AMERICAN UNIVERSITY OF BEIRUT

ANALYSIS OF THE POSTHARVEST FOOD SAFETY MANAGEMENT SYSTEMS IN THE MEAT SUPPLY CHAIN: A CASE OF UGANDA

by
SIYA BALAAM JEFFER

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Approved by:

_____

Dr. Gumataw Kifle Abebe, Assistant Professor   Advisor
Department of Agriculture

_____

Dr. Issmat Kassem, Associate Professor   Member of Committee
Department of Nutrition and Food Sciences

_____

Dr. Samer Kharroubi, Assistant Professor   Member of Committee
Department of Nutrition and Food Sciences

_____

Dr. Mohamad Abiad   Member of Committee
Department of Nutrition and Food Sciences

Date of thesis defense: November 24, 2020

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ABSTRACT
OF THE THESIS OF

Siya Balaam Jeffer <u>   </u>for<u>   </u><u>Master of Science</u>
<u>Major: Food safety</u>

Title: <u>Analysis of the Postharvest Food Safety Management Systems in the Meat Supply</u>
<u>Chain: A Case of Uganda</u>

Under Ugandan Vision 2030 and the rural sustainable development goals, the Ugandan Government considers livestock production as an essential economic activity that can be used to promote food security and reduce poverty. The meat sector contributes about 9% of Gross Domestic Product (GDP) and 17% of the agricultural. Due to an increase in the population, urbanization, and rising income, there is an increasing demand and consumption of meat and animal products in Uganda and other developing countries; However, Meat-borne outbreaks and cases of non-compliances by meat producers to safety procedures have led to the rejection of the meat in the global markets. Also, the meat produced loses its economic value because of the poor quality and safety of the meat and meat products. The contamination of meat is primarily from the exterior of the animal, mainly from the hide of the animal and the surrounding environment. Therefore, meat producers are generally expected to relay on the use of several control and assurance activities such as washing of hands, wearing of protective clothing, cleaning, and sanitization of butchery equipment and utensils, transportation of meat in clean containers and storage of meat at appropriately low temperatures along the supply chain.

These study aimed at assessing the performance of the core control and core assurance activities of slaughterhouses, evaluating the hygienic and preventative practices of the retail outlets (butcher shops and Supermarkets), and analyzing, the existing governance structures between the slaughterhouse and retail outlets and how they influenced the safety and quality of meat. A cross-sectional survey was conducted in three slaughterhouses and 204 retail meat outlets (butcher shops and supermarkets) within the five divisions of Kampala, Uganda.

All the slaughterhouses were located within areas that were close to heavy traffic and were surrounded by residential houses that allowed very little room for expansion of the facilities. The average score for the core control activity was one which meant that the activities carried out were basic and were often characterized by ad-hoc sampling, minimal criteria used for Food Safety management systems (FSMS) evaluation, and existence of various food safety problems due to different issues in the FSMS. The core assurance activities had not been fully implemented as compared to the core control activities though

they too had an average score of one. The retail outlets majorly depended on visual characteristics to determine if the meat is of good quality rather than microbial tests. In general, the supermarkets implemented better hygienic and preventative practices as compared to the butcher shops. The study also revealed that most meat handlers in Kampala do not adhere to the required hygienic and preventative practices. All the sanitation and hygiene handling practices investigated could provide avenues for contamination of meat and the possibility of occurrence of foodborne pathogens and spoilage organisms, hence decreasing the chances of meeting the international standards. Most of the contracts between the retail outlets and the slaughterhouses were reported to be market/ transactional, while very few reported having flexible contracts. The nature of communication was reported to be informal and most of the information exchanged was planning information since the retail shoppers rarely reject meat due to lack of laboratory/facility to test microbial pathogen levels. The choice of slaughterhouse chosen by the retail meat handlers is varying but most reported searching for good quality meat as the reason for using one or more suppliers.

In conclusion, these highlights that most of the meat handlers in the supply chain Kampala did not adhere to the required meat sanitation and hygiene standards and all the practices investigated could provide avenues for contamination of meat and the possibility of occurrence of foodborne pathogens and spoilage organisms, hence raising public health concerns. This study recommends that meat handlers should invest more on education on the basic practices of meat handling hygiene. It also recommends that the standards be sold at cheaper prices or given out freely so the meat operators can have access to them. The government should put up a more stringent measure to ensure all butcher shops have quality standard certificates. Furthermore, there is allot of overlap and fragmentation among the different supervisory authorities in government, they should set up one body that is solely responsible for the meat sector.

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INTRODUCTION

1.1. Background

Under Ugandan Vision 2030 and the rural sustainable development goals, the Ugandan Government considers livestock production as an essential economic activity that can be used to promote food security and reduce poverty(ACET, 2015). The Ugandan meat sector contributes about 9% of Gross Domestic Product (GDP) and 17% of the agricultural GDP and is considered one of the primary sources of proteins(Gerald Nizeyimana, 2014). Due to an increase in the population, urbanization, and rising income, there is an increasing demand and consumption of meat and animal products in Uganda and other developing countries (Gerald Nizeyimana, 2014).

The Ugandan meat sector comprises of livestock products including ruminant meat and its products, poultry, and meats of other animals with edible meats. Ruminant meat is the primary source of animal protein in the country, and cattle are mooted to be the essential livestock, although other animals are equally crucial. These animals are kept on rangelands, which occupy 84,000 km²(Mbabazi and Ahmed, 2019). Meat consumption in Uganda is highest in Kampala, where the demand and consumption level of beef is estimated at 15,500 tons annually(Gerald Nizeyimana, 2014).

There has also been an increased demand for Ugandan meat in the international market; however, low quality and quantity of meat, high prevalence of meat-borne outbreaks, and cases of non-compliance by meat producers to safety procedures have led to the rejection of the meat in the global markets(Behnke and Nakirya, 2012). The lower quantity of meat is attributed to several factors including poor animal husbandry practices, inferior breeds, low quality of inputs such as veterinary drugs, land availability, poor quality of feeds, inadequate supply of quality feed, and poor methods used in production and transportation of animals, processing, and handling of meat, manufacturing, distribution, and preparation of meat products among others. The poor quality of meat is attributed to malpractices in the production, processing, and related meat value chain activities that expose the meat and meat products to several food contaminants. (Benson and Mugarura, 2013, Waiswa, January 2016, Behnke and Nakirya, 2012) Also, the meat produced loses its economic value because of the poor quality and safety. Unpublished data estimates Uganda to be losing more than 200 million dollars due to its failure to sell meat that meets the international standards. The supply of beef is minimal and cannot reach the global market since most of it is consumed locally. This is because meat consumed in Uganda is mostly from indigenous genotypes that are raised under extensive management(UIA, 2016). The inherent features of indigenous beef animals are survival rather than productivity; hence their small body size slow growth means they take at least five years to attain market weights (Gerald Nizeyimana, 2014).

The contamination of meat is primarily from the hide of the animal, gut, and the surrounding environment. Therefore, meat producers are generally expected to relay on the

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use of a variety of control and assurance activities such as hand washing, use of protective

gear, hygiene, and sanitizing of butchery equipment, transport of meat in tidy containers,

and storage of meat at appropriately low temperatures along the supply chain. As so, meat

handlers like the butcher shop owners and slaughterhouses directly have an impact on the

meat sold in the Ugandan market through the decisions they make for example, which

slaughterhouse they buy from, the type of contractual relations with this slaughterhouses,

and what quality standards they adopt and implement.

1.2. Problem statement

Meat producers and processors are expected to rely on the use of good

manufacturing practices (GMPs) and Hazard Analysis and Critical Control Points

(HACCP) system to ensure food safety (Thomson et al., 2013); however, the

implementation of GMP and the use of HACCP has not been wholly adopted by the

outright majority of meat producing and processing businesses in Uganda. Slaughter places,

for example, operate under poor standards while most butcher shops handle meat in places

having lots of dust and flies. Also, animal carcasses are often transported in sacks that may

also contribute to meat contamination. The shortage of refrigeration facilities in

slaughterhouses, trucks that transport carcasses, and in the butcheries creates further

challenges in case the meat is not sold off quickly. These challenges are further exacerbated

by the lack of clean water in slaughter places. This has resulted in the high prevalence of

zoonotic meat-related diseases in Uganda (Byaruhanga et al., 2017, Nakanwagi et al., 2020,

Nyakarahuka et al., 2018) and subsequent failure to export meat to the international

markets. There is, therefore, a need for the players in the meat supply chain to take

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stringent measures to ensure adherence to established FSMS, policies and implement a company-specific system of control and assurance activities that help to guarantee meat safety (Njage et al., 2018). FSMS has therefore assumed great importance as a critical driver for organization and management of meat production systems along the supply chain (Luning et al., 2009, Sampers et al., 2010, Golini et al., 2017).

1.3. Justification of the study

In the Ugandan meat supply chain, the biggest players are the slaughterhouses since the majority of the meat is slaughtered at the slaughterhouse(SAMUEL, 2013). The retail outlets (butcher shops and supermarkets) are equally important since they are major suppliers of meat to the consumers (Mbabazi and Ahmed, 2019). Therefore, activities are done by these major actors in the supply chain significantly plays a role in the quality and safety of meat in the supply chain.

Until now, limited studies have focused on activities done by the individual slaughterhouses and a few retail outlets. This study, however, seeks to compare activities carried by all most of the slaughterhouses and retail outlets in Kampala from a chain perspective. Also, the current studies that concentrate on the retail outlets focus majorly on butcher shops, we seek to study and compare activities carried out by both the butcher shops and supermarkets. Finally, limited studies concerning governance structures in the meat supply chain and Food Safety Management Systems (FSMS) have been carried out in Sub-Saharan African countries. We, therefore, seek to map out the governance structures implemented in the Ugandan meat supply chain.

1.4. General objective

The overall aim of this research is to analyze the performance of food safety management systems and analyze the governance structure in Uganda's meat supply chain

1.5. Specific objective

1. To assess the performance of the core control and core assurance activities of slaughterhouses.

2. To evaluate the hygienic and preventative practices of the retail outlets (butcher shops and Supermarkets).

3. To analyze, the existing governance structures between the slaughterhouse and retail outlets and how they influence the safety and quality of meat.

1.6. Significance of the research

Assessment of core control and assurance activities of slaughterhouses, hygienic and preventative practices of the butcher would help point out activities that are still lacking in the effort to ensure meat produced is safe and of good quality. The study will hence recommend intervention strategies leading to the production of meat that will meet the international market standards and reduction of zoonotic disease prevalence in Uganda. Analysis of existing governance structures and contractual relationships would help understand how the decisions were taken up by the different stakeholders affect the safety aspects of meat. Among the meat retail outlets, the study will help the responsible authorities ascertain which category needs more prudent supervision. After that, the study

will suggest a model that would enhance the performance of the FSMS. The outcomes of this research will also be of value to different stakeholders in pointing out gaps, and opportunities to be tapped and hence recommend interventions and strategies.

Concerning government policies and strategies, the study will be a benchmark on which they will base on the appraise the adoption of policies by the meat handlers. It will also direct the government on what gaps to fill up in their strategies and which plays to concentrate on along the supply chain.

1.7. Limitations of the Study

Though the research adopted the supply chain framework, a fundamental limitation associated with the study was the inability to carry out surveys on the meat processors. This was due to the COVID 19 pandemic, which resulted in some meat processing facilities closing while the open ones declined to participate for safety reasons.

Furthermore, some of the respondents were initially hesitant to participate in the research due to the presumption that the research could be a way the government was trying to identify meat handlers that were not having the required standards. However, an introduction of IRB approval documentation and the student ID card and an indication of the consent of the traditional authorities in the community helped to overcome this challenge.

1.8. Organization of the Study

The study has been organized into six chapters. Chapter I entails the background and problem statement, justification of the study, research objectives, significance of the study, limitations, and organization of the study.

Chapter II focuses on a literature review that encompasses information on the Livestock subsector in Uganda, meat-related safety concerns along the supply chain, Analysis of the food safety control and enforcement systems in Uganda, and the meat legislation and standards in the international market. It also sheds light on the FSMS and FSMS diagnostic tool, Transaction Cost economics, and theoretical frameworks

Chapter III focuses on the methodology, which comprises the context of the study area, research design, sampling techniques, data collection process, and the data analysis process. Chapter IV focuses on the results concerning the Core control, core assurance FSMS activities and food safety performance output at the slaughterhouses, the hygienic and preventative practices of the retail outlets, and Characterization of the governance structures in the value chain Chapter V looks at the discussion, and linkage of the findings. Chapter VI focuses on the conclusion, recommendations, and highlighted areas of future research

CHAPTER 2

LITERATURE REVIEW

The literature review looks at available literature on the Livestock subsector in Uganda, meat-related safety concerns along the meat supply chain hindering the prosperity of the meat sector, common spoilage microorganisms associated with meat and meat products. It also looks at the food safety control and enforcement systems in Uganda and the meat legislation and standards in the international market as they are the baseline of which activities should be carried out in the meat sector. It further sheds light on the concepts on which this study is based on i.e. FSMS and FSMS diagnostic tool, and Transaction Cost economics frameworks.

2.1. Livestock subsector in Uganda

According to the Ministry of Agriculture, animal and fisheries (MAAIF) and the Uganda National Bureau of Statistic survey in 2018, Uganda had a livestock population of over 14 million heads of cattle, 16 million goats, 4 million sheep, 47 million chicken, 4 million pigs, and about 4.5 million households (70.8%) rear at least one kind of livestock or poultry (UBOS, 2018a, MAAIF, 2010)

Table 1: Animal Livestock Population Growth 2008-2017. Source; (UBOS, 2018a)
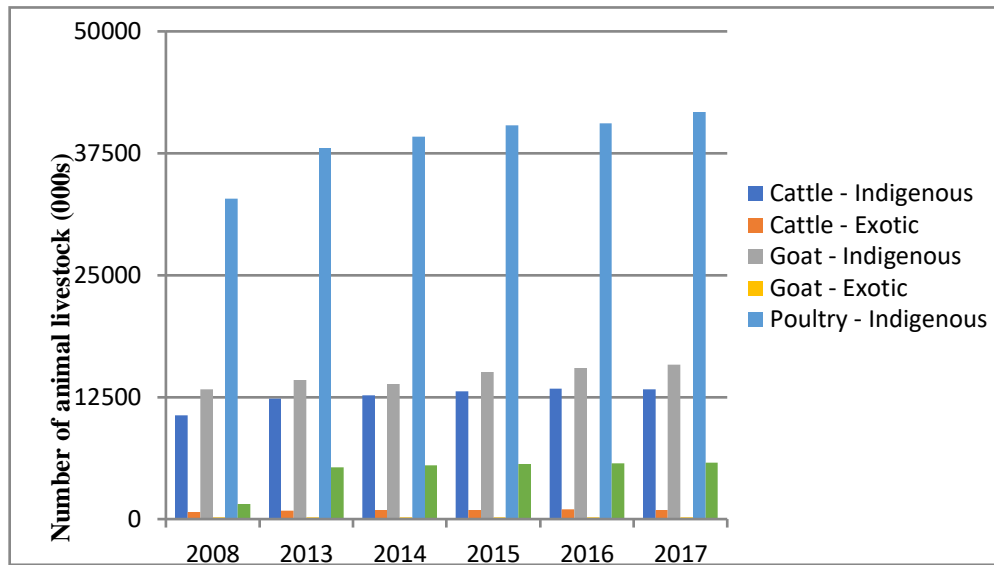
Livestock production is majorly made up of; commercial farming (ranches), pastoralist farming, and agro-pastoral farming (MAAIF, 2008). The commercial farmers use, to a certain extent, modern husbandry practices. The agro-pastoralists keep animals ranging from 2-20 animals, while pastoralists keep animal herd ranging from 10-200 cattle. The highest population of livestock is found in the "cattle corridor" (fig 1), extending from South-Western to North Eastern Uganda(UIA, 2016).

Figure 1: A map of Uganda showing the cattle corridor where the highest population of animals is found. Source; (Tayebwa et al., 2018)
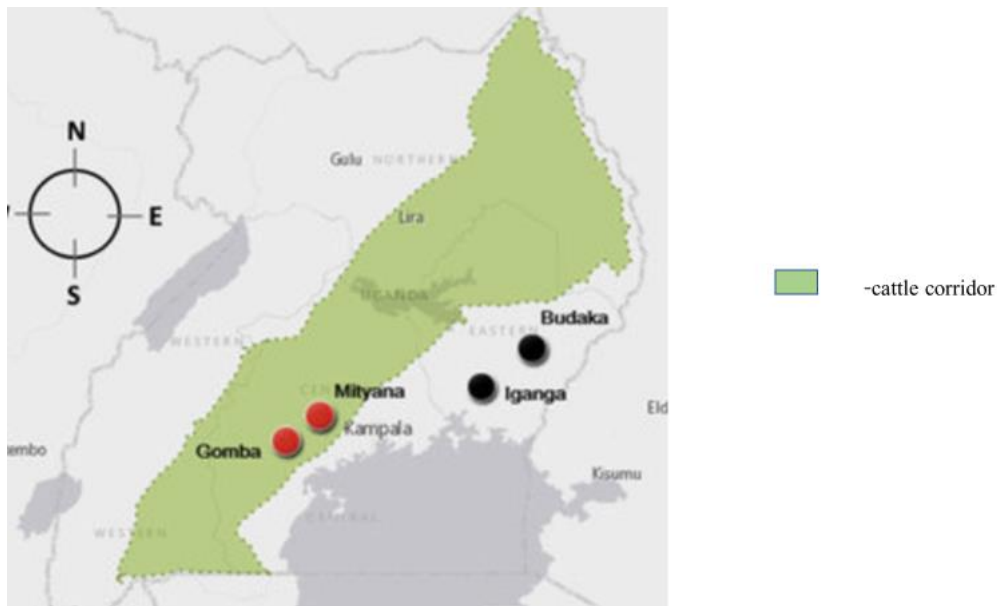
In economic value, cattle are the primary source of meat in the country and are thought the most important animals, although others such as goats, sheep, pigs, and poultry are equally important(UIA, 2016). The livestock sector in Uganda is predominantly characterized by slow-growing beef animals, which do not turn in yield of the desired quantity and quality of meat (Table 1)(UBOS, 2018a). The indigenous (local) breeds are primarily reared under extensive systems and include; East African short-horn zebu, long-horned Sanga, Ankole, Turkana, and Toposa. The exotic breeds, however, are; Charolais, Hereford, Aberdeen, Beef short, and Braham (UIA, 2016, Mbabazi and Ahmed, 2019). Small numbers of exotic tropical cattle breeds are reared in commercial ranches, especially Boran and, to a lower degree, the Bonsmara and their crosses within indigenous breeds(Gerald Nizeyimana, 2014, Mbabazi and Ahmed, 2019).

2.2. Imports and exports of live animals and meat in Uganda

Livestock trade in Uganda is still performing below its potential(Kyeyamwa et al., 2008). Like many countries in Sub Saharan Africa, the exact value of livestock imports is practically non-existent (Verbeke et al., 2009). It was estimated that Uganda's livestock export earnings raised from approximately USD 5.75 million in 2004 to nearly USD 10.4 million in 2008, of which meat products were one of the primary export earners(Agriterra-EKN, 2012). Currently, meat export in Uganda is very dwindling (table 2), with only small quantities exported to South Sudan, Democratic Republic of Congo, and, more recently, Somalia (ACET, 2015, Behnke and Nakirya, 2012). This could be due to high domestic demand, the inability of meat to meet the international market standards, shortage of standard slaughterhouses, and the high prevalence of livestock diseases(Byaruhanga et al., 2017). Uganda has continuously failed to supply quality meat to the more lucrative markets like Europe, the Middle East, and China because of quality issues (ACET, 2015). This has affected the income generated on export as they continually remain low. It has also left the meat sector stunted in terms of technological revolution since there is no pressure to use techniques and equipment from the global competitors.

Table 2: Uganda's Meat Export Growth. Source:(UBOS, 2018b, NDP, 2017)
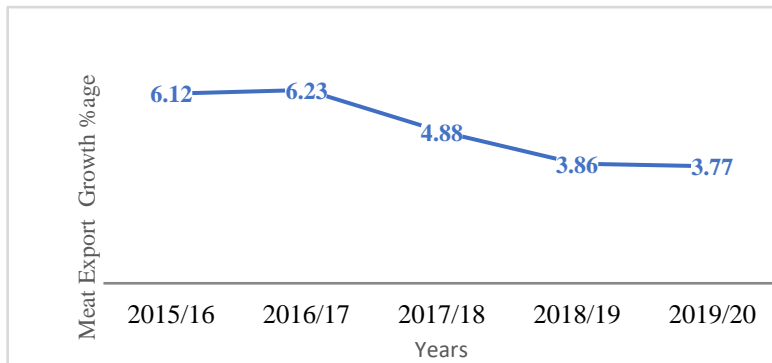
2.3. Analysis of meat-related safety concerns along the supply chain

The meat supply chain involves many stakeholders, which raises the meat safety concerns(in't Veld et al., 1994). These, therefore, warrants control throughout the chain starting from; farm of origin, transportation of animals, before and after slaughter, handling, and storage of meat and products until the time of consumption (Oloo, 2010, Haileselassie et al., 2013, Wamalwa, 2009, Chepkemoi et al., 2015). This is also partly because the meat is highly perishable due to its high protein composition, pH of 5.5 – 6.5, and water activity of 0.98-0.99. These conditions favor the growth and survival of almost all contaminating microorganisms(Ntanga, 2013, Wamalwa, 2009).

2.3.1. At the farm

At the farm level, usually many farmers lack knowledge of specific food safety practices and policies required to keep animals for meat production (Diez et al., 2015, Gesesew et al., 2016, Musiime, 2019). These include practices like regular spraying of

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animals, labeling, and traceability practices deworming, and correct use of antibiotics. This is probably because most of the farmers keep animals for domestic purposes or selling to the local market, which usually doesn't require the farmer to have any pre-requisites (Ouma et al., 2017).

Currently, Uganda has a few animal feed manufacturing industries and a vast number of un-regulated small-scale animal feed outlets, resulting in the production and sale of sub-standard animal feeds. (Lukuyu et al., 2013) Such sub-standard feeds lead to stunted growth among animals, the introduction of contaminants in the livestock food value-chain with hazardous health effects to final consumers/humans, and increased vulnerability of animals to many highly virulent, pathogens due to reduced immunity and many other results.

2.3.2. Transportation of animals

The transport of live animals in Uganda is governed by the Prevention of Animal Cruelty Act of 1957. (1957) It is, therefore, a requirement that all loading and off-loading facilities be equipped with ramps of the minimum slope to ensure ease and safety of loading. Very often, animals are transported in overloaded trucks and for very long distances without any stops (Greger, 2007). This can stress the animals and leads to poor quality of meat after slaughter. The animals, too, get injured during transportation, which leads to a decrease in the quality of meat, and the injuries act as inlets for the entry of pathogens that lead to contamination of meat (Oyinlola et al., 2019).

2.3.3. Contamination during Slaughter and Transportation of Slaughtered Animals

Most meat contaminations majorly occur during the slaughter of animals. Before that, the meat is usually free of pathogenic microorganisms (Shilenge et al., 2017). Contamination mainly originates from the skin of the animal, the environs, body discharges, and excreta from animals in holding pens or lairages, the meat handlers, the water used, and instruments used in dressing and killing(Osés et al., 2012). The transport means used to transport meat from slaughterhouses to retail outlets include; trucks (with or without refrigerators), motorcycles, bicycles, and by hand(Okunribido and Gingell, 2014). These transport means may act as an avenue of contamination as they are often unclean and are not well covered, leading to exposure to dust, insects, and flies(Sulley, 2006). Contaminations are even higher because some of the trucks are used for transporting different things other than meat.

2.3.4. Retail outlets (butcher shops and supermarkets)

The retail outlets usually cut the meat into smaller chunks that are sold in a retail form to the local consumers mainly. The cutting of the meat into smaller pieces increases the surface area, subsequently increases the chances of introduction of the pathogenic microorganism. In butcher shops and supermarkets, the bacteriological quality of meat is severely influenced by the hygiene conditions of the meat handler, method of storage, and the surrounding environment(Leotta et al., 2016, Barros et al., 2007). Contamination of meat is mainly through dirty hands, equipment, clothing, dirty floors, and dust from the environs (da SILVA et al., 2016, Kungu et al., 2017). Meat ought to be stored in hangers, and in chilled rooms or refrigerators, however, failure to do so increases chances of

contamination and rate of pathogen growth. Also, keeping meat in the retail outlets longer than two days without complete sale off increases the chances of contamination and usually results in meat losing its quality and safety(Sohaib et al., 2016). The largest source of contamination is the meat handlers who do not follow standards of operation in retail outlets. They come in transfer pathogens using their hands, hair, nose, and mouth as they do not put on protective gear (Yenealem et al., 2020).

2.4. Common Spoilage Microorganisms Associated with Meat and Meat Products

The commonest pathogenic microorganisms encountered in the meat sector are bacteria, yeast, and mold(Nørrung et al., 2009). These pathogens cause spoilage by changing the color, taste, odor, and texture of meat and meat products. Bacterial spoilage of meat is more prevalent as compared to yeast and molds in Uganda(Bogere and Baluka, 2014, Bagumire and Karumuna, 2017).

2.4.1. Bacterial pathogens related to meat and meat products

Globally, the most commonly identified bacterial pathogens related to meat and meat products are *Salmonella spp, Campylobacter spp, Staphylococcus aureus, E coli, Listeria monocytogenes, Clostridium spp, Yersinia enterocolitica, Bacillus cereus,* and *Vibrio parahaemolyticus* (Mor-Mur and Yuste, 2010, Nørrung et al., 2009). These are predominantly found in the guts and skin of animals and may infect the flesh after or during slaughtering if it is not adequately handled (Dave and Ghaly, 2011). The contamination of the meat can be through improper dressing practices like; poor employee hygiene and contaminated knives and/or working (Chepkemoi et al., 2015). In Uganda, the most

commonly identified bacterial pathogens are *Staphylococcus aureus, E coli,* and *Salmonella spp,* respectively(Bogere and Baluka, 2014). *Staphylococcus aureus*, for example, causes spoilage by fermenting of meat to produce off odors, and a slime layer around meat(Dave and Ghaly, 2011), Whereas *E coli* and *Salmonella spp,* are pathogenic to humans when consumed(Nørrung et al., 2009).

2.4.2. Yeast and fungi pathogens related to meat and meat products

Yeasts and fungi are present in small proportions and possess a slower growth rate compared to bacteria(Hinton Jr et al., 2007). The most prevalent fungal species associated with meat spoilage include; *Acremonium*, *Alternaria*, *Aspergillus*, *Cladosporium*, *Epicoccum*, *and Penicillium* (Nasser, 2015). while the yeasts include; *Candida mesenterica*, *Candida saitoana*, *Cryptococcus albidus*, *Cryptococcus laurentii*, *Cryptococcus luteolus*, *Rhodotrula glutinous*, and *Rhodotrula mucilaginosa* (Hinton Jr et al., 2002). The yeast and fungi flourish at temperatures between −10 to −2 °C, the water activity of 0.80, and pH range <1.0 to 11.0(Dave and Ghaly, 2011).

2.5. Analysis of the food safety control and enforcement systems in Uganda

Uganda's food control system is made up of '5 building blocks' and have been identified as follows; Food laws and regulations, Food control management, Inspection services, Laboratory services, Information, and education, communication, and training(Bagumire et al., 2009, Mutukumira and Jukes, 2003)

2.5.1. Meat-related food safety laws and regulations

The food safety legal framework compromises of several acts and regulations covering the mandates of different stakeholders. Uganda adopted a legal framework that food legislation does not necessarily contain the details of the practices and health conditions to be complied by the various stakeholders in the food industry, but general regulatory instructions and a clause that empowers responsible duty bearers to issue detailed guidelines(Bagumire et al., 2009). The meat industry in Uganda is controlled by several stakeholders that are mandated by different laws.

Most of these laws are generally prescriptive rather than risk-based, which poses challenges to the effective implementation of an effective food control system (Mutukumira and Jukes, 2003, Ejalu and Fortin, 2008, Mbabazi and Ahmed, 2019). The Acts include;

- Public Health Act 1933, revised in 1964

- Water Act 1995

- National Water Policy 1999

- Animal Breeding Act 1997

- Animal Diseases Act 2001

- Cattle Traders Act 1945

- Animal Prevention and Cruelty Act

- Cattle Grazing Act 1945

- Dairy Industry Act 2000

- Rabies Act 1935

- Hides and Skin Act

- Consumer Protection Act (Draft)

The polices are as follows;

- National Agricultural Policy

- Livestock Development Policy (Draft)

- Animal Breeding Policy 1997

- National Veterinary Drug Policy

- National Drug Policy

- National Food and Nutrition Policy

- National Meat Development Policy 2003

- National Animal Feeds Policy 2005

- National Extension Services Policy 2017

- National Health Policy 1999

- National Delivery of Veterinary Services Policy 2003

- Pasture and Rangeland Policy (Draft)

- Animal Feeds Bill

Statutory Instruments and regulations within the sector, include:

- Animal Diseases Statutory Instruments

- Meat and Milk Hygiene Regulation

- Animal Diseases (Declaration of Diseases) Statutory instrument 38 (1-2)

- Animal Diseases (Importation of Poultry) regulation, Statutory Instrument 38 (12)

- National Environment and Waste Management Regulation 1999

- Regulation of Effluent into Water and Land Standards 1998

- Animal Health Master Plan (Draft)

The public Health Act 1935 is the primary legal basis for food safety controls undertaken by the Ministry of Health and its partner agencies. The UNBS act is the legal basis of food safety controls conducted by the Ministry of Trade, Industry, and Cooperatives (MTIC) through the Uganda National Bureau of Standards (UNBS). The Animal Disease act is the current basis for control of safety issues for products of animal

origin being undertaken by the Directorate of animal resources under the Ministry of Agriculture, Animal husbandry, and Fisheries (MAAIF).

A food safety Bill was developed between 2005 and 2015 to consolidate food control efforts made by several stakeholders through a multi-sectoral effort. However, it is still pending due to possible disagreements on the agencies to lead the food control function before it enters the legislative process. The bill is quite comprehensive in most aspects and addresses some of the omissions in the above laws. It, however, lacks some elements of good food law as envisaged by the international best practices outlined by FAO/WHO guidelines and recommendations like technological developments in the food industry such as food additives and contaminants and packaging, does not establish systems and principles for inspection services as required such as monitoring, surveillance, and control of entire supply and value chain or conduct of official controls for all food commodities. It is not risk-based and, therefore, does not promote the modern concept of risk analysis as a food safety control and management. It also doesn't consider matters like traceability, application of international best practices during the inspection, particularly HACCP, and protection of the entire food chains.

2.5.2. Meat-related food control Management

Uganda does not have an agency responsible for the coordination of food safety control. However, there are exceptions for some exported commodities like fish, horticulture, and honey, where an established market like the EU emerged with crucial requirements of a single competent authority. In such cases, the government-appointed

specific departments to act as competent authorities for the respective commodities. Apart from these, different ministries, departments, and agencies are responsible for different mandates in food safety control. As a result of the arrangement, the food safety and quality control infrastructure are fragmented and ambiguously shared among several ministries, departments, and agencies. Table 1 shows a summary of the different stakeholder managing the meat sector of Uganda

Table 3: The main Institutional food safety control framework managing the meat sector in Uganda

Institution	Product	Mandate
Ministry of Agriculture, Animal Industry and Fisheries (MAAIF)	All veterinary products, animal and animal products	Responsible for formulation review of laws, regulations and standards, strategies and plans related to the implementation of food safety measures
Uganda Bureau of Standards (UNBS)	National standards	Responsible for setting standards to meet international requirements
National Standards council	Technical regulations	Approve the national standards and technical regulations set
Ministry of Health	Human and animal safety	Ensuring public safety and food safety in all meat-related premises
Ministry of trade industry and cooperation	Trade policy formulation	Coordinating domestic, regional, and international trade through policy formulation for national and international trade negotiations for increased access to markets.

Ministry of Education and sports and institutions of higher learning	Human resource development and capacity building	Training and nurturing the human resource capacity
National Agriculture Research Organization	Research	Undertake, promote and coordinate research for crops, livestock, fish, and forestry in Uganda
Ministry of Water and Environment	Water and environment	Policy formulation in the management of water and environment
National Environment Management Authority (NEMA)	Environment	Management of environment and ensuring the safety of the environment
Directorate of water	Water	Development and improvement of water sources and ensuring water quality and safety

2.5.3. The inspection services in the meat sector

The stakeholders mandated to conduct food safety inspection services for meat are MAAIF, MOH, and UNBS. MAAIF is mandated by the Animal disease Act 1964, Agricultural and chemical Act 1964 to inspect the primary production in the meat sector. They inspect and manage outbreaks of any diseases related to animals and are also mandated to examine the veterinary medicines used.

MOH is mandated by the Public Health Act 1933 to ensure that premises selling meat are up to the required standards. Inspection is also done by UNBS as mandated by the UNBS Act. 1983

2.5.4. Laboratory services

For efficient enforcement of food safety and protecting the health of consumers, the country requires a sound and dynamic laboratory testing and analytical capacity both at the national level and regional level. In Uganda, there are several labs in various ministries, departments, and agencies, which include; UNBS, Chemiphar Ltd, Uganda National Fish Laboratory, Dairy Development Authority Laboratory, National Water laboratory, Government Analytical Laboratory, Uganda Industrial Research Institute, Ministry of Health laboratory, etc. Also, numerous academic and research institutions have labs that are used to undertake food safety-related activities such as surveillance and monitoring of the food safety status of different commodities. Efforts by MTIC have also been set to ensure that the laboratories are equipped and staffed. A few of the testing laboratories are accredited for specific test per the quality, administrative, and technical requirements of ISO 17025. These international standards provide general requirements for the competence of testing and calibration laboratories. However, most of the laboratory testing infrastructure in Uganda is generally weak, and most labs have not been accredited. There is usually low awareness by producers, business, and industry operators on the importance of testing of products to the consumer market which is compounded by the general lack of safety consciousness and quality culture within Uganda producing and consuming public

2.5.5. Information, education, communication, and training

In Uganda, awareness about the importance of a well-established food safety control system to the economy and national development generally lacks among the policymakers, politicians, public sector, and private sector decision-makers and workers

(Heilmann et al., 2016). Food safety control measures are often considered to be a costly expenditure and constraints instead of as a tool for ensuring human health as well as the competitiveness of the economy(Muyanja et al., 2011). The media reports on food safety are usually after an outbreak, and not all the information is covered(Bagumire and Karumuna, 2019).

2.6 Analysis of the meat legislation and standards in the international market

Consumers at the international markets require meat to be of high and consistent quality throughout the year and at modest prices (Font-i-Furnols and Guerrero, 2014). As so, international traders source their products from all over the world while ensuring the safety of the meat and meat products and alertness to maintain consumer trust. They do this by ensuring that safety standards are followed from the farm, which implies a shared responsibility of the stakeholders within the farm-to-fork continuum. The following section briefly describes the framework of meat/food legislation and standards in which regulation of meat and meat products operate at the international level.

2.6.1. Codex Alimentarius standards

The Codex Alimentarius Commission (CAC) was formed by the Food and Agricultural Organization (FAO) and the World Health Organization (WHO) in 1963(Alimentarius, 1994). Its primary objective is to develop food standards, guidelines, and codes of practice at the international level (Dawson, 1995) to ensure consumer protection, fair trade, and coordination of food standards (Bevilacqua, 2006). It's through

the CAC that developing countries have a voice in the decisions that affect their market access and, consequently, national social and economic development (Clarke, 2010). Many nations use the Codex documents as a baseline while setting their national legislation. Still, in countries where there are no national standards, Codex Alimentarius standards become obligatory, and meat and meat products exports may be rejected or banned for failing to meet these food safety and/or quality standards (Majone, 2006). Application of Sanitary and Phytosanitary Measures (SPS) created by The World Trade Organization (WTO) Agreement in 1995 also concur with the standards and guidelines established by the Codex Alimentarius Commission as a reference in international food trade(Veggeland and Borgen, 2005, Clarke, 2010).

2.6.2. EU legislative requirements

Data sharing between supply chain partners is considered vital for; improving the competitiveness, innovativeness of business firms, and food safety and traceability. Referring to this, the European Union (EU) created a European Food Safety Authority (EFSA), which is in charge of setting up stringent food standards, guidelines, and codes of practice for all foods consumed in Europe (Buonanno, 2006). Countries that export meat and its products to the EU must be able to meet their legislative requirements to ensure a high level of protection for public health and consumer interests regarding meat products. The basis for the EU food safety public standards is laid down in the General Food Law or Regulation (EC) 178/2002(Law, 2002)

In recent years the supply chain concept has grown much significance in agribusiness since it is considered vital for the understanding of current issues in the management such as traceability (Theuvsen et al., 2007). EFSA has taken up the same concept and, therefore, has set up traceability standards to ensure that meat and its products can be withdrawn from the market in the event of a problem (Lawless and Wiedemann, 2011). Furthermore, companies have to conform with hygiene requirements, which have to be documented, and certificates of phytosanitary health are also required (Dwinger et al., 2009).

2.6.3. Private standards

The agribusiness and particularly the global meat supply chain, is rapidly extending across the globe due to improved communications, transportation technologies, and policy environment that boosts more free international trade (Peine, 2013, King et al., 2017). Ownership is also becoming more monopolized by huge multinational companies that have immense power over the global markets (Wilkinson, 2009). These companies, e.g., Walmart, Carrefour, Sainsbury's, Tesco, and others, aim at the standardization of quality, safety, and ethical practices of their suppliers (Henson and Reardon, 2005, Kotsanopoulos and Arvanitoyannis, 2017) which has led to the emergence of private food safety and quality standards as substantial driving forces across the globe. These private standards are predominantly driven by consumer concerns on food safety, quality, and scientific developments regarding the risks associated with food (Clarke, 2010). They operate alongside public regulatory systems, although not mandatory to use them; they can be de

facto in determining market access by suppliers in some cases (Henson and Reardon, 2005). In some developing countries, private standards may also be used in case of missing public institutions or ensure the enforcement of otherwise not-enforced public standards (Unnevehr, 2015).

Furthermore, private standards are not only being demanded at the international markets. Still, they are also increasingly being required by supermarkets in developing countries(Sonntag et al., 2016), as local market players are also adopting terms converging towards the ones in the international export supply chain. The adoption of private standards by domestic players is likely to become more important than those of the export supply chain as the potential local market is much larger (Unnevehr, 2015).

A series of international quality standards have also been established by the International Standard Organization (ISO) standards. The ISO standards are coined from the quality management system that combines all activities and handling procedures to ensure product compliance. The best-known ISO standard is the ISO 19000 series for quality and ISO 22000 for Food Safety Management System, targeting the whole supply chain(Nicolae et al., 2016, Dafallah, 2017).

The meat sector has faced several evolutions leading to a systematic restructuring of the supply chain and increased use of private quality standards, e.g., BRC, FSA, SQF 2000, FSSC 22000, SQF 1000, and IFS(Clarke, 2010). These private standards all have different principles they base on. For example, FSA has produced a detailed Meat Industry Guide, the UK Meat Industry (FSA, 2018). These guidelines are relevant to people that; slaughter animals for human consumption, dress carcasses, cut or process meat, and sell meat. It covers; the legal obligations with which all meat plant operators must comply, how

meat plant operators can meet their legal requirements, and the application of HACCP principles (FSA, 2018).

2.6. Food Safety Management Systems

Food Safety Management System (FSMS) is a combination of two things: food safety and management system. Food safety is related to food quality(Luning and Marcelis, 2009) and termed as the guarantee that food shall not cause harm to the person that eats it when it is prepared and/ or eaten accordingly. Management System is related to the organizational structure, responsibilities, processes, procedures, and resources that enable the attainment of quality management (Jacxsens et al., 2011). Therefore, a FSMS encompasses the elements of the Quality Management System (QMS) that are specific to food safety. These elements aim at controlling and assuring the safety of food from microbiological, chemical, and physical hazards (Nanyunja, 2015). Given the need to ensure that food safety risks are significantly reduced, FSMS has, therefore, assumed extreme importance as a critical driver of a food production system (Kussaga et al., 2014).

A FSMS entails a plethora of preventive and performance-based safety and quality assurance standards and guidelines aimed at controlling and ensuring food safety. For example, Pre-Requisite Programs (PRP), Good Manufacturing Practices (GMP), Good Hygienic Practices (GHP), quality assurance standards (e.g., ISO Standards), and Hazard Analysis and Critical Control Point (HACCP) plans (Nanyunja, 2015). The biggest challenge for a food-producing company is to meet consumer requirements by implementing a company-specific FSMS. Food producers may, therefore, be obliged to combine and

implement different safety and quality assurance standards and guidelines into their FSMS depending on customer requirements. These decisions are made while bearing in mind the company and product-specific contextual status (Onjong'Hillary, 2013, Jacxsens et al., 2011). This results in the variable implementation of the FSMS and hence variability in safety output among different food producers (Kirezieva et al., 2013).

2.6.1. Performance measurement of a food safety management system

Food companies bestow ample funds in developing and maintaining their food safety management systems. As so, it is essential to appraise and improve the performance of the implemented FSMS to meet the demands of the consumers and different stakeholder requirements (Luning et al., 2011b, Jacxsens et al., 2011). Approaches of appraisal typically focus on examining actual microbiological output and the implemented activities in the FSMS against preset standards with the presumption that fulfillment of these standards indicates a sound food safety output. However, these approaches do not give insight into the actual activities in the FSMS (Luning et al., 2008, Luning et al., 2011b). It is, therefore, logical to analyze and appraise the performance of food safety control and assurance activities while taking into consideration the contextual situations. The contextual conditions are product, process, organizational, and chain environment characteristics (Jacxsens et al., 2010).

2.6.2. *Food Safety Management System Diagnostic Instrument*

The FSMS-diagnostic instrument(FSMS-DI) that assesses safety context, control, and assurance activities in an FSMS was designed by Luning et al. (Luning et al., 2011a). It enables a systematic analysis evaluation of degrees at which core control and assurance activities are implemented in an establishment to guarantee that food safety requirements are met. FSMI-DI has previously been implemented in meat, poultry, dairy, fish, and lamb supply chains to appraise the performances of the FSMS (Sampers et al., 2010, Osés et al., 2012, Kussaga et al., 2014, Kussaga et al., 2015, Njage et al., 2018). The FSMS-DI allows for systematic analysis and differentiated assessment of levels at which core control and assurance activities are executed in a company to grasp and ensure that food safety requirements are met. It is independent of the quality assurance standards and guidelines that have been implemented (Luning and Marcelis, 2009).

2.7. Transaction Cost Theory

The general scheme of transaction cost theory(TCT) is that chain stakeholders line up the governance features of inter-organizational relationships to correspond to known exchange hazards, especially transaction-specific investments or uncertainty (Williamson, 1991a). In this context, transaction cost theory, as proposed by Williamson, deliberates the economic organization to be a governance structure that assists in lessening transaction costs. Different forms of governance are offered that aim to minimize the effects of bounded shrewdness and protect transactions against chain member opportunism (Abebe et

al., 2017, Williamson, 1993). Therefore, transaction costs are influenced and created conferring to the complexity of each operation (Ashenbaum et al., 2009).

Conferring to transaction cost economics (TCE), one of the determining factors of governance structure is the degree of uncertainty, asset specificity, and frequency of the transaction (Williamson, 1991b). This means that simple governance structures should be applied in combination with modest contractual relations, and complex governance structures are applied in conjunction with complex relationships (da Silva Martins et al., 2020, Zhang and Aramyan, 2009).

TCE assumes that exchanges between agents generate transaction costs; that is the costs resulting from the transfer of property rights between agents (Rosales et al., 2019). Transaction costs theory is coined from what Williamson calls the discriminating alignment hypothesis. This hypothesis states that depending on the scopes of transactions (asset specificity, uncertainty, and frequency) and behavioral assumptions (bounded rationality and opportunism), economic negotiators will choose a governance structure that decreases production and transaction costs (Riordan and Williamson, 1985).

TCE identifies several organization modes, which include; market-based, hybrid, or hierarchical (Ménard, 2018, Rosales et al., 2019, Abebe et al., 2017). Market- based are the most decentralized coordination modes typified by transactions that favor autonomous adaptation such as price changes. Hierarchical governance allows better control of transactions and cooperative adaptation by having a vertical integration (Martins et al., 2017). In between the market-based and hierarchical modes lie numerous hybrid

41

organization modes ranging from oral and written contracts to partnerships and joint ventures (Abebe et al., 2017). When moving from market-based to hierarchical mode, control over transactions increases in intensity, and the adaptation mode shifts from an autonomous decision structure to a cooperative structure (Rosales et al., 2019).

Given that transaction costs are defining aspects in the organization of transactions partaken in the supply chain, implementing a proper mode of organization is of supreme importance for chains' effectiveness (de Oliveira et al., 2019). A better-coordinated chain tends to be more stable, particularly when confronted with difficult situations that require instant action (Abebe et al., 2017).

2.7.1. Theoretical framework Research hypotheses for analyzing the performance of the governance structures

The performance of governance structures in an Agri-supply chain can be analyzed basing on two features as emphasized by Kataike et al. (Kataike et al., 2019) and Gyau et al. (Gyau and Spiller, 2008) which include; nature of the contract, and relational governance structures used. Thirdly, standards and certification can also be used for the analysis of governance structures (Abbott and Snidal, 2001, Wanjiru, 2018).

2.7.2.1. Nature of contracts governance and chain performance

Nature of contracts usually spells out the requisite terms of engagement. Contracts, as a governance mechanism, are intended to achieve two main objectives: first, outline authority responsibility structure; and two, share risk between chain associates (Ghosh and

Fedorowicz, 2008). Nature of contract is also interpreted to be related to aspects of rights and obligations of the contracting parties. Some forms that the nature of contract take include; closed one (terms are pre-agreed and documented. They cannot be modified in the event of unexpected market conditions), flexible (terms pre-agreed and documented but are subject to modifications in the event of unforeseen market conditions), relational (terms related to price, delivery, quality and safety conditions but no written form and are pre-agreed but subject to modifications depending on market conditions), and market or transactional (no pre-agreed terms, prices delivery, quality are determined on the spot) (Abebe et al., 2017).   In the case of a closed contract, performance and behavioral standards are specified in the contract, and the buyers are guaranteed of conformity in the actions performed(Abebe, 2020, Kataike et al., 2019). On the other hand, market or transactional contracts usually result in the suppliers acting opportunistically to realize short term profits from the transactions (Gyau and Spiller, 2008). Therefore, the chain partners end up incurring more costs to safeguard themselves against the possible opportunistic attitudes, and hence transaction costs are increased while the overall economic performance is reduced(Kataike and Gellynck, 2018). During a study on the impact of market or transactional contracts (spot markets) on quality management implementation on pork processors in china, Han et al. (Han et al., 2011) found out that spot market transaction has a negative impact. Hence, we hypothesize that-;

H1. Spot market transactions are negatively related to the performance of the governance structures

2.7.2.2. Relational governance and chain performance

Good relational governance is a product of trust due to long term commitment between the stakeholders in the chain (Kataike et al., 2019). A trusting partner has a strong desire to remain in the trade relationship. Therefore, the length of the trade relationship is correlated to the fulfilments of mutual requirements concerning quality arrangements (Zhang and Aramyan, 2009). Excellent relational governance is ensured by encouraging a two-way communication of all the information that may affect the price, delivery, quality, and safety conditions of the meat and ensuring a consistent supply of quality beef. A regular supply of quality meat can be tracked through the percentage of meat rejected by the buyer. These relational governance practices are more influential in improving performance as long-time commitment reduces the time and costs associated with recurrent disputes, posturing, and renegotiations (Range and Leonard, 2016).

Similarly, good relational governance has a positive and substantial impact on the performance of exporters (Yang et al., 2015). During a study on the Governing of buyer-supplier relationships through transactional and relational mechanisms in china, Lui et al. (Liu et al., 2009) indicated that relational mechanisms were expected to be more effective in elevating the performance between companies in a supply chain that have a long-term relationship. As so, the following hypothesize is set to be tested:

H2. Relational chain governance has a positive relation to the performance of the governance structures.

2.7.2.3. Standards and certification and chain performance

Standards and certifications have mainly been used as either a remote governance instrument or a differentiation determinant in specialty marketing (Wanjiru, 2018). With this governance understanding, Abbott et al. (Abbott and Snidal, 2001) suggested that standards and certification schemes are applied to deal with externalities and are sub-categories of governance, to these authors, "externality occurs whenever one actor's conduct affects the well-being of another"(347). Ponte et al. (Ponte and Gibbon, 2005) also suggested that standards are the baseline for regularization through promoting or sanctioning functions. Therefore, standards and certifications have helped the management and administrative mechanisms of value chains and their structures as well as availed advancement opportunities for producers or appealed means for sustainability (Ponte and Cheyns, 2013).

Implementation of standards food standards in the meat value chains calls for a steady provision of good quality meat which therefore results in a more vertically integrated value chain (von Hagen and Alvarez, 2011). As so, the following hypothesize is set to be tested:

H3. Standards and certificates have a positive relation to the performance of the governance structures.

CHAPTER 3

METHODOLOGY

3.1. Context of the study

3.1.1. Background on the Food Safety Laws and Regulations (Legal Framework)

The main law that governs food safety control measures in Uganda is the Food and Drugs Act (1964). In 1993, the drug element was transformed into the Drug Act to establish the National Drug Authority (NDA). This left the food element of the Food and Drug Act hanging. No amendment has been made to this date on what now is referred to as the Food Act

With the existence of obsolete food law, Uganda relies heavily on several legislations related to food safety that are scattered in different Ministries, Agencies and Departments (MDAs) established to regulate different food commodities or aspects of food safety. These food legislations cover the mandates of different MDAs to regulate food safety in the country. For instance, the Uganda National Bureau of Standards (UNBS) carries out its mandate under the guidance of the UNBS Act, UNBS Inspection and Clearance of Imports Regulations 2018, and UNBS use of Distinctive Mark regulations 2018. Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) also carries out its mandate under the guidance of various acts and regulations that direct the control of food products covered by the different mandated directorates or departments. Among the laws guiding the operations of food controls undertaken by MAAIF include among others:

Animal Diseases Act, Adulteration of produce Act, Agricultural Chemicals (Control) Act, 2007; the Plant Protection Act of 2015, the Fish Act 1964. Some regulations have been developed to elaborate on the implementation of some laws. For instance, there is the Animal Diseases (selective importation of livestock, livestock products, co-products, and by-products) regulations, 2003; Animal Diseases (Control of Bee diseases) Rules, 2004 which are key in undertaking food controls by MAAIF on products of animal origin. There is the Fish and Aquaculture Products (Quality Assurance) Rules and Fish (Aquaculture) Rules established under the Fish Act which assist to regulate aspects of food safety in accordance with the modern concept of risk analysis.

The Food Act and Public Health Act established under the Ministry of Health have an effect on food commodities regulated by other MDAs and are used in combination with other legislation in undertaking food controls by all the responsible CAs. Under the Public Health Act, several regulations that address food safety issues and in accordance with international best practices have been developed. They include the Public Health (Meat Hygiene) Rules, Public Health (Milk Hygiene) Rules, Public Health (Eating Houses) Rules, and Public Health (Baking Houses) Rules. These rules together with the parent Public Health Act, even though developed by the Ministry of Health, are used by all the mandated CA during official controls.

There are also particular laws such as Dairy Development Act and the Coffee Development Act and with the regulations issued under them which were established to address concerns of the specific commodities (milk and coffee). Although these laws and

related regulations are not specifically targeted to food safety regulation, they provide guidance on how food is to be handled at a particular point within the value chain.

There has been effort to establish a National Food Safety Policy to harmonize and coordinate the roles of different mandated MDAs in food safety control. The Bill to establish a National Food and Drugs Authority (NFDA) has also been drafted and currently, it is undergoing debate within different layers of government. The NFDA Bill is expected to regulate mainly locally manufactured and imported manufactured food stuffs that are currently being regulated under the UNBS Act as a stop-gap measure. However, even with the enactment of NFDA Bill, in the law in the current form would still leave out the control of food safety for food produce traded on local markets (since MAAIF using the available laws only controls exported produce) which pause a greater risk to consumers.

More so, even with the existing mandates, the lack of a comprehensive specific food safety law affects regulation of other produce not covered by the existing laws in MAAIF. For instance, the Food Act and the Public Health Act are not effective in ensuring the safety of meat and meat products in some aspects. Whereas modern food controls require competent authorities to implement a national drugs and chemical residue monitoring programme (RMP) for all food products of animal origin (meat, dairy, honey, eggs, etc.), there is no existing legislation to support this requirement in any of the existing laws. Also there is no effective legislation to support the traceability of the animals and animal derived products to guarantee food safety.

Other areas that lack effective legislation to regulate food safety is animal feeds. The modern food controls require that feed for food animals be handled and treated in the same

way as food for human consumption. Although a National Animal Feeds Policy was passed in 2005 to guide the production and utilization of animal feeds, no law has been enacted to regulate the feed sector in accordance to modern risk-based approaches to food safety.

3.1.2. Description of the meat supply chain in Uganda

The chain commences at the farm when the farmer decides to sell animals by taking them to a market or sell to a middleman from the farm gate. Middlemen then transport the animals by truck to slaughterhouses /market places in bigger cities, though in most cases, it is the capital Kampala. (Gerald Nizeyimana, 2014) The slaughterhouses form a sort of a stock exchange for life stock, so the middleman may either slaughter the animals and sell the carcass or sell the live animal to a person that then deals with the slaughter business. Alternatively, the live animals may be taken from the slaughterhouses to other markets where they are sold off and transported out of the country.

At the slaughterhouses, animals may be kept alive for 2 to 10 days before slaughter, depending upon demand for beef. During this time, the animals are kept in kraals or animal waiting-areas and are usually only given water. The animals are also inspected during the waiting time for any injuries, any signs of sickness, and inspected to ensure they satisfy the required animal health standards for animals to be slaughtered. To further ensure the safety of the meat, inspections are done after slaughter by qualified personnel is carried out, and meat is indicated to be safe by stamping on the carcass. Upon clearance by the veterinarian, the meat is distributed to retail outlets (small butcher shops and supermarket) for retail selling. Processors too buy meat for processing from the slaughterhouses. (ACET, 2015,

Kyeyamwa et al., 2008). Apart from slaughterhouses in and around Kampala, there are several facilities in Uganda where animals are slaughtered: At-the-farm slaughters, at village markets, town slaughter slabs, and urban slaughterhouses. This research focused on the slaughterhouses within Kampala.

The processors then process the meat into many meat products and then sell them to the local and/or international markets. They are engaged in the processing of meat to provide a range of meat products like sausages, ham, prime cuts, and minced meat. (Gerald Nizeyimana, 2014) the retail outlets sell mainly to the local community. Some retail outlets also process the meat (minced meat) but on a small scale.

Figure 2 Summary of Uganda's meat supply chain

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                    ┌─────────────────┐
                    │  Animal farms   │
                    └─────────────────┘
                             │        ┌──────────────┐
                             │        │  middleman   │
                             │        └──────────────┘
                             ▼
                    ┌─────────────────┐
                    │ Primary stock market │
                    └─────────────────┘
        ┌──────────────────┐        │
        │ Secondary market │        ▼
        └──────────────────┘   ┌─────────────────┐
             │            │    │ Slaughterhouses │───────────┐
             ▼            │    └─────────────────┘           ▼
   ┌──────────────────┐   │         │              ┌──────────────────┐
   │ Live animals for │   │         ▼              │  Retail outlets  │
   │     export       │   │   ┌────────────┐       └──────────────────┘
   └──────────────────┘   │   │ processors │              │
                          │   └────────────┘              ▼
            ┌─────────────────────────┐       ┌──────────────────┐
            │ International and local │       │ Local consumption│
            │      consumption        │       └──────────────────┘
            └─────────────────────────┘
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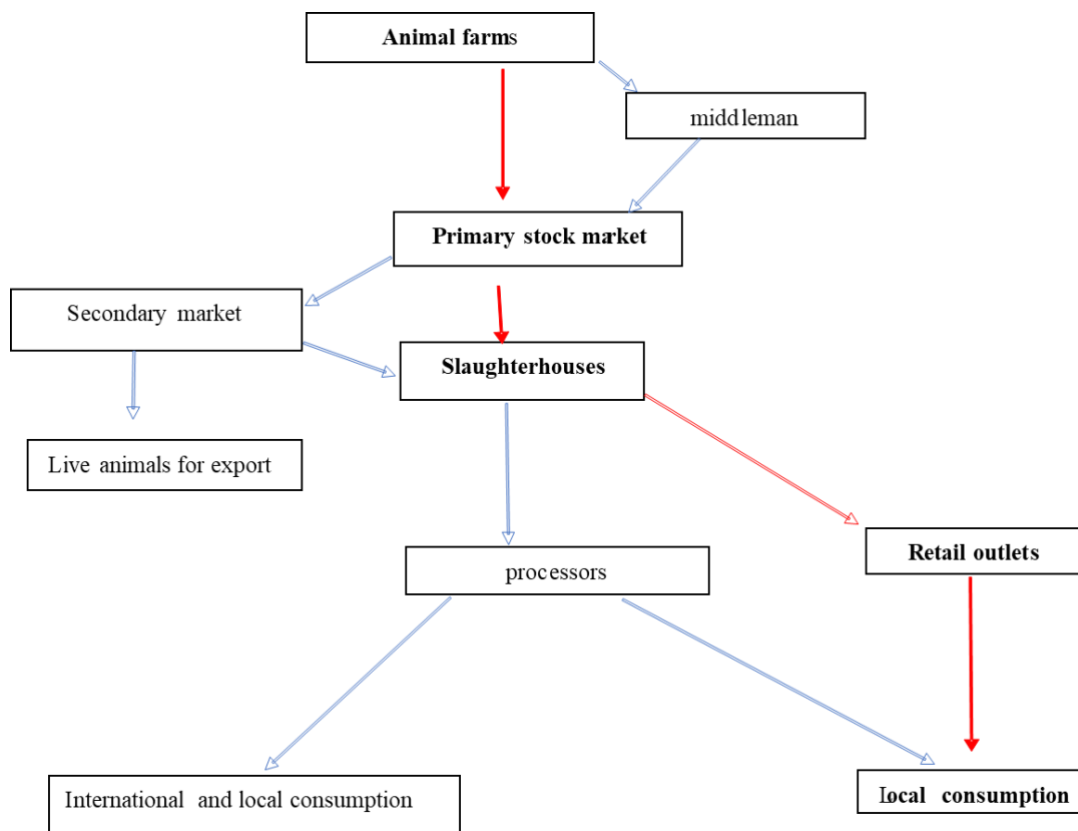
3.1.3. Background of the study area

The study was carried out in Kampala (latitude 0.31573 north and longitude 32.57726 east), which is Uganda's capital city and the central commercial district of the country. Kampala has a population of approximately 1,680,800 people (UBOS, 2020). It's also the principal local government administrative unit. Kampala district is subdivided into five divisions: Rubaga, Kawempe, Nakawa, Makindye, and Central division (fig 3). There are five main abattoirs in Kampala that supply meat to the capital market: City Abattoir (Nakawa division), Ugandan Meat Packers Ltd. (Nakawa division), and Nsooba Slaughterhouse Ltd (Kawempe division), Wankulukuku slaughterhouse (Rubaga division), and Kazo boys slaughterhouse (Kawempe division). The slaughterhouses each slaughter 200-400 animals daily and supply meat to Kampala and its environs, which is the largest market for beef in Uganda and accounts for the highest proportion of livestock slaughtered in Uganda. All these slaughterhouses are run privately though they are supervised by Kampala City Council Authority (KCCA).

Butcher shops and supermarkets are numerous, privately owned, and are unevenly distributed within Kampala. The Butcher shops are mainly concentrated in division markets though a few are found outside the main markets. Each division has at least one primary market that is under KCCA. The kind of FSMS implemented by the slaughterhouses are based on HACCP and ISO guidelines while the butcher shops and some of the supermarkets, on the other hand, implement basic hygienic and meat safety preventative practices to ensure meat safety

Figure 3: Map of Kampala showing its divisions. Source; (Zziwa et al., 2016)
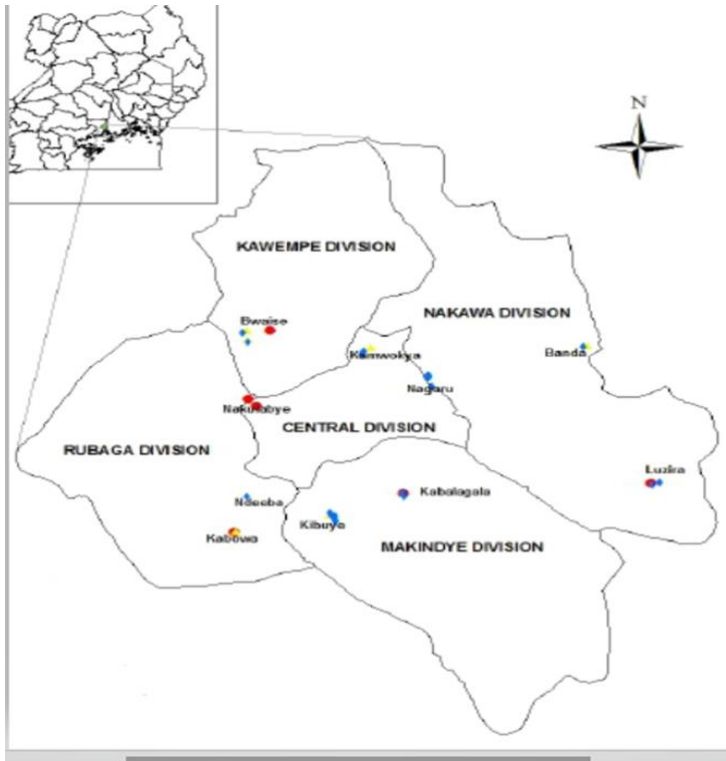
3.2. Research Design:

The research is a cross-sectional study that combined both quantitative and qualitative research methods. The qualitative research method was used to understand the opinions of retail outlet operators on the most critical factors affecting the safety and quality of meat in Uganda. The quantitative research method was used to analyze the activities carried out by retail outlets and investigate relationships of different variables.

Quantitative research methods were used to assess control activities, assurance activities, and food safety performance of the slaughterhouses and helped categories the FSMS of the different slaughterhouses according to guidelines set by Luning and Jacxsens (Luning et al.,

2008, Jacxsens et al., 2010). The quantitative method was further applied in characterizing the retail outlets (butcher shops and supermarkets) according to the activities they carry out to ensure the safety of meat. It was also used to describe and explain relationships between slaughterhouses and retail outlets and how these relationships affect the safety of meat sold by the outlets.

The study units were the slaughterhouses, butcher shops, and supermarkets. the research gathered information from both primary and secondary sources. The primary data were sourced from the slaughterhouses and retail outlets within Kampala. These primary data provided the opportunity for the research to access firsthand information from either the owners or operators who were directly involved in the handling and selling of meat in the retail outlets and the quality control officers of the slaughterhouses. The secondary data were drawn from peer-reviewed articles, books, and government project reports in both electronic and printed. Data were assembled from both primary and secondary sources to extensively explore the issue of study and carefully analyze the research objectives.

3.3. Sampling Technique

A meeting was organized with the KCCA, which oversees the supervision of all retail meat outlets and slaughterhouses in Kampala. However, they couldn't give the exact number of all the retail meat outlets. An approximate total number of butcher shops in Kampala (700) was established by getting the average number of butcher shops (35) in two significant markets Nakawa (28) and Nakasero (42) and multiplied the number of major markets (15) in Kampala hence the required sample size at 90% confidence level and 5%

error was 196. The markets included; Nakasero, Usafi, Makindye, Kalerewe, Wandegeya, Nakawa, Bugolobi, Kireka, Bweyogerere, Kisekka, Katwe, Mpelerwe, Kitintale, Luzira, and Natete. KCCA also helped identify the top 25 supermarkets dealing with meat out of the total 46 that sold meat. The supermarkets included branches of Quality supermarket, Tuskys, Capital Shoppers, Shoprite, Uchumi, Mega standards, and Kenjory.

A stratified sampling technique was used as the participants were divided into three strata; slaughterhouses, butcher shops, and supermarkets. All 25 identified supermarkets and the five slaughterhouses determined by KCCA were invited to participate in the survey, while 15 butcher shops were randomly chosen from each market. 184 butcher shops, 20 supermarkets, and three slaughterhouses agreed to be interviewed.

3.4. Recruitment and Data Collection Strategy

The slaughterhouses were recruited using formal and professional methods. A meeting was scheduled with the administrators of the slaughterhouse, and after that, permission was requested to interact with the individual in charge of safety and quality. After receiving approval to participate in the research, an appointment was set, mentioning a convenient time and location for the participant. At the commencement of the meeting, the investigator and participant are introduced to each other. Shortly after, a written consent form was handed to the participant to inform them briefly on the research topic and the research method used. The consent form also informs participants of their rights, where they have the right to stop or not answer if they felt uncomfortable during the session. It also tells them of the social and economic risks involved and how the research team

promises them to protect them by keeping their identity and that of their company anonymous from third parties or publication material. To ensure anonymity, the participant was not requested to sign any document but handed a copy of the consent form. The company's personnel in charge of quality was interviewed using a questionnaire (See Appendix), and after the interview, the participant was taken through the facility to ensure honesty.

For the retail outlets, the form of contact was informal, where the participant verbally introduced himself to the owner of the business or the person handling the meat and requested the participants to take part in the interview. After receiving approval to participate in the research, a written consent form was handed to the participant to inform them briefly on the research topic and the research method used. In case the participant didn't understand English, the interview communicated in the local language (Luganda).

3.5. Data collection tools

Two questionnaires were formulated; one for evaluating the FSMS control, assurance, and food safety performance indicators in the slaughterhouses modified from Jacxsens and Luning (Jacxsens et al., 2011, Luning et al., 2008). The other questionnaire was used to establish the sanitation and hygiene practices employed by butcher shops and supermarkets. This was based on 'Butcher Safe'(Food_Standards_Scotland, 2013). It was also used to determine the kind of contractual relationships that the retail outlets had with the slaughterhouses, respectively, as based on studies done by Abebe et al. (Abebe et al., 2017). The interview was carried out in English, but in case the person did not understand

English, the questions were orally translated into Luganda, which is the local language in Kampala.

3.5.1. Questionnaire for evaluating the FSMS control, assurance, and food safety performance indicators in the slaughterhouses

FSMS control, assurance, and food safety performance indicators comprised 25, 9, and 4 indicators, respectively. For each indicator, the respondents had to choose the level that best described their performance levels, whether 'not conducted or applied' (level 0), basic (level 1), average (level 2), or advanced (level 3). Level 0 means the activity is not implemented or not conducted (score 0). The basic level (level 1) for control activities is characterized using own experience, general knowledge, ad-hoc analysis, incomplete descriptions or registration or programs, not bench-marked, instability, and/or regular problems. The basic level (level 1) for assurance activities is epitomized by problem-driven levels, which are only checked when issues arise, rarely reported, and lack of independence. The average level (level 2) for control activities makes use of expert (supplier) knowledge, sector or governmental guidelines, best practices, and standardized methods with occasional problems. The average level for assurance activities corresponds with an existing translation of stakeholder requirements, further analysis, and documentation of the system, regular reporting of status, and input of experts. The advanced level (level 3) means that the control or assurance activity is characterized using specific information, science-based knowledge, critical and in-depth analyses, systematic methodology, and autonomous positions.

Similarly, for the food safety output, the interviewees had to select the grid that best depicted their FSMS performance or output for the 4 food safety performance indicators. These were 'not done' (level 0), poor (level 1), moderate (level 2), and good food safety output (level 3). These situational levels of performance corresponded with scores of 0, 1, 2, and 3, respectively, and were thus scored. Level 0 means no indication of food safety performance and refers to absent, not present, or not conducted. It means that the FSMS evaluation is not done, and/or that the specific food safety performance information is not known. Level 1 means poor performance and is associated with aspects like ad-hoc sampling, minimal criteria used for FSMS evaluation, and the existence of various food safety problems due to different issues in the FSMS. Level 2 represents moderate performance and refers to regular sampling, several criteria used for FSMS evaluation, and restricted food safety problems mainly due to one (limited) type of problem in the FSMS. Level 3, which means excellent performance, portrays a systematic evaluation of the FSMS using specific criteria and the existence of no safety problems. Level 3 implies that all requirements of the stakeholders have been met, and no significant comments and/or only minor remarks on aspects of the FSMS are observed, and hence, an excellent food safety performance.

3.5.2. Questionnaire for evaluating the sanitation and hygiene practices employed by butcher shops and supermarkets

A detailed questionnaire was formulated, comprising of specific sanitation practices by the butcher shops and supermarkets. The questions included methods for cleaning and sanitizing, frequency of cleaning premises, availability of standard, pest control, waste

management, maintenance of premises and equipment, personal hygiene, environmental, staff training, and others. Also, questions regarding existing contractual relations with trading partners and the occurrence and, if any, the frequency of detecting pathogens and other incidents resulting in the rejection of meat.

3.6. Assembling and Confidentiality of Data

After collecting the data from the participant, the information was placed in a secure device, where a personalized folder of the participant was created. The information was translated and transcribed to include all relevant information. The folder contained identifiers understandable by the investigator, and any identifying information like names, addresses, and contact information was omitted

3.7. Data Analysis

Data from questionnaires were entered and analyzed using IBM SPSS (Version 23.0). Descriptive statistics (frequencies) were obtained to describe each of the assessed variables. The butchers' opinions about the most critical factors affecting the safety/quality of meat in Uganda were manually entered a spreadsheet in Microsoft Excel 2016 and prepared for analysis.

The FSMS activity and food safety output scores ranged from zero (not applied or done) to three (advanced for FSMS activities and suitable for food safety output). These scores were added up and mean obtained for both FSMS activities and the food safety performance of each processor. These were done using Excel Spreadsheet (Microsoft

Corporation). Because the scores represented qualitative descriptions, the scores were then transformed into assigned ratings, according to Luning et al. (Luning et al., 2009).

3.7.1. Measurement of the governance structures

This study used a dichotomous scale to obtain a "Yes" or "No" answer. The relationship between the meat value chain governance determinants and chain performance were measured by using descriptive statistics.

Nature of contract was determined by the types of contract applied and formality of exchange; standards and certification were determined by the possession of standards; relation and trust was determined by duration of relationship, type of information exchanged and nature of communication between the two stakeholders involved in the transactions. The study sought to ascertain the determinants that constitute value chain governance

3.7.2. Measurement of the chain performance

Chain performance has usually been classified into four categories: quality, time, cost and flexibility ((Beamon, 1999, Shepherd and Günter, 2006). Previous studies (e.g. Aramyan et al.(Aramyan et al., 2007) and Gunasekaran et al. (Gunasekaran et al., 2004) proposed that traits such as flexibility, quality, efficiency and responsiveness are the four major indicators for determining beef supply chain performance. In the present study we considered quality to measure the performance of the meat supply chain in Kampala. Rejection of meat by the retail outlets was considered an indicator that the meat did not meet the required quality by the retail outlets and hence a poor chain performance.

3.7.3. Data Analysis and Processing

Data processing involved editing, classification and tabulation of data collected so that they are easily analyzed. Quantitative data in this study was analyzed using descriptive statistics. The purpose of descriptive statistics was to meaningfully describe the distribution of scores or measurements using a few indices or statistics, with the types of statistics or indices used being dependent on the type of variables in the study and the scale of measurement.

CHAPTER 4

RESULTS

4.1. Context at the slaughterhouses in Kampala.

All the slaughterhouses were located within areas that were close to heavy traffic and were surrounded by residential houses that allowed very little room for expansion of the facilities. The fencings were not adequate in most of them as so, were easily exposed to vermin and unauthorized people, which increased the chances of transmission of zoonotic diseases or even reverse zoonosis. Since slaughterhouses often doubled as marketplaces, they were often congested with people who were not involved in the slaughtering and processing of the animals, which may contribute to contamination of meat.

On several occasions, slaughterhouses had appeared on press headlines due to the poor state of slaughterhouses in Kampala(Waiswa, 2015, Nalubwama, 2014). These reports majorly focused on the unregulated flow of the effluents to the nearby surrounding and the pile-up of the gut contents and other solid wastes like horns and scraps of tissues which resulted in a stinking odor in the surroundings. Observation also showed that most of the gut waste content and other solid wastes were disposed of outside near to the slaughterhouses, which resulted in a discomforting smell in the surrounding area. It also attracted birds, rodents, flies, dogs, and other unwanted insects and animals around the abattoir that posed safety risks to the safety of meat.

Figure 4: Stagnant stinking bloody water from the abattoir and an open drainage system near the homestead

4.2. Characterization of the meat retail outlets

All the supermarkets visited had been in operation for between 6 years to 14 years possibly because the supermarkets are own mainly by foreign investors and only began to invest in the country after prevalence of a peace and a stable government. Butcher shops on the other had were owned by the natives who were not deterred by insecurity but rather factors like availability of startup capital hence the variability of the age of the businesses. It was also noted that, more than half of these butcher shops were less than 14 years most likely due to the prevalence of peace in Uganda for the last 20 years which has encouraged more locals to invest in the meat sector.

Results from the study revealed that 55% of the supermarkets bought from only one slaughterhouse while 45% bought from only two slaughterhouses. The butcher shops on the other had bought from one (40.2%), two (48.4%), or three (11.4%) slaughterhouses. The highest percentage (66.2%) of the outlets claimed they bought meat carcass from only one

slaughterhouse because it provided safe and quality meat all the time while 42.6 % choose

more than one slaughterhouse because they claimed to be searching for quality meat for the

customers.

None of the surveyed butcher shops possessed any quality certifications or quality

assurance standards (e.g. GMP, GHP, HACCP, ISO 9001, ISO 22000), while 14 (70%) of

the supermarkets visited implemented at least one quality assurance standard (Fig. 5).

Figure 5: A graph showing the percentage of outlets that had and those that lacked any Quality
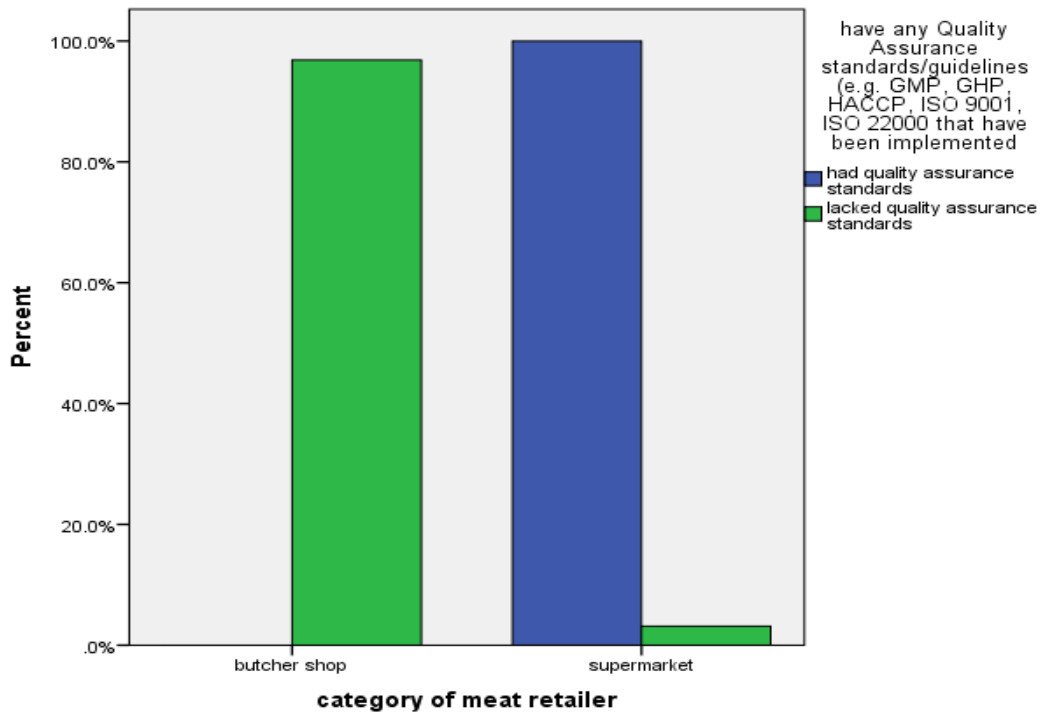
4.3. Core control, core assurance FSMS activities and food safety performance output at the slaughterhouses.

Table 4 shows the scores of the core control activities and core assurance activities at the slaughterhouses.

4.3.1. Core control activities

The average score for the core control activity was one which meant that the activities carried out were basic and were often characterized by ad-hoc sampling, minimal criteria used for FSMS evaluation, and existence of various food safety problems due to different issues in the FSMS.

The preventative design measures of slaughterhouses were predominantly performing at an average level (mean score 2). They performed averagely because they applied expert knowledge, sector or governmental guidelines, best practices, and standardized methods to prevent problems that occasionally occur. The hygienic plan of the equipment and facilities and the cooling facilities of all the slaughterhouses, however, were thin and inadequate. The lairages and the kraals were open areas with an insufficient shelter to prevent the animals from the harsh climate (too much sunshine) that causes dehydration and results in poor quality meat. Of the three slaughterhouses visited, only one had a sheltered lairage and kraal though it needed renovation. The kraals of all the slaughterhouses had not been partitioned to separate the incoming animals from those already inside or to isolate the sick animals from the rest. Also, at the time of the visit, there were inadequate procedures for people entering and coming out of the slaughter area as this

can end up contaminating the meat leading to food poisoning. This could be because the

retailors bought the carcass directly from the slaughtering area in the slaughterhouses. The

slaughtering and skinning of the of animals was mainly done using knives and machetes

rather than electric cutters. Of all the slaughterhouses, only one had a functional cooling

facility.

The design intervention processes of slaughterhouses were generally basic and

epitomized by problem-driven levels, which were only checked when problems arise, rarely

reported, and lack of independence. Sterilization of equipment was reported to be done

using hot water rinse; however, during the time of the survey, there were no thermometers

in two of the slaughterhouses to monitor the temperature of the water used for sterilization.

Similarly, maintenance and calibration for intervention equipment in all but one of the

slaughterhouses was initiated by a breakdown of the machines. Packaging intervention

equipment however were nonexistent (score 0) in all the slaughterhouse in Kampala.

Sometimes they are placed in small wooden boxes or wrapped with polyethylene and are

transported off. These packages were not meant to reduce nor inactivate pathogens

(Onjong'Hillary, 2013). The slaughterhouses monitoring systems were generally poor

(score 1) as were the extent of the corrective actions.

The allocation of CCPs for two of the three slaughterhouses visited was based on

general hygiene codes while it was completely nonexistent in one of the slaughterhouses.

There were no labels to indicate CCP points along the processing line; however, the

veterinary personnel in charge indicated points at which specific activities like postmortem

inspection done.

The types of measuring equipment of the slaughterhouses were varying from slaughterhouse to slaughterhouse. One of the slaughterhouses had an in-line measurement and automated for immediate response and visual information history; however, it wasn't fully functional since it had not been serviced for a while and had been in place since the 1970s. other slaughterhouses had hanging weighing scales since carcass was sold depending on its weight. Only one company had functioning cooling facilities though it was unstable due to the instability of electricity and high electric costs. The environmental temperature of cooling facilities was also not automatically monitored, and deviations were not systematically analyzed since the facilities had been built in the 1970s.

The slaughterhouses had not fully adopted the calibration program for measuring and analytical equipment. Only one of the slaughterhouses had an advanced program (level 3), while the others attained a mean score of 1. The slaughterhouse with an outstanding calibration program outsourced from UNBS that has a metrological department that works based on international standards; however, the calibration programs were not specific for meat production. UNBS helped to calibrate mainly the weighing scales (Fig 5). The frequency of calibration, however, could not be ascertained.

Figure 6: A UNBS sticker on one of the weighing scales indicating which month it was calibrated and verified

Appropriateness of standards and tolerances design for two of the three visited

slaughterhouses are specified, and the standards were derived from general hygiene codes

and legal requirements (mean score 2). Sampling design for microbial assessment and

measuring plan had not been adopted by the majority (2/3) of the slaughterhouses because

they had no laboratories to carry out any tests. However, an effort to carry out microbial

sampling was being done in one slaughterhouse but was at a minimum level and based

inhouse knowledge. There was no information about the distribution of pathogens samples,

but they were instead taken as spot-check procedures.

The actual availability of procedures for two out of the three slaughterhouses visited

was partly available and difficult to understand (level 1). Paper-based procedures were

available in these slaughterhouses, but there is a need for updates. The procedures,

however, had not been digitized as this would ensure easy availability. Similarly, compliance with the set procedures is at a basic level, or procedures are completely not followed. Slaughtering, bleeding, skinning, and evisceration was performed in the same area in these slaughterhouses. The third slaughterhouse, however, had a clear planned procedure, and the operators were aware of the existence and content of procedures and consciously followed them. Furthermore, safety tasks were internalized, and employees' exercised self-control in compliance with procedures

In relation to the contextual state of each slaughterhouse, an effort had been put to ensure the safety of meat. They cleaned before and after the closure of work although all the slaughterhouses complained about an occasional shortage of water.

The heads, legs, and skins were left on the floor in all the slaughterhouses, which could lead to contamination, yet the head and legs are a special delicacy in Uganda. The head and legs are often prepared on the floor, probably because of the absence of mechanical equipment to work on them.

The actual performance of measuring equipment left allot to be desired. They used hanging-weigh scales that were neither automated nor digital hence resulted in possible inaccuracy during the reading of weight values. The actual performance of the analytical equipment was even worse since the slaughterhouses had not put any effort into these areas. Most of the slaughterhouses claimed the analysis was supposed to be conducted by UNBS accredited laboratories.

4.3.2. Core Assurance Activities

The core assurance activities had not been fully implemented as compared to the core control activities though they too had an average score of one. The defining system requirement of slaughterhouses in Kampala were basic (mean score 1). Only one company had an average score for the system defining requirements. They often employed consultants to study their facility and recommend new requirements. This could be because the company had plans to expand to the international market. The same slaughterhouse also scored better in terms of systematic use of feedback to improve FSMS for probably the same reasons.

Translation of external requirements into FSMS and the systematic use of feedback information to improve the FSMS had not been fully taken up hence the poor score. Systematic analysis of data was done from validation and verification reports and translated into sound FSMS. There were clear procedures for modifications and assigned responsibilities which were well documented. Validation of the three validation activities that influence the performance of assurance activities in the slaughterhouses visited, on average, scored low (mean score 1-2) (Table 4). In contrast, validation of the preventative systems, intervention systems, and monitoring system of two of the three was moderate (score 2). Verification of performance in slaughterhouses in Kampala had performed poorly (mean score 0) as two of the three slaughterhouses inspected had never verified their people-related performance plus equipment and method related performance. The documentation system for two of the three slaughterhouses was assigned level 2, which is characterized by partial automation and information available through access to specific persons in the administrations of the slaughterhouses. Record keeping system for the

majority of (2/3) the slaughterhouses were ad hoc and lacked full registration of critical

product and process data in a central integrated online system. Accessibility to records was

also through specifically authorized personnel.

Table 4: Frequency of individual scores of the core control and core assurance FSMS activities at the slaughterhouses.

Indicators of FSMS activities	Frequency of individual scores of all three slaughterhouses				mean (assigned scores)
	0	1	2	3	
I. Core safety control activities					1
Design preventive measures					2
Sophistication of hygienic design of equipment and facilities	0	2	1	0	1.3(1)
Adequacy of cooling facilities	2	0	0	1	1(1)
Specificity of sanitation program	0	0	3	0	2(2)
Extent of personal hygiene requirements	0	0	2	1	2.3(2-3)
Adequacy of raw material control	0	0	2	1	2.3(2-3)
Specificity of product specific preventive measures	0	0	3	0	2(2)
Design intervention processes					1
Adequacy of physical intervention equipment	1	0	2	0	1.3(1-2)
Adequacy of packaging intervention equipment	3	0	0	0	0(0)
Specificity of maintenance and calibration for (intervention) equipment	0	2	1	0	1.3(1-2)
Specificity of intervention methods (chemical and biological)	0	2	1	0	1.6(1-2)
Design monitoring system					1
Appropriateness of CCP analysis	1	0	2	0	1.3(1-2)
Appropriateness of standards and tolerances design	1	1	1	0	1(1)
Adequacy of analytical methods to assess pathogens	2	1	0	0	0.3(1)

Adequacy of measuring equipment to monitor the critical process and product conditions	0	1	1	1	2(2)
Specificity of calibration program for measuring and analytical equipment	0	2	0	1	1.6(1-2)
Specificity of sampling design (microbial assessment) and measuring plan	2	1	0	0	0.3(1)
The extent of corrective actions					0
Operation control strategies	0	2	1	0	1.3(1-2)
Actual availability of procedures	1	1	1	0	1(1)
Actual compliance to procedures	0	1	2	0	1.6(1-2)
Actual hygienic performance of equipment and facilities	0	0	3	0	2(2)
Actual cooling capacity	2	0	1	0	0.6(1)
Actual process capability of physical intervention equipment	1	1	1	0	1(1)
Actual process capability of packaging intervention equipment	3	0	0	0	0(0)
Actual performance of measuring equipment	0	2	0	1	1.6(1-2)
Actual performance of analytical equipment	3	0	0	0	0(0)
II. Core assurance activities					**1**
Defining system requirements					1
Sophistication of translation of external requirements into FSMS	1	1	1	0	1(1)
Degree of systematic use of feedback information to advance FSMS	1	1	1	0	1(1)
Validation					1-2
Sophistication of validation of preventive measure	0	1	2	0	1.6(1-2)
Sophistication of validation of intervention systems	0	1	2	0	1.6(1-2)
Sophistication of validation of monitoring system	0	1	2	0	1.6(1-2)
Verification					0

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Extent of verification of people related performance	2	0	0	1	1(0)
Extent of verification of equipment and methods related performance	2	0	1	0	0.6(1)
Documentation and record-keeping					1-2
Appropriateness of documentation system	1	0	2	0	1.3(1-2)
Appropriateness of record-keeping system	0	2	1	0	1.3(1-2)

Scores in bold are the allocated overall scores for core control and assurance activities, respectively. The scores in brackets are the assigned mean scores for each activity. (If an average score for activity was between 0 and 0.2 then the allocated score is 0, if between 0.3 and 1.2 (allotted score is 1), if between 1.3 and 1.7 (assigned score is 1-2), if between 1.8 and 2.2 (allocated score is 2), if between 2.3 and 2.7 (assigned score is 2-3), and if the mean score was between 2.8 and 3.0 then the allocated score is 3. For the indicators of FSMS activities; 0 indicates the low level (absence, not applied), 1- basic level, 2- average level, 3- advanced level.

4.3.3. food safety performance output

The food safety performance of the slaughterhouses in Kampala was carried out (Table 5), and the average score was zero, meaning that there were no indications of food safety performance assessment carried out. Only one slaughterhouse had a restricted number of complaints and were able to dedicate it to a specific problem in the functioning

of the FSMS because they had an operational quality assurance department that was able to

cite and rectify any problems indicating a fairly performing FSMS.

Table 5: Frequency of individual scores of the food safety performance of the slaughterhouses

Assessment of food safety performance					0
Food Safety Management System evaluation	0	3	0	0	1(1)
Seriousness of remarks	2	0	1	0	0.6(0-1)
Microbiological food safety complaints	2	0	1	0	0.6(0-1)
Hygiene related complaints	0	2	1	0	1(1)

Scores in bold are the allocated overall food safety performance score of all the

slaughterhouses in Uganda. Typical characteristics of performance levels (0 means no

indication of performance, 1 means poor performance, 2 means moderate performance, and

3 means excellent performance.

4.4. The hygienic and preventative practices of the retail outlets

Both the butcher shops and supermarkets were asked about their pest control, waste

management, personal hygiene, environmental hygiene, carcass transportation, meat

storage, and staff training practices (Table 6).

Table 6: Assessment of hygiene practices carried by the butcher shops verses supermarkets

Variable	Total percentage	Butcher shop	Supermarket

	(n=204)	percentage (n=184)	Percentage (n=20)
Pest control			
Presence of rodent traps e.g. rat trap, housefly traps, fly screens	44	39.1	90
Keeping the floors, walls, roof, doors and window openings in a good state of repair with no gaps or spaces	74.5	72.3	95
keeping the meat in pest-proof containers	55.5	51.6	90
Electronic fly device	20.6	14.7	75
Waste management			
Wastes (un-edible parts) are placed in containers with suitably fitted lids and removed frequently from meat handling areas where it is produced	70.6	71.2	65
Use of waste containers but without lids	29.9	25.5	70
Waste containers regularly cleaned and disinfected	88.6	87	85
Presence of a waste control plan	30.9	26.1	75
Personal Hygiene			
Hand washing	94.6	94.6	95
Use of protective clothing like gloves	0	0	0
Exclusion from work in case of illness	85.8	84.2	100
Reporting of illness	50.5	47.8	75
Environmental hygiene			
Designate the area where meat is stored and ensure restricted entrance by other people	94.6	94	100
Surfaces and floors are smooth, impervious and capable of being thoroughly cleaned and disinfected	88.2	87	100
Meat is stored on hangers to avoid contamination from the floor	80.4	78.3	95
Transportation of carcass			
refrigerated trucks	14.7	8.2	75
trucks without refrigerators	27	27.2	25
motorcycles (boda-boda).	84.3	84.2	85
by hand.	6.9	7.6	0
Storage of meat			
In refrigerators, freezers, chilled rooms	67.9	64.1	100
In a guarded glass compartment	68.6	66.3	90
On hangers	80.4	78.3	95
On the floor	2	2.2	0

Staff training			
Training for new staff	92.6	94	80
Retraining	17.6	11.4	75
HACCP based training	14.2	7.6	75
Government oversight			
Monitoring/checking and any other appropriate records used by your business	14.2	7.6	75
Does the government or NGO provide any form of training to your staff	0	0	0
Does the government set any specific qualifications to be able to run or open a butcher shop	3.9	2.2	20

4.4.1. Pest control

In general, the meat retail outlets mainly controlled pests by keeping the floors, walls, roof, doors, and window openings in a good state and with no gaps or spaces (72.3% and 95% of the butcher shops and supermarkets respectively. This was done by the tiling of the walls and floors of the meat handling area as this was part of the requirements set by government for meat retailors. The use of electronic fly devices had not been adopted by the butcher shops (14.7%) as compared to supermarkets (75%) possibly due to the high cost of electricity that could that seemed too costly for the butcher shops. Keeping meat in pest-proof containers is important but only 51.5% of the butcher shops had installed them in facilities compared to 90% of the supermarkets.

4.4.2. Waste management

Only 26.1% of the butcher shops reported to having a waste control plan compared to 75 % of the supermarkets. The wastes generated were reportedly dumped in containers with suitably fitted lids and removed frequently from meat handling areas by 71.2% and 65% of the butcher shops and supermarkets respectively. Worrying however, was the high percentage (70% of supermarkets and 25.5% of the butcher shops) using waste containers that lacked lids as this could increase the chances of cross-contamination by pests.

4.4.3. Personal Hygiene

The meat handlers at all the meat retail outlets in Kampala did not wear gloves; however, 94.5% of the meat handler reported washing their hands before handling meat (Table 6). It was also observed that all meat handlers used the same bare hands that they held meat to hold money and therefore increased the risk of meat contamination.

Figure 7: A consumer waiting to hand over money to the meat retailer at a butcher shop.

Only 50.5% of the meat handlers in the retail meat outlets claimed to report any illness that may pose any risk to meat safety where the supermarkets (75%) performed better than the butcher shops (47.8%). The respondents in the study did not have enough knowledge on the importance of reporting of illness which poses a risk to meat safety, such as skin, nose, throat, stomach, or bowel trouble or if they have any infected wounds. The supermarkets performed better than the butcher shops possibly because most of the butcher shops are run by the owners therefore there is no one to monitor the health of employees.

4.4.4. Environmental hygiene

Meat retail outlets in Kampala had set measures to counter the cross-contamination of meat from the environment. They include the storage of meat on hangers to avoid contamination from the floor by 78.3% and 95% of the butcher shops and supermarkets respectively, making sure the floors and walls are impervious and capable of being thoroughly cleaned and disinfected which has been done by 87% butcher shops and all the supermarkets. They also have restricted entrance by non-meat handlers into areas where meat is stored in 94% of the Burcher shops and 100% of all the supermarkets. The use of hangers to store meat in butcher shops however had not been fully adopted as many placed their meat on counters (Fig 6) and on wooden stamps which led to a higher risk of contamination from the floor. It was also observed that even the butcher shops that had hangers didn't have a protective glass to reduce contamination by houseflies and dust. Similarly, it was observation that all the butcheries displayed meat (beef) mixed with offals openly on tables and wooden logs.

4.4.5. Frequency of cleaning and maintenance of equipment and premises

A summary of the frequency of cleaning is shown in Table 7 while Table 8 shows a summary of the frequency of maintenance of equipment. Most food contact surfaces such as chopping boards, cutting tools, and display trays were reported to be cleaned every after use by 63.3% and 75% of the butcher shops and supermarkets respectively. As the other cleanings were reported to be done mainly twice every day by most of the retail outlets. All the meat reported using water and washing detergents for cleaning. However, it was observed that most of the butcher shops lacked taps for provision of potable water. They had jerrycans of water which they used to store water for cleaning indicating that the cleaning may not be enough as cleaning of blood-stained butcheries may require plenty of water. Some were observed to sweeping of meat residues as one of or the only cleaning method with is insufficient.

Regarding, maintenance, the supermarkets generally performed better than the butcher shops. Maintenance of the equipment was only done when there is a breakdown of equipment by 88.6 % of the butcher shops.

Table 7:Summary of the frequency of cleaning

	Percent of Butcher shops (n=184)					Percent of supermarkets (n=20)				
	No standard practice	After every use	Twice a day	daily	weekly	No standard practice	After every use	Twice a day	daily	weekly
Food contact equipment	0	63.3	13.6	20.1	0	0	75	20	5	0
Non-moveable equipment	0	6	7.6	88.4	0	0	55	20	25	0
Food waste containers	1.1	1.1	87	4.3	6.5	0	0	0	100	0
Cloths	0	0	53.8	46.2	0	5	0	75	20	0
Refrigerator	0	8.4	84.4	4.5	2.8	0	0	35	65	0
Dry storage area	1.1	9.8	0	89.1	0	0	0	35	65	0
Floors	0	0	57.6	40.8	1.6	0	0	55	45	0

Table 8: Summary of the frequency of maintenance of equipment

Frequency of maintenance of equipment	% of Butcher shop (n=184)	% of supermarkets (n=20)
Weekly	7.5	60
monthly	0.5	0
yearly	0.5	0
Only when there is a breakdown of equipment	88.6	40
Never	2.7	0

4.4.6. Transportation of carcass

The commonest mode of transport was the motorbikes (84.3%) locally known as boda-boda. Only 41.7% of the retail operators reportedly used trucks of which 14.7% possess refrigerators while 27% of the trucks used lack refrigerators. We observed that meat transport vehicles were also used to transport other food and non-food items. This could be a possible source of microbial contamination and may compromise on safety and shelf-life of meat. It was also observed that some closed vehicle used for meat transportation had blood stains from previously transported meat, indicative of inadequate cleaning. About 7% of butcher shops reported transporting meat by hand possibly since they were within walking distance from the slaughterhouses.

4.4.7. Storage of meat

When meat arrived at the retail outlets, it took less time to be sold off as compared to the butcher shops, 90% of the supermarkets reported selling off their meat with one day while 10% reported taking two days. On the other hand, 65.8%, 30.4% and 3% of the butcher shops reported being able to sell meat within one, two, and three days respectively. 64.1% of the butcher shop operators in Kampala stored in refrigerators as compared to the supermarkets where all stored meat in cold facilities. 78.3% and 95% of the butcher shops and supermarkets also reported storing meat on hangers however, 2.2% of the butcher shops reported storing meat on the floor.

It was observed during the study that the butcher shops that lacked refrigerators in their shops shared or transferred the remaining meat to another butcher shop where

refrigerators were available and meat from different retail meat outlets were mixed. This might lead to the transfer of microbes from one retail meat outlets to another if the hygienic condition is not well observed. It was also observed that since most of the butcher shops are located along dusty streets or roads, hanging meat in open space in the butchery exposes it to environmental contamination from dust and flies.

4.4.8. Staff training

During the study, it was revealed that the training of new staff was done by 94% and 80% of the butcher shops and supermarkets respectively. Retraining of workers by the butcher shops was not done by 82.4% of the butcher shops and 25% of the supermarkets. Only 7.6% and reported getting HACCP based training while 75% of the supermarket reported giving HACCP based training to the workers.

4.4.9. The role of government

84.2% of the retail outlets claimed government authorities made monthly checks for compliance. However, inquiry on whether retailers were aware of any specific qualifications to be able to run or open a meat retail business showed that only 2.2% and 20% of the butcher shops and supermarkets claimed there were existing requirements.

4.5. Characterization of the governance structures in the value chain

4.5.1. The retail outlets characterization

All the supermarkets visited had been operation for between 6 -14 years. The butcher shops however, had no uniform period which they had been in operation apart from up to 74.5% of the butcher shops being in operation for more than five years.

Table 9: Number of years the retail outlets have been in operation

Number of years in operation	Percent of butcher shop (n=184)	Percent of supermarket (n=20)
1 – 5	25.5	0
6 – 14	37	100
15 – 20	31.5	0
21 – 28	6	0

The supermarkets reportedly mainly acquired their meat from Uganda Meat Parkers and/or city abattoirs (75%) suggesting that there was a degree of consistency. 55% of the supermarkets also reported using only one slaughterhouse while 45% indicated that they used two slaughterhouses which further suggested that the supermarkets were conscious of where they bought their carcass from. However, this was not the case for butcher shops who did not have a specific slaughterhouse they bought from. Only 40.2% reported using one slaughterhouse while the rest used more than one. The supermarkets reported buying meet from more than one slaughterhouse due to safety concerns (60%) and search for good quality meat (60%). The Butcher shops similarly suggested the same reasons but 7.1% responded choosing certain slaughterhouses because they provided better prices. 19% of

the butcher shops also suggested that they choose some slaughterhouses because of other reasons like proximity to their butcher shops, reliability and better customer care.

4.5.2. Governance structures implemented by the retail outlets

The major contractual arrangement adopted by the butcher shops and supermarkets was the market or transactional contracts as 98.4% and 80% of the butcher shops and supermarkets respectively reported having a market or transactional arrangement. It involved the buyers visiting the slaughterhouses, then going to the carcass display area of the slaughterhouses and visually picking what parts of carcass meat they preferred. The price was set per kilogram and determined by the seller. The retailer then arranged how to transport the meat carcass out of the slaughterhouses. The form of payment was cash, and there were usually no bookings done as it was based on "first come, first serve". The prices, quality, and safety requirements were determined on the spot.

However, 20% of the supermarkets reported having flexible forms of contracts. They had set contact terms per-taking prices, delivery and safety conditions. These were documented but were subject to modification in the event of unexpected market conditions. These same supermarkets reported having most a formal mode of exchange as they used emails or documents. As a result, 83% of them reported having rejected meat because it did not meet the standards they required. Similarly, they all reported using more than one slaughterhouse because they wanted safe and quality meat for their customers. The nature of communication used by the majority meat retailers with slaughterhouses was majorly informal i.e. based on phone calls or visits.

Table 10: The nature of contract terms between the meat retail outlets and the slaughterhouses

Category of meat retailer	Nature of Contracts	Percent
Butcher shop (n=184)	Flexible	1.1
	Relational	0.5
	Market or transactional	98.4
Supermarket (n=20)	Flexible	20.0
	Market or transactional	80.0

Standard and certifications had not been adopted by all the butcher shops while only 30% of the supermarkets had adopted them. Of the 30% of the supermarkets that reported having standards and certificates of any form78.6% of them reported being able to reject about 1% of the total meat they received from the slaughterhouses because the standards and certification scheme gave them a baseline to make decisions.

In Kampala, the 80% and 89.7% of the Supermarkets and butcher shops reported receiving planning related information from slaughterhouses. They reported receiving information majorly focused on demand for the meat and any shortage of meat in the market. These suggested that players in the supply chain were only interested in money related issues and availability of meat. Safety related information was very rarely shared suggesting that the meat retailers were less interested which points to a poor chain performance. Only 20% of the supermarkets and 1.6% of the butcher shops reported receiving information related to microbial levels, traceability and safety. These explained why there were very few retail outlets that reported rejecting meat since they could not ascertain information for example where animal was gotten from.

CHAPTER 5

DISCUSSIONS

This section is organized into three sub-headings: discussion of the main findings on the performance of the core control and core assurance activities of slaughterhouses, the hygienic and preventative practices of the retail outlets, and the performance of the governance structures in the meat value chain.

5.1. Analysis of the performance of the core control and core assurance activities of slaughterhouses

5.1.1. Core control activities

5.1.1.1. Design of preventive measures

Sanitation programs, personal hygiene requirements, and Animal control scored better possibly because the slaughterhouses are often surprised by the veterinary officials from KCCA, sanitation, and hygiene officials from UNBS and MOH. The veterinary official ensures that the animals slaughtered are safe for human consumption and free of diseases. The premises are evaluated by MOH and UNBS as mandated by the public health Act and UNBS Act, respectively, therefore, the hygiene and sanitation programs put up to meet the expected requirements by the respective authorities.

5.1.1.2. Design of intervention processes

The term 'intervention' as used in meat safety means practices that are intended to lead to a reduction of contamination (Wheeler et al., 2014). These intervention practices are eventually cumulative with the final intervention, most likely a CCP, immediately before chilling of the meat. Due to the lack of adequate running water and electricity in all the slaughterhouses, implementation of physical intervention practices like carcass trimming and washing, hide and offal washing, and equipment sterilization(Brashears and Chaves, 2017) are hardly carried out. These have resulted in the use of rudimentary methods to, for example, stream and sterilize equipment. The use of modern chemical methods of sterilization like Acetic acid and Lactic acid rinse(Buege and Ingham, 2003) had not been adopted, possibly due to the costs of acquiring them.

Packaging intervention equipment were nonexistent in all the slaughterhouse in Kampala possibly because immediately, the animal had been slaughtered and processed into a carcass; they were bought off while still on hangers in the slaughterhouses and put into cars then whisked off to the retail outlets.

5.1.1.3. Design of monitoring system

The slaughterhouses monitoring systems were generally poor possibly because the slaughterhouses were not under any pressure from the suppliers to carry out any Hazard and risk analysis. They also lacked a quality control laboratories dedicated to carrying out microbial and chemical analysis of meat because instead, the veterinary personnel who doubled as a quality control official majorly focused on examining the internal carcass

organs for the presence of any disease and parasite infections majorly by basing on physical observation to determines if the meat is suitable for human consumption.

5.1.1.4. The extent of corrective actions

KCCA and MOH regularly do hygiene performance reviews; hence the average performance of the extent of corrective actions. This is expected to control better cross-contamination (Jenni and Janne, 2016, Kotisalo et al., 2015).

However, a concern was the drainage from the slaughter area passed through the kraals, as this could increase the chances of infection of animals (Maluquer de Motes et al., 2008, Dankaka et al., 2018). It is imperative to ensure hygiene in the lairage since such structures can act as a source of contamination to the carcasses, especially during skinning since the meat may be soiled with cattle fecal matter (Henry et al., 2018). In the present study, the lairages of all the slaughterhouses in Kampala were in poor hygienic conditions.

The actual cooling capacity of two of the slaughterhouses was low because they lacked any cooling rooms. They depended on hanging the meat and selling of carcass within hours of slaughter since the demand is quite high.

5.2. Core assurance activities

Core assurance activities are activities that offer evidence and sureness to stakeholders that safety requirements will be met (Onjong'Hillary, 2013, Luning et al., 2009). It is assumed that slaughterhouses that carry out the required safety activities can provide confidence to the stakeholders involved by carrying out assurance activities such as

validation, verification, and documentation (Luukkanen, 2019). These ensure that the performance is better evaluated, and changes are better organized (Jacxsens et al., 2011).

The core assurance activities had not been fully implemented as compared to the core control activities because the most essential national regulatory requirements strictly focus on control activities for ensuring food safety. For example, the Public Health Act 1964, which is the basic legislation for safety control in slaughterhouses, offers a detailed description of control activities, which focus on food safety in slaughterhouses. Some supporting guidelines (e.g. National Meat Development Policy 2003 and Meat and Milk Hygiene Regulation) also provide specific descriptions for applications of control activities. Therefore, as slaughterhouses try to follow these requirements, technology-dependent control activities become the strong points, and managerial quality assurance activities become weak points (Ren et al., 2016). It is also well recognized by managers that assurance activities take more time and money to implement, and they do not usually bring economic benefit to the company directly. Thus, control activities gain the commitment of managers, while assurance activities receive less attention.

5.2.1. Defining system requirements

The defining system requirement of slaughterhouses in Kampala were basic possibly because the number of slaughterhouses was quite small as compared to the number of retail outlets. Therefore, the demand for meat was very high, and so the slaughterhouses were at liberty to set their terms. "The rule is to pay, or someone else will pay for it."

5.2.2. Validation

Validation of the three activities that influence the performance of the assurance activities in the slaughterhouse scored low compared as compared to validation of the preventative activities possibly because UNBS, MAAIF, and MOH had all sent minimum requirements that a slaughterhouse had to follow, and these validation activities were all included. They sent experts that would recommend slaughterhouses on what they should do to improve meat safety while basing on comparison with regulatory documents and specific hygiene codes. The activities were, however, not done regularly, and there have been reports of bribery and money mindedness (editor, 2013). A recent news report by the daily monitor(Monitor, 2017) indicated that possession of a meat quality certificate (stamp) didn't guarantee the safety of meat. Ideally, certification of a slaughterhouse would suggest that the slaughterhouse was providing safe meat; however, some of the slaughterhouses continued to work without all the minimum requirements and sold unsafe meat (Faridah Kulabako, 2011). This possibly because the responsible authority's vision of quality meat seemed to be focused on the money-generating processes of stamping meat with their quality mark rather than the quality activities.

To attain an advanced systematic validation, the slaughterhouse systems should be vetted by independent experts, while basing on specific scientific foundations, historical results and own experimental trials. This should be done consistently every after a system modification. Activities and conclusions ought to be well documented (Onjong'Hillary, 2013).

5.2.3. Verification

Since validation involves finding hints that the food safety control measures managed by the FSMS are capable of being effective, and verification approves that food safety hazards are within identified acceptable levels and demonstrated conformity to planned arrangements, they become the basis for identifying the need for updating or improving the FSMS. The absence of third-party experts makes the evidence provided by validation and verification less convincing. A more scientific evidence-based, systematic, and independent validation and verification would improve the FSMSs of the companies in the long-term operation(Onjong'Hillary, 2013, Luning et al., 2009).

Verification of performance in slaughterhouses had performed poorly thus suggesting possible presence of food safety hazards within the slaughterhouses. This because verification activities are supposed to be done by internal experts from the quality assurance department of the slaughterhouses. However, they lacked quality assurance departments therefore, these slaughterhouses were not able to identify the need for updating or improving the FSMS since verifications provide a basis of where and when an update id supposed to be done (Ren et al., 2016).

5.2.4. Documentation and record-keeping

The documentation was structured, decentralized, and updated. Documents need to be fully automated for all to access to transparency and can help in the validation of FSMS(Støier et al., 2011, Luukkanen et al., 2018).

The slaughterhouses should consider installing integrated systems that are available online and accessible to all persons as they help support validation and verification activities better in addition to full registration of critical product and process data (Kussaga et al., 2015). Meat handlers consider them as difficult to implement and time-consuming (Govender and Genis, 2010).

The deficiency of documentation and record-keeping can also be explained through organizational policies. The managers are required to keep slaughterhouse information in a limited group, instead of sharing with all employees to avoid leakage of company information to the press or competitors. This leads to an added burden on information-related activities of the FSMS. Since some employees have no access to the latest data and information, they are would depend more on experience, instead of science-based information (Ren et al., 2016). Providing access to slaughterhouse information would support employees in quality systems to make informed and predictable decisions, reducing the chance of safety problems. That would contribute to a sustainable FSMS.

5.3. Food Safety performance activities

The food safety performance provides information about the output level of the FSMS. It is assumed that a better level is associated with a better system performance, which means that the likelihood of food safety problems is reduced(Jacxsens et al., 2011). It, therefore, indicates that that slaughterhouses in Kampala were lagging and pose a threat to the public health safety of the meat consumers. This is in line with the findings of

Bogere et al, who found a relatively high level of microbial contamination in one of the slaughterhouses in Kampala(Bogere and Baluka, 2014).

FSMS evaluation in all the slaughterhouses is usually done by UNBS which is the national food safety agency. Besides, KCCA, MOH, and MAAIF also carry out inspections as they are mandated by several national acts. They are also expected to give seriousness of remarks on various and specific aspects of FSMS especially; personal hygiene, sanitation, waste management, cleaning, and disinfection. However, since authorities like UNBS are responsible for an overwhelming number of duties, inspections are not done or done irregularly. Attention is only drawn in case of a media backlash or in case of an outbreak related to the meat sector. There had therefore led to poor performance in the seriousness of remarks. Slaughterhouses should alternatively involve accredited third-party food safety agencies to carry out the inspection/audits, however, they are not under any pressure to do so because of the high local demands that don't consider safety a priority. They, therefore, consider FSMS evaluation activities as extra costs that they preferred to forego. Similarly, there are no known microbial safety complaints because the clients buying the carcass cannot carry out microbial tests which, indicate a poor FSMS.

Complaints related to hygiene could be related to multiple problems in the functioning of the FSMS in two of the three slaughterhouses because hygiene-related problems do not require complex equipment, nor does it require the company to have a laboratory. Similarly, the poor performance of the hygiene-related complaints also indicates the poor performance of the FSMS. One slaughterhouse had a better performance in all the food safety performance activities as compared to the rest of the slaughterhouses because

they had a quality control lab and were able to relate any complaints to points in the FSMS. It can also be explained that these slaughterhouse quality assurance department regularly searches for new legislation and guidelines and update the FSMS since they strictly follow the requirements of national food safety regulation

5.4. Evaluation of the hygienic and preventative practices of the retail outlets

5.4.1. Pest control

Pest control is extremely important in the control of the zoonotic transfer of pathogens from animals to foodstuffs (Santos et al., 2017). Studies by Heilmann et al. (Heilmann, 2016) showed that houseflies play a central role in the transmission of pathogenic microorganisms particularly *Salmonella spp*. and *Escherichia coli* in butcheries. The flies are especially dangerous because of their feeding mode which results in the transfer of germs from one place to another by landing on contaminated surfaces like fecal matter and the food briefly opened. These flies carry many different bacteria their bodies and thus are vectors. Microbiological analysis on feces, legs, and snout of houseflies have highlighted their role as a reservoir of pathogenic microorganisms(De Jesús et al., 2004). Pest like rodents, cockroaches, termites, etc. are also a major threat to the safety and suitability of meat at meat outlets (Mirembe et al., 2015, Ebuete et al., 2020, Tidjani et al., 2013), therefore retail meat handlers ought to use; traps (rat traps, housefly traps, fly screens, etc.), electronic devices, pest-proof containers, etc. to control these pests. They can also control pests by ensuring that floors, walls, roof and window openings are in a good state with no gaps or spaces for pests like cockroaches to hide.

Mirembe et al. (2015) reported that 58.9% of the butcheries lacked a standard fly screen and fly in Kampala district, in our study we report a lower proportion (44%). The low usage of fly and rodent traps in meat retail outlets is indicative of the increased risk of microbial contamination of meat by insects as reported in the studies done by Heilmann et al. (Heilmann, 2016).

Most of the supermarkets had generally performed better than the butcher shops regarding pest control management probably because they are a bigger business entity targeting a bigger and richer population that is more conscious of the safety of the food they buy. It could also because they deal with other business products, therefore, are at a higher risk of pest infestation, hence the need to set up a better pest control system.

5.4.2. Waste management

In meat outlets, the main waste materials generated are; animal dung, blood, bones, condemned meat, etc.(Adeyemi and Adeyemo, 2007). The butcher shops surprisingly performed better than the supermarkets with regards to waste management probably because the butcher shops hanged/ placed the carcass in places where the customers were able to see the meat and customers, therefore, dictated the parts/cuts of meat they needed which resulted in more condemned parts and bones therefore a greater need for waste containers. The supermarkets on the other hand sell meat that has already been cut and is packaged which therefore means the buyer doesn't have to condemn any parts as the already cut pieces of meat appear more appealing.

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Having a waste control plan among the supermarkets also meant that there is proper disposal of wastes and hence better performance of the safety management systems of the supermarkets as compared to the butcher shops. Most of the butcher shops had no waste control plans possibly because most butcher shops are very small businesses with minimal funds to invest in such activities. It could also be due to a lack of enough knowledge on the importance of some of the required practices but only concentrated in activities that would scare aware customers. Studies by Mirembe et al (Mirembe et al., 2015) also cited the lack of enough knowledge on the importance of maintaining sanitation and hygiene in butcheries and concentration on only activities that would scare away customers as a reason for the poor performance in meat safety-related activities in Kampala.

5.4.3. Personal hygiene

There is a high possibility that meat handlers could be important vehicles for contaminating meat with pathogenic microorganisms and consequently foodborne diseases (Abd-Elaleem et al., 2014). Therefore, meat handlers are required to wear protective clothes, gloves, and gumboots. Several studies have documented the lack of personal protective wear among meat handlers in Africa (Mirembe et al., 2015, Chepkemoi et al., 2015, Abd-Elaleem et al., 2014). In our study, all the meat handlers at the meat retail outlets did not wear gloves. This is similar to a study done by Haileselassie et al. (Haileselassie et al., 2013) who showed that 11.3% of the abattoir workers randomly selected from Mekelle city did not wear aprons and they all handled food with their bare hands. A study by Chepkemoi et al. (Chepkemoi et al., 2015) on butchery operators wearing protective clothing while handling and selling meat in Nairobi and Isiolo counties

reported that only 30% and 18% respectively wore protective handling. Mirembe et al. (Mirembe et al., 2015) reported that only 31.5% of butchery workers in Kampala district, Uganda had personal protective wear.

Since all the meat handlers use bare hands while handling meat, they must wash their hands. Even though handwashing may seem insignificant to the meat handlers, failing to do it can have catastrophic consequences. Accordingly, improved hand hygiene would lead to the basic control of the cross-contamination of meat from the handlers. In the present study, 94.5% of the head handler reported washing their hands before handling meat in Kampala (Table 6). Similarly studies by Abd-Elaleem et al. (Abd-Elaleem et al., 2014) in Alexandria, Egypt reported that 80% of butchers wash their hands when entering the abattoirs. Ntanga et al (Ntanga, 2013) also reported 71% of the butchery workers in Morogoro municipality, Tanzania their hands before handling meat.

Hand sterility is not a novel concept for the prevention of cross-contamination of meat in the meat industry. Regrettably, hand washing is neither done nor done in the correct manner and frequency (Wambui et al., 2017, Smigic et al., 2016, Michaels et al., 2004). In this study, it was observed that all meat handlers used the same bare hands that they held meat to hold money and therefore increased the risk of meat contamination. Muinde et al. (Muinde and Kuria, 2005) likewise reported that all the street food vendors in Nairobi, Kenya handled money while serving food. The individual handling money should not handle meat during retailing but if they do, they should wash their hand every after handling the money because money is dirty and can contaminate food (Cortese et al., 2016).

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In a study by Todd et al. (Todd et al., 2010) they, explained that food-handling personnel does not wash their hands at appropriate times because of laziness, time pressure, inadequate handwashing facilities and supplies, lack of accountability, and lack of involvement by industry management and workers in supporting proper handwashing. From our observation, retail meat handlers were not practicing handwashing possibly due to lack of hand-washing facilities like running tap water, washing basins, soap, etc. Training of workers on personnel hygiene should, therefore, be conducted and handwashing facilities availed by meat business owners to enable the meat handlers to access washing water.

5.4.4. Environmental hygiene

Contamination of meat from surrounding environments has been well documented (Ali et al., 2010, Giaouris et al., 2014, Olowoporoku, 2016). A *Listeria monocytogenes* outbreak in South Africa which left over 200 dead and over 1000 infections in 2017-2018 was traced to a meat processing plant (Thomas et al., 2020, Allam et al., 2018). The exact source in the plant was not clear but environmental cross-contamination is the has been suggested as the most probable source (Ogunbanjo, 2018). Meat retail outlets in Kampala have in this regard therefore set measures to counter the cross-contamination of meat from the environment which include storage of meat on hangers to avoid contamination from the floor, making sure the floors and walls are impervious and capable of being thoroughly cleaned and disinfected. The supermarkets performed admirably concerning the floors and walls being imperious and capable of being thoroughly cleaned and disinfected because all the supermarkets were permanent structures that had tiled areas where the meat is sold.

The butcher shops on the other hand are required by the UNBS through the Meat and Milk Hygiene Regulation to install tiles on their floors and walls however, most of them had not implemented this because they were temporary wooden structures that were operating illegally.

5.4.5. Frequency of cleaning and maintenance of equipment and premises

Maintenance of the equipment was only done when there is a breakdown of equipment by most of the butcher shops possibly because the butcher shops used basic equipment like knives and machetes that rarely needed any form of maintenance. It could also be because the butcher shops were very small business running under minimal budgets and therefore such cost are considered a luxury. The supermarkets performed better possibly because they run under a bigger budget and the nature of the customers, they targeted were high end.

5.4.6. Transportation of meat carcass

The mode of transport used to transport meat from the abattoir to retail meat outlets may act as sources of contamination since often lack regular cleanliness and are not well covered leading to contamination by dust, insects, and flies(Ntanga, 2013). The commonest mode of transport was the use of motorbikes possibly due to the high level of traffic congestion in Kampala which necessitated the meat retailers to opt for motorbikes that easily maneuvered through the congested roads coupled with the short distance between the slaughterhouses to the retail outlets. Also, most of the retail outlets bought

small amounts of meat which didn't require the use of trucks that would cost more. The results (83.4%) are, however, higher than reports by Adzitey et al. (Adzitey et al., 2011), in Bawku Municipality Ghana who reported that 33% of butchery operators transported meat using motorbikes and bicycles. The use of motorbikes, therefore, results in higher risks of meat contamination during the transportation of meat carcass. Bogere et al. (Bogere and Baluka, 2014) reported that the mean bacterial load of butcher shops in Kampala was slightly higher at the butchery level than at the slaughterhouse level. These, therefore, pointed to the accumulation of bacteria on the way to the retail outlets or acquiring more bacteria during transportation as the use of motorbikes is the commonest mode of transport.

5.4.7. Storage of meat at retail outlets

The lower usage of refrigerators by butcher shops as compared to supermarkets could be attributed to the high costs of electricity and refrigerators. To overcome the problem of lack of cold storage it would be expected that butcher operators would stock only daily meat sale capacity however it is not the case as 34.2% reported keeping meat for more than a day

5.4.8. Staff training

Training of meat retail handlers about basic concepts like personal hygiene and its environment plays a significant role in ensuring the safety of meat sold to consumers (Bersisa et al., 2019).. Surprisingly, the butcher shops performed better than the supermarkets in this category. Mirembe et al. (Mirembe et al., 2015) reported that only 57.5% of the workers at butcher shops had attained at least secondary education. It,

therefore, means that almost half required basic education and on how to run the business hence the high percentage of training new staff. On the other hand, supermarkets were observed to target the high-end customers, therefore its most likely that they employ qualified personnel that require less training as compared to butcher shops hence the higher percentage of training of new staff. Similarly, a survey conducted at Makelle City, Ethiopia by Haileselassie et al. (Haileselassie et al., 2013) found that out of 26 butcher shop workers interviewed, 7.7% were illiterate, 61.5% had no any training regarding meat hygiene. Thus, they paid no attention to the hygienic standards and as a result, contributed immensely to bacterial contamination. Consequently, retraining of workers by the butcher shops was not done almost all of the butcher shops possibly because they considered it expensive. It, therefore, indicates a low appetite for new knowledge and technology

The training given to new staff by the butcher shops was observed to be mainly related to basic concepts like knowing the parts of the beef, how to ration, customer care, basing financial management, etc. The teaching was observed to done by mentors who had acquired knowledge through experience rather than HACCP based training, hence the low performance in butcher shop regarding HACCP based training. The supermarkets encouraging performed better in terms of training of new staff, retraining, and HACCP based training which indicates that there are higher chances of purchasing quality meat in supermarkets as compared to butcher shops in Kampala hence the slightly higher prices of meat in supermarkets.

5.4.9. Role of government

The institutions that regulate the meat sector in Uganda include the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) through the Directorate of Animal Resources, Uganda Bureau of Standards (UNBS), ministry of local government, Ministry of Trade, Industry and Cooperative (MTIC) and Ministry of Health, Department of Public Health (MOH). (MAAIF, 2012). These have led to the fragmentation of efforts by different institutions and poor coordination leading to overlapping and duplication. For example, the Ministry of Health (MOH) is responsible for appointing inspectors under the public health act, but the demarcation of responsibility between these inspectors and veterinary officers from MAAIF is not clear. The responsibilities of meat inspections are shared by MOH, MAAIF, and the ministry of local government. However, even if the structures and guidelines are in place, all the retail meat handlers claimed the government did not provide any form of training and education. Interestingly 84.2% claimed government authorities made monthly checks for compliance. This indicated that the government authorities were rather interested in policing rather than education. Inquiry on whether retailers were aware of any specific qualifications to be able to run or open a meat retail business showed that only 2.2% and 20% of the butcher shops and supermarkets claimed there were existing requirements. These, therefore, pointed many meat retailers not being aware of the existing guidelines. Some claimed to be aware but were unable to acquire them since these guidelines are sold by UNBS.

5.5. Characterization of the governance structures between retail outlets and slaughterhouses and how they affect the chain performance of meat supply chain in Kampala.

All the retail outlets were run by male workers which is similar to a report by Mirembe et al. (Mirembe et al., 2015). This is probably because the meat retailing business requires a lot of physical strength and needs to be carried out by energetic men. Salifu et al. reported that the butcher operations are quite an energy-demanding and may involve lots of traveling to livestock markets hence the need for men to run the business (Salifu and Teye, 2006). These outlets purchased their meat carcasses from slaughter facilities within and out of Kampala.

5.5.1. Nature of contracts

Largely, the main contractual arrangement adopted by the butcher shops and supermarkets was the market or transactional contract. Similarly, Ouma et al. (Ouma et al., 2017) reported that the pig supply chain in Uganda was majorly dominated by market or transactional contracts. They also indicated that as a result of these nature of contracts, pig producers are generally price takers and lack a common voice. In our study however, the slaughterhouses, were a small number and therefore had monopolized the business hence they were majorly the terms of trade setters and the retail outlets that were very many and not united had no say on the terms of trade. As a result, the food safety performance output of the slaughterhouses was generally poor (level 0) (Table 5). The retail out lets also opted for spot market transactions because the vast majority reported being unable to carry out

microbial tests hence, they were unable to set any quality related terms with the slaughterhouses. It is also possible that the supermarkets and butcher shops opted for spot market contracts because meat is highly perishable and yet lacked safe meat storage facilities and a reliable market for the meat. These retailers operated by selling off all the meat that they had acquired first before going back to buy more. These therefore resulted in unregular demand for the meat carcass.

The nature of communication used by the majority meat retailers with slaughterhouses was majorly informal i.e. based on phone calls or visits. The visits resulted in a very high number of people at the slaughterhouses which in turn increased chances of cross contamination of meat since the buyers could enter the meat carcass display area for them to choose the parts they needed to buy. Also, since most of the butcher shops and supermarkets bought meat in small quantities, they were usually specific with the parts of meat they required and preferred to hand pick the carcass themselves. We also observed that none of the slaughterhouses possessed an official website or online booking portal where a retailer would make and order therefore, they had to physically visit the slaughterhouses.

The fact that the majority of the retailers opted to visit the slaughterhouses could also indicate a lack of consistency in the quality of meat carcass sold by the slaughterhouses.it could also indicate a lack of trust by the meat retailers for the slaughterhouses to deliver hence the buyers need to physically be available to pick the parts they prefer.

5.5.2. Standards and certifications

Standards and certification schemes are set to ensure safety and efficacy through setting a baseline controls and procedures with the intention of promoting conformance with what is pre-designed against the outcome (Wanjiru, 2018). The implementation of these baseline controls and procedures, however, requires the meat operators to invest heavily as implementation of these controls and procedures is quite costly. Also, the Meat retail outlets possibly found a challenge of failure to get products certified to a Quality Mark due to non-approved slaughterhouses, unhygienic slaughterhouses and the carcasses purchased from these slaughterhouses usually fail microbiology tests. Product certification schemes implemented by UNBS were very costly whereby each product was given a permit that costs about 250 US dollars and expires in one year in addition there are sampling fees and audit fees. As so, the butcher shops and supermarkets in Kampala that are majorly profit oriented had not implemented standards and certification schemes possibly due to the costs associated with them. Also, it was observed that the adoption of standards and certification had been very low because the consumers had little knowledge about the relevance of standards in ensuring safety and quality of meat hence did not pressure the meat retailers into implementing them.

It was observed during the study that some of the supermarkets that had certificates, mainly had Hallal certificates because their interest was to be able to supply meat to the Muslim customers. Some had HACCP certificates however they were outdated which suggested a lack of surveillance by the responsible bodies.

Possession of standards and certificates ensures better performance of the supply chain as traceability, hygiene, microbial quality etc. is ensured (Bahlmann and Spiller, 2008, Kotsanopoulos and Arvanitoyannis, 2017). The supermarkets that had some form of standards or certification scheme were able reject meat that they found unsafe since the standards gave them a baseline in their decision making thus improving the chain performance. The butcher shops for the same reason never reported any cases of meat rejection since they had no baseline guidelines for making such decisions. They possibly could not reject any meat because they are small businesses that operate while basing on GAPs. These do not necessitate establishing for example microbial checking capacity thus the lack of microbial testing by all the butcher shops. It therefore meant a poorer performance by the butcher shop as compared to supermarkets as they could be easily supplied with contaminated meat.

5.5.3. Relational governance

Good relational governance is a product of sharing of transaction information between parties in the supply chain and trust due to long term commitment between the stakeholders (Kataike et al., 2019). Sharing of information widely believed enhance profitability through a high degree of cooperative behavior (Jie et al., 2016, Uddin et al., 2017). The information shared may include; product information; Process information (e.g., laboratory results of microbial levels and pathogens, hygiene, traceability, and safety, etc.); Planning information (Demand forecasts, quantity, quality, etc.).

The poor performance regarding sharing safety related information between the slaughterhouses and the meat retail outlets could also be as a result of the meat consumers having little interest in these kinds of information when purchasing meat hence the meat retailers do not pay attention to it. The lack of safety related information when purchasing meat increases chances of spread of zoonotic diseases to the meat consumers. There have been several reports of disease outbreaks in Uganda, (Monje et al., 2020, Nakanwagi et al., 2020, Musiime, 2019, Nyakarahuka et al., 2018) however, since information of for example the origin of animals is not shared it puts people at a risk of contracting diseases given that even the retail outlets have no labs to do any tests. Studies by Monje et al. (Monje et al., 2020) reported multiple human anthrax outbreaks in Arua, Kween, and Kiruhura districts, Uganda. They reported that it the outbreaks were caused by exposure and consumption to domestic ruminants that died of anthrax. Such kind of scenarios would be alleviated if information on the origin and other safety information is shared as traceability would be very easy.

A long term commitment between the stakeholders is a product of trust between the stakeholders and a sign that the two parties are mutually satisfied Therefore, the length of the trade relationship is correlated to the fulfilments of mutual requirements concerning quality arrangements (Zhang and Aramyan, 2009). These relational governance practices are more influential in improving performance as long-time commitment reduces the time and costs associated with recurrent disputes, posturing, and renegotiations (Range and Leonard, 2016).

The number of years of operation of a meat retail outlets is considered essential because food safety performance has been assessed to improve with increasing experience (Abebe, 2020, Wanjiru, 2018). All the supermarkets visited were between 6 -14 years. The Butcher shops however, had a variability in the number of years in operation. 74.5% of the butcher shops had been in operation for more than five years. This is possibly because the supermarkets are own mainly by foreign investors and only began to invest in the country after prevalence of a peace and a stable government. Butcher shops on the other had were exclusively own by the natives hence the variability of the age of the businesses. Similarly, more than half of these butcher shops are less than 14 years most likely due to the prevalence of peace in Uganda for the last 20 years which has encouraged more locals to invest in the meat sector.

Since the majority (77%) of the retail outlets reported to have been getting meat from their slaughterhouses for more than five years, it indicated that they had enough experience to understand the dynamics of the market and better make decisions.

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

6.1. Conclusions and recommendations for the slaughterhouses

Meat is highly perishable and therefore, slaughterhouses are expected to implement excellent core control and assurance system. In this case study, we used an existing diagnostic tool to assess the performance of a FSMS in the slaughterhouses as well as the implemented core control and assurance activities. Most of them had implemented a FSMS that was performing poorly except for one company had performed moderately. The FSMS of most of the slaughterhouses were, therefore, incapable of consistently producing safe and quality meat. All the slaughterhouses lacked adequate cooling facilities and did not implement any physical or packaging intervention method which are core control activities required for ensuring the safe production of meat. Assessment of assurance activities like validation and verification also indicated that most of the slaughterhouses only depended on UNBS to carry these activities yet UNBS is overwhelmed the high number since it does the same responsibility in other agribusinesses. External assessment of food safety performance activities like FSMS evaluation, complaints on hygiene, and microbiological problems indicated a poor performance for all but one of the slaughterhouses.

The country does not have an agency responsible for the coordination of meat safety control. Different ministries departments and agencies are responsible for different mandates in meat safety control. As a result of the arrangement, the meat safety and quality

control infrastructure are fragmented and ambiguously shared among several ministries, departments, and agencies. For example, the commissioner veterinary services from MAAIF is responsible for appointing the inspectors under the Meat Rules, but the boundaries of responsibility between the environmental Health and food officer of MOH and the veterinary officers from MAAIF is not clear. It results in the sharing of the responsibility of meat inspection between MOH, MAAIF, and the local government.

For the slaughterhouses to improve their FSMS to a higher level, they should use scientifically underpinned processes in preventive, intervention, and monitoring systems to enhance predictability. They should also invest in the development of laboratories in each slaughterhouse to perform and organize necessary changes for effective and reliable FSMS. More effort should also be put into involving third-party auditors to carry out verification and validations of the implemented FSMS. The policies should be updated and harmonized with the international standards while the government should work mandating one body to carry out all the work-related meat.

6.2. Conclusion and Recommendation for the Retail outs

The study revealed that the majority of butcher shops Kampala did not adhere to the required sanitation and hygiene standards. However, the supermarkets performed slightly better though there is need for improvement. All the practices investigated could provide avenues for microbial contamination of meat and the possibility of occurrence of foodborne pathogens and spoilage organisms, hence raising public health concerns. Training of meat retail meat handlers on HAACP based practices and retraining had not been carried out by the vast majority hence the poor performance in other practices like records management,

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sanitation and hygiene etc. Most of the butcher shop operators were not aware of government requirements for running a meat retail outlet and government did not carry out any training but rather concentrated on policing. To ensure better performance of the meat retail outlets, this study recommends that government increases efforts on educating the meat retailers on the basic practices of meat handling hygiene. It also recommends that the standards be sold at cheaper prices or given out freely so the meat operators can have access to them. The government should put up a more stringent measure to ensure all butcher shops have quality standard certificates. Furthermore, there is allot of overlap and fragmentation among the different supervisory authorities in government, they should set up one body that is solely responsible for the meat sector. Further research should be done to assess, the meat safety

6.3. Conclusions and recommendations concerning the governance structures.

This study highlights the implications and challenges on food safety performance of the meat value chain result from the governance and contractual structures partaken by the butcher shops and supermarkets with the slaughterhouses in Kampala. The meat sector in Kampala is largely underdeveloped although it has high potential for growth, given the mounting demand for meat both domestically and internationally. The supermarkets have a slightly better food safety performance as compared to butcher shops due to the governance and contractual relations they partake. The supply chain in general is dominated by spot market contracts, lack of standards and certification schemes, and informal relationships. The implication is that, meat retailers (Butcher shops and Supermarkets) have little or no say in the quality related terms of trade and lack a common voice since they are very many

as compared to the slaughterhouses that have monopolized the meat sector business. The meat consumers too had little knowledge on meat safety related issues so had not pressured the meat retailers into implementing stringent measures to ensure meat safety. These were some of the key drivers triggering of poor meat safety performance in the meat supply chain of Kampala.

In order to improve the meat safety chain performance, meat consumers should be educated on their role in ensuring meat safety by the kind of demands they make to the meat retailors as it would push the retailers to improve their standards. This would trigger improvement in issues like traceability and information sharing, licensing and standards adoption, general hygiene and sanitation state of the meat retail outlets etc. The meat retailors should form associations to have a better say in the decision makings when negotiating with the slaughterhouse and reduce transaction costs associated with individual spot market transactions for buying meat carcass. Government engage in educating the supply chain players on the advantages of adopting standards and certification schemes and UNBS should vigilantly ensure all meat dealers are licensed.

This study reveals gaps due to the fewer number of slaughterhouses as compared to the retail outlets in the meat value chain, currently dominated by the slaughterhouses. It also shows minimal investments by private sector players in butcher shops in Kampala, yet these are critical avenues for upgrading the supply chain. Opportunities for investment in appropriate slaughterhouses and butcher shop facilities exist, through private or public-private partnerships. Government also has a role in supporting the growth of the meat

supply chain in Kampala by providing a favorable business environment to encourage private sector investments in the Kampala.

6.4. Contributions of this study

Until now, limited studies on slaughterhouses in Kampala have majorly focused on activities done by the individual slaughterhouses and a few retail outlets, this study covers a significantly bigger number of the slaughterhouses in Kampala (nearly all of them) hence giving a clearer depiction of the state of affairs in the Meat sector in Kampala and Uganda. Also, the available literature concentrate on butcher shops only, however this study introduces goes further to study supermarkets as part of the meat retail outlets and compares activities carried out by both the butcher shops and supermarkets. Also, limited studies have implemented Food Safety Management Systems diagnostic tool (FSMSDI) to understand the status of the food safety in Sub Saharan Africa, to the best of our knowledge, this is the first study to use this concept in the meat supply chain in Uganda particularly. This is also the first study to look into how the governance structures taken by the meat retail outlets and slaughterhouses affect the food safety performance of the whole supply chain and then map the Ugandan meat supply Chain.

6.5. Limitations and Directions for future research

Whilst this study provides an important insight into the food safety management systems of the meat sector in Uganda in the supply chain perspective, there are some limitations that must be taken into consideration when interpreting the results. One of them is the failure to include the meat processors in the study. This was because of the COVID

19 pandemic which resulted in meat processing companies declining to take part in the studies for safety reasons. Also, the study did not look at the microbial studies which would have been compared with the activities carried out by each value chain actor. The study also did not put into consideration the demographic characteristics as factors that affect the governance structures taken up by the value chain players.

The study also looks at only Kampala the capital city. The future research should therefore consider including the meat processors and carrying out a country wide study. Microbial tests should also be considered. Studies should also take into consideration more governance structures as this study only tackles only three governance structures. It is expected that this would boost a comprehensive understanding of the food safety performance of the meat supply chain in Uganda and could be used as a foundation for developing a more comprehensive performance evaluation which may serve as a director for the selection of an suitable governance structures.

APPENDIX 1

Results for allocated scores of FSMS activities and performance output of each slaughterhouse

	SH 1	SH 2	SH 3
Indicators of FSMS activities	*1.2(1)*	*0.6(1)*	*2(2)*
I**. Core safety control activities**	*1.2 (1)*	*0.7(1)*	*1.8(2)*
Design preventive measures			
Sophistication of hygienic design of equipment and facilities	1	1	2
Adequacy of cooling facilities	0	0	3
Specificity of sanitation program	2	2	2
Extent of personal hygiene requirements	2	2	3
Adequacy of raw material control	2	3	2
Specificity of product specific preventive measures	2	2	2
	1.5(1-2)	*1.6(1-2)*	*2.3(2-3)*
Design intervention processes			
Adequacy of physical intervention equipment	2	0	2
Adequacy of packaging intervention equipment	0	0	0
Specificity of maintenance and calibration for (intervention) equipment	2	1	1

Specificity of intervention methods (chemical and biological)	2	1	2
	1.5(1-2)	*0.5(1)*	*1.3(1-2)*
Design monitoring system			
Appropriateness of CCP analysis	2	0	2
Appropriateness of standards and tolerances design	1	0	2
Adequacy of analytical methods to assess pathogens	0	0	1
Adequacy of measuring equipment to monitor critical process and product conditions	1	2	3
Specificity of calibration program for measuring and analytical equipment	1	1	3
Specificity of sampling design (microbial assessment) and measuring plan	0	0	0
	1(1)	*0.5 (1)*	*1.8(2)*
Extent of corrective actions			
Operation control strategies	1	1	2
Actual availability of procedures	1	0	2
Actual compliance to procedures	2	1	2
Actual hygienic performance of equipment and facilities	2	2	2
Actual cooling capacity	0	0	2
Actual process capability of physical intervention equipment	1	0	2

Actual process capability of packaging intervention equipment	0	0	0
Actual performance of measuring equipment	1	1	3
Actual performance of analytical equipment	0	0	1
	0.9 (1)	0.1(0)	1.6(1-2)

II. Core assurance activities	**1.1(1)**	**0.4(1)**	**2.1(2)**
Defining system requirements			
Sophistication of translation of external requirements into FSMS	1	0	2
Extent of systematic use of feedback information to improve FSMS	1	0	2
	1(1)	*0(0)*	*2(2)*
Validation			
Sophistication of validation of preventive measure	2	1	2
Sophistication of validation of intervention systems	2	1	2
Sophistication of validation of monitoring system	2	1	2
	2(2)	*1(1)*	*2(2)*
Verification			
Extent of verification of people related performance	0	0	3
Extent of verification of equipment and methods related performance	0	0	2

	0(0)	*0(0)*	*2.5(2-3)*
Documentation and record-keeping			
Appropriateness of documentation system	2	0	2
Appropriateness of record-keeping system	1	1	2
	1.5(1-2)	*0.5(1)*	*2(2)*
Assessment of the food safety performance	**0.5(1)**	**0.3(1)**	**1.8(2)**
Food Safety Management System evaluation	1	1	1
Seriousness of remarks	0	0	2
Microbiological food safety complaints	0	0	2
Hygiene related complaints	1	1	2

Appendix 2

Questionnaire for Retail outlets

Part I: Backward linkages (relationship with the slaughterhouses)

1. Describe the company's contractual relationship with the slaughterhouses

    1.1. How many slaughterhouses did you use to buy meat during the previous year? _____

    1.2. If you used more than one slaughterhouse during the previous year, what was the main reason for doing so? 1= To search for a better price 2= To search for good

quality meat for my customers 3= Due to safety concerns 4= Other (specify)

_____

1.3. If you had used only one slaughterhouse during the previous year, what was the main reason for doing so? 1= We have a long-term contract with the slaughterhouse 2= This slaughterhouse always offers a better price than others 2= This slaughterhouse supplies good quality meat at all times 3= This slaughterhouse supplies safe meat (is certified by third-party) 4= Other (specify) _____

1.4. Considering the **past few years**, which slaughterhouses did you use **most** as a source of meat for your butcher shop? 1=   Nsooba slaughterhouse Ltd   2= City Abattoir   3= Ugandan Meat Packers Ltd   4=Other

1.5. Think of the slaughterhouse that <u>supplied most of the meat during the past few years,</u> and answer the following questions <u>only based on your relationship with</u> <u>this</u> <u>slaughterhouse</u>.

  1.5.1. Duration of relationship: How long have you been buying meat from this slaughterhouse? _____ (years)

  1.5.2. What is the nature of communication between your company and the slaughterhouse? 1=There is always a two-way communication between the company and this slaughterhouse; 2= Two-way communication is occasional or none – existence.

  1.5.3. What type of information do you often exchange with the slaughterhouse *(more than one answer is possible)*? 1=Product information exchange (e.g., animal feed, type of breed, the animal origin/location); 2= Process information exchange (e.g.,

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laboratory results of microbial levels and pathogens, hygiene, traceability, and safety, etc.); 3= Planning information (Demand forecasts, quantity, quality, etc.); 4= Other (specify)

1.5.4. The formality of exchange: 1= The communication between my company and this slaughterhouse is mostly formal (i.e., in writing or by email); 2= Informal (phone calls or visits)

1.5.5. The nature of contract terms: 1= ***Closed one*** – i.e., the contract terms related to price, delivery, quality and risks (safety conditions) are pre-agreed and documented (in writing), and cannot be modified in the event of unexpected market conditions; 2= ***Flexible*** – i.e., the contract terms related to price, delivery, quality and risks (safety conditions) are pre-agreed and documented (in writing), but are subject to modifications in the event of unexpected market conditions ; 3= ***Relational*** – the contract terms related to price, delivery, quality and risks (safety conditions) are pre-agreed **but not in written form** and are subject to modification depending on the market conditions; 4=

1.5.6. What percent of the total meat delivered by this slaughterhouse is being rejected by the company on average per year? _____

1.5.7. Have you ever had incidences of detecting excessive microbial pathogens from the meat supplied by this slaughterhouse in the previous one year? 1=Yes 2= No, 3= We don't know because we don't have the laboratory/facility to test microbial pathogen levels

2. In your opinion, what are the most important factors affecting the **safety/quality of meat** in Uganda? Please mention up to three.

    2.1. First   most   important   factor

    _____

    2.2. Second   most   important   facto

    _____

    2.3. Third   most   important   factor

    _____

Part 2: Assessing the food safety control system implemented by the butcher shops

1. Does your company have any Quality Assurance standards/guidelines (e.g. GMP, GHP, HACCP, ISO 9001, ISO 22000 that have been implemented? 1=Yes 2= No

2. **Chose which option(s) best describes what you do at your butcher shop**

    2.1. Pest control (Rodents, cockroaches, and flies)

        2.1.1. What are the control measures you carry out in order to overcome issues related to pests?

        a. Presence of rodent traps like a rat trap, housefly traps, fly screens, etc. 1= Yes; 2=No

        b. Keeping the floors, walls, roof, doors and window openings in a good state of repair with no gaps or spaces. = Yes; 2=No

        c. keeping the meat in pest-proof containers. 1= Yes; 2=No

        d. Use of electronic fly devices. 1= Yes; 2=No

e. Others. Specify…………

2.1.2. How often do you check for signs of pests such as rodent droppings, smear marks, insect egg cases, and either live or dead insects done? 1=daily; 2=weekly; 3=monthly; 4=annually; 5=never done

2.2. Waste management

2.2.1. What measures do you carry out to endeavor proper management of wastes in your premises?

a. Wastes (un-edible parts) are placed in containers with suitably fitted lids and removed frequently from meat handling areas where it is produced. 1= Yes; 2=No

b. Use of waste containers but without lids. 1= Yes; 2=No

c. Waste containers regularly cleaned and disinfected. 1=Yes; 2=No

d. No waste control plan. 1= Yes; 2=No

2.3. Cleaning programs (method and regularity of cleaning and disinfecting meat preparation areas as well as machinery and utensils used)

Item and areas	Frequency of cleaning; 1=after every use; 2=twice a day; 3= daily; 4= weekly; 5=monthly; 6= no standard practice	Cleaning materials used: 1= cold water only; 2= cold water and detergents; 3= Hot water, with detergents and other chemicals

Food contact equipment/ utensils such as chopping boards, tongs, cutting tools, hooks, display trays, containers, etc.		
Non-moveable equipment such as work surfaces, wash hand basin, taps, door handles		
Food waste containers and refuse waste bins/area		
Cloths and work clothes		
Refrigerator/chill and freezer		
Dry storage area		
Floors		

2.4. Public oversight

    2.4.1. How often does the government authorities visit premises to check for compliance by the butcher shop? 1=Monthly; 2= Quarterly; 3=Every six months; 4=Annually; 5= Never

2.5. Maintenance (premises and machinery)

2.5.1. How often do you carry out general maintenance checks of the premises and the machinery? 1=Weekly; 2=Monthly; 3=Quarterly; 4=Yearly; 5=Only when there is a breakdown of equipment; 6=Never

2.6. Personal hygiene (Hand Washing, use of gloves, protective clothing, Excluding ill staff from duty)

2.6.1. Indicate which of the personal hygiene practice(s) you often carry out.

a. Hand washing. 1=Yes; 2=No

b. Use of protective clothing like gloves. 1=Yes; 2=No

c. Exclusion from work in case of illness. 1=Yes; 2=No

d. Reporting of illness which poses a risk to meat safety, such as skin, nose, throat, stomach or bowel trouble or if they have any infected wounds. 1=Yes; 2=No

2.7. Environmental hygiene

2.7.1. What measures do you do to ensure that the environment you are working on is safe and would not lead to any cross-contamination?

a. Designate the area where meat is stored and ensure restricted entrance by other people. 1=Yes; 2=No

b. Surfaces and floors are smooth, impervious and capable of being thoroughly cleaned and disinfected. 1=Yes; 2=No

c. Meat is stored on hangers to avoid contamination from the floor. 1=Yes; 2=No

d. Other. Specify……………….

2.8. *Correct handling, storage & transport*

    2.8.1. How is the carcass transported from the slaughterhouse to the butcher shop?

a. refrigerated trucks. 1=Yes; 2=No

b. trucks without refrigerators. 1=Yes; 2=No

c. motorcycles (boda-boda). 1=Yes; 2=No

d. by hand. 1=Yes; 2=No

e. other specify…………

    2.8.2. where is the meat stored in while at the butcher shop?

a. In refrigerators, freezers, chilled rooms. 1=Yes; 2=No

b. In a guarded glass compartment. 1=Yes; 2=No

c. On hangers. 1=Yes; 2=No

d. On the floor. 1=Yes; 2=No

e. Other. Specify…………

    2.8.3. How long does meat stay before its completely sold off? 1= A day; 2=Two

        days; 3=Three days; 4=Four days; 5=A week

2.9. *Staff training*

    2.9.1. Please indicate which practices you carry out regarding staff training

a. Training for new staff. 1=Yes; 2=No

b. Retraining. 1=Yes; 2=No

c. HACCP based training. 1=Yes; 2=No

d. Monitoring/checking and any other appropriate records used by your business.

   1=Yes; 2=No

2.9.2. Does the government or NGO provide any form of training to your staff?

   1=Yes; 2=No

2.9.3. If yes, how often is it provide?

………………………………

2.9.4. Does the government set any specific qualifications to be able to run or open

   a butcher shop?

a. Yes

b. No

If yes, specify

………

Appendix 3

Questionnaire for slaughterhouse

Food safety management system-Diagnostic instrument

Introductory section

The tool starts with;

 A. General questions about your company

B. Levels at which core control activities are addressed in your FSMS

C. Levels at which core assurance activities in your FSMS

D. Rough indication about food safety performance level.

1. Is your company part of a larger (inter/national) company?

Yes

no

2. Total number of employees in your company (in this location):

1-9

10-49

50-249

249

3 Which Quality Assurance (QA) standards/guidelines have been implemented?

PRP (GMP, GHP, GDP)

HACCP

ISO 9001

ISO 22000

BRC

IFS

GLOBALGAP (previously EUREP-GAP)

SQF 1000

SQF 2000

Auto-control system

Non

4. For which QA standards is your company certified?

ISO 9001

ISO 22000

BRC

IFS

GLOBALGAP/EUREP GAP

SQF 1000

SQF 2000

Auto-control system

None

5. Do you have a QA manager?

Yes

No

6. Do you have a QA department?

Yes

No

7. How many people are working in the QA department?

8. Who are the major customers of this company? (e.g. business to business, retailers, food

processing companies, catering, etc.)

ASSESSMENT OF FOOD SAFETY CONTROL ACTIVITIES

Assessment of preventive measures design

B1. Hygienic design of equipment and facilities

1. At which level would you place the hygienic design of equipment and facilities relevant

for your slaughterhouse?

Level 0	Level 1	Level 2	Level 3
Hygienic design of equipment and facilities not important/ not an issue	- Critical equipment not hygienically designed, - facilities meet basic requirements for food production	- Critical equipment purchased from suppliers of standard equipment designed in line with hygiene requirements. - Facilities comply with specific hygiene requirements	- Integrated hygienic design of critical equipment and facilities (according to EHEDG or comparable design criteria) - adapted and tested in the companies' specific food production circumstances in collaboration with

equipment and
cleaning suppliers

Supporting information to differentiate situation 2 and 3

- When critical equipment and facilities comply with EHEDG or comparable hygienic design criteria then level 2 or 3.

- Crucial for level 3 is that hygienic design is adapted and tested for your production circumstances

B2. Cooling facilities

2. At which level would you place the cooling facilities relevant for your slaughterhouse?

Level 0	Level 1	Level 2	Level 3
Cooling facilities not used in production	- Domestic/general cooling facilities; - principal cooling capacity not known nor testing product temperature	- Industrial cooling facilities - information about principal cooling capacity from suppliers, no testing of product temperature for different circumstances	- Industrial cooling facilities specifically adapted for companies' specific food production circumstances, - capacity tested by temperature check of environment and

products, for different

circumstances

Supporting information to differentiate situation 2 and 3

- When capacity of cooling facilities known then level 2 or 3.

- Crucial for 3 is that cooling facilities are adapted (modified) and tested for your production

circumstances, and actual product temperature checked for different circumstances

B3. Sanitation programs

3. At which level would you place the sanitation programs relevant for your slaughterhouse?

Level 0	Level 1	Level 2	Level 3
No specific sanitation programs in place	- Incomplete program not differentiated for specific equipment/facilities; - common cleaning agents not specific for production system;	- Complete program and differentiated for equipment and facilities. - Cleaning agents (i.e. Detergents and disinfectants) selected based on advices of suppliers.	- Complete programs, tailored for different equipment & facilities, -cleaning agents specifically modified and tested on effectiveness in the companies' specific food production system

Supporting information to differentiate situation 2 and 3

- When complete (full-steps) sanitation program(s) then level 2 or 3.

- Crucial for level 3 is that sanitation agents and their use are tested for your specific production circumstances

B4. Personal hygiene requirements

4. At which level would you place the personal hygiene requirements relevant for your slaughterhouse?

Level 0	Level 1	Level 2	Level 3
Personal hygiene requirements are not implemented	- Standard requirements for all employees on clothing (caps, gloves, jacks). - Idem personal care and health. - Common washing facilities. - No specific hygiene instructions.	- Additional task-specific requirements on clothing (own clothing, specific storage conditions). - Idem for personal care and health. - Special hand washing facilities. - Basic hygiene instructions	- High/specific requirements, for all food operators, on clothing. - Idem for personal care and health. - Tailored facilities to support personal hygiene. - Specific training and hygiene instructions

Supporting information to differentiate situation 2 and 3

- When specific personal hygiene requirements (clothes, personal care, health), and facilities and instructions then level 2 or 3.

- Crucial for 3 is that specific (high) personal hygiene requirements are for all employees and that facilities and instructions are tailored (i.e. Specific/special) for your production circumstances

B5. Animal control

5. At which level would you place your animal control relevant for your slaughterhouse?

Level 0	Level 1	Level 2	Level 3
No control on food safety level of incoming animal	- Animal control on food safety level is ad hoc and is mainly based on historical experience with suppliers	- Animal control on food safety level is systematic and is based on guidelines, or legislative requirements, or guidance document for sector	- Animal control on food safety level is systematic using statistical underpinned acceptance sampling (i.e. Sampling frequency, location, analysis, rejection criteria, etc.) based on actual historical data of suppliers

Supporting information to differentiate situation 2 and 3

- When animals are systematically controlled then level 2 or 3.

- Crucial for situation 3 is that acceptance sampling is based on statistical analysis of actual historical data of suppliers

B6. Product specific preventive measures

6. At which level would you place your product specific preventive measures relevant for your slaughterhouse?

Level 0	Level 1	Level 2	Level 3
No product specific measures used	- Animal control on food safety level is ad hoc and is mainly based on historical experience with suppliers	- Product specific preventive measure is based on guideline, legislative requirement, guidance document, expert knowledge, - but not tested.	- Product specific preventive measure is based on legislative requirement/guidance documents - and tested for specific food production circumstances.

Supporting information to differentiate situation 2 and 3

- When effect of product specific preventive measure is supported with expert knowledge/scientific information then level 2 or 3.

- Crucial for level 3 is that the product specific measure is tested for your production circumstances (it is known to what extent the measure can reduce cross contamination, high initial loads, etc.).

Assessment of intervention processes design

B7. Physical intervention equipment

7. At which level would you place your physical intervention equipment relevant for your slaughterhouse?

Level 0	Level 1	Level 2	Level 3
No physical intervention equipment used	-General intervention equipment not product specific - Process equipment capability not known	- Best standard' intervention equipment available in practice, product specific -process equipment capability described in specifications (provided by equipment suppliers). Equipment is principally capable to comply with standards and tolerances, but not tested for own production system	-Intervention equipment specifically modified for companies' specific food production circumstances and - process equipment capability is tested in company specific circumstances and information is well-documented

Supporting information to differentiate situation 2 and 3

- When process capability of intervention equipment is known then level 2 or 3.

- Crucial for 3 is that intervention equipment is specifically designed (modified) and tested for your production circumstances

B8. Packaging intervention equipment

8. At which level would you place your packaging intervention equipment (i.e. MAP, vacuum, active packaging) relevant for your slaughterhouse?

Level 0	Level 1	Level 2	Level 3
Packaging concept is not specifically aimed at reducing, inactivating pathogens	- Packaging conditions selected based on company knowledge - General packaging equipment not product specific - Packaging equipment capability not known	- Packaging conditions selected based on expertise of suppliers of dedicated packaging concepts (MAP, active packaging) - 'Best standard' packaging equipment available in practice, product specific - Packaging equipment capability described in specifications (provided by equipment suppliers).	- Packaging conditions are adapted and tested for the company specific circumstances -Intervention equipment specifically modified for companies' specific food production circumstances and Packaging equipment capability is tested in company specific circumstances and

Equipment is principally capable to comply with standards and tolerances, but not tested for own production system

information is well-documented

Supporting information to differentiate situation 2 and 3

- When effect of packaging conditions (e.g. Film properties, gas composition, product/headspace ratio) and capability of packaging equipment is known then level 2 or 3

- Crucial for level 3 is that the packaging conditions and packaging equipment are specifically designed (modified) and tested for your production circumstances

B9. Maintenance and calibration program for (intervention) equipment

9. At which level would you place your maintenance and calibration program for (intervention) equipment relevant for your slaughterhouse?

Level 0	**Level 1**	**Level 2**	**Level 3**
No maintenance applied	- Maintenance is basically initiated by problems, ad hoc.	- Maintenance program developed with support of, or by suppliers of equipment/tools.	-Maintenance program specifically designed for production process using data from regular inspections

	-no (clear) instructions about frequency and maintenance tasks;	- specific instructions about frequency and maintenance tasks,	and breakdown analyses,
	- not well documented	- well documented (at location or at equipment suppliers)	- specific instructions on frequency maintenance tasks; - well documented (at company).

Supporting information to differentiate situation 2 and 3

- When structural maintenance program for intervention equipment available then level 2 or 3.

- Crucial for 3 is that the maintenance program is specifically designed for your production process (based on actual process data and analysis).

B10. Intervention methods

10. At which level would you place your (chemical and biological) intervention methods relevant for your slaughterhouse?

Level 0   **Level 1**   **Level 2**   **Level 3**

No chemical or biological intervention methods used	- Intervention methods are applied based on company knowledge, and experience, - potential reduction level not known.	- Application of intervention method based on advices of specialized suppliers, but not tested for specific food production system characteristics, - potential reduction level known based on literature and expert knowledge	- intervention method is modified for the companies' specific food production system characteristics - Actual reduction level is known by testing in the real production system conditions id well documented

Supporting information to differentiate situation 2 and 3

- When effect of the intervention method is supported with expert knowledge, scientific information then level 2 or 3.

- Crucial for situation 3 is that the intervention method is tested for your production circumstances

Assessment of monitoring system design

B11. CCP/CP Analysis

11. At which level would you place the analysis of CCP/cps with respect to your slaughterhouse?

Level 0	Level 1	Level 2	Level 3
No analysis of ccps and cps executed (nor by company nor by external experts)	-Internal experience/knowledge used for hazard identification and risk evaluation; selection of hazards to be controlled based on internal discussions, - no strict methodology used. -CCP/CP determination based on consensus and not tested in practice.	- Hazard identification, risk analysis and allocation of CCP/cps based on hygiene codes for sector or executed by external expertise (consultancy) who work - according to official Codex guidelines. - CCP/CP determination by microbial product tests and or historical data.	- Hazard identification, risk analysis and allocation of CCP/CP executed by using own knowledge/experience, additional scientific literature and or expert knowledge, - according to Codex guidelines. - CCP/CP determination by microbial product tests and predictive modelling of hazard behavior and/or challenge tests

Supporting information to differentiate situation 2 and 3

- When your CCP/CP analysis is executed in a systematic way and based on expert knowledge, scientific information then level 2 or 3.

- Crucial for level 3 is that CCP/cps are tested for your actual production circumstances

B12. Standards and tolerances design

12. At which level would you place your standards and tolerances design with respect to your slaughterhouse?

Level 0	Level 1	Level 2	Level 3
No written standards for product and process parameters	- Standards for critical product parameters and process parameters are specified but tolerances not clearly specified. - Assessments of product/process standards basically on historical data and company experience.	- Standards and tolerances for critical product and process parameters are clearly specified. - Standards and tolerances of product/process parameters derived from general hygiene codes and legal requirements.	- Standards and tolerances for critical product/process parameters are clearly specified. - Standards and tolerances of product/process parameters derived from legal requirements, hygiene codes, and literature, adapted for own food production system.

Supporting information to differentiate situation 2 and 3

- When standards and tolerances are clearly specified and minimally based upon (available) legislative requirements then level 2 and 3.

- Crucial for 3 is that standards and tolerance are scientifically underpinned and adapted for your production circumstances.

B13. Analytical methods to assess pathogens

13. At which level would you place analytical methods to assess pathogens with respect to your slaughterhouse?

Level 0	Level 1	Level 2	Level 3
Pathogens are not analyzed (not by company nor by external lab)	-Conventional culture-based methods used (i.e. Plate counts, most probable number, presence -absence tests). - No (inter)nationally acknowledged procedures is followed	-Conventional culture-based methods used (i.e. Plate counts, most probable number, presence -absence tests) or modified quicker methods. - Internationally validated methods are used (not accredited)	-Conventional culture-based methods used (i.e. Plate counts, most probable number, presence -absence tests) or modified quicker methods. -Internationally validated and accredited methods are used

Supporting information to differentiate situation 2 and 3

- When internationally validated methods are used for pathogen testing then level 2 or 3.

- Crucial for level 3 is that the method is also accredited

B14. Measuring equipment to monitor process/product status

14. At which level would you place measuring equipment to monitor process / product status in your slaughterhouse?

Level 0	Level 1	Level 2	Level 3
No measuring equipment	-No standardized measuring equipment (accuracy not tested). -Off-line /at-line measurement, not automated, no information/data history available	-Standard available measuring equipment complying with ISO (other international recognized) norms (accepted accuracy). -On-line /in-line measurement (immediate response), often automated, information/data history available	-Specifically, selected equipment and adapted to the companies' specific production process and tested on accuracy. -On-line/in-line measurement (immediate response), automated, information history immediately visual.

Supporting information to differentiate situation 2 and 3

- When internationally acknowledged (in line) measuring equipment recording history information then level 2 or 3.

- Crucial for 3 is that the measuring equipment is adapted and tested on accuracy for your production circumstances

B15. Calibration program for measuring and analytical equipment

15. At which level would you place your calibration program for measuring and analytical equipment in your slaughterhouse?

Level 0	Level 1	Level 2	Level 3
No calibration/verificatio n program for measuring nor analytical equipment	-Calibration of measuring and or analytical equipment on ad-hoc basis. - tasks and frequency not clear, and not (well) documented.	-calibration outsourced at equipment suppliers or at external laboratories for analytical equipment - task and frequency based on international standards, not specific for food production system, documentation at equipment suppliers	- Calibration program specifically designed based on data from your own food production system, according to international standards - tasks and frequency in- house documented

Supporting information to differentiate situation 2 and 3

- When structural calibration/verification program (for measuring and or analytical equipment) according to international standards available then level 2 or 3.

- Crucial for 3 is that the calibration/verification program is specifically designed (or adapted) based on actual process data and analysis of for your own production process

B16. Sampling design (for microbial assessment) and measuring plan

16. At which level would you place sampling design (for microbial assessment) and measuring plan with respect to your slaughterhouse?

Level 0	Level 1	Level 2	Level 3
No sampling design nor a measuring plan in place	Sampling design and measuring plans based on experience and in-house knowledge. No information about distribution of pathogens, samples are taken as spot-check procedure	Sampling design and measuring plan based on common sampling plans for the specific sector (e.g. Meat, chicken, etc.) as available in literature (e.g. EU guidelines, or ICMSF)	Sampling design and measuring plan based on statistical analysis of pathogen distribution in own food production process

Supporting information to differentiate situation 2 and 3

- When sampling design and measuring plans are based on acknowledged guidelines/scientific information then level 2 or 3.

 - Crucial for level 3 is that sampling design and measuring plans are adapted based on statistical analysis of pathogen distribution in your production

B17. Corrective actions

17. At which level would you place corrective actions with respect to your slaughterhouse?

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Level 0	Level 1	Level 2	Level 3
No corrective actions have (yet) been described	- Corrective actions based on experience, and consensus within company. -Incomplete descriptions of process adjustments and handling of non-compliance products, -no structural analysis of cause of deviation. Corrective measures not differentiated for different deviations.	- Corrective actions based on hygiene codes including process adjustment measures and handling non-compliance products. -Complete descriptions but not adjusted for own process, product characteristics. - Ad hoc analysis of cause of deviations, no differentiated measures.	- Corrective actions based on systematic causal analysis of own product/process deviations. -Complete descriptions including process adjustments and handling of non-compliance products. - Structural analysis of cause of deviations, differentiated measures.

Supporting information to differentiate situation 2 and 3

- When complete description of corrective actions (minimally based on hygiene codes) then level 2 or 3.

- Crucial for 3 is the structural analysis of causes of product/process deviations and differentiated corrective actions specific for your production.

Assessment of operation of food safety control activities

B18. Actual availability of procedures

18. At which level would you place actual availability of procedures in your slaughterhouse?

Level 0	Level 1	Level 2	Level 3
No procedures in place	- Procedures are sometimes/partly available on location (often paper-based), - difficult to understand by users - and are not kept up to date	- Procedures are available at location (often paper-based) - and well to understand for most users - but are kept up to date on ad-hoc basis	- Procedures very easily available (digital, on-line) at location, - and are designed for specific users - and updated at a regular basis

Supporting information to differentiate situation 2 and 3

- When procedures available at appropriate locations then level 2 or 3.

- Crucial for level 3 is that procedures are specifically designed for the users and kept systematically up to date.

B19. Actual compliance to procedures

19. At which level would you place the actual of compliance to procedures in your slaughterhouse?

Level 0	Level 1	Level 2	Level 3
No procedures; no idea about compliance to procedures of operators	- Majority of food handlers execute tasks according to own insights, because there are not aware of existence of procedures for certain tasks. -Operators are controlled on compliance to procedures on ad-hoc basis	- Majority of operators are familiar with existence of procedures (but not always exact content); tasks are executed based on habits. -Operators are controlled on compliance to procedures on regular basis	- All operators are aware of existence and content of procedures and are consciously following procedures, safety tasks are internalized. -Self-control of compliance to procedures

Supporting information to differentiate situation 2 and 3

- When majority of employees are familiar with existence of procedures for core control activities then level 2 or 3.

 - Crucial for level 3 is that safety tasks are internalized (i.e. Employees know well content of procedures) and they control themselves (not by chief/QA)

B20. Actual hygienic performance of equipment and facilities

20. At which level would you place actual hygienic performance of equipment and facilities with respect to your slaughterhouse?

Level 0	Level 1	Level 2	Level 3
- Hygienic design is no issue. - No information/ idea about hygienic performance	- Regularly unexpected and unexplainable contaminations due to inappropriate equipment or facilities. - Hygienic performance of equipment and facilities never tested.	-sometimes unexpected and unexplainable contaminations due to inappropriate equipment or facilities. - Hygienic performance of equipment and facilities tested on ad-hoc basis	-Stable hygienic performance of equipment and facilities, - hygienic performance tests are executed on regular basis according to EHEDG/similar guidelines

Supporting information to differentiate situation 2 and 3

- When stable hygienic performance of equipment and facilities with only few contamination problems then level 2 and 3.

- Crucial for level 3 is that actual hygiene performance is systematically/regularly tested according to acknowledged guidelines/criteria (like described by EHEDG).

B21. Actual cooling capacity

21. At which level would you place the actual cooling capacity with respect to your slaughterhouse?

Level 0	Level 1	Level 2	Level 3

Cooling facilities not used. No cooling performance information known	- Regularly unstable performance with significant variations in facility temperature -no automatic temperature devices and deviations not systematically analyzed, -no information about product temperature	- Sometimes unstable performance, -automatic temperature control but no systematic analysis of deviations, - ad hoc information about product temperature	- Stable performance of cooling facilities, -environmental temperature is automatically monitored and deviations are systematically analyzed; -constant information about product temperatures

Supporting information to differentiate situation 2 and 3

- When stable cooling capacity with no or sometimes unexpected deviations based on information from (automatic) environmental temperature control then level 2 or 3.

- Crucial for level 3 is that actual cooling capacity is also stable based on regular analysis of actual product temperature under your production circumstances

B22. Actual process capability of physical intervention processes

22. At which level would you place the actual process capability of physical intervention processes with respect to your slaughterhouse?

Level 0	Level 1	Level 2	Level 3
No intervention equipment in place; no performance information known	- Regularly unstable process with unexplainable deviations from mean values of process parameters; variation not constant over time. -Variable differences in capabilities between different production lines. - No use of control charts	-Sometimes unstable process, with unexplainable deviations of process parameters; variation constant over time. -Significant but constant differences in capabilities between various production lines. - Control charts used but not systematically interpreted	-Stable process, mean values and variation of process parameters according to specifications and constant over time. - Minor deviations in mean values and variation between production lines. - Control charts used and systematically interpreted

Supporting information to differentiate situation 2 and 3

- When individual physical intervention equipment performs rather stable (i.e. Constant variation around target value) with no or sometimes unexpected deviations and actual performance is known based on information from actual process data then situation 2 or 3

- Crucial for situation 3 is that only minor deviations exist between similar process equipment and performance is systematically analyzed.

B23. Actual process capability of packaging intervention

23. At which level would you place the actual process capability of packaging intervention (MAP, vacuum, active) processes with respect to your slaughterhouse?

Level 0	Level 1	Level 2	Level 3
- no packaging intervention equipment in place - no performance information known	- regularly unstable packaging process with unexplainable deviations from mean values of process parameters; variation not constant over time	-sometimes unstable packaging process, with unexplainable deviations of process parameters; variation constant over time	-stable packaging process, mean values and variation of process parameters according to specifications and constant over time
	- variable differences in capabilities between different production lines	-significant but constant differences in capabilities between various packaging lines	- minor deviations in mean values and variation between packaging lines
	- no use of control charts	- control charts used but not systematically interpreted	- control charts used and systematically interpreted

Supporting information to differentiate situation 2 and 3

- When individual packaging intervention equipment performs rather stable (i.e. Constant variation around target value) with no or sometimes unexpected deviations and actual performance is known based on information from actual process data then level 2 or 3

- Crucial for level 3 is that only minor deviations exist between similar packaging equipment and performance is systematically analyzed

B24. Actual performance of measuring equipment

24. At which level would you place the actual performance of measuring equipment with respect to your slaughterhouse?

Level 0	Level 1	Level 2	Level 3
- No measuring equipment used; - no information about measuring equipment performance	Measuring equipment very sensitive to changes in production process circumstances	Measuring equipment sensitive for few specific well-known production process changes	Measuring equipment very stable under all different production circumstances

Supporting information to differentiate situation 2 and 3

- When measuring equipment not very sensitive towards changes in production systems then level 2 or 3.

- Crucial for 3 is that measuring equipment is stable under all different circumstances

B25. Actual performance of analytical equipment

25. At which level would you place the actual performance of analytical equipment relevant for your slaughterhouse?

- No analytical analyses executed (nor by company nor by external lab); - sensitivity analytical equipment unknown	Analytical equipment very sensitive towards minor changes in product composition (interference of compounds) and or other analytical circumstances	Analytical equipment sensitive for few specific well-known product compounds, and or analytical circumstances	- Analytical equipment very stable under different product compositions and analytical circumstances -Analytical equipment at accredited laboratories are assumed to be stable under different product and analytical circumstances

Supporting information to differentiate situation 2 and 3

- When analytical equipment not very sensitive towards changes in product composition then level 2 or 3.

- Crucial for 3 is that analytical equipment is stable for all different product compositions (also in case analyses are done by external accredited laboratories)

ASSESSMENT OF FOOD SAFETY ASSURANCE ACTIVITIES

Assessment of use of internal information and data

C1. Translation of stakeholder requirements into own FSMS requirements

1. At which level would you place the translation of stakeholder requirements into

own FSMS requirements related to your slaughterhouse?

Level 0	Level 1	Level 2	Level 3
Not (yet) any stakeholder requirement(s) translated	Translation of external assurance activities initiated by food safety performance problems (reactive) as perceived by stakeholders and or due to external directives, only necessary changes.	Translation of external assurance activities by actively acting on changes in external assurance and setting (new) requirements with support of external experts (e.g. consultants)	Pro-active translation of external assurance requirements based on systematic analysis of possible changes in stakeholder requirements (e.g. new legislation, new branch demands) and evaluated on critical aspects of own food production system; well documented.

Supporting information to differentiate situation 2 and 3

- When external assurance requirements systematically translated into (new) requirements on

own food safety control systems then level 2 or 3.

- Crucial for 3 is that assurance requirements are evaluated on your critical production

circumstances and translation activities well-documented

C2. Systematic use of feedback information to modify FSMS

2. At which level would you place the systematic use of feedback information to modify

FSMS related to your slaughterhouse?

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Level 0	Level 1	Level 2	Level 3
FSMS has not (yet) ever been modified	- Ad hoc modification of FSMS initiated by problems from own food production system; - not documented	- Regular use of standard data from food production system (process/product data); modifications mainly focused on control activities in production system; - not systematically documented	- Systematic analysis of information from validation and verification reports, translations into concrete modifications in FSMS are established in clear procedures with assigned responsibilities; - well documented

Supporting information to differentiate situation 2 and 3

- When systematically information is used from food production system to modify food safety control system, then level 2 or 3.

- Crucial for 3 is the use of verification and validation information established in procedures and all is well-documented

Assessment of validation

C3. Validation of preventive measures

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3. At which level would you place validation of preventive measures with respect to your slaughterhouse?

Level 0	Level 1	Level 2	Level 3
Effectiveness of preventive measures have (yet) never been validated	- Effectiveness of preventive measures is validated based on historical knowledge only, judged by own people. - on ad-hoc basis, and - findings scarcely (not) described	- Effectiveness of preventive measures is validated based on opinion of independent expert, using expert knowledge, regulatory documents and historical results; - on regular basis and after system modifications; - findings described in reports	- Effectiveness of preventive measures is systematically validated, by independent experts, based upon specific scientific sources (like scientific data/literature on validation studies, predictive modelling), historical results, and own experimental trials; - on regular basis and after system modifications, - activities and results well documented

Supporting information to differentiate situation 2 and 3

- When preventive measures independently (not by own people) validated based on expert knowledge and or scientific sources on a regular basis, then level 2 or 3.

- Crucial for level 3 is that actual effectiveness is tested with experimental trials and validation activities are established in procedures and well documented

C4. Validation of preventive measures

4. At which level would you place validation of intervention systems with respect to your slaughterhouse?

Level 0	Level 1	Level 2	Level 3
Intervention systems have (yet) never been validated	- Effectiveness of intervention systems are validated based on historical knowledge only, judged by own people - on ad-hoc basis, and - findings scarcely (not) described	- Effectiveness of intervention systems are validated based on opinion of independent expert, using expert knowledge, regulatory documents and historical results; - on regular basis and after system modifications;	- Effectiveness of intervention systems are systematically validated, by independent experts, based upon specific scientific sources (like scientific data/literature on validation studies, predictive modelling), historical results, and

| | | - findings described in reports | - own experimental trials;

- on regular basis and after system modifications,

- activities and results well documented |

Supporting information to differentiate situation 2 and 3

- When intervention systems are independently (not by own people) validated based on expert knowledge and or scientific sources on a regular basis, then level 2 or 3.

- Crucial for level 3 is that actual effectiveness is tested with experimental trials and validation activities are established in procedures and well documented

C5. Validation of monitoring systems

5. At which level would you place validation of monitoring systems with respect to your slaughterhouse?

Level 0	Level 1	Level 2	Level 3
Effectiveness of monitoring systems have (yet) never been validated	- Validation based on historical and/or commonly available knowledge,	- Validation based on comparison with regulatory documents (like specific hygiene codes),	- Validation based on scientific sources (reviews, historical data on hazards, reports on foodborne illnesses,

- executed by own people on ad hoc basis;	- by external expert on regular basis;	data on survival or multiplication, studies on control mechanisms);
- findings (not) scarcely described	- findings described in expert report	- by independent expert on regular basis and after system modifications;
		- activities and results well documented

Supporting information to differentiate situation 2 and 3

- When monitoring systems at CCP's are independently (not by own people) validated based on expert knowledge and or scientific sources on a regular basis, then level 2 or 3.

- Crucial for level 3 is that actual effectiveness is tested with experimental trials, and Crucial for 3 is that the actual performance is confirmed by real observations, and validation activities are established in procedures and well documented

Assessment of verification

C6. Verification of people related performance

6. At which level would you place verification of people related performance with respect to your slaughterhouse?

Level 0	Level 1	Level 2	Level 3
Procedures and compliance to procedures have (yet) never been verified	- Verification of procedures and compliance based on checking presence of procedures and records, on ad-hoc basis, - by own people who execute system; - not documented	- Verification of procedures and compliance based on analyzing procedures (both content and presence) and records, - on regular basis, - by independent internal staff, - internal report	- Verification of procedures and compliance based on analyzing procedures and records, and observations, - with defined frequency and when system modifications, -by independent external (official) expert; - activities and results well documented

Supporting information to differentiate situation 2 and 3

- When verification of performance of people related activities is based on independent analysis of procedures, records, etc. on a regular basis, then level 2 or 3.

- Crucial for 3 is that the actual performance is confirmed by real observations, and verification activities are established in procedures and well documented

C7. Verification of equipment and methods related performance

7. At which level would you place verification of equipment and methods related performance with respect to your slaughterhouse?

Level 0	Level 1	Level 2	Level 3
Performance of equipment and methods have (yet) never be verified	- Verification of equipment/methods performance based on checking if product, process parameters are correctly set (e.g. of equipment, facilities, measuring, analysis methods) - on ad hoc basis, - by people working in the system and provide the information,	- Verification of equipment and methods performance based on analyzing records (e.g. control charts, records data loggers, etc.) and calibration activities, restricted testing of actual performance, - on regular basis	-Verification of equipment/methods performance based on analyzing records, calibration activities, and confirmation of performance by actual (e.g. microbial) testing - with defined frequency and after system modifications,

Supporting information to differentiate situation 2 and 3

- When verification of equipment and methods performance is based on independent analyses of records, data, calibration activities, etc. on regular basis, then level 2 or 3.

- Crucial for 3 is that the actual performance is confirmed by testing (e.g. microbial tests) and or real measuring, and verification activities are established in procedures and well documented

Assessment of documentation and record-keeping

C8. Documentation

8. At which level would you place documentation with respect to your slaughterhouse?

Level 0	Level 1	Level 2	Level 3
No documentation of procedures, information, knowledge at all.	No structured documentation system, ad hoc	Structured documentation system, de-centrally organized and kept up to date, (partly) automated, available via specific persons; access to external sources not formalized (individual contacts)	Structured documentation system kept-up to date with assigned responsibilities, centrally organized, automated and on-line available for all, and with access to external sources of information (libraries, databases, etc.).

Supporting information to differentiate situation 2 and 3

- When structured documentation system that is kept-up-to date is available then level 2 or 3.

- Crucial for level 3 is that it is a central and integrated documentation system, which is online available and for all accessible, and has links to external sources of information (like libraries, data banks, etc.)

C9. Record keeping system

9. At which level would you place your record keeping system with respect to your company?

Level 0	Level 1	Level 2	Level 3
No record keeping of product nor process data at all	Ad hoc registration of record keeping data.	Full registration of critical product and process data in separated systems (not integrated), accessible via specific (authorized) persons.	Full registration of critical product and process data, in central integrated system, online available and accessible to all persons

Supporting information to differentiate situation 2 and 3

- When full registration of critical data then level 2 or 3.

- Crucial for level 3 is that it is a central and integrated system, which is online available and

for all accessible

ASSESSMENT OF FOOD SAFETY PERFORMANCE

Assessment of external

D1. Food Safety Management System evaluation

1. How would you typify your Food Safety Management System evaluation?

Level 0	Level 1	Level 2	Level 3

| An inspection or an audit of the Food Safety Management System was never performed | Inspection of the FSMS performed by national food safety agency | Audit of the FSMS performed by one accredited third party | Audits/inspections of the FSMS performed by several accredited third parties and/or national food safety agency |

Supporting information to differentiate situation 2 and 3

- If the FSMS is evaluated by an audit performed by an accredited third party then level 2 or 3.

- Crucial for level 3 is that more than one audit (or combined with an inspection) is performed by accredited third party(s) or in combination with an inspection by the national food safety agency. (For example, a BRC audit by accredited third party and inspection of the national food safety agency).

D2. Seriousness of remarks

2. How would you indicate seriousness of remarks of the FSMS evaluation?

Level 0	Level 1	Level 2	Level 3
Not appropriate because never an inspection or an audit of the FSMS was performed	Major remarks on various aspects of the FSMS	Major remark on one specific aspect of FSMS (eventually additional minor	No remarks or only minor remarks on specific or various aspects of the FSMS

remarks on other

aspects of the FSMS

Supporting information to differentiate situation 2 and 3

- If remarks are clearly attributed to one specific aspect of the FSMS (e.g. HACCP or preventive measure temperature) then level 2 or 3

- Crucial for level 3 is that the remarks are only minor remarks

D3. Microbiological food safety complaints

3. How would you typify the microbiological food safety complaints of customers?

Level 0	Level 1	Level 2	Level 3
Not known because no complaint registration	Various complaints which can be dedicated towards multiple problems in the functioning of the FSMS	Restricted complaints which can be dedicated to one specific problem in the functioning of the FSMS	No complaints regarding microbiological food safety

Supporting information to differentiate situation 2 and 3

- If restricted or no complaints regarding microbiological food safety then level 2 or 3

- Crucial for level 3 is that there are no complaints about microbiological food safety whereas at level 2 the reason of the complaints can be dedicated to one specific aspect of the FSMS (e.g. control of temperature, hand hygiene, cleaning and disinfection)

D4. Hygiene related complaints

4. How would you typify the hygiene related complaints by customers?

Level 0	Level 1	Level 2	Level 3
Not known because no complaint registration	Various complaints which can be dedicated towards multiple problems in the functioning of the FSMS	Restricted complaints which can be dedicated to one specific problem in the functioning of the FSMS	No complaints regarding microbiological hygiene indicators

Supporting information to differentiate situation 2 and 3

- If restricted or no complaints regarding hygiene then level 1 or 2

- Crucial for level 3 is that there are no complaints about hygiene whereas at level 2 the reason of the complaints can be dedicated to one specific aspect of the FSMS (e.g. control of temperature, hand hygiene, cleaning and disinfection)

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