow of process, indicating where inputs enter the process and also a visible layout to CCPs and install preventive and control measures for hazards. They should be sporadically audited, confirmed and adjusted, where needed, to reflect the actual blueprint of the production process.

Ropkins and Beck (2000) argue that the schematic process flow diagram should be a true reflection of actual production process, and must be assessed and audited to ensure conformity of each step of the process, plant site, under all different operating conditions and during all operating periods (shifts) to ensure representatives and accuracy. The flow diagram should be modified accordingly if any discrepancies are observed or any changes in raw material, formulation, equipment and product itself.

“Verification was conducted by reviewing the production process, coordinating with production operator to adjust the flowchart with actual condition in the field as well as doing a sample assessment in order to confirm the arranged flowchart diagram precision as compared to actual condition in the field” (Citraresmi & Wahyuni, 2018).

Pun and Bharro-Beekhoo (2008) suggest that the completed flow diagram should be checked for accuracy as new line managers often bring variations in work practices with them. Checking should be undertaken by HACCP team members at different times and shifts using checklists, which provide an assessment record and can be used as a baseline for assessing changes.

2.5.2.3.6 Analyse hazards and identify control measures – principle 1
Hazard analysis is the process of gathering and assessing information and data on hazards and the conditions that lead to their existence. The analysis is utilised to resolve which hazards are substantial for food safety and should be controlled in the HACCP plan (Rostron, 2012).
Rostron (2012) defines hazard analysis as a systematic detection and analysis of the current and potential hazards that may be detrimental to the product. A scientific approach is followed in analysing the hazard and a good understanding of the hazard and risk assessment is crucial. A hazard in food is caused by physical, chemical and microbiological agents that pose a significant risk of causing harm to the consumer if not managed correctly during production. Stanley et al. (2011) argue that a hazard analysis needs to correctly describe the hazards that are present, introduced, grow and survive in the process. This will enable control measures to be put in place that are associated with the process and can be installed to ensure that food safety hazards are removed; these control measures include policies and procedures.

According to Rostron (2012), “HACCP theorists have identified nine distinct steps within hazard analysis, which involve grouping, prioritising and controlling hazards” as follows:

1. Group together the food safety hazards (microbiological, chemical or physical);
2. Group the hazards in the order of importance;
3. Identify and classify individual food safety hazards;
4. Group the individual hazards in order of importance;
5. Ascertain and understand each food safety hazard individually;
6. Detect the point in the production process where the food safety hazards are likely to happen;
7. Plan production process;
8. Plan a control measure for CCPs; and
9. Assure and confirm the decisions taken.

“Hazard analysis can be defined as a process of collecting and evaluating information on hazards and conditions leading to their presence in food to decide which are significant for that food’s safety” (Pun & Bharro-Beekhoo, 2008:50). Dalgic, Vardin and Belibagli (2011) state that the analysis of food safety hazards begins with the knowledge and clear understanding of risks related to the incoming ingredient and material and moves on to process steps, packaging and end products, storage, transportation and utilisation of products.

An analyses of hazards gives the identification of potential danger and risk associated with all phases of the process from acceptance of raw materials and ingredients to final consumption of products (Marques et al., 2012). Hazard analysis, according to the USDA/FSIS (1997), is “conducted by preparing a list of steps in the process where significant hazards occur, and describing preventative measures” and the NACMCF (1998) added that the main objectives and purpose of the hazard analysis are to uncover and draw up a list of significant hazards associated with the process and product that have the potential to cause sickness to human health, if not effectively controlled and managed accordingly. Lu, Pua, Liu and Chang (2014) state that hazard analysis should be conducted at an infancy of the process to determine biological, chemical and physical contaminants prior to commencing with production and it is also conducted at every CCPs to control and remove hazards that may be detrimental to the product.

The food safety HACCP team performs a hazard analysis to detect potential hazards and design appropriate control measures to be installed at each point of production process. NACMCF (1998) indicates that it is important to consider in the hazard analysis the ingredients and raw material; each step in the process; product storage and distribution; and the final product. Safety concerns must be differentiated from quality concerns. Preventive measures should be designed on the basis of specialised literature and knowledge of the raw material. The flow diagram should be referred to for the process.
(Cusato et al., 2012). The USDA/FSIS (1997) outlines three objectives for conducting a hazard analysis and preparing control measures as:

1. HACCP plans are designed to remove and control food safety hazards and risk associated with product and establish associated control and preventative measures;
2. The hazard analysis may indicate if the modifications to a process or product is essential;
3. The hazard analysis provides a basis for defining CCPs.

The USDA/FSIS (1997) and Pun and Bharro-Beekhoo (2008) state that the process of performing a hazard analysis encompasses two stages: hazard identification and hazard evaluation.

![Diagram of hazard analysis process](image)

**Figure 5: Hazard analysis (Pun & Bharro-Beekhoo, 2008:49)**

The first stage is used to identify the food safety hazards and the contamination point in the production process. In the second stage, the hazard is evaluated through the mathematical determination of the probability and calculation of the risk severity.

To manage food safety risks, it is critical to identify which foods, organism or conditions lead to food-borne sickness and to decide the extent of the effect that these have on human wellbeing (Lammerding & Fazil, 2000). The risk of food-borne sickness can be a amalgamation of the likelihood of exposure to a contaminants in food, and the severity of the illness after the exposure or consumption of food. The NACMCF (1998) states that, on the finalisation of a hazard analysis, the hazard identified should be listed against their control measure.

**Stage 1 Identification of hazards and contamination point**

“Hazard identification is the first step in a formal risk assessment” (Lammerding & Fazil, 2000). This activity is mostly qualitative evaluation of the risks related with the product and a preliminary examination of data that is analysed in more detail in the subsequent steps of the process. For example, regarding toxicology and environmental health, the major focus of the hazard identification step would be to determine whether there is sufficient evidence to consider a substance (chemical) as a cause of an
adverse health effect (such as cancer). According to Pun and Bharro-Beekhoo (2008), hazard identification involves analysing each raw material, production process and consumer use, and identifying appropriate control measures to reduce or eliminate potential hazards.

The identification requires systematic evaluation of raw materials used in the food and the steps identified in the production flow diagram.

Hazard identification step, can be regarded as a brainstorming session, where HACCP team reviews the ingredients used in the product, the activities conducted at each step in the process, and the equipment used, final products and its method of storage and distribution, and the intended use and consumer of the product. Based on this review, the team develops a list of potential biological, chemical and physical hazards that may be introduced, increased, or controlled at each step in the production process (NACMCF, 1998:1250).

According to ISO 22000:2005 standard, “food safety hazards are biological, chemical or physical agents in food or condition of food with the potential to cause an adverse health effect” (Afoakwa et al., 2013). With this in mind, Afoakwa et al. (2013) argue that hazard identification process ought to build a list of probable biological, chemical and physical hazards that might be presented, expanded or oversaw at each progression in the production process. Dalgic et al. (2011) write that because hazard analysis is based on the calculation of potential hazard sources and on categorising their cause, this classification is achieved by creating a cause-and-effect diagram, in which a complete list of hazards that could potentially be of concern in the process associated with man, method, material, machine and environment is drawn up.

A cause-and-effect diagram itemise all probable hazards associated with the “4Ms” (Man, Method, Material and Machine) and “1E” (Environment). Pun and Bharro-Beekhoo (2008) consider the cause-effect diagram for the listing of current and potential hazards as critical for identifying hazards associated with a particular food product. This process usually starts with a list of human food pathogens, which is followed by an evaluation of raw materials, the production process and the possibility of contamination. Cause-and-effect analysis (Fishbone or Ishikawa) methodology is an organised technique for identifying possible causes of an undesirable occasion in the production. It sorts out the conceivable contributory components into general classifications, with the goal that every conceivable theory can be considered. It doesn't, nonetheless, independent from anyone else point to the genuine causes, since these must be controlled by genuine confirmation and exact testing of speculations (Valis & Koucky, 2009). Valis and Koucky (2009) and Pun and Bharro-Beekhoo (2008) explain that Ishikawa methodology gives an organised pictographic presentation of possible sources of a particular effect. Figure 5, below illustrates hazard analysis decision tree diagram for incoming raw material and production lines.
Dalgic et al. (2011) state that hazard analysis starts with inspection and analyses of the existence of a possible hazard and test whether their presence is intense or not in an incoming raw material or in the processing steps; this is achieved by answering a number of questions using a hazard analysis decision tree. The questions establish where the current or potential hazards in the raw materials or processing lines are significant. Questions 1 and 2 (see Figure 5) anticipate if a probable hazard in crude ingredients and in the production lines are likely to happen. A “no” answer will indicate that there is no hazard and “yes” will indicate the presence of a hazard. This will then lead to Question 3, which will ascertain if the identified hazards will result in an unacceptable contamination. A “yes” answer here will lead to Question 4. Question 4 seeks to understand if the contamination might increase or grow to an unacceptable level. Here “no” indicates no hazard, while “yes” shows that contamination is present at an unacceptable level. Then Question 5 establishes if the contamination can be reduced at a further stage. A “yes” answer indicates that the raw material and processing line provide no hazard, while a “no” answer shows the existence of a substantial hazards that should be measured.

**Stage 2 Hazard evaluation or risk assessment**

“Hazard evaluation is the process of reviewing each hazard that is identified to determine the severity of the health risk to the consumer and the probability of occurrence” (Pun & Bharro-Beekhoo, 2008). Pun and Bharro-Beekhoo (2008) give an example of risk assessment as the process of evaluating food premises to decide if they need to be inspected frequently or not. Lammerding and Fazil (2000) define risk assessment as a procedure that gives an estimation of the likelihood and effect of adverse health effects contributing to conceivably impure foods.

“Risk can be quantified mathematically but this approach requires careful interpretation” (Pun & Bharro-Beekhoo, 2008). According to the NACMCF (1998), based on the results of hazard analysis, HACCP team must decide whether hazards should be managed by HACCP plan or prerequisite programs. During this stage, each possible hazard is calculated according to its seriousness and occurrence. When performing a hazard assessment, the NACMCF (1998) recommends that the team responsible for hazard
analyses must consider the likelihood of exposure and the severity of the potential consequences if the hazard is not properly controlled and this should be based on the historical data and knowledge of the product.

The Food Standards Agency (which produces the MyHACCP website) states that the hazard description for each hazard (which includes a descriptor regarding its presence, introduction, growth and survival) provides a severity and likelihood score for each hazard and determines what score is significant. According to Marques et al. (2012), to conduct a risk assessment, the following data are considered: (1) evaluate of customer and consumer's complaints and concerns; (2) products recall; (3) external and in-house laboratory test results; and (4) internal and/or external audit reports. Ropkins and Beck (2000) write that hazard analysis can be used to detect and evaluate hazards and to prioritise them to be measured.

According to Valis and Koucky (2009), "risk assessment is the overall process of risk identification, risk analysis and risk evaluation. Risk assessment provides an understanding of risks, their causes, consequences and their probabilities". It does this by trying to answer the following questions: (1) what are the potential hazards? (2) What are the consequences if the hazards are present? (3) What is the probability of their hazard occurrence currently and in future? (4) Are there any measures that can alleviate the significance of the risk?

Risk analysis, according to Valis and Koucky (2009), (1) is about creating a comprehensive knowledge of the risk; (2) calculate and define the probabilities and the severity of identified hazards, and (3) consider the sources of risk.

Valis and Koucky (2009) outline "the risk assessment methods as qualitative assessment, semi-quantitative methods and quantitative analysis. Qualitative assessment defines consequence, probability and level of risk by levels of significance, such as "high", "medium" and "low"; may combine consequence and probability; and evaluates the resultant level of risk against qualitative criteria. Semi-quantitative methods use numerical rating scales for consequence and probability and combine them to produce a level of risk using a formula. Quantitative analysis estimates practical values for consequences and their probabilities and produces values for the level of risk in specific units defined when developing the context".

Figure 7: Risk assessment matrix (Marques et al., 2012)

"HACCP team needs to consider the probability of each identified hazard and its severity level which can be determined by observing the effect to the consumer health or company reputation. The result of the
identification will be used to determine the control action should be performed for each corresponding hazard possibility” (Citraresmi & Wahyuni, 2018).

In their risk assessment matrix (Figure 6), Marques et al. (2012) accentuate that risk assessment is performed on the basis of the hazard analysis, indicated by possibility of existence and seriousness of identified hazards and the evaluated preventive measure for their control. This suggests that people with a knowledge of the hazards associated with the process and product must be involved in hazard analysis. This often means that external consultants must also be involved.

2.5.2.3.7 Identify the critical control points – principle 2
CCPs are characterized as ventures in the production procedure at which management of hazards can be installed. CCPs are essential for neutralising contaminants presence in the food stuff. (NACMCF, 1998; Rostron, 2012; ISO 4, 2009, Karagozlu et al., 2009). Conversely, Cusato et al. (2012) define CCP “as points at which food safety hazards can be identified in the process flow chart by using a CCP decision tree”. Ropkins and Becks (2000) argue that CCPs are critical steps in ensuring the safety of foodstuffs and their accurate analysis and management is essential to the thorough, proficient and cost-effective advancement of observing, control and remedial strategies and practices. At the point when CCPs are not utilized accurately, they are the main source of food-borne sickness outbreaks.

Stanley et al. (2011) advise that for each point in the process flow diagram, the team responsible for HACCP must ascertain whether the step is a CCP, PRP or OPRP and managed accordingly. The WHO (1999) detailed that there may likewise be in excess of one CCP at which control can be applied to address a similar hazard; the assurance of a CCP in the HACCP framework can be encouraged by the utilization of a CCP decision tree. The NACMCF (1998) defines the CCP decision tree as an interrelated series of questions that can be utilised in computing whether a control is a CCP or OPRP. ISO 4 (2009) specifies that the HACCP team should employ a CCP decision tree to assess CCPs points where food safety hazards can be anticipated and decreased to a satisfactory level. Each step should then be categorised as a CCP, OPRP or neither.

The Centre for Food Safety and Applied Nutrition (CFSAN) (2007) states that the HACCP team may also use a decision tree to evaluate each hazard to determine if it can be prevented, removed or reduced to an acceptable level. ISO 22000 (2005) specifies that a “CCP needs to be identified along with the suggested control measures for each hazard to be controlled by the HACCP plan”.

According to Pun and Bharro-Beekhoo (2008), once the hazards and how they got into the food (source and contamination points) are identified, control measures can be decided on. A control measure is the action required to eradicate hazard or decrease its effect or event to an adequate level. Control measures are actualized at each critical point that is identified in the decision tree (Pun & Bharro-Beekhoo, 2008).
Figure 8 shows a CCP decision tree.

The NACMCF (1998) states “that full and precise detection of CCPs is essential for managing food safety hazards; the data obtained during the hazard analysis process is essential for the HACCP team to decide which steps in the process are CCPs or not”. Cusato et al. (2012) explain that the questions that make up the CCP decision tree should be answered with “yes” or “no” to determine the CCPs in the food chain.
• Question 1: This question attempts to find out if there is any control measure available for the hazard identified;
• Question 2: This question tries to understand if the activity in the process step is effective for removing hazards;
• Question 3: This question checks whether the hazards could proliferate to an unacceptable level; and
• Question 4: This question checks whether a consequent step, prior to food utilisation, eliminates the identified hazard or reduces its prevalence to an acceptable level.

Easdani, Khaliduzzaman and Bhuiyan (2012) explain that the CCP decision tree should be followed by beginning with asking Question 1, to understand if a preventative or control measure exists at the current step or subsequent step for the hazard identified. A “no” answer indicates that there is no preventative measure, which will then lead to a subsequent question to ascertain if the control at this stage is necessary. If it is necessary, as answered by “yes”, then the process will require modification. A “yes” answer to Question 1 will lead to Question 2, which asks if the step will eliminate or reduce the occurrence of the hazard to an acceptable level. A “yes” answer to this question means that the step is a CCP but a “no” answer will lead to Question 3, which asks whether the contamination could increase to an unacceptable level. A “no” answer indicates that the step is not a CCP. A “yes” answer will lead to Question 4, which asks whether a subsequent step will eliminate the identified hazards or reduce the likelihood of occurrence to an acceptable level. In answer to this question, “no” means the step is a CCP; “yes” indicates no CCP.

2.5.2.3.8 Establish critical limits – principle 3
The USDA/FSIS (1997) defines “the critical limits as the range between the upper control and lower control value to which a biological, chemical and physical hazard must be controlled at a CCP to prevent or eliminate it or to reduce its occurrence to an acceptable level”. The CAC (1993) defines “critical limit” as a specification with approved limits that separates what is satisfactory from what is not acceptable; critical limits must be specified and based on scientific and historic data and validated for every CCP, and they must also be measurable.

Cusato et al. (2012) state that each CCP ought to have a critical limit characterised in terms of time, temperature, pH, temperature, acidity, and other important measures, in order to ensure the safety of the process. Critical limits may be defined according to specialised literature, present regulations or the practical expertise of the HACCP team. They should also be scientifically based (NACMFC, 1998). Pun and Bharro-Beekhoo (2008) state that Statistical Process Control (SPC) charts can monitor the performance of agreed HACCP critical limits. Critical limits should be set on the control measure rather than on the hazard itself (Stanley et al., 2011).

2.5.2.3.9 Establish monitoring procedures – principle 4
The NACMCF (1998) defines monitoring as a predefined succession of visual perception or analytical or microbiological tests to analyse whether a CCP is under control and to deliver an accurate record for future use in verification. “Monitoring enables management to detect loss of control at a CCP. It is important to specify who, how and when monitoring is to be performed and recorded” (Pun & Bharro-Beekhoo, 2008). Monitoring accomplishes three main purposes according to the NACMCF (1998): Firstly, it assists in checking and tracking the operation; secondly, it decides when there is a loss of control or when deviation happens at a CCP; and, thirdly, it gives a composed report for use in verification.
The WHO (1999) argues that “the frequency of monitoring must be sufficient to guarantee that no unsafe product reaches the consumers” and points out that in creating the measurement procedures, the following critical questions need to be considered and answered: 1. what are the critical parameters that need to be measured and what are the range or specification and how are they measured? 2. The frequency of performing the measurement is sound to remove the hazards? 3. The measurement protocol well defined and validated to be fit for purpose?

Stanley et al. (2011) argue that the monitoring system should clearly address: (1) how the monitoring is to be carried out (parameters and record); (2) when the monitoring is to be carried out (frequency); (3) who has a responsibility for carrying out the monitoring; and (4) what record is to be taken.

Other important factors regarding monitoring are equipment, training, procedures and activities. The NACMCF (1998) indicates that equipment used for monitoring of CCP should be maintained at planned interval and calibration schedule must be defined and frequency must be complied to ensure accurate measurement. “Individuals responsible for monitoring must be trained in the monitoring techniques, for which they are responsible” (NACMCF, 1998). “The monitoring procedure should take into account how easy and fast results are obtained to ensure that the process is adjusted without delay, and that the flow of the process is not affected” (Cusato et al., 2012). Pun and Bharro-Beekhoo (2008) list the types of monitoring activities applicable as physical checks, observation/visual checks and microbiological checks, lab tests in a controlled environment and chemical checks that involve lab tests by quality staff.

2.5.2.3.10 Establish corrective actions – principle 5

“Corrective action shall be initiated when critical limits are exceeded or when there is a lack of conformity with operational PRP” (ISO 22000, 2005). The Federal Register (1996) states that “the corrective actions must be determined for each CCP in cases where the critical limit is not met or there is a deviation from established process”. The NACMCF (1998) states that the principal intention of doing corrective action is to ensure that any out of control or deviation are corrected or brought back to control before the product can reach the customers and consumers. As such, corrective action should include the following points: 1. Learn and redress the plausible and underlying driver of process deviation; 2. Characterize how the rebelliousness are arranged or adjust; and 3. Finish remedial activity log and record the move made to redress the procedure or rebelliousness. According to Pun and Bharro-Beekhoo (2008), a corrective action plan describes actions to be taken if a deviation is found; i.e. if a measurement lies outside the critical limit, which would suggest a loss of process control. Stanley et al. (2011) emphasise that corrective actions should consider the present (what is going to happen immediately in the production operation, how can control be regained); the past (what is going to be done with the product if it is rendered non-conforming); the future (how to prevent loss of control from happening in the future); who has a responsibility and authority for the action taken; and the record to be taken.

2.5.2.3.11 Establish verification procedures – principle 6

According to the NACMCF (1998), verification system is defined as the activities performed to confirm that the process is in control, other than monitoring that measure the strength of the HACCP plan and ensure that the system is operating according to the plan. The NACMCF describes two aspects of verification as: (1) an assessment of whether the plant’s HACCP system is performing in accordance to the HACCP plan and (2) the initial validation of the HACCP plan to determine that the plan is scientifically and technically sound and that all hazards have been identified. According to Cusato et al. (2012):
Verification activities should be performed routinely to measure and confirm whether the HACCP plan is working according to the plan, it is done by periodically reviewing of the flowchart for the process, studying and revising of the product or process critical limits, periodically reviewing of CCPs measurement protocol and records, internal and external laboratory analyses of the process and end product, and investigate out of specification process and devise a plan to bring it back to control.

“Validations are conducted when there is an unexplained system failure, a significant product, process, or packaging change occurs, or new hazards are recognized” (Cusato et al., 2012). Therefore, validation is the process of determining a composed confirmation which exhibit that a method, process, or activity carried out in testing and then production maintains the coveted level of compliance at all stages. Pun and Bharro-Beekhoo (2008) state that auditing is an important and effective way of confirming HACCP plans. An audit is a methodical and autonomous examination to affirm whether: 1) HACCP exercises and related outcomes agree to the measures set up and 2) those gauges are introduced successfully and are appropriate and sound to accomplish goals.

2.5.2.3.12 Establish a system of documentation and record keeping – principle 7
Rostron (2012) states all the procedures and records related to the application of the HACCP principles should be written up. According to Rostron (2012), “documentation should include all paperwork generated in the development and maintenance of an HACCP system, and should incorporate the minutes of meetings; diagrams relating to production processes; information relating to products, ingredients and supplier specifications; and documented evidence of principles 1 to 6”. Barron (1996) believes that developing an effective record-keeping system is essential for the implementation of an HACCP system in any food processing facility. According to the NACMCF (1998), the document and records for the HACCP system should include the following:

1. A report of the hazard analysis and control measure installed;
2. Product and process HACCP plan;
3. Validation and verification of records;
4. Laboratory and process inspection records generated during the production or analysis; and
5. Maintenance and calibration of equipment, certificate of analysis of raw material and ingredient.

According to Pun and Bharro-Beekhoo (2008), organisations should document systems and add in the requirements for activities that affect food safety, quality and customer satisfaction.

2.5.3 HACCP Prerequisite programmes (PRPs)
PRPs involve basic environmental and operating conditions and activities needed to provide cleanliness in the processing environment throughout the food chain. PRPs should be installed in such a way that it only assures that the environment condition of the plant is suitable for the food system (Nowicki & Sikora, 2007; Rotaru et al., 2005).

Arvanitoyannis and Kassaveti (2009) state that “planning and realisation of safe products incorporate the elements of PRPs and the HACCP, including any regulatory requirements applicable to the organisation and process”. Marques et al. (2012) write that to eliminate food impurities in the food system, every aspect of food safety should be managed using PRPs and/or an HACCP plan.
HACCP framework cannot function alone to achieve its intention of protecting consumers, but a HACCP framework that is excellently and strategically planned and designed, built on a sound prerequisite programs, and fully installed and sustained in the food operations process should practically remove and alleviate food safety problems from entering the products. (Wallace, 2014)

Schmidt and Newslow (2013) suggest that the term “prerequisite programs” be used only for those programs needed under regulation, in order to differentiate them from “precurorsy programs”, which are programs that have been deemed necessary.

Cusato et al. (2012) write that before the adoption of HACCP standards, some PRPs, such as GMPs, GHPs and cleanliness, should be in place in order to guarantee basic hygienic and environmental conditions in the processing plants. PRPs, if implemented correctly, may be able to remove most of the hazards associated with the basic conditions and reduce the number of CCPs. They will also provide the standards for correct movement of foodstuffs, making the HACCP framework more competent and easy to administer. Arvanitoyannis and Kassaveti (2009) trust that fundamental PRPs ought to be set up to shield food items from pollution by natural and introduced contaminants; to control bacterial development that can result from temperature abuse; and to clean and calibrate equipment used to produce food.

Stanley et al. (2011) argue that control of general threats to food safety arising from working conditions is normally part of GAP, GHP and GMP. Therefore, these should be effective prior to HACCP adoption. Examples of PRPs include appropriate training programmes for employees, preventative maintenance and calibration procedure, schedules for cleaning of equipment, and appropriate control of glass and foreign objects in the packaging materials.

Afoakwa et al. (2013) argue that “GMP” is a portrayal of the considerable number of ventures in a processing facilities and varies from the HACCP in a number of ways: (1) PRPs are not created to analyse specific hazards; (2) does not provide a method for measuring hazards; and (3) no specific record keeping procedure is defined or needed. Marques et al. (2012) add that PRPs manage risks related to the food processing environment and condition such as buildings, constructions, facilities, workforce, plant and machinery, while the HACCP ought to be utilised to control hazards related directly with food processes such as preparation, cooking storage, transportation and utilisation.

According to Easdani et al. (2012), “PRPs are implemented in accordance with the codex general principle of food hygiene and good manufacturing practice to establish basic conditions that are suitable for the production and handling of safe food at all stages of the food chain”. PRPs, if properly installed, will establish the standard for correct management of foodstuffs, which will make the HACCP more efficient to manage. “PRPs shall have a brief written description or checklist that the prerequisite programs can be audited against to ensure compliance, and PRPs should include what can be monitored, records that specify what is monitored, and how often it will be monitored” (CFSAN, 2007). Organisations should develop GMPs that are specifically tailored to their operations (Schmidt & Newslow, 2013). GMPs must be understood and followed by all employees, including non-production personnel, in management and maintenance, as well as by all visitors to the facility. The NACMCF (1998) indicates that PRPs are built up and overseen independently from the HACCP plan, although other aspects of a PRP may be amalgamated into an HACCP plan.

PRPs should be documented and audited regularly. Afoakwa et al. (2013) partition the idea of PRPs into two subcategories: (1) Organisation and support programs, which are utilised to address fundamental necessities of food cleanliness and acknowledged good practice of a more permanent program and (2)
OPRPs, which are employed to control or reduce the effect of identified food safety hazards in the product or the processing environment. Bolton and Maunsell (2004) suggest that “PRPs control hazards associated with the food service environment, while HACCP control hazards associated directly with food process”. According to Schmidt and Newslow (2013), a successful and effective HACCP system cannot be achieved in the absence of well-conceived, well-documented, and properly installed PRPs and must be specific to process within the plant.

The Canadian food inspection agency (2014) defines “OPRPs as food safety-related procedures essential for controlling the likelihood of introducing food safety hazards to and/or the contamination or proliferation of food safety hazards in the product or in the processing environment”. Stanley et al. (2011) emphasise that OPRPs are PRPs that ought to be included in the HACCP plan to control hazards which are considered “site-wide” or non-process specific. Schmidt and Newslow (2013) add that food-handling facilities that receive raw agricultural commodities to be used in production should require that their suppliers follow GAPs that use basic criteria and can be verified by an ad hoc audit and certificates of analysis prior to receiving goods. Schmidt and Newslow (2013) state that “PRPs are essential for the assurance of wholesome food and should be in place prior to the implementation of an HACCP”.

2.6 Benefits of the HACCP

Mortimore (2013) argues that the genuine advantage of the HACCP are that it is an exceptionally successful technique for decreasing the risk of failure and of maximising product safety. Romano, Cavicchi, Rocchi and Stefani (2004) assert that the implementation of the HACCP system is a prerequisite for accessing the markets. Karagozlu et al. (2009) state that the benefits of establishing an HACCP system in a plant are the reduced need for final inspection and analysis of a product, higher consumer satisfaction and trust in production safety, and improved food safety. According to Afoakwa et al. (2013), the HACCP has number of advantages or benefits over other systems. The HACCP:

1. identify and control hazards and provide a preventative measure;
2. allow for more well-organized record keeping;
3. Companies access international markets;
4. ensures that resources are utilised more efficiency and the response to food safety problems is quick; and
5. is compatible with other management systems such as QMS, FSMS etc.

Jenner, Elliott, Menyhart and Kinnear (2005) add that the benefits of the HACCP “are the enhanced focus on and ownership of food safety, enhanced buyer and consumer confidence, maintained and increased market access, business liability protection, reduction of operational costs, efficient oversight, improved product quality and consistency, and reduced wastage”.

Khalid (2015) recognizes the advantages coming about because of the execution of HACCP frameworks as: (1) Staff and entrepreneurs gain certainty and are better prepared for educated talk on the food safety measures with food assessors, auditors, consultants, exchanging accomplices, end-user and others; (2) The expanded level of process control can result in food item consistency and enhancements in traceability; and (3) The HACCP gives a premise to safeguard against case and decreases protection cost.

Pun and Bharro-Beekhoo (2008) state that the achievement from the implementation of the HACCP will promote the product, quality and safety standards of the company in the eye of its customers. This will
also strengthen the brand of the company and promote trust in the production of safe food to the consumers.

Basit (2000) stresses that fruitful execution of the HACCP brings the essential advantage of food wellbeing and optional advantages of quality improvement; cost viability; decrease of food loss and down time; expanded consumer trust in food safety and security; improvement in design of process line and product; expanded cleanliness and housekeeping; diminished maintenance; lessened examination time; and enhanced manufacturing conditions and competitive advantage. Sheriff (2013) outlines the advantages of HACCP implementation as: prevention of food-borne ailment, decrease in cost, legal security, reduce the risk, customer certainty, enhanced market access, product improvement, team ownership, improved relationships, improved management, improved trading and production process.

Mortimore (2013:215) elaborates on these benefits as follows: The benefits of the HACCP system helps with prioritization in making informed judgment on food safety matters and remove bias, ensuring that the right personnel with the right training are making the decisions; HACCP will also help to demonstrate effective food safety management through documented evidence which can be used in the event of litigation; HACCP can, after the initial setting up of the system, be extremely cost effective.

2.7 Barriers to HACCP implementation

According to Marques et al. (2012), the HACCP framework has been progressively reported and connected in the food business yet HACCP framework have not been reliably executed over all food and beverage industries, for the most part due to technical barriers. Herath and Henson (2005) assert that “the reasons for organisations not implementing HACCP seem far more complicated than imagined and cannot be solely explained in terms of unwillingness by manufacturers but rather by the presence of several technical barriers that may impede the benefits of the application of the HACCP system”. Marques et al. (2012) identify these barriers as: (1) Boundary before execution; (2) obstruction amid usage; and (3) hindrance post implementation. The boundaries are considerably more prominent with bigger and more organized organizations, remembering that operators require a decent learning to execute the framework and furthermore that all workers require great information and training. The execution of the framework is still more troublesome in organizations that work with little net revenues.

Sheriff (2013) states that: “In certain least developing countries (LDCs) some businesses and regulatory authorities don’t actually know what the HACCP system is all about whilst others feel that the system is too scientific, technological and complex all together.” Sheriff (2013) adds that some HACCP studies have reported that “despite the widespread dissemination and scientific support of HACCP principles, successful adoption and implementation of HACCP systems are yet to be experienced, especially in LDCs”.

Khalid (2015) states that food businesses face many challenges while developing and implementing HACCP plans in their facilities, with their problems summarised as: (1) infrastructure and facilities; (2) basic hygiene; (3) responsiveness and capability; (4) training and teaching; (5) lack of technical support (with external support needed if internal technical expertise is lacking); (6) financial issues; (7) communication; (8) poor food safety culture; and (9) low level of literacy and use of multiple languages among those working in the food business. Gilling et al. (2001) add that the difficulties with the appropriation and execution of the HACCP might be caused by at least one hindrance over the gathering of learning, disposition and conduct, with absence of adherence to the vital information, demeanour and
conduct an obstruction to the effective usage of the HACCP. “Other obstacles and difficulties faced by smaller companies are lack of knowledge of the principles of the system, and how they would fit into their reality; lack of knowledgeable technical expertise; difficulty in record keeping; and a high turnover of employees” (Cusato et al., 2012). It can be argued that the absence of knowledge and practical skills among employee in the food chain have caused a lack of clearness with respect to the ideas of the HACCP and have made vulnerability regarding their continuous work and consequently hindered the formation of a full HACCP team.

A lack of information and understanding creates confusion between the concepts of GHP, GMP, SSOP, HACCP, the ISO, TQM and overall QA (Sheriff, 2013). Development of training programmes in the HACCP and PRPs will help employees (both operators and managers) with a better understanding of the system. The knowledge gained in this way might change their attitude, which is one of the influences that prevent the successful execution of an HACCP system. A change of attitude toward the HACCP system can lead to the successful development of the system. Top management needs to motivate employees by making sure that everyone understands the system and their roles in developing the system. Appropriate behaviour must be driven by the employees themselves; they must follow the protocol and be able to report anomalies urgently to their superior without fear.

2.8 Cost of HACCP implementation

Jenner et al. (2005) point out that organisations need to be aware of the potential costs of implementing an HACCP system so that they can determine the resources they will need in their food processing facility. These authors suggest that the following factors must be considered before determining the resources needed for the implementation of an HACCP system: number of products and processes; associated risk of products, ingredients and process; conditions of the facility; state of the equipment; and the level of safety understanding and training of employees.

Sharma, Roberts and Seo (2011) reported that the “cost of HACCP implementation is a great challenge to businesses. Although the HACCP has been recognised as the most efficient method for ensuring food safety, implementing an HACCP system incurs various costs such as staff training, purchasing new equipment and maintaining the system and the cost of operational changes to comply with HACCP requirements”. Sharma et al. (2011) assert that the cost of HACCP implementation depend on current food safety practices within the operation. The cost of a HACCP can be extraordinarily decreased if the operations are already equipped with sound food safety practices and HACCP PRPs.

Gong, Ma, Yang, Bai and He (2008) outline the cost of implementing an HACCP system as involving external consultants, investment in new equipment, staff training, managerial changes, new employment of personnel, and staff time in documenting the system. Gong et al. (2008) state that the cost of operating an HACCP is attributed to record keeping, product testing, staff training and supervisor time.

Romano et al. (2004) list three ways that, under appropriate suspicions, can be utilized to gauge costs. The first approach is the accounting approach, which is used to identify and survey the capital and work used to implement and manage the system, without the determination of a cost work. The primary favourable position of this approach is its effortlessness inferable from the idea of the information required, which is typically found at the plant level. However, it introduces a noteworthy limitation in stretching out example results to the universe inferable from the bigger inconstancy of plants. The second approach is the financial designing methodology, which utilizes streamlining models in light of accessible specialized and monetary information by means of the estimation of cost capacities for sustenance.
security attributes of delivered products. The principle limitation of this approach is that it shares a poor level of outer legitimacy. The third approach is an econometrics approach.

This is portrayed by an exchange off between production process determination and the hypothetical consistency of evaluated models. Romano et al. (2004) indicate that saving because of a decrease in failure cost can be assessed by the accounting approach. “The importance of HACCP implementation to small businesses is identified as time, money, documentation and verification as costs, while finding confidence, expertise, team building, reduced costs, trading opportunities and legal protection are identified as benefits” (Sharma et al., 2011).

2.9 Personnel and training

“HACCP is a people-based system” (Mortimore, 2013). As an operational tool, the HACCP is used in plants producing food applied by people and if the individuals are not appropriately trained, and are inexperienced then the subsequent HACCP system is probably going to be insufficient, focused and unsound. FSMS requirements for any organisation in the food chain state that the organisation “shall identify the necessary competencies for personnel whose activities have an impact on food safety and also requires that training be carried out to ensure that the competencies are met” (ISO 22000, 2005).

The FAO/WHO (2009) state that “the confirmation of food safety along the whole food network requires creativity and education at all levels, especially private division and consumer education and awareness. Training and awareness are rudimentary component of the implementation of the HACCP and other activities engaged with delivering safe food. Management ought to be aware of the risks related with the food business and must find a way to relieve such hazard”.

International and national governments should provide resources and support to private sectors and encourage them to adopt GHP with comply with the Codex Code of principles of food hygiene as well as other codex-specific guidelines for certain foods as one way to mitigate food safety risk in their establishments. “The food safety team and other personnel carrying out activities having an impact on food safety should be competent and have appropriate education, training, skills and experience” (Arvanitoyannis & Kassaveti, 2009).

Anandappa (2013) argues that the HACCP training should, firstly, convey a shared knowledge of the practical consequences of HACCP for food safety; secondly, give the viable abilities and information important for HACCP application; and thirdly, give an upgrade to facilitate improvement and harmonization of the HACCP. Anandappa (2013) points out that HACCP training should include the specific principles and steps required to develop and implement an HACCP programme. The NACMCF (1998) states that the “success of an HACCP framework relies on educating and training management and employees in the significance of their part in delivering safe foods and should incorporate data on the control of food-borne hazards related to all stages of the food chain. Specific training activities should incorporate working guideline and techniques that outline the assignment of employees that monitor each CCP”. According to the NACMCF (1998), top management of the company must provide satisfactory time to intensive training and education, and employees must be given the materials and gear important to play out these assignments.

Newslow (2014) outlines nine key points for the implementation of training, awareness and competency (ISO 22000, 2005).
1) Training records and contracts with external advisors and consultants must be kept up in consistence with the organization’s record-keeping program. 2) Employees at all levels should persistently survey all assignments to guarantee that capabilities identified with food safety duties are identified and successful and that records are kept up in consistence with the record control process. 3) Training matrix that characterizes the food safety and quality requirements for each department and area inside of responsibility within the department should be created as this has proven to be very effective for some associations. 4) Fourthly, a training matrix should be used to identify the need for training and what should be covered in the training. 5) Plant’s training program should ensure that employees are educated in the food and quality policy statement, HACCP and GMP. 6) Communication on food safety may be achieved through team meetings, shift meetings, awareness meetings, management review meetings (ISO 22000, 2005), bulletin boards and emails. 7) Management must ensure that records confirming the effectiveness of training on food safety are available and stored using media stipulated in the policy. 8) Appraisal to confirm the successful training should be done by line managers and, lastly 9) Company must define the training protocol and how the training will be delivered and the record should be kept.

“All employees should be given HACCP training, but at levels relating to their responsibilities within the HACCP plan. Extensive training of line workers is critical because these are the individuals responsible for the product” (Northcutt and Russell, 2010).

2.10 Conceptual framework

The goal of the “conceptual framework is to categorise and describe concepts relevant to the study and map relationships among them” (Rocco & Plakhotnik, 2009). To achieve this goal, the researcher incorporated both relevant theory and empirical findings to establish an understanding of the impact of the implementation of a food safety HACCP system in the manufacturing and beverage sector and discover where any overlaps, contradictions, refinements and qualifications occur. A conceptual framework is thus “an interconnected set of ideas (theories) about how a particular phenomenon functions or is related to its parts” (Svinicki, 2010). Jabareen (2009) describes the conceptual network “as a network of interrelated concepts that together provide a comprehensive understanding of a phenomenon or phenomena”. This implies that the theories that establish a conceptual framework are interrelated and support each other, articulate their respective phenomena and establish a framework-specific philosophy.

This study was guided by a conceptual framework that interrelates the major components involved in an implementation of an HACCP system. The conceptual framework is depicted in Figure 8 below.
The conceptual framework is the building block that provides the pillars on which research is conceptualised (Frank, 2016). A successful implementation of an HACCP which is based on food safety system is founded on different pillars: GMP, GHP and equipment, raw materials and personnel, which are critical in determining levels of food safety hazards. The researcher was intrigued by the model of Kisembi (2010), as it provides a framework for the implementation of an HACCP system, which the current study investigated. Anandappa (2013) states that the Codex guidelines for HACCP emphasise training as a necessary part of an HACCP system. Therefore, an individual organisation should devise a training system for their personnel.

The common functions of the conceptual study can be identified by “describing hypotheses and intentions of previous studies, defining terms, and clarifying assumptions and limitations, citing relevant work to build a rationale and robustness for a study” (Rocco & Plakhotnik, 2009). This implies that the conceptual framework provides a foundational support for the research design, method and other instruments to be used in the study. The researcher therefore builds a case based on the conceptual framework as to which methodology is appropriate for the study and also provides reasons for why other methodologies are inappropriate for the study. “Methodology” is defined by Kothari (2004) as a systematic way of solving research problems. A methodology, according to Scotland (2012), is a “strategy or plan of action that lies behind the choice and use of particular methods and links the choice and use of these methods to the desired outcomes”.

“Conceptual frameworks possess ontological, epistemological and methodological assumptions, and each concept within a conceptual framework plays an ontological or epistemological role” (Jabareen et al., 2009). “Ontology” is defined as the investigation of existence; it is concerned with “what kind of world we are investigating, with the nature of existence, with the structure of reality as such” (Abdelhamid, 2008). Scotland (2012) explains the ontological assumption as a concern with what constitutes reality.

Epistemology is concerned with giving a philosophical establishing for deciding what sorts of knowledge and information are conceivable and how we can guarantee that they are both satisfactory and legitimate (Levy et al., 2006). Scotland (2012) explains that the epistemological assumption asks the question: What is the nature of the relationship between the would-be knower and what can be known?

The researcher prefers the epistemological over the ontological assumption, because of its natural ability to discover truth while the ontological assumption deals with an existing theory. According to Levy (2006), there are two viewpoints regarding epistemology, which are constructivism/interpretivism and

Figure 9: Conceptual framework for adoption of an HACCP system (Kisembi, 2010)
objectivism/positivism. An objectivist’s view point is that the true nature of reality can only be obtained through scientific methods and it is independent of the social world. Conversely, constructivists believe that reality is depend on social phenomena. These philosophical assumptions were employed to determine the validity of the study and also determine which methodology would be appropriate for the study. The study adopted a constructivist philosophy. As stated by Levy (2006), constructivism enables the researcher to investigate the perspective and cognizance of the distinctive participants within the subject background and perceives that each may have encountered a different understanding of the similar circumstance, a flexibility that is not available for objectivism.

Table 1: Broad explanation of positivism/objectivism and constructivism/interpretivism of epistemology (adapted from: Levy et al., 2006).

<table>
<thead>
<tr>
<th>Epistemology</th>
<th>Positivism/Objectivism</th>
<th>Constructivism/interpretivism</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nature of “existence” nature of the world</td>
<td>Have a direct access to the real world</td>
<td>No direct access to the real world</td>
</tr>
<tr>
<td>Reality</td>
<td>Single external reality</td>
<td>No single external reality</td>
</tr>
<tr>
<td>“Ground of knowledge” relationship between reality and research</td>
<td>Possible to obtain hard, secure, objective knowledge</td>
<td>Understood through perceived knowledge</td>
</tr>
<tr>
<td></td>
<td>Research focus on generalisation and abstraction</td>
<td>Research focus on the specific and the concrete</td>
</tr>
<tr>
<td></td>
<td>Thought governed by hypotheses and stated theories</td>
<td>Seeks to understand specific context</td>
</tr>
</tbody>
</table>

Table 1 above presents the key features and essential differences between positivism and constructivism, based on the nature and reality of epistemology as well as the grounds on which knowledge is obtained. The positivist philosophy focuses research on generalisation to a wider context, while constructivists believe that knowledge of the world can only be achieved through understanding as perceived by individuals. This implies that the constructivist approach is an appropriate approach for this study, as it helps the researcher to comprehend and investigate problems within a definite situation.

Abdelhamid (2012) and Levy et al. (2006) share the opinion that constructivism can be characterized as the view that all information, and therefore all meaningful reality, is dependent upon human practices, which are built all through the cooperation between individuals and their reality and created and transmitted inside a basically social setting. This implies that “meaning” is not “discovered”, but it is constructed. It further implies that the constructivist approach to understanding the relationship between reality and research is aligned to the approach employed by qualitative researchers. Therefore, in this study, the researcher constructed the theory based on an in-depth knowledge, understanding and experience of the participants in their settings and used a qualitative approach to collect and analyse data. Patton and Cocham (2002) state that “qualitative research is characterised by its aims, which relate to understanding some aspect of social life, and by its methods, which generate words, rather than numbers, as data for analysis”.

2.11 Theory of management

Kwok (2012) stated that “management theories originated in the industrialised revolution when the development in technologies, expansion of trades and markets, and growing of populations created
opportunities for production through a systematic process. Management theorists are concerned with formal relations among an organisation’s departments, tasks and processes, and the promotion of greater efficiency and productivity among the workers”. “Superior performance is ultimately based on the people in an organization. The right management principles, systems, and procedures play essential role, but the capabilities that create a competitive advantage come from people – their skill, discipline, motivation, ability to solve problems, and their capacity for learning” (Gino and Pisano, 2008).

This study focuses on the implementation of the HACCP food safety system in the manufacturing process (from receiving of raw material through the production process to the consumption of the final product), where different components come together and operate as a system. The most critical component of the system is considered to be people, as they have the ability, skills and knowledge to transform raw materials into products using the technology, information and tools at their disposal. Therefore, people are an enduring advantage of any organisation as they have the ability to influence how operational system work.

Gino et al. (2008) define operations management as a “multidisciplinary field that investigates the design, management and improvement of the processes aimed at the development, production, delivery and distribution of products and services”. Therefore, this study considers the following theories as a pillar for addressing the planning, management and improvement of the manufacturing process of a safe and wholesome product.

**Behavioural operations theory**

According to Gino et al. (2008) behavioural operations is defined “as the investigation of qualities of human behaviour and cognizance that influence the design, management and improvement of operating systems, and the study of the interaction between such attributes and operating systems and processes”. This implies that people are the pillar of any organisation; they have ability to transform inputs into outputs by utilising the resources available and they have an ability to differentiate signal from noise. This is important for the implementation of a food safety system as people are able to understand and react to variations. The behaviour of people can be changed through training and education.

**Systems thinking theory**

Aronson (2009) stated that “systems thinking focuses on how the constituent being studied interacts with the other constituents of the system”. This means that instead of isolating individual components of the system being studied, systems thinking works by interacting those individual components into a unit or system. An implementation of the HACCP system in any organisation involves many different facets, which are integrated into the system. Systems thinking demonstrates a broader understanding of how the individual parts of HACCP implementation can be integrated into the holistic system. This takes into account the people, equipment, raw materials, resources and individual principles of the HACCP as input and how they are transformed to produce the HACCP plan and holistic HACCP system as an output.

**Attribution theory**

“Attribution theory deals with how social perceiver uses information to arrive at causal explanations for events. It examines what information is gathered and how it is combined to form a causal judgment” (McLeod, 2010). This approach is employed to understand how the people employed at an organisation perceive the implementation of an HACCP system in the organisation. Furthermore, this approach is used to make sense of how information was gathered and how it became a causal judgement.
3 Methodology

3.1 Introduction

Kothari (2004) states that methodology and research designs direct researchers in planning and implementing their studies in a way that is most likely to achieve the desired goal. Rajasekar, Philominathan, & Chinnathambi, 2013 indicated that “Research methodology is a systematic and logical approach to resolve a research problem, it may be realised as a discipline to study how the research is performed in a technical and systematic manner”. It is a “practice employed by researchers to define, describe, explain and predict occurrence or phenomena” (Kothari, 2004). Collis and Hussey (2003) refer to “methodology” as a “holistic approach to conduct the research, from the theoretical understanding to the collection, analysis, reporting of the data and conclusion and provision of recommendation”. Research methods are those tools that are employed to collect the research information and data (Kothari, 2004).

For any research study to be successful, the researcher needs to make the right choice concerning which methodology to use, based on the research aim and objectives of the study. The research methodologies apply two main research approaches: qualitative and quantitative. Choy (2014) states that the qualitative approach begins with the researcher selecting a topic, starting with a broader area of interest and thinning it down to a specific research question that can be addressed in the study. In contrast, the qualitative approach commences with self-assessment and reflection about the situation in a social-verifiable condition and this approach does not barely focus on a particular inquiry but rather contemplates the theoretical philosophical paradigm in an inquisitive, curious and open-ended settling.

This research aimed to discover and understand a process, perception and the overall view of participants’ involvement in the implementation of an HACCP system in their breweries. The conceptual framework described in Chapter Two provides a rationale for using epistemology, constructivism/interpretivism and a qualitative research methodology for the current research study.

3.2 Research paradigms

Research involves systematic investigations, whereby data are collected, analysed and interpreted to empower individuals in the context (Collis and Hussey 2003). Collis et al, (2003) define “paradigms as a progress of scientific practice based on people’s philosophies and assumptions about the world and the nature of knowledge: how the research should be conducted”. It is therefore understood that a paradigm is a systematic model that the researcher employs to conduct research. A paradigm consists of four parts: “ontology”, “epistemology”, “methodology” and “methods”. Ontology is “concerned with the nature of existence” (Crotty, 1998). Epistemology, “deals with the nature of knowledge” (Crotty, 1998). Jackson (2016) states that the liaison between ontology and epistemology is essential and can be considered as the foundations on which research is built. It is the researcher’s ontological and epistemological assumptions that inform the decision to select a desire methodology and the methods of research.

Jackson (2016) asserts that techniques are the range of “methodological approaches used to collect the data that are to be utilised as a reason for inference and interpretation”. “Methodology is the strategy that justifies the decision of specific techniques”.
Saunders et al.’s (2008) research onion model is illustrated Figure 9, which shows different logical layers of research paradigm. The different layers of the onion model serve as a general basis from which to consider the following: the philosophical orientation; the research approach; research strategies; the research timelines; and the data-collection techniques.

This research study aimed to capture the understanding, beliefs, perspectives and knowledge of the respondents involved in the implementation of an HACCP food safety system rather than measuring hypotheses, which means that a phenomenological or interpretivism paradigm suits the requirements of the study. Dudovskiy (2016) defines a “phenomenological research study as a study that attempts to understand people’s perceptions, perspectives and understanding of a particular situation or phenomenon”. Padilla-Diaz (2015) adds that the best criterion for determining the appropriacy of the use of “phenomenology” is when the research problem requires a profound understanding of human experiences common to a group of people.

Mackenzie and Knipe (2006) argue that the “interpreivist or constructivist approaches tend to rely on the participants’ views of the situation being investigated and recognise the impact on the research of their own background and experiences”.
Table 2: Difference between the positivistic and phenomenological paradigms (adapted from: Collis & Hussey, 2003)

<table>
<thead>
<tr>
<th>Positivistic</th>
<th>Phenomenological</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quantitative data</td>
<td>Qualitative data</td>
</tr>
<tr>
<td>Objectivist</td>
<td>Subjectivist</td>
</tr>
<tr>
<td>Scientific</td>
<td>Humanistic</td>
</tr>
<tr>
<td>Experimentalist</td>
<td>Interpretivist/Constructivist</td>
</tr>
<tr>
<td>Uses large samples</td>
<td>Uses small samples</td>
</tr>
<tr>
<td>Generalises from sample to population</td>
<td>Generalises from one setting to another</td>
</tr>
<tr>
<td>Location is artificial</td>
<td>Location is natural</td>
</tr>
</tbody>
</table>

3.3 Research approach

According to Kothari (2004), a “qualitative way of doing research is more bias and instinctive in nature and includes scrutinising and reflecting on views in order to acquire understanding of social and human activities”. “The value of using in-depth qualitative methodologies has been identified as an insightful progression toward improved data collection, given that other methodological approaches have reportedly ‘left the adherence problem unresolved’” (Gilling et al., 2001). “Qualitative research is an approach for exploring and understanding the meaning that individuals or groups ascribe to a social or human problem” (Creswell, 2014). “Stemming from an interest in thorough understanding of human behaviour, social scientists tend to use qualitative research aiming to accumulate a detailed account of human behaviour and beliefs within the contexts they occur in” (Alshenqeeti, 2014).

Kothari (2004) also states that a “qualitative approach to research is concerned with subjective assessment of attitudes, opinions and behaviour. Research in such a situation is a function of the researcher’s insights and impressions. Qualitative research generates results either in a non-quantitative form or in a form that is not subjected to rigorous quantitative analysis. Generally, the techniques of focus group interviews, projective techniques and in-depth interviews are used”. The research approach used for the current study was qualitative, which is defined by Collis and Hussey (2003) as more subjective in nature and as involving examining and reflecting on perceptions in order to gain an understanding of social and human activities.

“Qualitative research is characterized by its aims, which relate to understanding some aspect of social life, and its methods which generate words, rather than numbers, as data for analysis” (Patton & Cochran, 2002). Hancock, Windridge and Ockleford (2007) define “qualitative research” as concerned with creating clarifications of social phenomena. This study employed a qualitative approach to allow in-depth and careful scrutiny of the situation. “Qualitative research is exploratory and open-minded, which is applicable to this study” (cf. Patton, 1987). Collis and Hussey (2003) state that exploratory research is performed to explore and solve a research problem or subject where there are no prior studies or fewer studies...
performed. Exploratory research was conducted so that the researcher could develop a theory from the knowledge gained from the participants’ experience.

Anderson, (2010) outline the strengths of qualitative research as:

- Issues can be investigated in detail and top to bottom; Interviews are not constrained to particular inquiries and can be guided or redirected by the scientist ceaselessly; the research system and course can be instantly re-evaluated as new data or information is available; the information in light of human experience that is acquired are ground-breaking and at times are more convincing than quantitative information; Subtleties and complexities about the exploration subjects as well as point are found that are every now and again missed by more positivistic enquiries; and data are ordinarily accumulated from a few cases or individuals, so disclosures can't be summed up to a greater population.

On the other hand, the limitations of the qualitative approach are described by Anderson, (2010) as:

- “Research quality is intensely reliant on the individual skills and aptitudes of the researcher and are more easily influenced by the researcher’s personal biases and idiosyncrasies; Rigour is more difficult to sustain, evaluate and illustrate; The amount of data acquired makes analysis and interpretation more tedious; At times, qualitative technique is not well understood and accepted as opposed to quantitative approach within the scientific community; The researcher’s presence during data gathering, which is often unavoidable in qualitative research, can negatively influence the responses and introduce bias; Issues of anonymity and confidentiality can present problems when presenting findings; and Findings can be more difficult and time-consuming to characterise in a visual way due to volume of data collected”.

“Qualitative researchers have been criticised for overusing interviews and focus groups at the expense of other methods such as ethnography, observation, documentary analysis, case studies and conversational analysis” (Anderson, 2010). The researcher conducted thorough a literature review and documentary analysis to minimise the limitations of this approach.

3.4 Research design

Collis and Hussey (2003) define “research design as the science and the art of arranging procedures for conducting studies so as to get the most valid findings”. Kothari (2004:2) writes that a research design is:

- The arrangement of conditions for collection and analysis of data in a manner that aim to combine relevance to the research purpose with economy in procedure. The research design is the conceptual structure within which research is conducted; it constitutes the blueprint for the collection, measurement and analysis of data.

A research design is a “blue print, structure and approach of research that is designed to obtain answers to investigate questions or problems”.

Kumar (2011:95) suggests that: “A traditional research design is a blueprint or detailed plan for how a research study is to be completed, operationalizing variables so they can be measured, selecting a sample of interest to study, collecting data to be used as a basis for testing hypotheses, and analysing the results.” “Research design stands for advance planning of the methods to be adopted for collecting
the relevant data and the techniques to be used in their analysis, keeping in view the objective of the research and the availability of staff, time and money” (Kothari, 2004). Kothari (2004) explains that “research designs in the case of exploratory research study are also known as formulative research studies. The main purpose of such studies is that of formulating a problem for more precise investigation or of developing working hypotheses from an operational point of view and look for patterns, ideas or hypotheses, rather than testing or confirming a hypothesis”. According to Kothari (2004), “the advantages or benefits of exploratory research incorporate adaptability and flexibility to change. Exploratory research is operational in laying the groundwork that will lead to future studies and these kinds of studies can possibly spare time and other resources by determining the types of research that are worth pursuing at earlier stages”. Kothari (2004) lists the “disadvantages of exploratory research as bias in the collection, analysis and interpretation of qualitative data and the use of a smaller samples make it difficult to generalise the finding and make a conclusion about the population. The major importance in such studies are on the discovery and revelation of ideas and insights about the real world”.

Table 3: Research design features of an exploratory study (adapted from: Kothari, 2004)

<table>
<thead>
<tr>
<th>Research design</th>
<th>Exploratory research</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall design</td>
<td>Flexible design</td>
</tr>
<tr>
<td>Sampling design</td>
<td>Non-probability sampling design</td>
</tr>
<tr>
<td>Statistical design</td>
<td>No pre-planned design for analysis</td>
</tr>
<tr>
<td>Observational design</td>
<td>Unstructured instruments for collection of data</td>
</tr>
<tr>
<td>Operational design</td>
<td>No fixed decision about the operational procedures</td>
</tr>
</tbody>
</table>

Collis and Hussey (2003) argue that the exploratory study focuses on gaining insights into and familiarity with the subject area for more rigorous investigations at a later stage. With this in mind, the approach to this research study was open and concentrated on gathering a wide range of data and impressions from participants in their setings. An exploratory study was considered appropriate for the study as the researcher aimed to gather data to provide insight into the implementation of an HACCP system.

3.5 Population and sampling

Collis and Hussey (2003:56) refer to a research population as a precisely defined set of people or collection of items that is under consideration. A research sample is made up of some of the members of the population.

Kumar (2011:179) finds that:

The purpose of sampling in quantitative research is to draw inferences about the group from which the sample was selected, whereas in qualitative research it is designed either to gain in-depth knowledge about a situation/events/episode or to know as much as possible about different aspects of an individual on the assumption that the individual is typical of the group and hence will provide insight into the group.

A sample is a therefore “subgroup of a population” (Latham, 2007; Kumar, 2011). Sampling has advantages and disadvantages according to Kumar (2011). “The advantage of sampling is it saves time, monetary and human resources. Conversely, the disadvantage of sampling is that the precision and accuracy of the outcome might be compromised because the characteristics of population is not known but estimated”. For the current study, the researcher selected a few individuals based on their knowledge.
of the food safety system, instead of involving everyone in the company. To overcome the disadvantage of sampling, the author selected only individuals known to be knowledgeable on the subject.

Kumar (2011) and Kothari (2004) indicate that non-probability and non-random sampling do not follow the theory of probability in the choice of samples from the sampled population. These types of sampling are used when the number of elements in a population is either unknown or cannot be individually identified. The research study was not interested in a statistical quantitative analysis, which meant that probability sampling techniques were inappropriate for the study. A non-probability sampling strategy was employed for this study because it did not follow the principles of probability statistics.

Latham (2007) and Kumar (2011) provide four types of non-probability sampling technique:

- **Quota sampling** is where the sample is selected from a convenient location and whenever a person with the visible relevant characteristics is seen that person is asked to participate in the study; this is similar to convenience sampling. **Accidental sampling** is based on a convenience in accessing the sampling population. **Purposive or judgemental sampling** is based on the judgement as to who can provide the best information to achieve the objectives of the study. This type of sampling is useful when constructing a historical reality, describing a phenomenon or developing something about which only little is known. **Snowball sampling** is the process of selecting a sample using a network; it starts with a few individuals in a group, who are then asked to identify other people.

The sampling strategy used for this study was “non-probability” or “non-random” sampling, and the sampling technique was purposive (judgemental) sampling. Purposive sampling is a “method generally utilised in qualitative research to identify and select individuals with required information and knowledge, and it can easily be performed under restricted resources. This includes recognizing and choosing people or group of people that are particularly educated or experienced with the subject of interest” (Palinkas, Horwitz, Green, Wisdom, Duan & Hoagwood, 2013). The primary consideration in purposive sampling is the judgement with respect to as for who can give the best data to achieve the destinations of the research.

The researcher chose the purposive sampling technique to select respondents carefully, based on their involvement in and understanding of the subject under investigation. The respondents were all in the supply department of the Africa Zone AB-InBev breweries, with the majority of them from the QA department. According to Latham (2007), “purposive sampling involves the selection of a sample on the basis of the researcher’s knowledge of the population, its elements and the nature of the aims of the research”. The first section of the interview used to collect data dealt with the personal information of the respondents’ background, where the respondents were requested to provide data on age, gender and ethnicity, level of education, professional categories and plant categories. This was used to confirm that the respondents satisfied the requirements of the purposive sampling.

The advantages of purposive sampling, according to Dudovskiy (2016), are that this “technique is made up of the most cost-effective and time-effective sampling methods available; appropriate methods are available if there are only a limited number of primary data sources who can contribute to the study; and the methods are effective in exploring anthropological situations where the discovery of meaning can benefit from an intuitive approach”. The researcher found that purposive sampling was cost- and time effective; individuals were known and selected on the basis of what they knew; the methods were appropriate for contributing to the study where the primary data was limited; and the technique was
appropriate for anthropological purposes and enabled the attitude and behaviour of individuals to be understood.

Conversely, Dudovskiy (2016) outlines the “disadvantages of purposive sampling as: vulnerability to errors in judgement by the researcher, a low level of reliability and high levels of bias, and the inability to generalise research findings”.

The researcher aimed to overcome the limitations of purposive sampling by carefully identifying and selecting individuals from the QA department of AB-InBev who had extensive experience in and knowledge of the subject investigated. Individuals were not only selected on the basis of their seniority or junior position in the business, but also according to their role with respect to the implementation and maintenance of the food safety system. A sample of 26 knowledgeable individuals was selected to participate and only 20 of these completed and returned the interview questions. This study did not involve a statistical analysis, but rather focused on solid and concrete information from knowledgeable participants. This meant that the size of the sample was adequate for the study.

3.6 Data-collection procedures

Hox and Boeije (2015) indicate that to “collect and gather data, social scientists utilise number of different data collection approaches. Firstly, experiments and quasi-experiments are important because they involve a research design that allows strong causal inferences. Secondly, surveys using structured questionnaires are another important data-collection strategy because they are involved in collecting data from a large number of variables from a large and representative sample of respondents. Thirdly, in qualitative research design the data-collection strategy typically involves collecting a large amount of data on a small, purposive sample, using techniques such as in-depth interviews, participant observation or focus groups”.

Hox and Boeije (2005) further state that “qualitative researchers examine how people learn about and make sense of themselves and others and how they structure and give meaning to their daily lives”. “Qualitative data are most often collected by researchers through interviews and questionnaires” (Hox, & Boeije, 2005). However, compared to questionnaires, interviews are more powerful in extract narrative data that allow researchers to investigate people’s views in greater depth (Alshenqeeti, 2014). A common method to collect data is the “qualitative interview”, in which interviewees are given the platform and space to dialogue about their experiences and views, and interview guides are used with a range of topics that can be adjusted.

In this study, the researcher explored the process and steps of implementing an HACCP food safety system at AB-InBev Africa Zone clear beer plants, with the primary purpose of proposing a tailored-made HACCP implementation model for the TAB categories. Qualitative text data were collected through in-depth interview questions administered to carefully selected respondents, based on their knowledge of, and experience and involvement in the subject under investigation. The respondents were purposively sampled from the supply chain (QA, Brewing, Utilities, Stores and Warehouse) of the organisation. “Text is considered a rich source of data in qualitative studies and may be solicited by mail or in person” (Oosthuizen, 2009). Pavlov (2017) emphasises that qualitative research is more interested in knowing a human behaviour from the respondent’s perceptive. In line with this, data were collected through emailed interview questions and data in the form of text were analysed by themes.

Collis and Hussey (2003) define interviews as a “method of collecting data in which selected participants are asked questions in order to find out what they do, think or feel. Interviews make it easy to compare
answers and may be face to face, voice to voice or screen to screen”. Alshenqeeti (2014) points out that, unlike the structured interview, unstructured interview is an open situation through which greater flexibility and freedom are offered to both sides in terms of planning, implementing and organising the interview content and questions. For the purposes of this research, in-depth interviews were used. In-depth interviews are personal and unstructured or semi-structured interviews whose aim is to identify the respondents’ emotions, feelings and opinions regarding a particular research subject. The main advantage of personal interviews is that they involve personal and direct contact between interviewers and interviewees, and eliminate non-response rates.

Collis and Hussey (2003) state that the researcher may follow predetermined questions with one or more tailored questions to explore answers in more depth. Semi-structured interviews, according to Patton (2002), are “conducted on the basis of a loose structure or topic guide made up of open-ended questions that define the area to be explored”. According to Welman, Kruger, Mitchell and Huysamen (2005), “semi-structured interviews identify the important variables in a particular area, to formulate penetrating questions about them, and to generate hypotheses for further investigation. In the current study, data were collected by email interview questions, where respondents were requested to answer the questions by recording their answers on the form provided”.

Meho (2006) outlines the benefits associated with the use of electronic interviewing in qualitative research as:

“Email interviews cost considerably less to administer than telephone or face-to-face interviews, The researcher can invite participation of large or geographically dispersed samples, email in research also decreases the cost of transcribing, data from email interviews require little editing before analysis, email also eliminates the need for synchronous interview times and allows the researcher to interview more than one respondent at a time”.

Table 4: Advantages and disadvantages of interviews (Alshenqeeti, 2014)

<table>
<thead>
<tr>
<th>Advantage</th>
<th>Disadvantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Useful for gaining insight into and context of a topic</td>
<td>Susceptible to interview bias</td>
</tr>
<tr>
<td>Allows respondents to describe what is important to them</td>
<td>Time-consuming and expensive compared to other data-collection methods</td>
</tr>
<tr>
<td>Useful for gathering quotes and stories</td>
<td>May seem intrusive to the respondent</td>
</tr>
</tbody>
</table>

3.6.1 Primary data

“Primary data are considered a data that are gathered for the particular research problem at hand, using technique that fit the research problem best” (Hox & Boeije, 2005). On every occasion that primary data are gathered, new information are introduced to the current store of social knowledge. Collis and Hussey (2003) and Kumar (2011) describe primary data as original data, which are collected at source.

Original data were collected from AB-InBev Africa Zone employees through semi-structured interview questions. Kumar, (2011) assert that interviews are the common method used to collect information from people. An interview is the process of an interviewer reading questions to respondents and recording
their answers. Interviews can be conducted face to face, telephonically and/or by email, where respondent complete sections and send them back to the interviewer. The researcher collected original data by email, where the respondents completed the sections on the form and also by telephonic interview, where the conversations were recorded on Microsoft OneNote 2010. The questions were approved by the researcher’s main academic supervisor as appropriate for use in obtaining data and that could be expected to answer the research question under investigation.

Hox and Boeije (2005) outline the advantage of collecting data as the “operationalisation of the theoretical constructs. The research design and the data-collection strategy can be tailored to the research question, which ensures that the research is coherent and that the information collected actually helps to resolve the problem”. On the other hand, Hox and Boeije (2005) add the disadvantage of collecting data as costly and time-consuming. To overcome these disadvantages, the relevant information on the research topic can be reused if it is accessible. The researcher collected primary data using email interviews and the respondents were reminded to return the answered questions by email until the information was provided.

3.6.2 Secondary data

Hox and Boeije (2005:593) define secondary data "as material created by other researchers and made available for reuse by the general research community". Collis and Hussey (2003) agree with the view expressed by Hox and Boeije (2005) that “secondary data” are data that are already available, such as books, documents and films.

The researcher, in this study, collected secondary data from literature and documents, including different publications such as textbooks, internet articles and journal articles and documents such as AB-InBev food safety policies, food safety procedures and food quality and safety manuals. Kumar, (2011) mention that qualitative research studies use secondary sources as a method of data collection to extract descriptive and narrative information. Documents that were particularly relevant for the study were the food safety policy Voyage Plant Optimisation) VPOQ-A3-100 and the AB-InBev breweries Quality Environmental Management System) QESH manuals (SAB, 2015).

3.7 Data analysis and interpretations

“Qualitative research yields mainly unstructured text-based data” (Wong, 2008). Saldaña (2009) argues that data consist of interview transcripts, observation notes, diary entries, pictorial display, audio or video clips, email correspondence or other multimedia materials. Wong (2008) defines data analysis in qualitative research as the “process of systematically searching and arranging the interview transcripts, interview notes, observation notes, or other non-textual material that the researcher accumulates to increase the understanding of the phenomenon being studied”. Spencer and Ritchie (1964) argue that “qualitative data analysis is about detection and the tasks of defining, categorising, theorising, explaining, exploring and mapping of data”. Levy (2006) adds that the aim of analysing qualitative data is to discover the perceptions and experiences of the participants so that the researcher can then extract themes.

The data collected by email interview were coded by circling and highlighting similar answers and grouping them into different categories. Coding was used as a technique for analysing qualitative data collected from interview questions. Saldaña (2009) and Theron (2015) agree that code is a descriptive construct designated by the researcher to capture the primary content of data. The researcher employed this coding technique to highlight and record the primary content of the data produced by different
respondents. Wong (2008) argues that coding “involves a process of making sense of huge amounts of data by reducing the volume of raw information, followed by identifying significant patterns, and finally drawing meaning from data and subsequently building a logical chain of evidence”. Conversely, Theron (2015) argues that coding does not constitute the totality of data analysis, but it is a method used to organise the data so that underlying messages portrayed by the data may become clearer to the researcher.

The researcher followed Saldaña’s (2009) model of streamlining codes to theory as depicted in Figure 10:

1. Interview answers were scrutinised, similarities were highlighted by coding technique and data were classified into different groups or categories.
2. Categories with cluster-coded data were further refined into subcategories.
3. Categories or subcategories were compared with each other and consolidated in various ways to make concepts or themes.
4. The concepts or themes were systematically interrelated to lead toward the development of theory.

Figure 11: A streamlined codes-to-theory model for qualitative inquiry (Saldaña, 2009)

This coding model approach was considered appropriate for the study to analyse the qualitative data collected from the respondents. The outcome of this data was used to develop an HACCP-based food safety system implementation model, which can be adopted by any organisation willing to implement the system.
3.8 Research trustworthiness

“Trustworthiness is the extent to which the findings are an authentic reflection of the personal or lived experiences of the phenomenon under investigation” (Curtin, 2007). Trustworthiness, as Gunawan (2015) suggests, becomes a subject of influencing, whereby researchers are viewed as having made those practices visible and therefore auditable. “The trustworthiness of qualitative research generally is often questioned by positivists, because their concepts of validity and reliability cannot be addressed in the same way in naturalistic work” (Shenton, 2004). However, according to Levy (2006), “trustworthiness within the context of qualitative research can be assessed by the concepts of credibility, dependability and conformability”. According to Gunawan (2015), trustworthiness for qualitative research has been divided into four parallel criteria: credibility, transferability, dependability and conformability. Roberts (2006) believes that “trustworthiness depends on a number of research features: the initial research question; how data are collected, including when and from whom; how they are analysed; and what conclusions are drawn”. Levy (2006) concurs with the view of Roberts (2006) on criteria for trustworthiness and suggests the following in order to meet these criteria: careful use, interpretation and examination of appropriate literature; careful justification of the qualitative research methodologies employed; and careful structuring of the data analysis to ensure full and descriptive evaluation and assessment, particularly in relation to data of key significance.

Morrow (2005) summarises these criteria as attempts to minimise bias and ensure validity of the data, systematic rigour of fieldwork procedures, triangulation, and reliability of coding and pattern analyses, correspondence of findings to reality and contribution to theory.

The researcher adopted three main techniques to ensure the trustworthiness of the study in achieving the criteria.

The first technique used to ensure trustworthiness was the triangulation technique: “By combining multiple observers, theories, methods, and empirical materials, the researcher can attempt to overcome the weakness or intrinsic biases and the problems that come from a single method, single observer or single theory studies. Often the purpose of triangulation in specific contexts is to obtain confirmation of findings through convergence of different perspectives” (Creswell & Miller, 2000; Yeasmin & Rahman, 2012).

The triangulation technique, as explained by Oliver-Hoyo and Allen (2005), involves the careful reviewing of data collected through different methods in order to achieve a more accurate and valid estimate of qualitative results for particular constructs. Levy (2006) adds that triangulation is the collection of data from different sources, such as different interviewees and different sites, and the analysis of data from literature and document reviews and observations. The researcher used triangulation to compare data collected from the interviews with the data collected from the literature and company document reviews. Oliver-Hoyo and Allen (2005) affirm that “triangulation compares information to determine corroboration; in other words, it is a process of qualitative cross-validation”. Shenton (2004) adds that the use of different methods in a research study compensates for their individual limitations and exploits their respective benefits. Therefore, triangulation provides more accurate and valid results when each of three cross-validation methods yields the same results. Yeasmin and Rahman’s (2012) argument about triangulation is that it can be achieved by using different research techniques and is helpful for cross-checking and providing confirmation and completeness, which brings balance between two or more sets of data or research types.
The second technique to be adopted to ensure trustworthiness was purposive sampling. Interviewees were carefully chosen, based on their relevance to the subject rather than because they were representative of the sample. The researcher believes that data collected from a purposive sample is more likely to be accurate, as the respondents have an in-depth knowledge of the subject under study.

The third technique to be employed was peer debriefing. “A peer debriefing is a review of the data and research process by someone who is familiar with the research or the phenomenon being explored. Peer reviewers provide support, play devil’s advocate, challenge the researcher’s assumptions, push the researcher to the next step methodologically, and ask questions about methods and interpretations” (Creswell & Miller, 2000). The researcher’s academic supervisor was used as a de-briefer for this study as he continually and consistently criticised the research methodology and pushed the researcher to take the research to the highest level. In addition, the researcher’s manager, a professor with extensive knowledge in the field of study, was approached and used as a de-briefer and also advised on the logic most useful for conducting this research.
4 Results and Discussion

4.1 Introduction

The present study was an attempt to develop an HACCP-based food safety model for AB-InBev TAB categories and other food manufacturing organisations. The researcher selected a sample of 26 knowledgeable and experienced respondents in both TAB and clear beer plants in the Africa Zone of AB-InBev breweries. With this purposive sample, email interviews were conducted to understand the process, challenges and success of HACCP implementation. This chapter presents the results of the qualitative text-data obtained from the analysis of the answers to the interview questions. The results are grouped and presented in two sections: background information and understanding of the HACCP food safety implementation process.

4.2 Background information

This section provide a background information of individual’s participated in the study, this include the age, gender, ethnicity, education level, professions, number of years in the business of the participants, department and AB-InBev categories.

4.2.1 Respondents’ age distribution

The results depicted in Table 5 show the ages of the respondents involved in the study, with the results grouped into four categories. The first category consists of individuals between 25 and 35 years old, which contributed 30% of the sample; respondents aged between 36 and 46 contributed 25% of the sample selected, and individuals between 47 and 57 years of age added 35%. Individuals above 58 contributed 10% of the sample. The distribution of age is based on the 77% of the respondents who returned the interview questions.

Table 5: The distribution of respondents’ ages

<table>
<thead>
<tr>
<th>Age range in years</th>
<th>Number</th>
<th>Percentages</th>
</tr>
</thead>
<tbody>
<tr>
<td>25-35</td>
<td>6</td>
<td>30%</td>
</tr>
<tr>
<td>36-46</td>
<td>5</td>
<td>25%</td>
</tr>
<tr>
<td>47-57</td>
<td>7</td>
<td>35%</td>
</tr>
<tr>
<td>58-68</td>
<td>2</td>
<td>10%</td>
</tr>
</tbody>
</table>

4.2.2 Gender of respondents

Figure 13 below presents the bar graph results concerning the gender of respondents in the AB-InBev supply function (Brewing, Quality, Utilities and Packaging). The results indicate that the majority of
respondents who participated in the study were females, with 60% represented; males had only 40% represented.

![Gender distribution of the respondents](image1)

**4.2.3 Ethnicity of respondents**

Figure 14 highlights that the majority of respondents who participated in the study were black at 70%, the highest percentage of all the ethnicity groups. White respondents constituted only 15%, with Indians and Coloured people forming 10% and 5% of the respondents respectively.

![Ethnicity of respondents](image2)

**Figure 14: Ethnicity of respondents who participated in the study**
4.2.4 Highest education level of respondents

Figure 15 indicates that the majority of respondents (45%) were post-graduates; 30% of respondents were in possession of a Bachelor’s degree; 15% of respondents had a diploma and 1% had matric or other, which could be on-the-job training. Respondents were selected on the basis of their involvement in the subject under investigation and the researcher noted that majority had higher education qualifications, which could be expected to have a significant and positive impact on the outcome of the study.

![Qualifications chart](image)

Figure 15: Highest education level of the respondents

4.2.5 Professional categories of respondents

Figure 16 depicts the professional categories of the respondents in the form of a doughnut graph. It was noted that the majority were senior managers (50%), such as regional QA managers, plant QA managers, brewing managers, utilities/engineering managers, and warehouse and store managers, who are responsible for the implementation of the food safety HACCP system in their respective sectors. An additional 30% were line managers (lab managers and team leaders), who are mainly responsible for ensuring that the requirements of the HACCP are executed, and 15% were specialists (QESH), who mainly own the quality and safety manual of the organisation. Only 5% of the respondents were top managers, who are responsible for setting policy direction and providing resources for the implementation of the system.
4.2.6 AB-INBEV categories of respondents

The interview questions were sent to five different sectors (Beer, Soft drinks, TAB, Spirit and Malting), and feedback was received from Beer, TAB and Malting only. As indicated in Figure 17, the majority of respondents were from the Beer sector at 65%, followed by TAB with 30% of respondents. From the Malting sector, only one person returned the questions and from the Soft drink and Spirit plants none were received. The information provided in Figure 17 is very important as it conveys different messages about the site categories. The analysis of these plants contributed positively to the study and assisted in reaching the desired outcome.
4.2.7 Years of respondents in the business

Figure 18 below presents the number of years of experience that each respondent had in the business. The figure indicates that the majority of respondents in strategic positions had experience of between 10 and 20 years. This is positive as it suggests that the organisation is retaining experience and skills. However, the figure reveals that an insignificant number of new people are recruited or promoted to business or strategic positions. There are also few individuals with more than 30 years of experience in AB-InBev.

![Figure 18: Respondents' years of experience in the business](image)

4.2.8 Departments in which respondents work in the business

As shown in Figure 19, the majority of respondents (60%) were in the QA department, with a minority in other departments such as Engineering, Supply, Technical, Brewing and Innovations. This was an important finding of the study as individuals from different departments were expected to contribute and share their knowledge and experiences. Skills shared within multidisciplinary teams are critical for any organisation as one department depends on the others for proper functioning. The interviews were aimed at personnel in the supply function, which covers the QA, Engineering, Technical, Brewing and Innovations departments, but the majority of respondents were QA personnel as they have a more extensive knowledge of the subject than those in the other departments, because they are the leaders and custodians of quality and safety in the business.
4.3 Motivation for adoption of HACCP system

The question: “What motivated the need for your organization to implement the food safety Hazard Analysis Critical Control Points (HACCP) system?” was asked by the researcher to understand if the respondents were aware of the factors that motivated or compelled their organisation to implement the HACCP system. This is an open-ended question and was very important for the study as the feedback on this question could be expected to give a sense or level of understanding of the subject investigated.

One respondent responded as follows:
“It is a policy of AB-InBev which makes the implementation of HACCP in all of its production plants mandatory and non-negotiable. Also, some of our consumers are demanding that we are HACCP compliant.”

Respondents outlined the reasons to implement HACCP system as follows:
“A need to assure safe products for the consumers and customers, to have a validation system for products, consumer and legal compliance, business continuity, prevention of contaminations, corporate reputation” to “Implement the system was motivated by the ability of system to effectively prevent contamination of their products and ability to give assurance to the customer/consumers of adequate controls that will ensure safe food”.

Other factors mentioned by the respondents were compliance with local and international legal requirements on food safety and reducing the number of food safety complaints from the trade market. Voyager Plant Optimisation (VPO) requirements were also mentioned. These are part of the AB-InBev policy on management of the business, which covers the three important aspects of Safety, Food safety and Quality and must be implemented in production.

Generally, all respondents agreed that, among other factors, the need for AB-InBev to implement the system was motivated by consumer safety; they wanted to ensure that their consumers consumed products that were free of contaminates. As Brito (2017:3) states: “The consumers are the boss and we
want to receive their feedback, which ultimately helps us improve our processes. If we provide them with consistent high quality and safety products, they are more likely to share positive feedback."

4.4 Respondents’ understanding of the HACCP food safety system

According to “Ergönü and Güng (2004), the HACCP is understood to be an effective food safety system based on GMPs and SSOPs for providing safe and healthy foods. It is understood to be an effective system because it provides an information flow for preventative and corrective actions and can easily be established on the production lines of all kinds of foods. On the other hand, if the HACCP is not well understood and adopted correctly in the plant or production line, the food safety hazards associated with the production may seep into the product and negatively affect the final consumers.

4.4.1 The HACCP as a food safety system

“A comprehensive food safety system that looks in details the risk associated with the raw materials, process and finished product and ways of eliminating them before the hazards happen. HACCP team is appointed by the senior leadership to oversee the food safety process and ascertain the control measures by considering the following steps such as, identifying hazards that requires control, measurement/control method for critical control points (CCPs), critical limits (in the case of a CCP), frequency of measurement, corrections and corrective actions, records of monitoring."

“HACCP and ISO 22000 systems manages food safety risk or hazards (Biological, Chemical and Physical) for the entire production process from incoming raw materials through production stages up to the final consumers.” It was further revealed that the HACCP plan is installed in the plant, throughout the production stages from receipt of raw material to final product to ensure that hazards are eliminated.

Respondents also stated that the system needs to be reviewed at least once a year even if there have not been alterations either to the system or process and all agreed in describing the HACCP as a “system designed to ensure food safety by preventing biological, physical and chemical hazards in processes and identifying control measures to reduce risk to a safe level”.

“In our TAB plants, we receive raw materials from small scale farmers who lack proper facilities to store commodities to produce opaque beer and beverages and we don’t have a system in place to remove food safety hazards from the receiving of raw materials to final product, and we don’t have microbiological set up to analyse the type of microbes that might be present in the product, we don’t have sophisticated equipment and method to measure the levels of lethal mycotoxins and pesticides, we basically rely on simple chemical analysis of caustic contamination, acid contamination, pasteurisation units and physical inspection of dust, foreign objects on packaged material and metal and foreign objects on raw materials." Further stated that, “I have been in the company for 8 years in the brewing department and I have heard about the HACCP, but never implemented the system in my plant due to the cost constraint and limited knowledge of the system, we are following the brewing protocol and issues are not significant or known, I guess in future the company need to comply with HACCP requirements and budget need to be made available.”

“HACCP implementation involves many different steps.” This is the view of one of the subject matter experts (SMEs), who demonstrated their understanding of HACCP implementation as follows: Firstly “a multidisciplinary team of different expertise such as Microbiologist, Food technologies, Engineers, Quality and Manufacturing professionals and Logistics is formed; Secondly, describe the process/product by
writing a full description of food handling operations; *Thirdly,* list all potential hazards at each step and list all controls which exist or could exist to eliminate or reduce hazards to acceptable level; and, *lastly,* use CCP decision tree.”

Respondents demonstrated a broader understanding of the HACCP food safety system in the food production settings and outlined their understanding of the categories as follows: “HACCP described as a structured and preventative food safety system, hazardous analysis of critical control points in the production process and install control measure to mitigate food safety hazards from raw materials to final products. This is achieved by establishing of a HACCP team whose responsibility among others is to oversee the requirements for the implementation, develop and approve process flow charts.”

On the other side, they described the HACCP as “a fundamental tool that identifies the hazards, evaluate the significance of the hazards and put control measures in place to prevent, eliminate or reduce hazards to acceptable level. Food safety is made up of prerequisites programs PRPs, HACCP, and product integrity.” It is added that: “HACCP system implementation is a commitment made by AB-InBev through their policy to assure consumers and customers with safe beer products.”

HACCP was further described as follows, “HACCP is a preventative tool employed to identify, eliminate and control food safety hazards from the receipt of raw materials through production process up to the point of consumption, implementation of HACCP system follow international principles. In our plant, HACCP plan is developed based on the principles for every stage of the process from raw material to final product.”

“As a malting plant of AB-InBev, we are responsible for ensuring that clear beer and opaque production plants, receive a malt and barley of high quality with reduced risk, we have installed a control measures to alleviate risk such as mycotoxins and pesticides from our farms, transportation, storage and packing of malts. HACCP is the best system to eliminate risk of producing unsafe product.”

### 4.4.2 Prerequisite programmes (PRPs) of HACCP food safety systems

The main PRPs are good manufacturing practices (GMPs) and sanitation standard operating procedures (SSOPs). These programmes involve the following components: physical structure and maintenance and sustaining of the plant, sufficient and flow water supply, employee’s health and personal cleanliness, pest control, sanitisation of the plant and production equipment, calibration and servicing of instruments, quality control and assurance of incoming raw material and ingredients, recall and traceability procedures and measures related to consumer complaints (Cusato et al., 2012).

Respondents, when asked to explain their understanding and knowledge of PRPs in their plants and how they perceived their importance, they answered as follows:

“PRPs stands for prerequisites programs and it is performed to evaluate GMPs within the plant, to avoid and control production hazards so we can ensure product integrity and the consumer’s health and are programs you need to put in place in the plant for HACCP to work properly, they centre mostly on GMPs.”

PRPs are further described as: “These are the control measures that the hazard analyses identify as necessary and which are not otherwise managed by the HACCP plan.” It is further explained as: “a basic foundation for HACCP to function. Well-functioning PRPs simplify and strengthen HACCP. The list of PRPs is inclusive but not exhaustive of the following: 1) facilities (building, workspace, change rooms, canteen, ablutions etc.), 2) utilities, 3) clean and sanitation, 4) pest control, 5) personal health and
hygiene, 6) prevention of cross contamination, 7) employee training and competence, 8) equipment maintenance and calibration."

In contrast, respondents from the Opaque beer plant in Africa responded as follows: “I am fully aware of the PRPs and what it aimed to achieve, our plant is very small with old technology and equipment’s, improper storage facilities and we are flooded by birds and rats, cockroaches and even snakes, proper facility need to be built to prevent contamination of our raw materials.” Furthermore, the respondents added that in their plants where TAB products are produced, a prerequisite program is not fully implemented due to the size of the plant and the small volume we are producing and the area we are situated, the biggest problems is the inability to control rats, snakes, wild animals and birds, the pest control is managed by external company but the situation is not improving.

“AB-InBev Quality, Always, Culture, which was recently launched as a pillar to focus on food safety, outline fabric, technology, GFSI and people and management as a pillar to ensure that products produced are safe for human consumption” was mentioned by individuals participated in the study. They further respond that “fabric” refers to the facilities and building and design of the plant to ensure the safety of products and “technology” refers to appropriate machines and equipment used in the plant and the testing laboratory to ensure that hazards and failure of quality is not missed. The GFSI is an umbrella to ensure that appropriate standards are used to assure food safety and people and management are responsible to ensure that the above mentioned are executed.

“In our malting plant, the biggest problem is metal detector to detect and remove the metals before our malt leaves the plant, but due to its inflated cost and lack of agent to supply us with the machine it makes it difficult to confirm that our malt is free of metal.

“Lack of skills and inability of microbiological and hygiene graduates to demonstrate the ability to understand and execute the microbiological activities in our country led to failure of our plant to implement hygiene procedure and emphasize on best cleaning and sanitation procedures. All of this is the results of lack of time to train people in critical area of food safety.”

One respondent from the biggest AB-InBev plant in South Africa stated that their plant was at an advanced stage in terms of PRPs and they had received a clean audit for receiving and storing of raw material such as hops and malts, with each material stored in a separate room at an appropriate temperature. This respondent added that they had implemented a new AB-InBev policy called block stock, which had replaced the SABMiller traceability; the system was working very well, with no issues experienced up to this point.

Almost all the respondents associated PRPs with “hygiene”, and they summed up PRPs as: “They are programs that assist in management of the cleanliness, hygiene and tidiness that support the HACCP program and understood to be good practices that promote the HACCP system and they form foundation of a good HACCP system and focus on the following areas of the fabric: plant exterior, grains handling and brew-house, fermentation and maturation, filtration and bright beer, bottle lines, can lines, keg lines, logistics, employee GMPs.”

Respondent related their understanding as to the programs as: “PRPs are the basic conditions and activities that are necessary to maintain a hygienic environment throughout the manufacturing process prior to HACCP implementation. This provides a foundation for implementation of an effective HACCP system and without this, HACCP alone will not be sufficient to reduce or eliminate food safety hazards.”
Personal hygiene is defined as the maintenance of personal health, particularly by cleanliness (Wandolo, 2016). Wandolo (2016) records that personal hygiene is achieved through daily bathing or showering, wearing clean underwear and clothes, and caring for the hair, mouth, teeth, hands and nails.

One respondent added that good hygiene was the foundation for preventing the spread of food-borne illnesses, as human beings were said to be the major source of food contamination. For this reason, their plant had installed “touchless taps” in their bathrooms and sanitizer in every section and pause areas to minimise uncleanliness and the spread of pathogens to the production areas.

On the basis of the results and findings from different respondents, PRPs can be defined as basic hygienic conditions that every company needs to put in place prior to the implementation of an HACCP, because this will reduce conditions that will aggravate hazards and hinder the HACCP from focusing on CCPs of the production.

Cusato et al. (2012) add that the inadequate installation of PRPs may lead to more complex HACCP plans to be developed, with a greater number of CCPs to be monitored. More CCPs identified means an increase in difficulties of managing the HACCP plan and affects efficacy in terms of food safety.

4.4.3 Respondents’ knowledge and experience of implementation and maintenance

This question was designed to evaluate individual experience and knowledge of and exposure to HACCP system implementation and/or maintenance.

To answer the question, respondents responded as follows: “As a Quality Assurance (QA) manager it has been imperative that I have a good working knowledge and experience of the systems as the team leader of the brewery on this aspect and I have successfully gone through several external audits by SABS with no findings. Implementation was not too difficult, we were able to mobilize and get buy in from the value chain practitioners. However, issues around traceability took time to entrench. Maintenance was difficult in that first two years as people felt it was Quality Assurance (QA) ‘s responsibilities, but with time and the introduction of AB-InBev Manufacturing way, platforms were established where quality was cascaded to and discussed at all levels of the personnel”.

“HACCP implementation and maintenance is supported and nurtured by regular awareness and training to remind operators what the system stand for and aimed to achieve. Also, in the operational areas, the process checklists, statistical process control are designed in such a way to control and monitor all facets of the PRPs and CCPs. Twice a year we also do internal audit to keep the system alive. We also do level 3 Gemba walks (Plant managers and his managers) to support GMP facets.”

Another respondent, who had limited exposure to the AB-InBev HACCP system, responded as follows: “Not much exposure and experience at in my plant. However, I was previously involved in HACCP and ISO 22000 implementation at a company I worked for and I was the HACCP team leader. Therefore, I was responsible for ensuring the HACCP team has been trained and is competent as well as HACCP implementation and alignment to ISO 22000 requirements.”

The findings from this question indicated that 80% of the respondents had knowledge and experience regarding HACCP system implementation and maintenance that ranged from good to expert, while 20% of the respondents rated their exposure to the system as fair. However, they all agreed that the HACCP is an “effective system” for assuring food safety and also acknowledged that the HACCP is an evolving system that needs continuous review.
Respondents who viewed themselves as individual with limited exposure to the system stated that: “HACCP is not event but continuous process which needs thorough reviews and updates as some of the hazards continue to surface daily and every change to the product, the process requires HACCP review and update.”

Some respondents stated as follows: “We have started the process of implementing food safety system in our plant in 2015, and we have implemented it per line from raw material to finished product and we have followed the HACCP principles such as hazard identification, determining critical control point and developed a method of analysis for chemical but microbiological is currently outsourced and we are still busy revamping the lab to include micro lab”. Definitely, the HAACP follows critical steps and is dependent on the knowledge of the people involved and the availability of resources.

4.5 Barriers to HACCP Implementation

This question was asked in an attempt to understand and outline the challenges and barriers associated with implementation of an HACCP food safety system at AB-InBev Africa. Figure 20 outlines the challenges and barriers experienced by AB-InBev respondents during planning and implementation of the HACCP system.

![Figure 20: Barriers to the implementation of the HACCP system](image)

The most frequent response was lack of training, knowledge, skills and education (14 respondents). According to the results obtained from the respondents, lack of training is the most frequently recognised barrier to the implementation of a food safety system. It is understood that for a food safety HACCP system to be effectively implemented and maintained, a training programme needs to be on the list of any organisation that wishes to implement such a system. One respondent confirmed that: “Lack of adequate training is an issue in our plant, we have limited budget to cover all aspect of food safety and as a result compliance become difficult.”

Bas, Ersun and Kvanç (2004) reported that the problems of effective implementation of an HACCP in food businesses have been “associated with low levels of management commitment, high staff turnover
rates, lack of motivation, lack of financial resources, inadequate equipment and poor physical conditions at the facility. The findings depicted in Figure 20 confirm the findings of Bas et al. (2004) that lack of management commitment, increased stuff turnover, unavailability of resources and inability to form a cross-functional HACCP team are barriers to HACCP implementation.

Employee commitment was followed by management commitment as challenges in the implementation of an HACCP system, with a tally of 6 and 5 respectively. Lack of financial and other resources, such as GMPs and PRPs, and lack of cross-functional teams were also identified as hindrances to effective implementation of the system, with scores of 4 and 2 respectively. Respondents acknowledged lack of accountability at source, employee turnover and unavailability of time as barriers for HACCP implementation but did not believe that they were significant, with each receiving a tally of 1.

“The HACCP system requires the top management team of the company to provide commitment and direction, strong leadership and adequate resources for the programme to succeed” (Wandolo, 2016). However, in this case the system was compounded by a number of challenges, which included lack of financial resources, lack of time, and lack of technical expertise and trained personnel, in addition to other internal and external barriers, such as staff turnover. Wandolo (2016) adds that, given the troubles in the activity of the food business, the HACCP framework has been viewed as a weight in itself since the business encounters challenges in adjusting to various operational working examples notwithstanding sudden varieties sought after and remaining task at hand on the menu.

Khalid (2015) and Gilling et al. (2001), argue that lack of training on food safety impedes the fruitful implementation of the HACCP. On the other hand, Cusato et al. (2012) specify that the lack of adequate resources such as GMP, GHP, machinery and equipment is the result of the ineffective implementation of an HACCP system.

### 4.6 Benefits of the HACCP

The respondents were asked if they were aware of the benefits associated with effective implementation of an HACCP food safety system. Figure 21 outlines the benefits of the HACCP system with their frequencies as recorded by the respondents.
The greatest benefits of the HACCP food safety system were high consumer compliments and improved quality, meeting specifications and reducing downtime, with a frequency of 20% and 17% respectively. Other benefits, with a respective frequency of 13% and 11%, were a decrease in consumer complaints and an increase in product safety; and a reduction in cost and waste and an increase in awareness and in the visibility of process and product CCPs. Protecting the reputation of the company and adherence and compliance to local and international legislation and regulations were recognised as benefits but were cited less frequently.

Mortimore (2013) as reporting that implementation of an HACCP system maximises the safety of the products and Romano et al. (2004) as arguing that organisations with a sound HACCP system have greater access to the international market. Karagozlu et al. (2009) and Basit (2000) find that increased customer satisfaction and product safety are the benefits of having an effective HACCP system in place. Sheriff (2013) and Khalid (2015) add that HACCP system implementation ensures and maintains company reputation.

4.7 Skills needed for HACCP implementation

The researcher asked the respondents from AB-InBev breweries with the aim of understanding the critical skills needed in food industries to implement an HACCP system. Figure 22, depicts the types of skills needed for the implementation of a food safety system and their frequencies.
The most frequent skills needed for effective implementation of an HACCP system were reported to be external consultant and technical skills (31%), followed by leadership and change management at a frequency of 28%. The majority of respondents argued that the company must seek the guidance of a consultant on food safety systems and the top leadership of the company must provide clear direction regarding what the company needs to achieve. Time and project management skills had a frequency of 21%, which is significant, and execution, training and coaching skills appeared to be necessary but less important, with frequencies of 14% and 7% recorded.

Arvanitoyannis and Kassaveti (2009) and Anandappa (2013) agree that the food safety team and internal and external individuals responsible for food safety must have the necessary competencies and skills for HACCP application and maintenance.

4.8 Resources needed for implementation

Figure 23 illustrates the different resources needed to implement an HACCP food safety system as identified by the respondents.
The most frequently identified resources needed were equipment and materials, with a frequency of 14; followed by financial resources as also important with 13, and 10 for human resources. Figure 23 indicates that information and time management are considered as a significant resources needed for HACCP implementation. Jenner et al. (2005), indicate that assets and resources must be adjusted to the quantity of products and processes, conditions of the facility and the states of equipment, and level of safety understanding and training of the employees.

4.9 Training needs for implementation

“Training of personnel is essential to ensure supervisors, managers and operators are able to efficiently implement the HACCP plan. Training should cover topics such as the sources of hazards, the role of CCPs, the controls and monitoring procedures for which the individuals are responsible, and the documentation requirements” (Khandke & Mayes, 1998). However, the respondents attempted this question by providing the training needs for the implementation of the HACCP system and their answers are indicated in Figure 24 in the order of their importance, based on their frequencies.
Almost every respondent believed that training provided must focus on the HACCP system; this, according to the interpretation of the researcher, meant that the training must cover all 12 HACCP implementation steps. One respondent summed up the HACCP training needed as “we need to do several HACCP-related training, starting with the training of the members of the food safety team and all the employees of the factory”.

PRPs/GMP/Hygiene, Food Safety and Internal auditor training featured as elements of basic and essential training that every employee of the company that needed to implement and maintain the system should be trained and equipped in.

HACCP manual and records keeping training was rated by respondents as less frequent training that should be provided to employees for the system to be successfully implemented. This training could be provided mainly as “on-the-job training” on the production process from raw material to final output and should be covered by HACCP training. Regulatory awareness and process for certification were identified as training that needed to be provided in the form of continuous ongoing awareness.

### 4.10 Top management involvement

Early involvement of top management of the plant is essential for the effective implementation of HACCP. Real commitment can only be achieved if there is complete understanding of what it takes to develop and maintain a food safety programme and how the HACCP fits into the whole system. “This means that top managers need a basic and solid understanding of food safety hazards and how to design a way to control them. This includes an understanding of what HACCP actually is, what benefits it can offer to the company, what is really involved and what resources will be required” (Mortimore, 2013).

The respondents were asked to describe how they perceived the involvement of top management in their plants and one skilled respondent who worked as a line manager answered as follows:

![Training needs](image)
“Most HACCP failure are associated with management’s lack of commitment, the commitments of top managers in our plant were demonstrated as follows:

a. Openly stating to facility employees during meetings and through other avenues (e.g. signage) that HACCP is important and will be implemented.
b. During bi-annual plants meetings the plant management reviews sits and reviews all the HACCP stats or have taken interest in the HACCP-related training sessions.
c. Making sure that they themselves are aware of and adhere to all applicable HACCP related procedures and policies whenever they are in the facility.
d. Purposefully determining and allocating resources to the HACCP coordinator for the development and implementation of HACCP.
e. Requesting and reviewing periodic progress reports on the status of the HACCP system.
f. Implementing disciplinary consequences for facility employees who fail to fulfil their HACCP responsibilities.
g. Attending HACCP audit opening and closing meetings and introducing themselves to the auditors.
h. Visibly supporting HACCP teams when difficult decisions need to be made.”

Another respondent, who worked as a specialist, believed that top management in their plant was supportive of the whole process, especially on resource provision. Management review was conducted and action taken. However, another respondent’s view on top management was different: “average commitment from top management and we are currently resolving this, so that it runs top to bottom”. Another respondent stated: “Our plant is very small compared to other, the top management are not visible at the time needed, and the structure of the plant is complex as the quality is not directly reporting to the plant manager but to zone quality which is based at headquarters.”

4.11 Cross-functional teams involved

“HACCP team members consisted of food safety team leader, departmental managers or factory manager, production supervisor, head of quality control and sanitation, head of procurement division, head of Human Resource and Development and head of technical division. HACC P team is responsible for arranging HACCP plan, supervising HACCP implementation as well as verifying and implementing HACCP system” (Citraresmi and Wahyuni, 2018).

The respondents were asked if the teams from other departments were involved in the implementation of the HACCP and what their roles were.

Most of the respondents indicated that implementation of an HACCP system requires expertise from different departments of the business; food safety issues are the responsibility of everyone in the business not only quality personnel. One respondent indicated that the “HACCP team in their plant comprises of Quality manager, utility manager, brewing manager, packaging manager, stores team leader, warehouse manager to oversee food safety of the plant”. The quality manager in the food safety team is a food safety team leader, who facilitates all food safety issues and chairs food safety meetings. Another respondent added that “multidisciplinary team of knowledgeable individuals from different departments was appointed by brewery operation director and their role amongst other things is to
develop and verify the process flow, compile reports for management review, hold their department accountable to food safety and continuous training of their team members”.

A significant number of respondents agreed that all departments were represented in the HACCP team and that their roles were to ensure that HACCP principles were implemented and food safety concerns addressed and any changes to the process, product or method were incorporated into the HACCP plan.

The Zambia Breweries (2015) *Integrated Management Systems Manual* states that: “Multi-disciplinary food safety team have been appointed in the brewing, packing, warehouse, engineering/utilities, and HR department to develop and carry out the food safety studies.” Chamdor Brewery (2015) outlines its multidisciplinary team involved in food safety as follows: QA manager (Team Leader), Packaging Unit manager, Utility Manager, Brewing Specialist, Manager Quality Control (QC) services (Brewing and Packaging), Brewery Microbiologist, QESH specialist, Trade specialist and Risk Specialist.

In contrast, a respondent from TAB stated: “Our plant is so small, the volume is not big and food safety bi-weekly meeting is attended by lab team leader and production team leader, production manager and plant director and the meeting is coordinated by plant quality manager, meeting discuss certificate of analysis (COA), results of lab analysis, returns and complaints.”

Another respondent indicated that their plant was very small and struggling to constitute a solid food safety team from different departments. The level of skills needed was lacking and people were sceptical about attending a food safety meeting.

### 4.12 Continuous improvement of the HACCP system

This question attempted to understand from the respondents if there was any way that the system could be further improved.

A respondent stated: “The HACCP system is not a zero risk or all problem solving system but rather a system designed to enhance the safety of the food produced. It is continuous system that gets improved every time there is an opportunity identified through the review period. Currently I would say that our system has matured since we have measures in place to control or minimize known threats to the system furthermore when there are changes we are able to review the system to ensure effectiveness.”

This view indicates that the system can be further improved to ensure that existing and potential hazards are identified and controlled and subsequently that a safe product is produced.

Different respondents raised different factors that they believed could or would further improve the HACCP system in their plants. However, four respondents believed that if the system was implemented correctly, nothing should be changed and that teams should only “fix what is broken”.

The majority of respondents agreed that the HACCP system needed to be nurtured, areas for improvement identified and the system continuously improved. One Manager indicated that for HACCP system to be matured, the following must be considered: continuous system review; training and retraining of employees; implementation of the “Plan”, “Do”, “Check” and “Act” (PDCA) cycle for process improvement and problem solving; internal audits to verify the implementation of the system; implementation of the ISO 22000; and the implementation of an electronic document management system.
4.13 Satisfaction of respondents with the system

Almost every respondent indicated that they were very satisfied with the system and the way it performed. One respondent stated that the HACCP system worked well in their plant. Another respondent indicated that they were happy and the system worked well; however, the team leaders needed to ensure that operators followed the process and met the specifications. Another respondent added that the system worked well if policed and integrated into the QMS and FSMS across the plant.

4.14 Triangulations

Triangulation, according to Oliver-Hoyo and Allen (2005), “involves the careful reviewing of data collected through different methods in order to achieve more accurate and valid qualitative data”. Following Oliver-Hoyo and Allen’s (2005) view that triangulation is the process of qualitative cross-validation, the researcher employed peer review and document review of manual or procedure to determine the reliability and validity of the results. The results collected were sent to AB-InBev Zone Central Laboratory Manager to validate whether the results provided by the respondents were accurate.

4.15 Discussion of findings

This section provides a discussion of the main findings from the research study and, where applicable, relates the literature review to the outcomes of the research.

The researcher acknowledges that the sample from which data were extracted was small, but considers it sufficient to provide meaningful understanding, insights and outcomes that could be converted into knowledge and subsequently used to tailor a model for the implementation of an HACCP system. The researcher is confident about the validity of the data obtained, because of the nature of the purposive sampling used. The respondents were carefully chosen, based on their involvement, knowledge and experience in the HACCP food safety system of their companies.

To accomplish the objective of the study, interview questions were sent to the selected respondents. The outcomes of the interviews revealed that the implementation of an HACCP food safety system is a rather complicated process that requires a systematic understanding of the system and involvement of top management and all employees. It also requires a concerted team effort and the interrelated aspects of food safety. Management must demonstrate its commitment by being visible and providing clear policy direction and the resources needed for the implementation process (Mortimore & Wallace, 2012).

The findings suggested that employees should be convinced to embrace the system, because the buy-in of all employees is critical for ensuring that the activities are executed effectively. Quality and food safety must not be owned by senior management only as indicated by the research findings summarised in Figure 15, where 50% of respondents were senior managers. Instead, food safety must be owned and embraced by all employees and the line managers must ensure that this philosophy is preached in their respective teams. The results of this research suggested that food safety activities lie in the QA department. However, the researcher believes that QA should merely advise and guide on quality and food safety, and that each department must own and embrace food safety.

The results of this research show that the HACCP is an evolving system and its implementation strongly requires individuals with a higher education qualification to ensure innovation, creativity and continuous improvement. Top management, among other things, should appoint a multidisciplinary HACCP food safety team from different departments of the company, with a team leader to oversee the implementation
and management of food safety, react to any deviations and report any progress and issues to plant management. However, the research found that it is difficult to get a multidisciplinary team to lead the HACCP system; this is because skilled staff leave the company. The HACCP team must ensure that skills are available within the company and, if not, top management must source these skills from outside the organisation.

These research findings support the view expressed in the literature that the implementation of the HACCP system should incorporate five preliminary steps and seven HACCP principles (twelve implementation steps) and that, prior to that, PRPs should be in place. Almost every respondent emphasised the importance of PRPs as basic conditions needed to eradicate hazards associated with establishments. However, they reported that their facilities were old and equipment and technologies outdated, making it difficult to prevent the hazards from going into the production process.

The research indicates that implementation of HACCP food safety is associated with a number of challenges. Top management must be involved in every step of the implementation process to ensure that these challenges are identified and eliminated. The research confirms literature findings that the inability to provide sufficient training to all employees results in an ineffective food safety system in place.

The literature review revealed a number of challenges or barriers that prevent food businesses from implementing the HACCP system, but limited studies address the challenges related to beer and TAB manufacturing in Africa.

The research indicates that the lack of a training programme is a major challenge to HACCP implementation and maintenance, as employees will not understand their roles in the system. Lack of employee commitment is also one of the challenges organisations face, so management needs to ensure that employees buy in to the system. Top management should ensure that: 1) training programmes are available and relevant to the HACCP and must be provided to everyone; and 2) employee commitment must be encouraged through awards or incentives. Top management must be convinced that food safety is a primary function of the company and must at all times be enforced. Management commitment was also found to be an issue, with the research indicating that management visibility and involvement were lacking. Other barriers identified were the lack of skills in the organisations; the lack of resources, including GMP; old facilities, poor hygiene and old and outdated technology in the plants; and one individual felt strongly about the lack of a metal detector and other online equipment in their plant. These were all seen as big challenges to executing the HACCP requirements.

The study further indicates that the lack or unavailability of skills in the business contributes negatively to the implementation of an HACCP food safety system. The findings suggested that the expertise of an external consultant is needed to provide guidance and direction and the consultant must have an intensive knowledge of the business and experience in implementation, problem solving and auditing of food safety. Where the skill was found to be available inside the company, it was not considered to be adequate; an external opinion was considered important.

Customer and consumer satisfaction, improved food safety, reduction of customer complaints and preservation of company reputation are some of the benefits the organisations enjoyed as a result of HACCP implementation. The researcher concludes, based on the findings of the study, that HACCP implementation is beneficial to any food manufacturing organisation, as it assures customers that the products are safe for consumption. Food safety is also improved as everyone understands and embraces the culture of food safety. As a result of HACCP implementation, customer compliments exceed
complaints, and there are fewer recalls due to unsafe products. Subsequently the reputation of the company is preserved, with no litigation as a result of unsafe products.

The study findings reveal that an HACCP food safety system must be based on a solid foundation of PRPs, commitment from top management, a knowledgeable HACCP team, and the availability of resources, a training programme and the buy-in of employees.
5 HACCP-based food safety system implementation model

5.1 Introduction
In this chapter, based on the research findings and learnings from the literature review, the researcher presents a proposed conceptual and practical model to act as a framework to assist food and beverages businesses in developed and developing African countries with a strategic and systematic process of implementing an HACCP food safety system. Key concepts of the model are also discussed in this chapter.

5.2 HACCP-based implementation model
The proposed model is presented in Figure 25. The model shows the key processes and activities that should be addressed during the implementation of an HACCP food safety system and the role-players that should address them. The model framework was derived in response to the findings of the research study and empirical findings of the literature review. It also addresses the concerns associated with the implementation of the HACCP system and provides systematic and logical steps to alleviate implementation shortcomings within food and beverages businesses, particularly AB-InBev Africa Zone TAB plants.

The model consists of four phases of implementation of an HACCP food safety system:

1. S1 – Initial phase;
2. S2 – Planning phase;
3. S3 – Execution phase; and
4. S4 – Key Performance Indicator (KPI) phase.
Figure 25: HACCP-based food safety implementation model
5.2.1 S1 – Initial Phase

5.2.1.1 Consumer, customer, legal and statutory requirements

The initial phase of the model recognises the requirements of the customers and consumers. Today’s world is more demanding of food safety on the part of final consumers (Erceg, 2015). This implies that current customers and consumers worldwide demand quality and safe food products. Brito (2017), current CEO of AB-InBev, argues that consumers and customers are the “boss” of AB-InBev. Customers and consumers dictate what systems should be in place and the top management must incorporate their needs and wants into a food safety policy statement and outline how the safety of the products will be achieved and even exceeded. The company must devise a communication channel to give customers and consumers feedback on the requirements.

The policy of AB-InBev as a global beverage company is to provide its customers and consumers with a quality and safe product. As such, AB-InBev incorporates customer and consumer demands and legal requirements into its food safety policy. The AB-InBev food safety policy is reviewed every two years by top management and changes are incorporated with a view to providing customers with safe products.

Food companies must be guided by and comply with international and national food regulations. For HACCP food safety system implementation, organisations must comply with the CAC and any other food safety regulations or laws. “To ensure that foods are safe for human consumption, almost all countries should introduce a food control system to protect their citizens against unsafe, adulterated or otherwise poor-quality food” (Gauthier & Mahabir, 2012). Internationally, the CAC administers the Codex Alimentarius, which is a food standard developed and presented in a uniform and codified manner. Organisations must incorporate these food safety laws into their policy statements and outline how they will comply with them. Therefore, customer and legal requirements must be a guiding fundamental in developing the food safety policy and subsequently food safety system, and this must be a basic foundation for the planning phase.

5.2.1.2 Top management commitment

Mortimore (2001) states that it is essential to gain commitment at senior level and ensure proper allocation of resources. Top managements are the main drivers of food safety efforts throughout the implementation process (Pun & Bharro-Beekhoo, 2008). Therefore, they need to support food safety concepts and the implementation process of the HACCP in their processing facilities, by understanding the challenges, benefits, commitments, costs and duration of the implementation of an HACCP food safety system. Their visibility is of paramount importance for effective implementation. Management must understand and capture all the customers’, consumers’ and legal requirements and incorporate them into its leadership and the policy statement of the organisation on food safety. According to Pun and Bharro-Beekhoo (2008), management should nurture a safety culture, establish objectives, appoint authorities and provide resources to enable food safety. This implies that the top management of the company should select and appoint a knowledgeable multidisciplinary HACCP-based food safety team; provide and allocate a financial Capital-Investment (CAPIN) plan to acquire equipment and instruments and human resources, and ensure that the necessary skills are sourced externally to complement available skills within the organisation.
5.2.2 S2 – Planning Phase

The planning phase is the second phase of the tailor-made implementation model and comprises the following: selection and appointment of an HACCP food safety team and team leader, provision of necessary and adequate resources and sourcing of required skills, and alignment of departmental or functional managers. This phase is critical and the foundation of the subsequent step.

5.2.2.1 Appointment of HACCP team and team leader

AB-InBev top management (plant manager) should demonstrate its commitment to food safety by appointing an HACCP food safety team (steering committee) and a team leader who is responsible for implementing the HACCP system and overseeing food safety in the organisation. A steering committee (the food safety team) should be in place to monitor the implementation of food safety-related activities. Records are maintained so that the food safety teams have knowledge of products, processes and equipment, and food safety hazards within the scope of the FSMS.

“Selection of the HACCP team members and team leader should be based on their knowledge of raw materials, products, processes and hazards” (Mortimore, 2001). The team selected must have multidisciplinary skills and be a cross-functional team that represents every department in the business. The AB-InBev food safety HACCP team is made up of a steering committee with members such as the brewing manager and team leaders, packaging manager and team leaders, utilities manager, warehouse manager, laboratory manager, trade quality specialist and quality specialist, with the quality manager as the HACCP team leader.

The steering committee team should have an extensive knowledge of raw materials, ingredients, and processing lines, and hazards from operations, machinery, storage and distribution. The HACCP team must be able to design the HACCP plan, and understand the HACCP implementation steps and principles and the PRPs of the plant. In 2015, the AB-InBev Chamdor plant HACCP team comprised the following members who developed the Brewing HACCP plan.

Table 6: AB-InBev HACCP team for development of Brewing HACCP plan (SAB, 2015)

<table>
<thead>
<tr>
<th>POSITION TITLE</th>
<th>ROLE – DESCRIPTION OF TASK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brewhouse Specialist</td>
<td>To develop and amend this document</td>
</tr>
<tr>
<td>QA Manager</td>
<td>To conduct the HACCP studies</td>
</tr>
<tr>
<td>Manager QC Services: Brewing and Packaging Brewhouse Specialist</td>
<td></td>
</tr>
<tr>
<td>Risk Controller</td>
<td>To verify the HACCP studies</td>
</tr>
<tr>
<td>QESH Specialist</td>
<td>To train and make the employees aware of this procedure</td>
</tr>
<tr>
<td>QA Manager Brewhouse Area Manager</td>
<td>Adhere to the procedure</td>
</tr>
</tbody>
</table>
5.2.2.2 Provision of resources and required skills

As mentioned earlier, the top management, among other activities and responsibilities, is responsible for the provision and allocation of the financial Capital-Investment (CAPIN) plan and human resources to ensure that the HACCP food safety system is effective and successfully implemented and maintained. The resources will enable the HACCP team to manage the requirements of the HACCP system effectively and, subsequently, an HACCP team through their team leader (quality manager) is to report back to the top management on the adequacy of the resources provided and how they were managed.

Financial/Capital resources: provision and allocation of finances will enable the systems to be implemented correctly and effectively. The organisation needs a budget to revamp and upgrade the plant, introduce advanced technological machinery and equipment and analytical and microbiological instruments to monitor and control the safety of the production and products. These resources must address food hazards and must be CCPs such as pasteurisation unit metal detectors and test equipment.

Human resources: provision of training material, awareness, education as well as competency programmes are essential for ensuring that the HACCP food safety is understood and implemented correctly. The organisation must ensure that time is available for employees to be equipped with knowledge to execute their responsibilities. AB-InBev takes the transfer of knowledge very seriously; every plant has a training coordinator in each department to ensure that training is imparted to the workforce and head office has ensure that training on food safety with an external institution is happening every year. Head office or a zone learning-and-development specialist issues a training schedule to all plants and the zone covers the cost of external training.

CAPIN resources: the organisation should allocate a sufficient CAPIN budget for the company to ensure that new and correct technologies are sourced in, and to be able to assure the safety of the products. This will include production equipment and laboratory instruments to identify and quantify the hazards accurately and easily. Functional managers must be able to identify the equipment needed to produce safe products. The Africa zone, which is based at head office, consolidates the list of all the equipment and how old each piece of equipment is and motivates for a CAPIN. The CAPIN at AB-InBev must be aligned to the food safety policy and also address the food safety issues in the plant.

Top management needs to ensure that the necessary skills are available in the organisation for the effective implementation of an HACCP-based food safety system. The required skills such as technical skills, project management skills, leadership skills, and training and coaching skills must be available within the company and, if not, the external skills such as of consultants, inspectors and auditors must be sourced in to provide guidance and direction.

5.2.2.3 Functional managers

The AB-InBev plant manager has the responsibility to appoint functional managers and align their responsibilities to the food safety needs of the organisation. Functional managers should implement the food safety policy in their functions and ensure that activities are executed by employees in their teams and that the budget is adequate and is used for the benefit of the organisation. Functional managers must continuously report to the plant manager the progress of their functions, any issues that arise and how they are addressing them.
5.2.3 S3 – Execution Phase

The third phase is the execution phase and this covers the HACCP design and HACCP plan, PRP and HACCP training. This phase requires the concerted effort of all employees in the AB-InBev plants, the strong leadership of the HACCP team and the commitment of the plant manager as well as the influential skills of the functional managers. Employees of the organisation need to be empowered with the knowledge and skills necessary to execute the responsibility to promote food safety. If all the aspects of the execution phase are incorporated and implemented correctly, then a food safety HACCP system that effectively ensures that consumers receive safe food products can be implemented.

5.2.3.1 HACCP design

*Gap analysis:* a knowledgeable multidisciplinary team must conduct a gap analysis audit. The audit must cover the whole production process from receipt of raw materials through to the production process up to the consumption of the product. The gap audit must assess the current situation against the required destination, determine the difference and incorporate the difference into the planning and design. Mortimore and Wallace (2012) indicate that it is “important for companies to evaluate their resources and systems currently in place and compare them against the requirements for managing an HACCP system effectively, before putting together a project plan for the HACCP implementation”. For this reason, the assessment review must include the facility environment, the supplier’s capability to supply safe raw materials, current food safety control systems and personnel resources. The results of the evaluation against the requirements of the HACCP system indicate the gap that needs to be closed and the HACCP team must assign actions for closing the gaps to the relevant departmental managers. The HACCP team must be knowledgeable about the HACCP requirements and be able to evaluate the current system and recommend a way forward; alternatively, an external consultant must be approached for guidance. “The most effective way of identifying the gaps is to carry out a baseline audit of current control measures for food safety and quality management, using auditors with expert knowledge of the standards and systems required to support HACCP” (Mortimore, 2013). AB-InBev plants conduct baseline or self-assessment audits, identify the gaps and devise a way to close them, and then the zone or head office sends an experienced specialist to do the audit and identify the gaps that must be closed before the external accredited auditor issues the certificate.

*HACCP study:* the AB-InBev steering committee with the strong leadership of the quality manager as team leader must demonstrate a strong understanding and knowledge of the HACCP process, production process (from raw material to product consumption), and intrinsic and extrinsic hazards associated with the production and products. Consultants must be sourced for guidance and to complement the knowledge within the company. This study is undertaken to understand the potential hazards associated with the production of the product.

AB-InBev followed the five implementation steps outlined to design the HACCP plan, with the five steps summarised as follows:

*Product description and intended use:* the AB-InBev HACCP team, led by the quality manager, should start with an intense understanding and knowledge of the products their company produces and the composition and processing of the products, as well as the hazards related to the products. Information on the formulation of product, materials used, intended consumer use and handling are important to the HACCP team for evaluations. Biological, chemical and physical hazards associated with the products, ingredients and processing may vary on handling and intended use, but sensitive ingredients that are
historically associated with known hazards must be identified. This information is important for the HACCP team to make comprehensive evaluations. “The description of the product requires knowledge of the following: 1) product characteristics and composition, 2) structure, 3) processing, 4) packaging, 5) storage and distribution conditions, 6) required shelf life, and 7) instruction for use” (Pun & Bharro-Beekhoo, 2008). More details should be provided with regard to microbiological characteristics, nutritional values, and chemical and physical properties, and the HACCP team should be able to provide such information. The HACCP team must be able to describe the products holistically and their intended use and should consider the following as per Table 7 below.

Table 7: Product description and intended use (SAB, 2015)

<table>
<thead>
<tr>
<th>Products: Beer/Lager</th>
<th>Alcoholic beverages, Flavoured alcoholic beverages, Non-alcoholic beverages, Traditional African beverages (Chibuku and Mateu) and Spirit alcoholic beverages.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intended Use and Consumers of the Food</td>
<td>Product consumed as is, preferably cold. The product is not intended for consumption by persons under the age of 18. The final product is dispensed into non-returnable glass bottles, returnable bottles, cans, draught, kegs and cartons.</td>
</tr>
<tr>
<td>Storage, Handling and Distribution</td>
<td>The product is packed into sealed containers and stored at room temperature. Product is transported by covered trucks on a wooden pallet. Avoid excessive shaking, and exposure to heat or freezing may cause bursting. Product to be stored in supplied packaging where possible.</td>
</tr>
<tr>
<td>Ingredients and Composition</td>
<td>Barley, Hops, Malt, Rice, Sorghum, Carbonated Water, Lactic Acid and Yeast.</td>
</tr>
<tr>
<td>Processing Method</td>
<td>The product is made by fermenting dextrose with yeast. The brands have an alcohol content of not more than 6% (v/v), pH of not more than 5.0 and also carbonated. The brands are flavoured with hops for bitterness and no artificial preservatives are added.</td>
</tr>
<tr>
<td>Potential to Support Microbial Growth</td>
<td>Microbial stability is maintained through good GMP &amp; sanitation practices, carbonation and pH of less than 5.0, and the presence of hops, which has antibacterial properties.</td>
</tr>
<tr>
<td>Packaging/Shelf Life</td>
<td>Alcoholic, Non-Alcoholic, Flavoured beer and Spirits beer Can (330, 340, 440 ml), Bottle (330, 500, 660, 750, 950, 1000 ml), Kegs 5L • Shelf life 6 to 12 months Traditional beer • 250, 500, 1000 ml • 5 days for unpasteurised beer and 3 months for pasteurised beer</td>
</tr>
</tbody>
</table>

**Develop and verify process flow:** the AB-InBev HACCP team should construct a process flow diagram for the operation process. This flow diagram should follow the product from raw materials through finished product distribution to the ultimate consumer use. The diagram should include all points in the production process, from the receipt of raw materials, manufacturing, packaging and storage to distribution and consumer use. The flow diagram is aimed at visualising the flow of the production and making the process more transparent. Process flow diagrams cover the sequence and interaction of various steps and indicate in the process where there is a need to outsource work. They indicate where in the production raw material, ingredients and processing aids are added and where rework or recycling takes place. They also point out where the product, waste and by products are removed from the line. Once the flow is in place, HACCP team members verify the process and “walk the processes” with different shifts to check if there are any variations. A checklist must be filled in for different shifts.
The HACCP team for each AB-InBev plant has constructed detailed sequential flow diagrams of the specified areas of operation that fall within the defined boundaries, which include the following:

1. Input, sub-process, process and by products;
2. Chronological numbering of the processes;
3. Identification of ingredients, packaging materials, cleaning chemicals, detergents and disinfectants used; and
4. Identification of sampling points and CCPs.

The flow diagrams have been constructed and verified on-site by the food safety team in the following areas: Brewing, Packaging, Engineering utilities and Warehousing.

5.2.3.2 Establish and maintain PRPs

AB-InBev plant managers must provide financial and human resources to ensure that PRPs of the HACCP are implemented. “PRPs are implemented in accordance with the Codex general principle of food hygiene and good manufacturing practice to establish basic conditions that are suitable for the production and handling of safe food at all stages of the food chain” (Easdani et al., 2012). It is therefore understood that PRPs are the basic foundation for ensuring food safety and should be in place prior to implementation of the HACCP system. In AB-InBev plants, PRPs are classified into the two categories of GMP and Infrastructure.

An appropriate GMP programme in the production lines is embarked on and this programme is operated and maintained on a regular basis. The gap list generated from the site walkabout is reviewed once a month until such gaps are closed. Infrastructure PRPs, maintenance programmes and operational PRPs are verified by independent audit to confirm implementation and effectiveness.

The plant should cover the following PRPs and ensure that they are set up in a way that promotes food safety in the organisation: Facilities (plant exterior and interior); Utilities (water, electricity, fuel and gas); Cleaning in place and out of place and sanitation; Pest-control management by external professional; Personal health and hygiene; Prevention of cross-contamination of raw material and product; Equipment maintenance and calibration; and Training programmes. The HACCP team must develop the PRP programmes and procedures along with a checklist to evaluate the effectiveness of the PRPs on a continuous basis. The objective of the PRPs should be to reduce the hazards so that the HACCP system can function effectively. Erceg (2015) confirms that PRPs are a set of GMP, GHP and GLP and support the HACCP system.

5.2.3.3 HACCP Plan

The “HACCP plan is a document. The document must capture knowledge and activities that are implemented, maintained and supported by strong PRPs, including having a hygienic operating environment and an educated and trained workforce” (Wallace, 2014). HACCP team members must own the HACCP plan and it must be based on hazard analysis and regularly updated to stay current. The HACCP plan can be product and/or process specific or generic, depending on the nature of the product produced. The HACCP plan is developed by employing seven HACCP principles. Karagozlu et al. (2009) and Ergönü and Günç (2004) state that all production lines have different CCPs and HACCP plans. With this in mind, AB-InBev has developed an HACCP plan for each process from receiving of raw materials
to distribution of beer products. Table 8 and 9 below depict the HACCP plan for the AB-InBev brewing process, incorporating all seven HACCP principles.

Identify hazards and control measures: HACCP team members have the huge responsibility of conducting a hazard analysis. This must be undertaken by listing all the hazards that can be present, through growth, adulteration and contamination. The team needs to assess the probability and severity of risk and identify control measures through which the hazards can be controlled. According to Pun and Bharro-Beekhoo (2008), risk assessment is the process of evaluating food premises to decide if they need to be inspected frequently or not, and the risk (R) is defined as a likelihood or probability (P) that a hazard will occur, with consideration of severity (S). Control measures identified in the CCP decision tree are implemented at each critical point. The HACCP team must provide the training and awareness necessary for employees to understand the hazards associated with the products and what measures need to be in place to assure the safety of the products.

The AB-InBev HACCP team employs a risk assessment matrix to identify any biological, physical and chemical hazards associated with the production process. Hazards in the process that are found to be significant are further classified as CCPs and PRPs by decision tree.

Establish CCPs: the HACCP team is also responsible for identifying CCPs in the process steps. This is achieved by employing a CCP decision tree approach, which is the systematic and logical approach of asking five questions to determine if each step in the process is a CCP or not. A CCP is a step in the process where a control measure needs to be in place.

Establish critical limits: subject matter experts, line managers and supervisors from different stages of the production (from raw material to finished products) together with the HACCP team must establish critical limits for the CCPs identified. External consultants with extensive expertise and knowledge of hazards can be consulted to provide guidance on the critical limits of the CCPs. Critical limits must be based on scientific and toxicological data. The organisation can use different tools to manage the critical limits such as: SPC, control charts, dots charts and moving charts. The HACCP team must provide training to all employees at different levels. Line managers and supervisors must be able to interpret the data and act proactively if there is a case of deviation, and operators must be equipped with knowledge to update the data as per schedule.

Develop monitoring system: AB-InBev line managers and supervisors of each process must develop a CCP monitoring system and the quality manager must approve the monitoring system. Pun and Bharro-Beekhoo (2008) define monitoring as a series of measurements or observations to ensure that controlled measures are being implemented correctly and within critical limits. Monitoring enables management to detect loss of control at CCPs. Hence, the monitoring procedure must clearly specify who, how, and when it is to be performed and recorded. Monitoring systems must be able to detect variations and deviations from the normal and must use instruments that are calibrated, serviced and validated to detect the issues. Physical monitoring includes observation; microbiological monitoring requires internal or outsourced microbiological lab tests; and chemical monitoring requires QA staff to conduct a chemical analysis in the analytical lab.

Determine corrective actions: line managers and supervisors are responsible for ensuring that corrective actions are taken when there is a loss of product owing to variation or deviations. All managers and supervisors at AB-InBev are trained on the white belt programme (Problem solving programme) to be able to solve the process problems.
Corrective action describes what should happen if a deviation is found or the measurements trend outside critical control limits. Line managers, supervisors and team leaders should devise appropriate problem-solving methodology to eradicate the problem and bring the process under control. Different methodologies can be employed such as the PDCA model, the Ishikawa diagram for probable cause identification, 5why (root cause identification methodology) for root cause identification and many more. The main objective of the corrective action should be to eliminate the root cause and bring the process back under control. Corrective action is a team effort and employees at all levels need to be equipped with the necessary skills and training.

Establish verification system: auditing, the reference control system and collaboration studies are some of the most important verification systems that organisations can employ. The line managers, supervisors, team leaders and operators should be involved in the verification of results. Audits must be arranged and scheduled by senior management and everyone in the business must comply with them. A reference control system should be set up by line managers and the operators must update the results on a daily basis. Collaboration studies must be carried out as per a schedule set up by the relevant line manager. The results of the verification system must be available at all times. An AB-InBev verification policy is in place to verify the output of the process and operation work diagnoses as a result of deviation.

Develop documentation and record system: documentation and records are important for the implementation and maintenance of the HACCP system. It is the responsibility of the organisation to develop a documentation system, define the mode of storage and specify the retention time. All HACCP records must be stored consistently. AB-InBev has a data-management policy that stipulates how to treat soft and hard copy records and how to use the Laboratory Information Management System (LIMS) and other electronic web-based systems to store and save the records.

Table 8: HACCP plan for brewing, showing hazards and decision tree (SAB, 2015)

<table>
<thead>
<tr>
<th>Process step</th>
<th>Inputs</th>
<th>Hazard type</th>
<th>HACCP decision tree</th>
<th>CCP Y/N</th>
<th>Risk Y/N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process cleaning</td>
<td>Caustic/Acid water cleaning</td>
<td>Caustic/Acid</td>
<td>Chemical</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>Milling</td>
<td>Malt</td>
<td>Stones Metal Wood</td>
<td>Physical</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>Mashing</td>
<td>Lactic acid</td>
<td>Lactic acid</td>
<td>Chemical</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>Lautering</td>
<td>Brewing liquor mash</td>
<td>Microbial</td>
<td>Biological</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>Wort boiling</td>
<td>Wort</td>
<td>Microbial</td>
<td>Biological</td>
<td>yes</td>
<td>no</td>
</tr>
</tbody>
</table>

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Table 9: HACCP plan for brewing, showing critical limits, control measures and monitoring, corrective, verification and record systems (SAB, 2015)

<table>
<thead>
<tr>
<th>Process step</th>
<th>Critical limit</th>
<th>Control measures</th>
<th>Monitoring</th>
<th>Corrective actions</th>
<th>Verification system</th>
<th>Document records</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process cleaning</td>
<td>&lt;30ppm</td>
<td>CCP vessel, tanks</td>
<td>Caustic/Acid test</td>
<td>Abnormality report</td>
<td>Calibration of meter</td>
<td>Charts</td>
</tr>
<tr>
<td>Milling</td>
<td>&lt;250um</td>
<td>Magnetic</td>
<td>Metal detected/visual</td>
<td>Abnormality report</td>
<td>-</td>
<td>Charts</td>
</tr>
<tr>
<td>Mashing</td>
<td>0.00ppm</td>
<td>pH measurement</td>
<td>pH measurement</td>
<td>Abnormality report</td>
<td>Calibration</td>
<td>Chart/record</td>
</tr>
<tr>
<td>Lautering</td>
<td>Negative micro</td>
<td>Boiling</td>
<td>Micro test</td>
<td>Abnormality report</td>
<td>-</td>
<td>records</td>
</tr>
<tr>
<td>Wort boiling</td>
<td>Negative micro</td>
<td>Boiling</td>
<td>Micro test</td>
<td>Abnormality report</td>
<td>-</td>
<td>records</td>
</tr>
</tbody>
</table>

5.2.3.4 Food Safety HACCP training

The HACCP team together with the functional heads must ensure that food safety HACCP training is provided to all employees irrespective of their level in the organisation. Every person must be equipped with basic knowledge and understanding of the HACCP and food safety systems. Any person handling food directly or indirectly must be trained on food safety. The training must cover all important aspects of the HACCP food safety system and should be run continuously. The HACCP team should be trained on HACCP principles, application and implementation. Once the team is trained, it can provide training to all employees. Training should focus on HACCP design, HACCP plan and PRPs.

Enablers

In order for the HACCP system to function effectively, the top management, HACCP team and all line managers should ensure that the enablers outlined below are in place.

Education, Training and Awareness: the organisation must run awareness campaigns and always remind operators and everyone who is in contact with production about the importance of HACCP and the different hazards associated with the production process. Through the awareness programmes, employees can be encouraged to be food safety HACCP ambassadors. Employees should be encouraged to further their education studies and the organisation must provide the time and funds for these studies.

Methodology and Procedure/Standard Operating Procedure (SOPs): these must be in place and simplified so that they are understood; managers must review the procedures to include current technologies or methodologies.

Employee commitment: it is the responsibility of everyone in the business to embrace the changes in the business and top management must ensure that everyone is committed to the food safety of their products.

Audit plan/schedule: this is critical to ensure and verify that the process is in control and that no changes in the production are not reflected in the documentation. It is the responsibility of managers to schedule
the audits and all employees must make sure that their activities conform to the requirements of the procedure.

### 5.2.4 S4 – Key Performance Indicator (KPI) Phase

The fourth phase of the model is the KPI phase, which is used to evaluate the effectiveness and performance of the HACCP-based food safety system. The system is an evolving process and needs to be reviewed, updated, corrected and adjusted continuously.

#### 5.2.4.1 Evaluation of food safety system and continuous improvements

The performance and compliance of the system should be evaluated, to measure its effectiveness. The organisation must develop a checklist that should be maintained, with specific criteria being agreed to and communicated as to what defines performance within each specific milestone. This will ensure transparency and that all employees are aligned with the business expectation and definitions of what is regarded as achievement.

The HACCP team and top management must meet at defined intervals to evaluate the effectiveness of food safety and the food safety policies and objectives. Scheduled management reviews will provide a platform for the HACCP team, through its appointed team leader, to present the food safety progress, issues and changes to top management. From its side, top management will allocate the resources needed to ensure that food safety requirements are not compromised. The HACCP team leader (quality manager) will also present customer feedback, legal and regulatory requirements, validation and verification results, and the audit plan as well as audit results to top management. The continuous improvement of the HACCP system will enhance the effectiveness of the HACCP-based food safety system. If any weaknesses are identified in the system, HACCP team members and top management must devise a plan for continuous improvement for the HACCP system to be robust.
6 Conclusion and Recommendations

6.1 Conclusion

This chapter presents the conclusions based on the major findings reached during the course of the research study; the main findings are presented in Chapter Four. Recommendations are made to the AB-InBev Africa Zone and other beverage companies with reference to the tailored-made food safety HACCP model presented in Chapter Five of this study. The chapter ends with suggestions for further research studies that could be conducted in the future. The main objective of the study was to explore the implementation process of the HACCP system in the AB-InBev Africa Zone and the development of an HACCP model that could be rolled out to the TAB plants of AB-InBev.

The findings of the study indicated that the implementation of an HACCP food safety system follows well-defined and standardised HACCP steps and principles. The study showed that the employees of AB-InBev understood the concept of the HACCP system and that for an HACCP system to be effective, it needs to be built on the solid foundation of PRPs. However, practicalities of the system were highlighted as an issue. Food safety governance was perceived to be the responsibility of the Quality department instead of all departments taking ownership. The results, as shown in Figure 18, indicated that the majority of respondents were Quality personnel. This perception is fuelled by the lack of knowledge and accountability of individuals on food safety across the board and also by the invisibility of top management on the ground.

The findings also showed the importance of top management forming a knowledgeable HACCP team and appointing an experienced team leader to manage and oversee the food-related issues in the plant and ensure that the relevant resources, adequate training and accountability are provided. However, this was limited by the lack of a knowledgeable cross-functional team that could form an HACCP team and also by the high employee turnover.

The study used purposive sampling to select the respondents, based on their experience, education and knowledge of food safety, and the findings do not provide the overall feeling of people on the ground. However, the responses from the respondents, who were mainly managers and team leaders, expressed concern about the level of education of the people on the floor, indicating that communication was at times difficult. The findings further indicated that continuous awareness on the shop floor should be in place to equip employees with the necessary knowledge and understanding.

The overall findings of the study present convincing evidence of the relevance and importance of implementing a food safety HACCP system in food and beverage manufacturing to control and manage the food safety of the products.

Given the findings of the study, it is concluded that the implementation of HACCP food safety should be conducted in a systematic manner and, above all, that the top management should play a prominent role in giving direction on food safety and the appointment of an HACCP food safety team and team leader to manage and oversee the whole HACCP process and report back to it. Top management should also ensure the provision of resources and that employees buy in to the system, in this way minimising and managing employee turnover. The findings also indicated the importance of a multidisciplinary team from different functions of the business, strong leadership of functional heads to lead employees in their departments and the provision of training programmes to empower employees at all levels. The researcher proposes a tailor-made model that could be adopted by food and beverage manufacturing industries wishing to implement an HACCP-based food safety system.
6.2 Recommendations

The following recommendations are guided by the findings of the study and the HACCP-based model presented. The research findings indicated that the successful implementation of an HACCP system is based on the understanding and execution of difference phases of the HACCP-based model and also an understanding of the challenges and factors that affect the implementation and provision of resources and skills. This understanding can be made possible by highly skilled employees with “know-how” and high education levels.

It is recommended that top management as the face of the organisation must demonstrate leadership through policy direction and presence in the field. Employees at all levels from different departments must receive a basic HACCP training and must also be involved in the implementation of the system. All departments must own the food safety system and take responsibility for their actions. Food safety and quality must be owned by everyone in the business and must not be shifted to QA department.

It is recommended that the HACCP-based model should integrates all significant elements of HACCP implementation that will guide food manufacturers in the implementation of system. It also incorporates the requirements of customers and consumers and regulations as well as PRPs, which are excluded from many HACCP implementation models, HACCP designs and HACCP plans. HACCP food safety is an evolving system. Therefore, the model includes evaluation and continuous improvement to keep the system alive and relevant. The HACCP model was categorised into four different phases to assist organisations to consider each phase when implementing the system.

It is also recommended that organisations have clearly defined HACCP training programmes, which are important for the implementation of the HACCP system. The training can be conducted by external expertise in this field. A related recommendation is that organisations source skills from outside the organisation to complement the skills within the company. To enhance the skills in food safety, organisations must partner with higher education institutions and encourage them to offer food safety courses at university level. The food and beverage companies must sponsor these initiatives. It is also recommended that companies make a great effort to retain skills and also source graduates and allow them to mix with experienced members to learn and gain experience.

The food manufacturing companies are considered the main drivers in the creation of sustainable jobs and strengthening the economic growth of the country. They also attract international investors (Madonsela, 2015). However, there is a little initiative by private companies and government to invest in food safety education from early schooling.

The study highlighted a number of researchable aspects that could be pursued further by those involved in the implementation of the HACCP system. The results of the study have shown that failure to implement a food safety system is exacerbated by lack of management involvement, lack of training programmes and unavailability of skills, amongst other issues. Therefore, there is an urgent need to address this problem by focusing studies on training and the reduction of employee turnover geared towards ensuring effective implementation of a food safety system.

The researcher suggests that further studies should be conducted to evaluate the effectiveness of the implementation the HACCP-based model. This study has reached certain conclusions that can be further explored in a broader sense. The study aimed to implement an HACCP food safety system in TAB plants. For this reason, a qualitative approach was employed as a methodology for the collection of data and purposive sampling was used to select respondents to participate in the interviews. Respondents were selected according to their knowledge and experience on the HACCP food safety system. A further study
could be explored to investigate the effectiveness of the implementation of the HACCP food safety system. This can be conducted by selecting different sampling techniques (sample type and size) to obtain the opinions from different stakeholders and different methodological approaches, data-collection methods and techniques.

To address the challenges experienced during HACCP implementation, organisations need to focus on training, education, food safety awareness, provision and adequate use of resources, along with commitment of people at all levels. Refining the data-collection technique used in this study and replicating the study with a larger sample of respondents from different departments involving people at all levels might prove useful for establishing whether these factors work to counter challenges faced during HACCP implementation.
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Appendix 1:

PLEASE ANSWER THE FOLLOWING QUESTIONS BY CROSSING (X) THE RELEVANT BLOCK OR WRITING DOWN YOUR ANSWER IN THE SPACE PROVIDED.

Section A: Background information

This section of the questionnaires below refers to biographic information. The information will only be used for data comparison or analysis. I assure you that your response will remain anonymous. Your cooperation is highly appreciated.

1. Gender

| Male | Female |

2. Age

3. Ethnicity

| Black | White | Coloured | India/Asian |

4. Highest Education

| Matric | Diploma | Bachelor degree | Post graduate degree | Other |

5. Professional category

| Top management | Senior management | Line management | Team leader/specialist | Technician/Shop floor |

6. AB-InBev category

| Beer | FAB | TAB | Spirit |
7. Please describe your role in the business

8. How long have you been with the company

9. Department/Section of work

Interview questions

1. What motivated the need for your organization to adopt and implement the food safety
   Hazard analysis critical control point (HACCP) system?

2. What do you understand about the HACCP based Food safety systems?

3. Would you please describe the HACCP implementation process or steps in your
   organization?

4. What do you understand about the HACCP prerequisites programs (PRPs) and how are
   they important to your business?
5. How would you describe your experience, knowledge and exposure to the implementation and maintenance of the HACCP based food safety systems?

6. What significant challenges did you experienced as an organization during the implementation of the HACCP based food safety system?

7. Would you describe how the implementation of the HACCP based food safety system benefited your organization and what are the measurable benefits?

8. What skills were required to implement the system? Were skills available in the organization or outsourced outside the organisation?

9. What resources were needed to fully implement the system?
10. What training needs were required to implement and maintain the system?

11. In your own view, how did you perceive the involvement of the top management?

12. What cross functional teams were involved and what was their role?

13. In what way can the system be further improved?

14. How satisfied are you with regard to the HACCP system?