MAKERERE UNIVERSITY

THE IMPLICATION OF STANDARDIZATION ON THE QUALITY OF AGRO-PROCESSING PRODUCTS IN UGANDA: A CASE OF LOCALLY PROCESSED MAIZE FLOUR

BY

RONALD KABIGUMIRA AHIMBISIBWE

Dip. Mech. (KyU), B. Sc. Mech. Eng. (Mak)

Student No. 205020771
Reg. No. 2011/HD06/3126U

A DISSERTATION SUBMITTED TO THE DIRECTORATE OF RESEARCH AND GRADUATE TRAINING IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF SCIENCE IN TECHNOLOGY INNOVATION AND INDUSTRIAL DEVELOPMENT DEGREE OF MAKERERE UNIVERSITY

MAY, 2014

DECLARATION

I, Ronald Kabigumira Ahimbisibwe, do hereby declare that this dissertation is original and has not been published and/or submitted for any other degree to any other University before.

…………………………………..

Ronald Kabigumira Ahimbisibwe (Student)

May, 2014

Supervisors:

Dr. Mackay Okure

Associate Professor, Department of Mechanical Engineering,

College of Engineering Design, Art and Technology,

Makerere University

……………………………………..

May, 2014

Dr. John Baptist Kirabira

Associate Professor, Department of Mechanical Engineering,

College of Engineering Design, Art and Technology,

Makerere University

……………………………………..

May, 2014

COPYRIGHT STATEMENT

ACKNOWLEDGMENT

There are a number of people without whom this piece of work might not have been written, and to whom I am greatly indebted. I sincerely thank my supervisor, Dr. Mackay Okure and the co-supervisor Dr. John Baptist Kirabira, without whom this document would not exist in its present form and especially their time amidst their busy schedules and their confidence in me.

To the NORAD from the Norwegian Government who facilitated me during the two years of the study under the NOMA Programme, I am highly appreciative.

I have to thank my family and friends for their love and support throughout this study. Thank you all for giving me strength to reach for the stars and chase my dreams.

The Uganda National Bureau of Standards team, I would also like to thank you for your understanding, support and encouragement, in many moments of crisis. Your friendship makes my life a wonderful experience.

Above all, I thank the Lord for always being there for me.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS AND ACRONYMS

AAS: Atomic Absorption Spectrometer

CAC: Codex Alimentarius Commission

EIM: Erasmus Institute of Management

GHP: Good Hygiene Practices

GMP: Good Manufacturing Practice

HACCP: Hazard Analysis and Critical Control Point

IEC: International Electro-technical Commission

ISO: International Organization of Standardisation

Ppm: Parts per million

PPM: Production Process Management

SMEs: Small and Medium Enterprises

UNBS: Uganda National Bureau of Standards

UNIDO: United Nations Industrial Development Organization

USEAS: Uganda Standard East African Standard

ABSTRACT

In developing countries which are dependent on agriculture, value addition through local agro processing is always encouraged as a way to achieve economic growth and gaining of international competitiveness. A successful and sustainable growth and development of an agricultural nation such as Uganda would largely depend on value addition using good manufacturing practices and technologies that are efficient, effective, price sensitive and responsive to market needs in addition to product quality and safety requirements . To this end, the purpose of this study was to assess the extent and impact of standardization in the agro-processing Small and Medium Enterprises (SMEs) in Uganda with specific focus on indigenous maize processing mills and the quality of their flour output. This was done through assessing the level of standardisation based on a specified criterion guided by the US 28 EAS 39 standard guidelines on Code of practice for Hygiene in the Food and Drink Manufacturing Industry that was developed in form of a checklist, product testing and analysis based on Uganda product standards as well as open ended discussions with experts in the field of Quality.

The data obtained by the checklist was analyzed using SPSS while the one from test results was interpreted using descriptive statistics to bring to order the research findings. The findings indicate minimal levels of input material, human element and methods, GMP, GHP, equipment/technological standardization among local maize processing SMEs and maize mill fabricators. The experimental results revealed that maize flour from locally fabricated maize mills did not pass the test for quality as it tested positive for extraneous matter (Iron filings) with an average net of 1.8 mg/kg of iron content. Key factors affecting standardizations among maize processing SMEs were found to include lack of control of source of raw materials, negative attitudes to standardization, low enforcement of standards, lack of awareness, costs and information gaps.

The findings of the study suggest that there is need to modify the designs of locally fabricated mills to include provisions that eliminate the extraneous matter in the final processed maize flour to guarantee safety of the consumers. Also, it suggests that adoption of standardization practices such as certifications of inputs, equipment and processes would improve product safety and quality hence enhance competitiveness of these agro-processing SMEs on the local and international market.

CHAPTER ONE: INTRODUCTION

1.1. Background

Although the concept of standardization is defined differently by different authors the consensus view is that standardization is the process of establishing technical standard specifications, test methods, definitions and procedures with a local and global understanding and acceptance (Ericson, 1996; Chee and Harris, 1998; ISO 9000). World over, standardization gained prominence in product design as a prerequisite for meeting quality expectations, customer demands/expectations and the ability to take advantage of economies of scale which in turn leads to significant cost savings and finally exploiting good ideas that are formed in one context and extend these to other contexts (Gilani and Razeghi, 2010).

Developing countries which are dependent on agriculture, local agro processing have been encouraged for national economic growth and gaining of competitive advantage (UNIDO, 2006). Spangenberg (2002) had earlier noted that a successful growth and sustainable development of agro processing products' manufacturing in developing countries would depend largely on the design and fabrication of indigenous machines and equipment which are efficient, effective, price sensitive and responsive to local needs in addition to quality and safety requirements.

Cognizant of the need to develop and strengthen indigenous agro-processing product development, initiatives have been made through a coordinated effort by Makerere University College of Engineering Design Art and Technology, private sector foundation, Ministry of Trade, Industry and Cooperatives, Uganda National Bureau of Standards, Ministry of Finance Planning and Economic Development and practitioners like metal fabricators through formation of clusters to share knowledge and develop locally demanded agro-processing machinery. While the materials used by local fabricators in manufacturing of agro-processing machines are sourced locally, there seems to be limited or no effort to harmonize the codes of practice at this level.

This has hence created a concern in the food safety especially in the milled grains on the health of consumers hence threatening the competitiveness of locally processed agro-products.

A study was carried out by Normanyo et al., (2009) in a Ghana about the existence of iron filings in corn flour; it was found out that iron filings were contained with the fine grind of the corn which was gotten at the final stage of production. In his study, half a bowl of corn at the finest grind was used and gave out an indication of existence of iron filings using magnetic field attraction. One can therefore imagine the amount of iron filings that gets into the human body from the grounded food taken.

A recent assessment on food safety and quality on the Ugandan market identified existence of heavy metals and objectionable matter in locally processed cereals (UNBS, Report 2011). Although it was suspected that objectionable matter in form of iron filings existence was attributed to tear and wear in the production process machinery and raw material inputs among others, no effort was undertaken to confirm their influence on the level of contaminants (extraneous/objectionable materials) in the final products.

The fabrication of food processing machines locally is widely encouraged as an approach for micro-economic development and growth particularly in the value addition process. However, it should be noted that the inability to meet national and international product manufacturing standards continuously constrain the achievement of the development goal of small scale manufacturing sector in the country. This constrains the competitiveness of not only the agro-processing machinery made locally but also the market of their output products from the value addition approach.

1.2. Statement of the Problem

The existence of a high level of contaminants in milled food products in the country threatens the competitiveness of agro-processing SMEs as it compromises the food safety standards locally and internationally. The key question in this study is if the manufacturing practices used in fabrication of agro-processing machines locally, selection of input materials, the human element and technologies used are partly responsible for the level of objectionable materials in the milled food products on market. To date, no study examining the association between these factors and the quality of output from the indigenous maize mills has been reported. Similarly, there is seemingly a lack of strategic and operational intervention initiatives within the government and other stakeholders to ensure standardization in agro-processing product development to enhance the competitiveness of agro-processing SMEs in Uganda. This study therefore intended to establish the implications of standardization among maize milling SMEs in Uganda.

1.3 Main Objective of the Study

The main objective of the study was to assess the impact of standardization in the indigenous maize processing mills with respect to the quality of flour output

1.4 Specific Objectives of the Study

The specific objectives of the study were to;

i. To establish the level of Standardization among maize processing SMEs in Uganda.
ii. To establish the quality of maize flour from milling machines in relation to Machine designs.

iii. To establish the factors that affect standardization and hence leading to the existing quality of flour on Ugandan Market.

iv. To recommend strategies for enhancing quality of manufacturing SMES through standardization in maize milling technologies in Uganda.

1.5 Research Questions

The study was guided by the following research questions;

i. What is the level of standardization among maize processing SMEs in Uganda?

ii. What is the relationship between process standardization and the quality of flour from grain milling machines in Uganda?

iii. What factors influence standardization in Ugandan grain milling sector?

iv. What strategies can enhance the quality of agro-processing small and medium enterprises?

1.6 Significance of the Study

The study findings will be useful in the following ways:

i. It will help the government of Uganda and other stakeholders such as Ministry of Trade Industry and Cooperatives, Uganda National Bureau of Standards and other regulators in standardization, in providing an avenue for standardization policy enhancement for food safety among indigenous agro processing SMEs.

ii. It will point out problems/omissions by the fabricators hence encourage them to use standardised approaches in material selection, fabrication methods and assembly for their equipment thereby reducing production costs with improved quality machines and outputs.

iii. It will help the indigenous agro-processing millers to enhance their local and global competitiveness through minimization of product output defects achieved through standardization and the resultant consumer confidence.

iv. It will provide means through which the consumers are informed of the quality of products on market and hence put pressure on the processors and regulators to have quality products on market.

v. The study findings will help fill literature gaps on the influence of the inputs used for fabricated agro-processing machines, and the design on the quality of output in the academia.

1.7 **Scope of the Study**

The study concentrated on the current practices in the grain milling industry and existing metal fabricators especially dealing in agro-processing machinery. The study was conducted in specific geographical areas of Kampala, Jinja/Iganga and Kasese/Hima for maize milling facilities data gathering and in different markets spread across Kampala for the maize flour sampling. The study focused on indigenous maize milling SMEs, and Maize Mill Fabricators in Kampala business area which houses the majority of the local maize mill fabricators and a few from other areas of Jinja and Kasese.

1.8 Conceptual Framework

Figure 1 shows the conceptual framework in which it is illustrated that quality of final product (output) is dependent on the level of standardizations of inputs; human elements and methods; technology and equipments. This relationship is moderated by the practices undertaken by the manufacturer in ensuring a good quality of the final product.

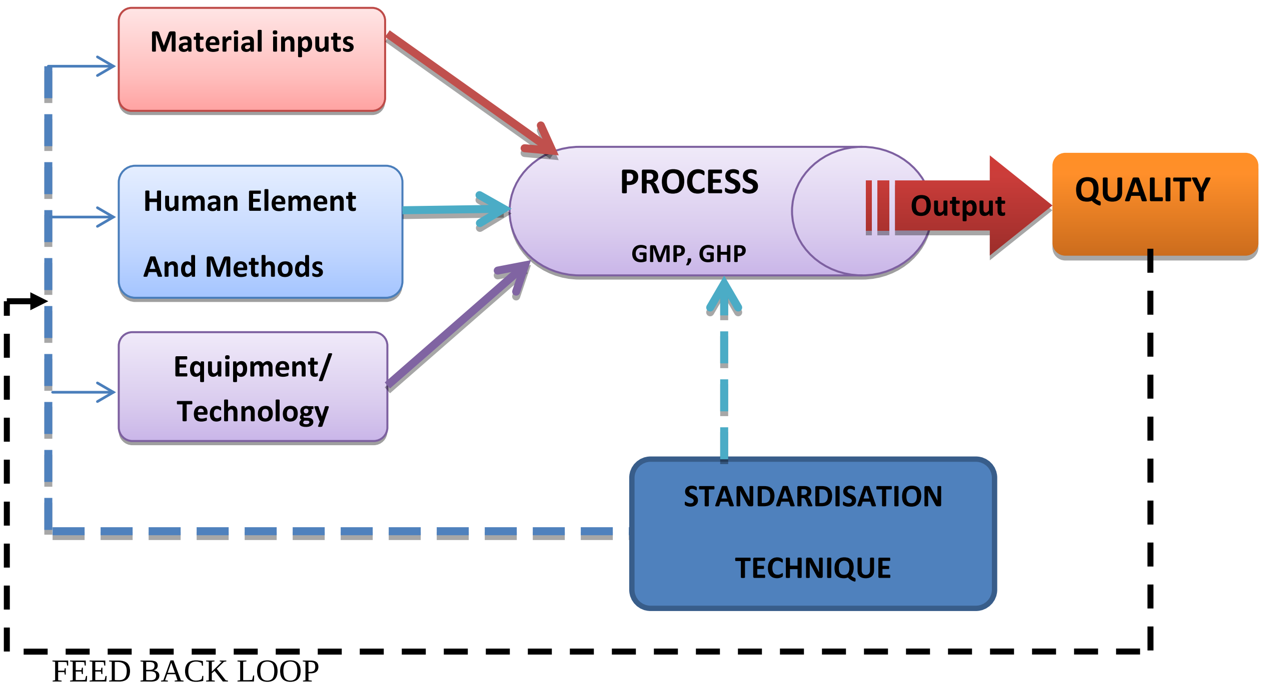

Figure 1: Model showing the relationship between Standardisation and quality of output

1.9 Some Key definitions and terms

The following key definitions help to understand the rest of the presentation:

i. **Standardization** in this study refers to the efforts to comply with technical, specification, test method, definition and procedure standards with a local and global understanding and acceptance

ii. **Input Material** in this study will refer to the materials used in fabricating maize mill components, as well as maize grains for milling.

iii. **Human element** in this study means Labour force or production workers.

iv. **Quality of output** in this study refers to the extent of conformity of the maize flour to the National and regional requirements.

v. **A manufacturing process** in this study is considered to be the use of the three basic elements, i.e. Man and methods, machine, and material to produce a maize mill and also to process maize grains into maize flour by milling.

CHAPTER TWO: LITERATURE REVIEW

2.1 The Concept of Standardization

Standardization refers to the creation and use of guidelines, codes of practice and procedures for the production of uniform, interchangeable components or products of similar characteristics that are of the required qualities. It also refers to the establishment and adoption of guidelines for conduct in a given context. In global marketing, the term is used to describe the simplification of procurement and production to achieve economy.

The concept of standardization originated near the turn of the 19th century. Before that time, products were made individually, with unique, hand-fitted parts. Eli Whitney (1765-1825), inventor of the cotton gin, has been credited with developing the concept of standardization, which he first applied to rifle manufacture in 1797. Instead of handcrafting each weapon, he produced components of uniform size in quantity and then assembled the parts into finished products. The concept saved time and money in production, and allowed for easy repair.

Twentieth century industrialist Henry Ford (1863-1947) was a great proponent and beneficiary of mass production. He organized the Ford Motor Co. around its principles, taking standardization to a high level. His plants manufactured only one type of car at a time. Each auto that came off the production lines was identical, even down to the color—black. Standardization not only saved on production costs, but also benefited consumers, who no longer had to have replacement parts machined by hand.

Ford's success contributed to the proliferation of mass-production principles, including standardization, throughout the developed world. The concept has promoted a dramatic increase in manufacturing productivity, which in turn improved living standards. The concept of standardization has been applied in many ways since.

In general, standardization determines and promulgates criteria to which objects or actions are expected to conform. Standardization for manufacturing may entail the creation of production standards, tolerances, and/or specifications. These can be expressed as formulas, drawings, measurements, or definitions. Standards delineate the limits within which products or components must fall in order to be useful and interchangeable. Components that do not adhere to such limits are "nonstandard" or, more commonly, "rejects." Virtually any aspect of a product or component can be standardized. Quality control and testing are used to measure achievement of standards. The use of such standards promotes clear communication within and among organizations. It can also lower the costs of labor, production, and repair. In the current business climate, businesses have demanded ever-increasing standardization from their suppliers as well as from their own production.

The ISO issued its ISO 9000 series of standards and guidelines governing quality management and assurance in 1987, and issued its ISO 14000 series of standards for environmental management, policies, tools, and systems in 1998. Sets of voluntary standards such as these are known as metastandards, and provide universal guidelines and models for entire industries, groups of industries, and other areas of activity. Metastandards are also often used by public agencies forming industrial, professional, environmental, and technical regulations.

2.2 Standardization Principle

According to the International Standard Organization, for general vocabulary (ISO/IEC Guide 2:2008; EN 45020:1998), a standard is a document which provides, inter alia, requirements, rules, and guidelines, for a process, product or service. These requirements are sometimes complemented by a description of the process, products or services. Standards are the result of a consensus and are approved by a recognized body aiming at achieving the optimum degree of order in a given context. The process of formulating, issuing and implementing standards is called standardization**.**

2.3 Economic Benefits of Standards

According to EIM Business and Policy Research, Fuente & Vries (1995), the European standardization council engaged two economists, Temple and Williams, to explain why standards are important and the effect they have on enterprises, markets and the economy at large. The authors looked at standards, in a broad historical perspective, as a 'public good' and also as an instrument of marketing policy in the life cycle of products. They examined issues behind the provision of standards by the market only and/or by intervention of public authorities. The authors conclude that standards are beneficial to the overall structure of industrialized economies and explain how diverse stakeholders implicitly rely on standards.

While confirming the general belief that standards are necessary and on the whole beneficial, (Temple and Williams, 2006) also point out that the availability of standards may not be commercially advantageous for all companies at all times. They found that Standards are vital in assuring that expectations are met. They contribute to the trust needed for any economy to operate. We connect our laptops easily to computer networks anywhere in the world because there is a nearly universal type of connector used for connecting to an Ethernet network, a so-called RJ-45 plug. Already, since the days of Adam Smith in the eighteenth century, economic development is based on an ever-increasing specialization and division of labour. This implies that production is broken down into a series of linked activities, into what is nowadays called a value chain and obviously standards do a lot to make this possible.

In general, according to Sánchez-Rodríguez, et al (2006) and UNIDO report (2006) standards and standardization play a big role in diminishing trade barriers, promoting interoperability of products, systems and services, promoting common technical understanding, supporting policies of free technical integration and protection of consumers.

2.4 Material Inputs and Quality of Output/Product

Manufacturing processes such as machining and welding are widely used to produce many products, and for some companies, these are the key production features. Products may range from simple to complex; examples include pressure vessels, domestic and agricultural equipment, cranes, bridges, transport vehicles and other items. These processes exert a profound influence on the cost of manufacture and on the quality of the product. It is therefore important to ensure that these processes are carried out in the most effective way and that appropriate control is exercised over all aspects of the operation. In general, ISO 9001 standard has been developed in order to apply a consistent Quality Management System.

However, surface coating, painting, composite manufacture, welding and brazing are considered as “special processes” because the quality of the manufactured product cannot be readily verified by final inspection. In the case of welded products, quality cannot be inspected directly in the product, but has to be built in during fabrication, as even the most extensive and sophisticated non-destructive testing does not improve the quality of the product. For this reason quality management systems alone may be insufficient to provide adequate assurance that these processes have been carried out correctly. Special controls and requirements are usually needed, which require adequate competence control before, during and after operation.

For products to be free from serious problems during production and in service and hence guarantee quality, it is necessary to provide controls from the design phase through material selection, into manufacture and subsequent inspection. For example, poor design may create serious and costly difficulties in the workshop, on site, or in service; incorrect material selection may result in problems, such as cracking in welded joints and hence contamination for those that get in contact with other media such as food, water and beverages. Therefore, to ensure sound and effective manufacturing that guarantees the quality of output, the management needs to understand and appreciate the sources of potential problems and to implement appropriate procedures for their control.

2.5 Input Standardization

Dowlatshashi (1992), in her paper about concurrent engineering, discussed the role of materials standardization as an area of collaboration between the purchasing and design and production functions. Jayaram and Vickery (1998) empirically analyzed the relationship between procurement lead-time and overall performance and identified standardization as an antecedent to procurement lead-time performance. They defined standardization as “the use of standard procedures, materials, parts, and/or processes in designing and manufacturing a product” (Jayaram and Vickery, 1998)

Using the same definition of standardization as in Jayaram and Vickery (1998), Jayaram et al. (2000) empirically examined the direct and complementary effects of information system infrastructure and process improvements strategies on several time-based performance indicators. They found out that standardization was the most influential enabler affecting delivery speed, responsiveness to a customer's performance in terms of customer expectations especially product attributes.

According to this result, it seems that standardization of procedures, parts, and processes has a positive influence not only on being able to deliver on time but also on meeting customer needs effectively, which in turn is likely to have a positive effect on business performance. Additional literature has shown that purchasing managers can save money by developing standard purchasing procedures that would enable them to spend more valuable time on "non-routine" activities (Bennett, 1982) as sited by Sánchez-Rodríguez, et al (2006), such as cost/value analysis, supplier development, and concurrent engineering.

Standardization of materials/components and standardization of procedures has been considered both by practitioners and academics as improving business performance. However, the arguments supporting these relationships have been based on sketchy evidence (such as Avery, 1998; Porter, 2002), case studies (Handfield, 1993), and empirical studies with limited samples. Consequently, there is a need for more comprehensive empirical evidence that assesses the benefits associated with materials standardization and standardization procedures and more specifically, their impact on business performance particularly their contribution to improving product quality in grain milling industry in Uganda.

2.6 Manufacturing and Hygiene Practices in Food Manufacturing

These are all practices regarding the conditions and measures necessary to ensure the safety and suitability of food at all stages of the food chain. They are standardised manufacturing process controls that include supplier control, specifications, calibrations of equipment, traceability, equipment designs where conditions for food safety can be achieved, maintained and monitored, storage conditions and control of operations (Ropkins and Beck, (2000))

A study by Lewis et al. (2005) on the evidence of suspected risks micro-biological issues from such practices was conducted in Kenya and it was established that consumers were actually exposed to dangerous mycotoxins in maize products These mycotoxins are disease causing in nature produced by moulds which grow on the product mostly resulting from inappropriate storage conditions specifically damp conditions.

This suggested at all times, maize products should be subjected to stiff quality control and handling practices from the farm gate through to the market shelf. The above study on mycotoxins agree to the fact that there is a requirement of the hazard analysis and critical control point (HACCP) in the SMEs sector of graining milling in Uganda; HACCP is a scientific and systematic manner for assuring food safety (Nguyen et al., 2004), which is an internationally accepted system that identifies, evaluates and controls hazards which are significant for food safety through good manufacturing practices and good hygiene practices.

2.7 Human Element and Methods

The effectiveness of the Hazard Analysis and Critical Control Point system will also rely upon management and employees having the appropriate knowledge and skills (CAC, 2001). Baines and Manning (2004) also stated that a food safety management system is as effective as the skills and knowledge of the team developing and implementing it are adequately developed.

Griffith (2000) stated that one of the major problems regarding the effective implementation of HACCP is that employees in food industry often lack interest and they often have a negative attitude toward the food safety programmes. Chow-Chua et al. (2003) emphasized a failure to exercise adequate control over documents, a failure to define responsibility and authority for personnel, and inadequate training will affect the quality of the final product.

Ehiri et al. (1995) conducted an empirical study in the food safety management area analyzing the Hazard Analysis and Critical Control Point (HACCP) in SMEs. They found that factors such as insufficient knowledge and resources are obstacles that should be overcome for the effective implementation of HACCP. Small and/or less developed businesses are not always having the resources and the necessary expertise on site for the development and implementation of an effective HACCP plan (CAC, 2001). Also Taylor (2001) and Walker et al. (2003) identified barriers of the effective implementation of Hazard Analysis and Critical Control Point in small businesses such as the lack of expertise, absence of legal requirements and financial constraints.
Christos et al. (2007) also recognized that the practical application of HACCP in SMEs can be hindered by factors such as the lack of time, expertise, training, motivation, commitment and funding.

Mortimore and Wallace (1996) concluded that a major problem, particularly in small businesses, is the ability to gain access to appropriate expertise. Thus, they suggested the Hazard Analysis and Critical Control Point system to be developed, verified and maintained by experts. Yapp and

Fairman (2006) also identified the barriers affecting food safety compliance within SMEs such as the time and money, lack of trust in food safety legislation, lack of motivation in dealing with food safety legislation and the lack of knowledge and understanding of the system.

2.8 Technology /Machine Standardisation

A hammer mill consists of a large cylinder with a horizontal shaft that drives a rotor with several rows of free-swinging hammers. In their operation, the hammers rotate inside a perforated metal screen through which the flour is drawn as shown below.

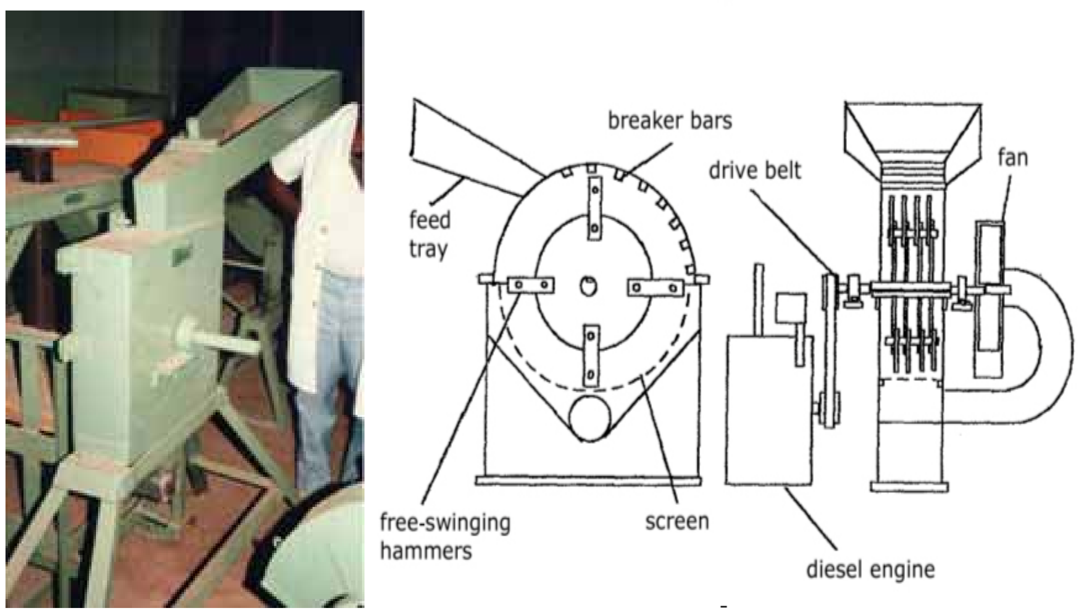

Figure 2. Locally made hammer mill and its typical construction

The hammers are driven by two or four sets of V section belts between the engine and the mill. The hammers spin at high speed, usually between 2 000 and 4 000 revolutions per minute to achieve a hammer-tip speed of about 60 m/second. The speed of the mill has to be matched to the size of the mill as a small mill needs to run at higher revolutions than does a larger mill.

Hammer mills work well for grains with a minimum moisture content of 12 percent (Nguyen et al., 2004). However, drier crops are very dusty when ground and can create health problems for mill operators. In Uganda, grain can be sun-dried to have a moisture content of 12 percent or less in dry regions.

Therefore, Standardization focused to engineering requirements of the above, such as properties of materials, fits and tolerances, and drafting practices; or on product standards, which detail the attributes of manufactured items and are embodied in formulas, descriptions, drawings, or models is a key towards achievement of better performance of the final product/part component and hence overall process maturity.

McCormack et al., (2009), argues that the concept of process maturity is becoming increasingly important as firms adopt a process view of the organization. They also continue to argue that owing to constantly changing business requirements and challenges such as decreasing product lifecycle, international competition and increasing cost pressure, companies are forced to improve their processes in order to keep pace with market requirements, with respect to safety, quality and cost of products. Elzinga et al., (1995), goes on to say that the quality of an enterprise’s products and services is a direct reflection of its ability to improve the processes via production process management (PPM). This is implies that process technology and its quality are key to achieve the market requirements.

2.9 Other Studies Conducted on the Ugandan Market

A study was conducted by Kaaya and Warren (2005) on fungi and aflatoxins in maize grains in five districts of Uganda (Kampala, Mpigi, Mubende, Luwero and Mukono) was conducted. The samples were obtained from shops and markets and were monitored for five months. Thirty six fungal genera represented by 83 species were isolated and Aspergillus flavus/paristicus was among the most frequent species. Aflatoxin levels ranged from 0 – 50 parts per billion during the storage period with seven out of eight samples contaminated by aflatoxin B group. More than 30% of the samples had their aflatoxin levels above 20 ppb while 50% contained up to 10 ppb.. The high aflatoxin levels were associated with high moisture content, in which 48% of the samples had moisture levels above 14%.

More studies were conducted by Wacker and Treleven, (1999) in which both baby foods imported (Heinz mixed cereal, Cerelac, Cornflakes, Wheetabix and Porridge oats) and locally manufactured (Baby soya, Kayebe, Mwebaza rice porridge, Jacinta millet and Mukuza brands) in Uganda were investigated for natural contamination by various types of fungi and aflatoxins. The samples in each category were purchased from displayed items in shops and supermarkets in five towns (Kampala, Jinja, Mbarara, Masaka and Mbale) and had similar expiry date. They were stored and monitored on a monthly basis for six months. Imported foods had less fungal contamination than locally manufactured foods and for both categories Aspergillus flavus was among the predominant species. Total aflatoxin analysis showed that all locally manufactured foods were contaminated, with some in the range of 20 – 50 ppb. Kayebe with maize, soybean and fish as ingredients was the most heavily contaminated while the least contaminated was Jacinta, composed of whole millet. Cornflakes were the most aflatoxin-contaminated imported food with 10 – 20 ppb range levels, while no aflatoxins were detected in Cerelac. It was recommended that manufacturers of baby foods should avoid use of already contaminated ingredients.

2.10 Standardization Relation with Output Quality

Terrana, (1994), noted Global quality is becoming a major concern for the medical device and diagnostics industry. That, whereas Good Manufacturing Practice (GMP) regulations aim to guarantee that effective and safe products are produced, the overall quality of a device depends on the quality of its components, which are frequently not manufactured by the manufacturer of the final product. The quality of components, such as reagents can be controlled by setting acceptance criteria, but the standardization of reagents would result in improved quality of the final product. The study briefly reviewed the role of GMP regulations with regard to product quality and provided examples of how the application of modern technologies can, and in some cases has, contributed to the realization of standardizable reagents with in the pharmaceutical industry.

UNIDO report (2006) stresses that once the design and planning for manufacturing have been completed, the manufacturing can begin. And if the planning has been well done, there should not be too many problems. The report goes ahead to highlight that during manufacturing, some common factors that can affect the quality of the product in the system include machine and set-ups, operators, materials and components. This imply that, in all manufacturing and specifically in the agro-processing, issues of raw material design, planning and manufacturing set up should not be under estimated as these directly impact on process quality as well as process output in terms of machines from fabricators as well as the final agro processed product. .

2.11 Factors that Affect Standardization

'Standardization' refers to a process resulting from a consensus based on scientific findings, obtained by parties most affected by the process. It may refer to a manufacturing process, or a method of test, calibration of equipment, operational procedures or any set of conditions required for a purpose. It deals with formulating and applying rules for an orderly approach to a specific activity for the benefit of, and with the cooperation of, all concerned. It is different from, and should not be confused with, 'standards' but it is key if the process is to give repeated results based on the set codes and standards. Therefore factors that affect standardization are those that cut short the process of application of standards or agreed methods and procedures.

2.12 Conclusions from the Literature Reviewed

A common criticism on Standardization is that it is a high investment and resource intensive program that only big companies can afford (Caulcutt, 2001). However, since the complications associated with a small company or agro-processing SME in terms of the size of the firm, nature of projects undertaken, team building, training needs, etc. are less compared to a large organization, it can be argued that implementation of Standardizations would be easier in SMEs, keeping aside the investment factor. Notwithstanding, few reports have proposed success factors, guidelines, tools & techniques, possible impeding factors to adopt Standardizations in an SME context (Jiju et al., 2005, Wessel and Burcher, (2004)).

A study by Jiju et al. (2005) cites two important reasons, among many, as to why most manufacturing SMEs in UK have not undertaken performance projects. These reasons are unawareness about standardizations and lack of enough resources. However, with the advent of information technology, awareness about the recent process improvement strategies like Six Sigma and standardizations are being created among many firms. Another study by Jiju et al., (2005) on a survey of selected SMEs in UK has highlighted the suitable tools & techniques in practice in SMEs that have adopted such practices as Six Sigma and standardizations. Wessel and Burcher, (2004) have examined a sample of German SMEs and suggested modifying these approaches to be applicable and valuable in an SME environment. Another study (Kifayah and Douglas, 2008) gives an overview of the implementation frameworks of Six Sigma and Standardization but with the context of large organizations.

Relating to the Ishikawa – cause effect principle on quality and as elaborated in the UNIDO report (2006), it can be realized that the quality of any process output is affected by factors of internal and external process nature hence a need to address them differently. Also from the review and related visits to few SMEs, it can be concluded that SMEs in Uganda have not yet been tapped for the application Standardization concept to improve their quality, performance, productivity, and competitiveness for they contribute significantly to the economy of the nation. Also, large organizations that have adopted Standardization and hence certification are mandating their supply base; many of them are SMEs, to adapt such certifications or standardization methodologies. Thus, for survival and growth, Ugandan SMEs need to improve their businesses using strategies such as System and Product standardizations.

CHAPTER THREE: METHODOLOGY

3.1 Introduction

This chapter presents the approaches and techniques the researcher employed to investigate the research problem. For descriptive data of this study, a case study approach was used with the target population being the agro-processing metal fabricators and grain millers in Uganda.

3.2 Sampling Design

A random approach method of sampling into the clustered members was used. In this approach, members considered for this study were clustered according to the regions i.e. Kampala cluster, Jinja Cluster and Kasese/Fort Cluster. A simple random sampling was performed in these clusters and the cluster population was partitioned into sub groups in order to have all the members get the same probability to be selected.

3.3 Sampling Size

The sample size of 54 SMEs of which 45 were grain millers and 9 metal fabricators were targeted of which, 50% were to be from Kampala Cluster because this is where most of the fabrication and milling takes place due to market accessibility as Kampala is taken as a center of distribution. The study also targeted 30% from Jinja/Iganga Cluster because according to Private sector foundation – Uganda (2002), south eastern part of Uganda i.e. Busoga region produces the highest followed by Eastern Highlands of Sironko, Mbale, Kapchorwa and followed by the Lake Albert Crescent hence about 20% of the sample was be from Kasese/Fort Cluster.

However, a total of 45 SMEs were accessed and considered in this study of which 40 were grain millers and 5 metal fabricators.

3.4 Data Collection

The primary data from the study sample was collected using a checklist – observation method/technique. The checklist was designed to cater for all factors that affect or have an influence on standardization based on the Good Manufacturing Practices, (GMP), Good Hygienic Practices, (GHP), Hazard Analysis Critical Control Point (HACCP) and ISO 9001 with specific attention to human and work methods for both fabricators and grain millers. (Appendix 1)

The researcher participated in some production activities where it was possible and where not possible for example most of the cases there would be too much fluff or dust in the production area, the researcher just observed the operations with some simple inquiries or interviews to participants with a view of obtaining direct information while filling the checklist and making comments. Also, open ended questions were used to obtain information from purposively selected experts in the field of quality and standardisation.

3.4.1 Experimental Tests on the Maize Flour/Seeds (Samples)

After carrying out the survey using a checklist, it was noted that the challenges facing the maize milling sector were nearly similar at all stages during the process. This compelled the researcher to use a market sampling approach to assess the product quality on market (specifically Kalerwe and Owino) Markets in Kampala. Therefore, product samples were got from the market putting into consideration the different maize mills / manufacturers based on the packaging and labeling information on the flour bags and packages.

Many samples were picked from the market and considered of which thirteen samples of one kilogram each, including a control sample of maize grains; which was a composite sample of small samples from different sources and also a sample of maize flour from a UNBS certified company were studied. The samples were coded for traceability and subjected to standard test methods for conformity based on Uganda Standard 370 (Specification for Maize flour), and USEAS 44:2011 (Milled Maize Corn Products – Specifications) in the Uganda National Bureau of Standards Chemistry laboratory for iron content as well as the objectionable matter.

3.4.2 Determination of the Existence of Extraneous / Objectionable Matter in Maize flour

A magnet was used by passing it around and within the whole flour sample to determine if any material gets attracted to it. This was verified physically using sense of sight with eyes but for confirmatory purposes, a magnifying glass was used.

3.4.3 Determination of Amount of Iron in Maize flour

This section outlines the procedure that was used in the determination of iron content in food/maize flour by flame atomic absorption spectrometry. The organic matter of the homogenized sample was removed by dry ashing technique, the mineral matter was dissolved in an acid (20% HCL) and the Iron determined by Atomic Absorption Spectrometry (AAS). The acidified filtrate of the test portion was aspirated into the flame of an atomic absorption spectrometer.

i. Equipment and Reagents

All the reagents (for example Nitric Acid, Hydrochloride acid, standard solution of iron) were of recognized analytical grade so that their use does not affect the accuracy of the determination. The water used was deionized water or distilled water containing no detectable concentration of the metals being determined when analyzed by a blank test. Some of the other equipment and reagents used are shown in Table 1:

Table 1: Table of some of the Equipment and Reagents used during analysis

S/N	Equipment	Function in the experiment
01	Atomic Absorption Spectrophotometer	Analyzing the samples for the total amount of iron
02	Magnetic rods	For creation of magnetic field to attract metallic elements of iron
03	Analytical balance	Determines the mass of something, such as a dry chemical.
04	Laboratory blender	For homogenizing the test sample
05	Volumetric flasks (e.g.10, 25,50,100mls)	To make solutions of known concentrations of iron (standard samples)
06	Pipettes (10-100µL, 1, 2, 5 and 10mls capacity)	Transfers relatively small amounts of liquid/sample
07	Beakers	For containing a chemical reaction, measuring liquids
08	Electric Muffle furnace	For ashing the sample
09	Platinum or glass crucibles	Holds small amounts of chemicals for heating at high temperatures
10	Conical Flasks	Used for general measuring
11	Funnels,	Transferring liquids to smaller narrow necked containers
12	Hydrochloric Acid – AR (Analytical Reagent)	For preparation of 20%HCL solution
13	Standard volumetric flasks	For preparation of samples
14	Nitric Acid 1%	For cleaning
15	Concentrated, AR	For preparation of standard samples used to prepare calibration curves
16	Deionized water with conductivity less than 2µS/cm	For preparation of standard samples
17	Iron standard solution	For preparation of standard samples

ii. Safety aspect during the experiment

In undertaking these experiments, a lot of precaution was taken while handling reagents, chemicals and others consumables. Laboratory coats, safety glasses for eye protection, chemical resistant gloves while handling the concentrated metal standards were used.

iii. Interferences:

The following interferences were considered during the experiment:

a) Chemical interference: Caused by failure of the atoms to be absorbed from the flame. This commonly occurred when the flame was not sufficiently hot to dissociate the molecules. This interference was always eliminated by separating the metal from the interfering material. Complexing agents were also used to eliminate the interference although they were primarily used to increase the sensitivity of the analysis.

b) Ionization interferences: These were encountered when the flame temperature would be sufficiently high to generate the removal of an electron from a neutral atom, giving a positively charged ion. This interference whenever it appeared was generally controlled by addition of both the standard and sample solutions, of a large excess (1000mg/l) of an easily ionized element such as Potassium and Lithium.

c) Spectral interference: This would occur when absorbing wavelength of an element present in a sample but not being determined falls within the width of the absorption line of the element of interest (iron in this case). The results of the determination would then be erroneously high due to the contribution of the interfering element to the atomic absorption signal.

3.4.4 The Procedure used for Removal of Organic matter using Dry Ashing Method:

A portion of about 1-10 g of the maize flour sample was weighed and placed into a crucible then the heated onto a hot plate till all the organic matter was destroyed with the sample turning black. Then after heating with the hot plate, the crucible was placed in an electric muffle furnace where the now black sample was turned into ash by evaporating the black matter hence the sample turned whitish/grayish or brownish. Then 10 – 20 mls of 20% Hydrochloric acid was added to make a solution ready for analysis. This is a standard procedure for determining amount of an element in foods by AAS as elaborated by Feinberg M. and Ducauze C., (1980) and as used by UNBS Chemistry Laboratory.

3.4.5 Blank Test / Control Sample

A blank test was carried out in parallel with the standard samples determination, by the same procedure, using the same quantities of reagents as in the sampling and determination but replacing the test portion with deionized water.

3.4.6 Preparation of the Sets of Calibration Solution

Take a weight of a given sample and add a known amount pure iron to give a required known concentration, say, 0.2ppm (spiking or fortifying the sample). Examples of Standard values for preparation of calibrated solutions are indicated in the Table 2

Table 2: Preparation of calibration solution

Analyte	Concentration, ppm	Vol. taken, ml	Vol. made up, ml	Final concentration, ppm
Iron	1000	0.200	50	4.0
	1000	0.100	50	2.0
	1000	0.050	50	1.0
	4.0	1.250	50	0.1
	4.0	2.500	50	0.2

3.4.7 Calibration and Determination

The specially made control samples with known concentrations are analyzed for absorbance of iron using the spectrometer set up according to the manufacturer's instructions by aspirating a calibration solution of iron. The values of absorbance from the known concentrations were given by the spectrometer and read from the computer display connected to the spectrometer.

A graph was generated automatically from results with absorbance read from the computer display against metal (iron) concentration in ppm, of the calibration solutions.

Test samples (of interest) with unknown iron concentrations were also ran the same way as the standard samples and the absorbance of iron was automatically measured and displayed on the screen. Then, the concentration of iron in the samples is then obtained by extrapolation. In case of situations where the results are beyond the scale set for the standard samples, a dilution factor was considered to bring the results into range and was considered during the calculation.

3.4.8 Computation of Metal Concentration

By reference to the calibration graph, the concentration of the iron metal is determined corresponding to the absorbances of the test Portion and the blank.

Concentration of Iron, mg/kg = $x = \frac{Cs - Cb}{M} V * D.F$

Where;

Cs = Concentration (mg/L) of element in the sample solution

Cb = Concentration (mg/L) of element in the blank solution

M = Weight of the sample taken in grams

D.F = Dilution factor, if any

V = Final Volume made up in ml

3.4.9 Quality Assurance during the Experiment

All the glassware would be thoroughly rinsed with 1% nitric acid followed by deionized water solution prior to use as standard samples can get easily contaminated. Proper care was taken while preparing the standard samples.

3.5 Analysis of Data

Data analysis being a process of bringing order, structure and meaning to the mass of data collected, in this work, involved inspecting, cleaning, transforming and modeling data with a goal of highlighting useful information suggesting conclusions to support decision making in the standardization application in Maize milling SMEs.

Two sets of data were obtained in this study. That is, data obtained from the checklist used directly in the SMEs operations and the data obtained from testing the quality of maize and flour samples in the laboratory. This checklist was carefully developed from the requirements of Hygiene in the food and drink manufacturing industry — Code of Practice which was developed through adoption of Irish Standard IS 3219: 1990 Code of Practice for Hygiene in the Food and Drink Manufacturing Industry as an East African Standard done by the East African Standards Committee in 2001.

A four point Likert scale ranging from 0 – not applied, 1 – Minimal levels of application, 2 – Average levels of application, 3 – Passes Requirement as shown in Table 3.

Table 3: The Four Point Likert Scale

Code	Level	Interpretation
0	Not applied	Means that at the time of the study visit, there was no evidence for consideration of implementation of the Hygiene and code of practice for food manufacturing industry standard of the given factor of investigation (as stated on the checklist) in the visited Enterprise.
1	Minimal levels of Application	Means that at the time of the study visit, there were slight and negligible traces of evidence that there is some consideration of application of the food manufacturing hygiene and code of practice standard requirement of a given particular factor of investigation (as stated in the checklist) in the given Enterprise.
2	Average levels	Means that at the time of the study visit of the given Enterprises, there was reasonable but inconsistent level in fulfilling the standard requirement but the practice could tend towards acceptable/adequate levels if something is done(or if consistence is sustained).
3	Passes Requirement	Means that a given enterprise adequately fulfilled the requirements of Hygiene in the food and drink manufacturing industry Code of Practice to an acceptable level at the time of visit.

The data obtained by a checklist through simple participation, observation and related interviews was categorized and scored. For Quantitative data obtained from the laboratory tests, descriptive statistics were generated using SPSS and such included measures of central tendency (mean, median, mode, or frequencies) and measures of variability (range, standard deviation or variance) which helped to model or bring order to the research findings. The orderly arranged data was then presented in form of frequencies, histograms, bar charts tables and graphs with a view of generating meaningful conclusions from the research objectives.

CHAPTER FOUR PRESENTATION OF THE STUDY FINDINGS

4.1 Introduction

This chapter presents the findings of the study on the standardization practices in indigenous maize processing SMEs, the quality of flour output and the factors that affect standardization Practices. The chapter is divided into three sections:

- The first section presents the study findings on the level/degree of standardisation in maize milling SMEs.
- The second section presents the experimental findings of the study on the quality of output from the different maize mills.
- The third section presents the study findings on the factors that affect/inhibit standardization implementation in maize processing based on open ended questions and discussions with the experts in relevant disciplines.

4.2. Levels of Standardization

The first objective of the study was to assess the level of standardization among flour mills in Uganda. In assessing the level of standardization, the study considered the level of application of standards in the input material, human elements and methods, Good Hygiene Practices (GHP), Good Manufacturing Practices (GMP) and equipment in maize processing.

4.2.1 Input Material Standardisation

Table 4 presents the findings on the degree of standardisation in relation to input materials.

Table 4: Level of Standardisation of input materials

Factor of consideration in Material Inputs	Level of Standardisation application in enterprises.									
	Not applied		Minimal application		Average levels of application		Pass the requirement		Total number, N=45	
	F	%	F	%	F	%	F	%	F	%
1. Are raw materials inspected before they are stored for subsequent use?	16	35.6	27	60.0	2	4.4			45	100
2. Are there specifications for raw materials?	6	13.3	39	86.7					45	100
3. Are the specifications for raw materials documented?	36	80.0	9	20.0					45	100
4. Are there acceptance criteria for raw materials (e.g., grains will be accepted only if the moisture content is less than 14% - or non-conforming grain may be accepted but at reduced price).	8	17.8	33	73.3	4	8.9			45	100
5. Are the acceptance criteria strictly being followed?	18	40.0	27	60					45	100
6. Are suppliers premises inspected to check on quality controls in place before accepting them to supply?	31	68.9	13	28.9	1	2.2		-	45	100
7. Are the acceptance limits set by the company at raw material inspection point are strictly being followed?	11	24.4	34	75.6				-	45	100
8. Is there an acceptance criterion for spare components? E.g. steel plates, screens, hammer carriers, hoppers, hammers, etc.	21	46.7	24	53.3					45	100
9. Is there an acceptance criterion for your machine assemblies? E.g. surface finishes.	20	44.4	25	55.6					45	100
10. Is there a method you use to check and accept materials such as welding rods, paint etc. used in your production?	38	84.4	7	15.6					45	100
11. Is there a procedure in place for the segregation and handling of all items from input reception final product to prevent damage and deterioration?	4	8.9	40	88.9	1	2.2			45	100
12. Suppliers – Is each supplier of your raw material or components inspected for proper product controls before supply?	27	60.0	15	33.3	3	6.7			45	100
13. Are finished products stored and handled in conditions which will avoid contamination and deterioration?	12	26.7	25	55.6	8	17.8			45	100

N = Total Number of SMEs

F = Proportion of recurrence or Frequency

Using SPSS software, the above data is summarized into the Figure 3.

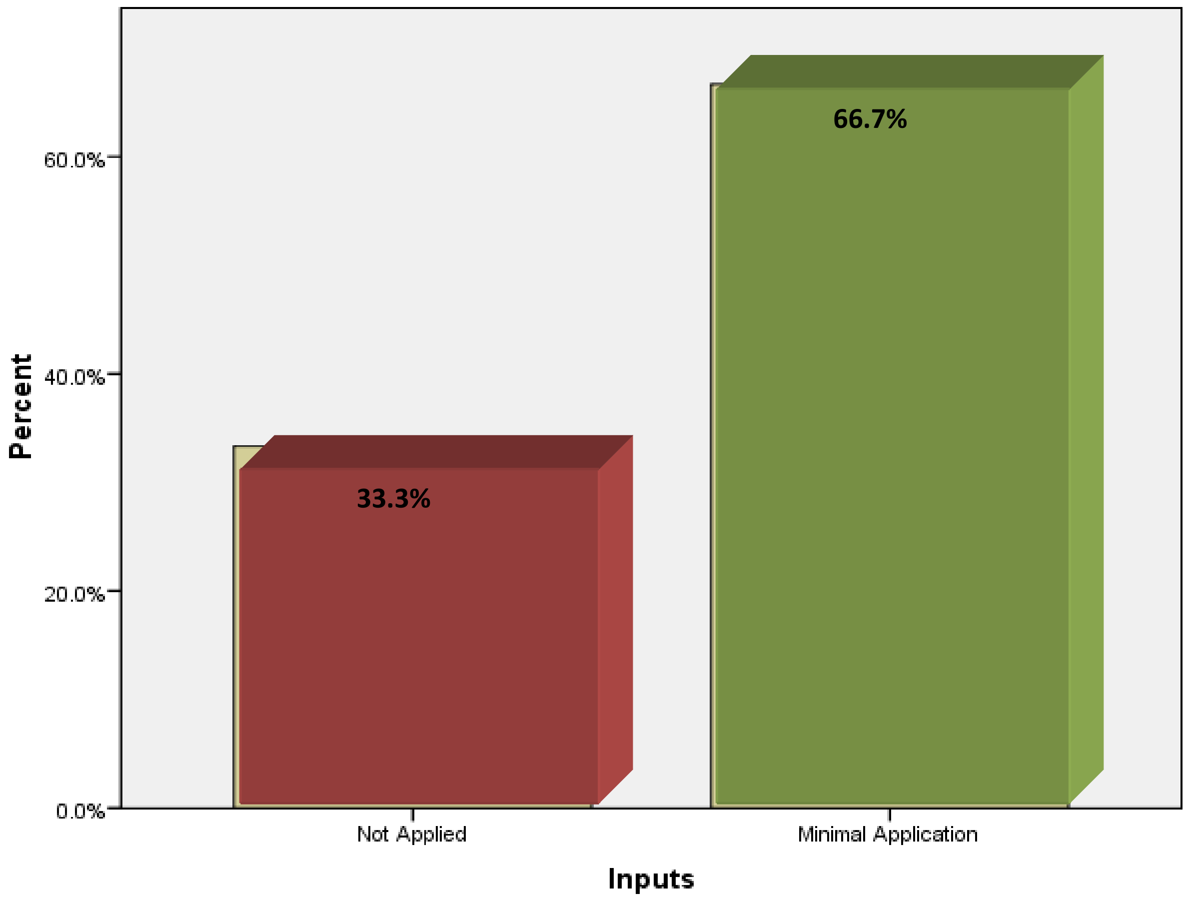

Figure 3: Summary of the level of standardisation of the input factors

Figure 3 gives an indication that the biggest proportion (7 in every 10) of the maize processing SMEs in Uganda applied the input material standard expectations at the minimum level and approximately a quarter of these SMEs do not applying any form of standardisation at the stage of input material consideration and handling. The prevailing minimal and none application of standardization among maize processers contravenes the nationally and internationally recommended practices and hence potentially affects the quality of final product and increases the likelihood of the final consumers facing adverse health hazards.

To further understand the relationship between the different factors of standardisation at material inputs, and using SPSS software, a cross tabulation of selected factors was considered to compare the relationship between them. Across tabulation of the existence of specifications and their following revealed insightful findings. Table 5 shows cross tabulation of acceptance criteria for raw material and if it was followed.

Table 5: Results of cross tabulation of existence of specifications of raw materials and whether they are followed

			Are the acceptance criteria strictly being followed?		Total
			Not Applied	Minimal Application	
Are there acceptance criteria for raw materials	Not Applied	Count	3	5	8
		% of Total	6.7%	11.1%	17.8%
	Minimal Application	Count	15	18	33
		% of Total	33.3%	40.0%	73.3%
	Average Application	Count	0	4	4
		% of Total	.0%	8.9%	8.9%
Total		Count	18	27	45
		% of Total	40.0%	60.0%	100.0%

Table 5 above shows that although 8.9% of the maize processing SMEs were rated to apply an acceptance criteria for their raw materials at an average level, the implementation of the said acceptance criteria was rated minimal. This finding suggested that although an SME was inclined to developing acceptance criteria for raw materials, it was likely to neglect the said criteria of the food manufacturing hygiene and code of practice standard requirement at the implementation level.

The minimal application of input related elements of standardization in the manufacturing of locally fabricated maize mills and local maize processors puts to question if the final maize flour consumed on the local markets will be safe and free from objectionable material or contaminants.

4.2.2 Human Element and Methods Standardisation

The second factor of standardization that this study investigated was the human element and methods as a gearing factor that determines the success of the implementation of the standards.

Table 6 presents the findings of the level of standardisation in relation to human elements and methods.

Table 6: Level of standardization on human elements and methods

Human Elements and methods	Level of Standardisation application in enterprises.									
	Not applied		*Minimal levels of application*		*Average levels of application*		*Passes requirement*		*Total Number =45*	
	F	%	F	%	F	%	F	%	F	%
1. Is your staff having enough skills to identify good/acceptable raw materials from bad/unacceptable raw material inputs that can affect the output product?	11	24.4	33	73.3	1	2.2			45	100
2. Are there any training organized for your technical team in regard to quality requirement of the process and output?	7	15.6	37	82.2	1	2.2			45	100
3. Is your technical team experienced to carry out simple maintenance to guarantee process and product quality consistent?	5	11.1	39	86.7	1	2.2			45	100
4. Are there procedures followed while doing process maintenance checks?	10	22.2	35	77.8					45	100
5. Are there work instructions for your technical team at key quality check points?	28	62.2	15	33.3	2	4.4			45	100

Using SPSS software, the data above on human element and methods on standardization is summarized in Figure 4.

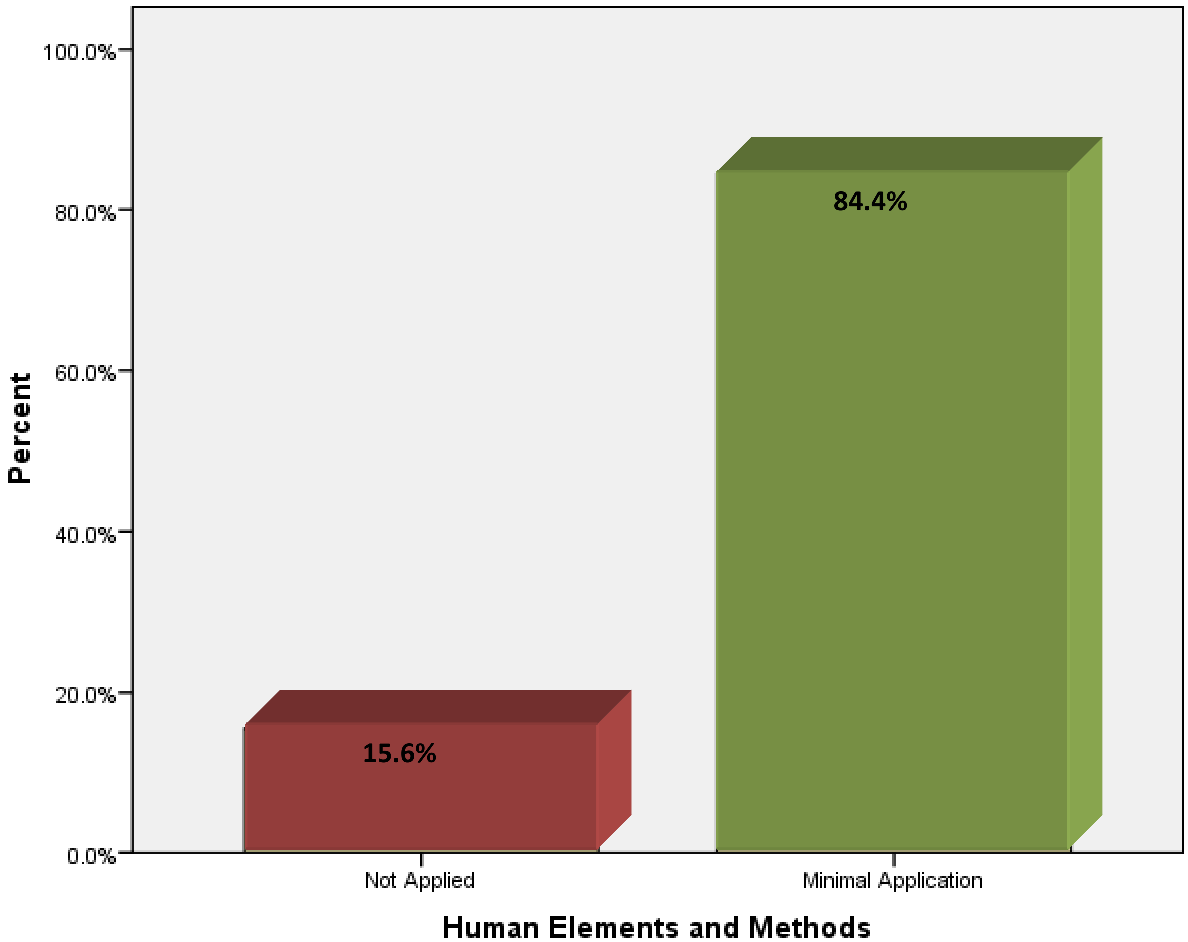

Figure 4: Summary of the degree of Standardisation of the human element and methods factor

Figure 4 gives an indication that the biggest proportion of the maize processing SMEs (8 in every 10) in Uganda applies the human element and methods standard expectation at the minimum level while 2 in every 10 did not apply any form of human factors standardisation requirements of Hygiene in the food and drink manufacturing industry Code of Practice.

The multiplier effect of the minimal applications of human factor standardisation expectations was that other elements of standardisation such as input materials, hygiene and manufacturing practices, machine maintenance and others were likely to be compromised since they depend on the human element for their adequate implementation.

A cross tabulation of selected factors in the human element and methods was performed to compare the relationship between them. The results of the cross tabs of human element and methods factors are presented in Table 7.

Table 7: A Cross Tabulation Human Element and Methods

			Are trainings organized for technical team in regard to quality requirement of the process and output			**Total**
			Not Applied	Minimal Application	Average Application	
Staff have adequate skills to identify good/acceptable raw materials	Not Applied	Count	0	11	0	11
		% of Total	.0%	24.4%	.0%	24.4%
	Minimal Application	Count	7	26	0	33
		% of Total	15.6%	57.8%	.0%	73.3%
	Average Application	Count	0	0	1	1
		% of Total	.0%	.0%	2.2%	2.2%
Total		Count	7	37	1	45
		% of Total	15.6%	82.2%	2.2%	100.0%

Table 7 above shows that majority of 82.2% of the maize processing SMEs were rated to apply Technical team training on quality requirement of the process and output at a minimal level, while 73.3% of the SMEs technical personnel skills to identify good/acceptable raw materials were rate minimal. This relationship suggested that although an SME was inclined to train its technical personnel in quality requirements, 7 in every 10 SMEs technical personnel did not possess the required food manufacturing hygiene and code of practice standard skills.

This study inferred that the minimal trainings given to employees were not effective to meet the objective of identifying acceptable input materials and this could affect the quality of the final food consumed in the product. This also puts to question the quality training content and approaches used by the SMEs.

The study compared some input and Human factors from the different elements of standardisation to see if there was meaningful relationship between them. For example, a comparison of the documentation factor of input material element of standardisation and issuing work instructions at key quality checks points factor from the human element of standardisation and the results as shown below in Table 8.

Table 8: Distribution of documentation and instructions on quality.

			Are the specifications for raw materials documented?		Total
			Not Applied	Minimal Application	
Are there work instructions for your technical team at key quality check points?	Not Applied	Count	24	4	28
		% of Total	53.3%	8.9%	62.2%
	Minimal Application	Count	10	5	15
		% of Total	22.2%	11.1%	33.3%
	Average Application	Count	2	0	2
		% of Total	4.4%	.0%	4.4%
Total		Count	36	9	45
		% of Total	80.0%	20.0%	100.0%

Table 8 indicates that there was no objective evidence at all of documenting specifications for input materials among majority of 80% of the SMEs. Among these, majority of 62.2% of the SMEs did not apply the work instructions for technical team at key quality check points at all. This finding suggested that 8 in every 10 machine fabricators and millers did not document their specifications which constrained work instruction at key quality check points. These input and human factor inadequacies ultimately compromise the quality of final maize flour consumed on the local market.

4.2.3 Good Manufacturing Practices aspect of standardisation

The third factor of standardization that this study investigated was the manufacturing practices in relation to standardization as a factor that determines the process efficiency. The findings of this factor are presented in Table 9.

Table 9: Level of standardization with GMP

GMP	Level of Standardisation application in enterprises									
	Not applied		*Minimal Levels of application*		*Average levels of application*		*Passes standards Requirement*		*Total Number*	
	F	%	F	%	F	%	F	%	F	%
1. Is your technical team aware of good manufacturing practices in fabrication and/or milling processes?	28	62.2	17	37.8					45	100
2. Are there internal standards in regard to manufacturing processes? I.e. specific codes of practice in the process.	19	42.2	23	51.1	3	6.7			45	100
3. Are there external standards in use in regard to manufacturing processes at your premises?	24	53.3	18	40	3	6.7			45	100
4. Are there any tests carried out internally for conformity analysis of the raw materials?	23	51.1	19	42.2	3	6.6			45	100
5. Are there any tests carried out externally on your product?	25	55.6	17	37.8	3	6.7			45	100
6. Are key quality parameters at each inspection point clearly known by the personnel in charge?	20	44.4	25	55.5					45	100
7. Is the frequency of inspection and testing at each inspection point understood and implemented?	18	40.0	37	60					45	100

This data on the level of GMP Standardisation within the maize milling sector is summarized in Figure 5

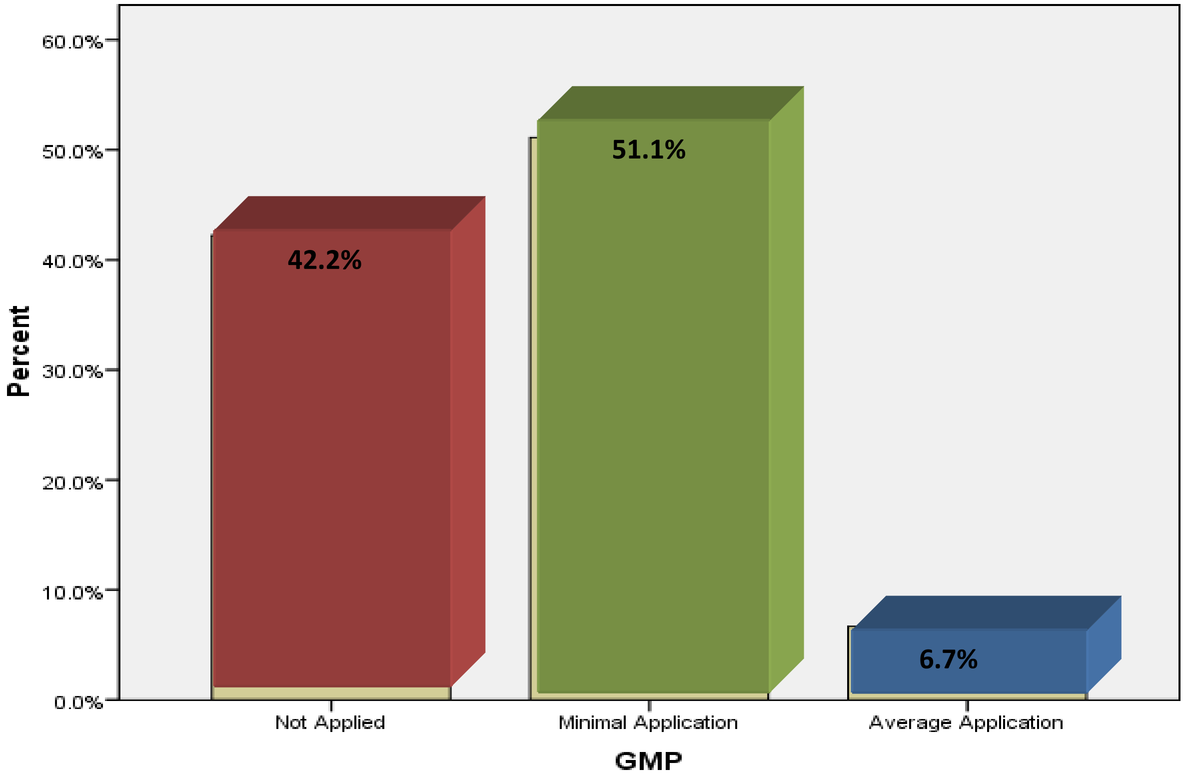

Figure 5: Summary of the degree of standardisation with the GMP

Figure 5 shows that about half of the maize processing SMEs (5 in every 10) apply the GMP standard expectation at the minimum level, 4 in every 10 did not apply the GMP factors standardisation requirements while only 1 in every 10 on average applied the GMP Hygiene in the food and drink manufacturing industry Code of Practice. The inference was that the GMP among maize mill fabricators and millers were inadequate and could not pass the standard requirements as they did not adequately comply with the general manufacturing practices for specific codes of practices, internal and external test for conformance of processes and products.

From these statistics on good manufacturing practices, a comparison of the technical team awareness of GMPs and having key quality parameters at each inspection point clearly known to them gave the results as shown below in Table 10.

Table 10: A cross tabulation of technical team awareness of GMPs and having key quality parameters clearly known:

			Is your technical team aware of good manufacturing practices in fabrication and/or milling processes?			Total
			Not Applied	Minimal Application	Average Application	
Are key quality parameters at each inspection point clearly known by the personnel in charge?	Not Applied	Count	16	4	0	20
		% of Total	35.6%	8.9%	.0%	44.4%
	Minimal Application	Count	12	10	3	25
		% of Total	26.7%	22.2%	6.7%	55.6%
Total		Count	28	14	3	45
		% of Total	62.2%	31.1%	6.7%	100.0%

Table 10 indicates that about 6/10 of the maize milling SMEs did not apply the standard expectation requiring technical team awareness of good manufacturing practices in fabrication and/or milling processes while only 6.7% applied this standard expectation at a minimal level. Similarly, 44.4% of the SMEs did not apply the standard requiring that key quality parameters at each inspection point are clearly known by the personnel in charge in their GMP.

This situation suggests that having few factors known to the technical and others not clearly known may not guarantee the quality of output because this quality of output may not only be affected by say only inputs material but also the inability to know and control the quality parameters within the milling system.

4.2.4 Good hygiene practices:

The fourth factor of standardization that this study investigated was the hygiene element of standardization within the maize milling SMEs especially this being a food sector English!!!. The findings about this factor are presented in Table 11

Table 11: Level of standardization of GHP in Maize Milling SMEs

GHP	**Level of Standardisation application in enterprises.**									
	Not applied		*Minimal levels of application*		*Average levels of application*		*Passes Standard requirement*		*Total Number N=45*	
	F	%	F	%	F	%	F	%	F	%
1. Is there an individual responsible for plant sanitation (cleaning and disinfection)?	7	15.6	34	75.6	4	8.9			45	100
2. Is the production premises and environment kept hygienic and systematic to ensure that the finished product does not get contaminated at all times?	18	40.0	27	60					45	100
3. Are all utensils and equipment cleaned and sanitized at intervals frequent enough to avoid contamination of food products?	28	62.2	17	37.8					45	100
4. Are the processing areas maintained free from insects, rodents and other pests?	26	57.8	19	42.2					45	100

The above data on the level of GHP Standardisation within the maize milling sector is summarized in Figure 6.

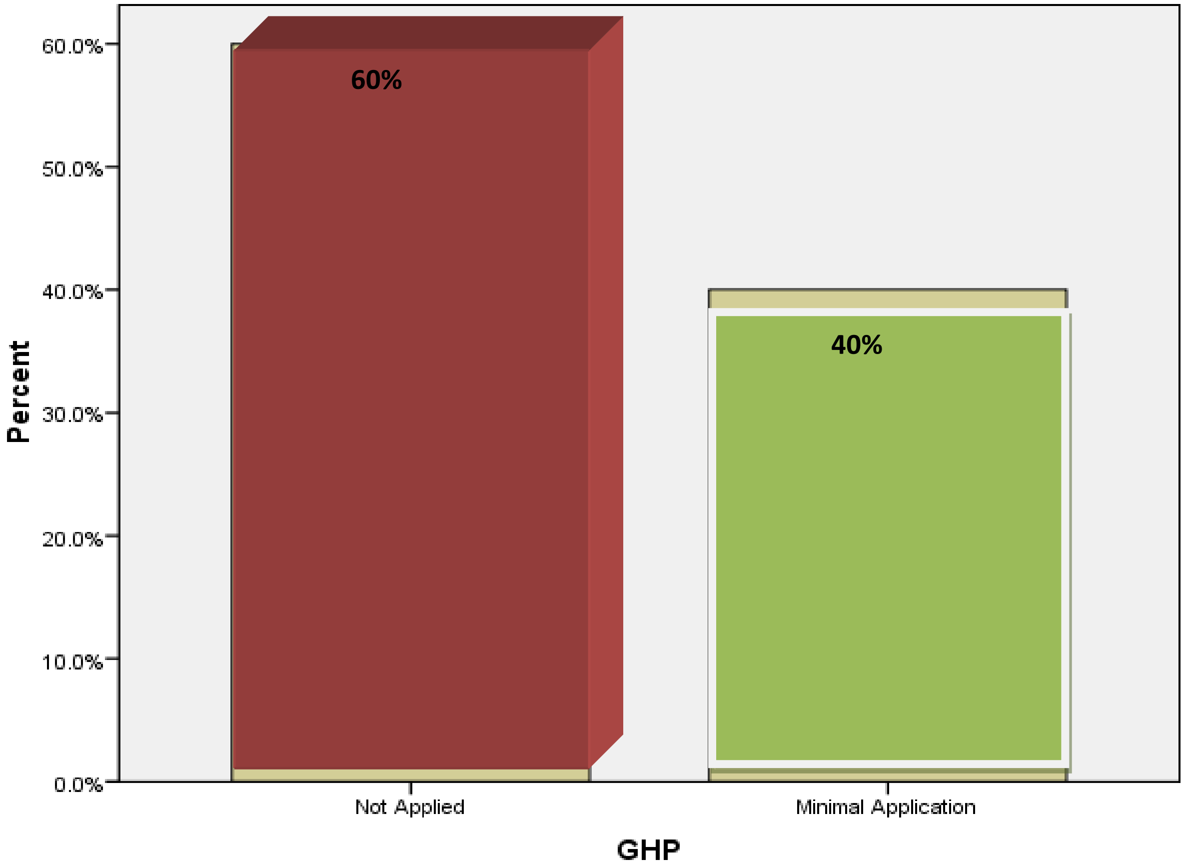

Figure 6: Summary of the degree of standardisation with the GHP

Figure 6 shows that 60% of the maize processing SMEs did not apply the GHP Standard expectation at all; while only 40% applied the GHP requirement to a minimal level. The interpretation was that the GHP among maize mill fabricators and millers were inadequate and could not pass the standard requirements.

Cross tabulating the factors in Table 9 on good manufacturing practices above to determine relationship of the presence of technical staff to ensure hygiene in maize milling facility and the state/results of cleanliness of the milling facility gave the results as shown in Table 12.

Table 12 : A Cross Tabulation of GHP factors in the level of Standardisation

			Is the production premises and environment kept hygienic and systematic to ensure that the finished product does not get contaminated at all times?		Total
Is there an individual responsible for plant sanitation (cleaning and disinfection)?			Not Applied	Minimal Application	
	Not Applied	Count	4	3	7
		% of Total	8.9%	6.7%	15.6%
	Minimal Application	Count	14	20	34
		% of Total	31.1%	44.4%	75.6%
	Average Application	Count	0	4	4
		% of Total	.0%	8.9%	8.9%
Total		Count	18	27	45
		% of Total	40.0%	60.0%	100.0%

From Table 12, it can be seen that 75.6% of the SMEs were rated as applying the standard expectation of having an individual responsible for plan sanitation at the minimal level while 60% were rated to minimal in applying the standard expectation requiring production premises and environment kept hygienic and systematic to ensure that the finished product does not get contaminated at all times.

These findings suggested that the failure to deploy plant sanitation personnel lead to contamination of final product due to operating in unhygienic environments among local maize mill fabricators and maize millers.

4.2.5. The equipment /technology aspect of standardisation

The fifth factor of standardization that this study investigated was machine/technology element of standardization within the maize milling SMEs as a factor that determines the success of the implementation of the standards for quality output. Table 13 gives the statistics of the standardisation element of equipment/technology within the Maize Milling SMEs

Table 13: Level of Standardization of Equipment/Technology

Equipment/Technology	Response with respect to equipment standardisation									
	Not applied		*Minimal levels of application*		*Average levels of application*		*Standard required levels*		*Total Number = 45*	
	F	%	F	%	F	%	F	%	F	%
1. Is the equipment designed and used in the process in a manner that prevents contamination with lubricants, contaminated water, metal fragment, etc.?	17	37.8	25	55.5	3	6.7			45	100
2. Is the facility kept clean and in good physical repair?	10	22.2	35	77.8					45	100
3. Do you have standard tests and checks for conformity of your final product (Machine & components) based on customer requirement?	11	24.4	33	73.3	1	2.2			45	100
4. Do you have standard checks for conformity of your testing equipment?	20	44.4	25	55.6					45	100
5. Do you trace the consistence of your instruments and apparatus used in production process?	24	53.3	21	46.6					45	100
6. When there is a need to re-do a component or part that is used in production, do you have a system to control your tooling practices?	25	55.6	18	40	2	4.4			45	100
7. Is there a mechanism to control gauging and measurement in your fabrication/ production process?	30	66.7	7	15.6	8	17.8			45	100
8. Are the facilities adequate as per the implementing guidelines or standards? Specify any tests not being carried out.	14	31.1	31	68.9					45	100

The data on the level of equipment/technology Standardisation within the maize milling sector from Table 13 is summarized in Figure 7 below.

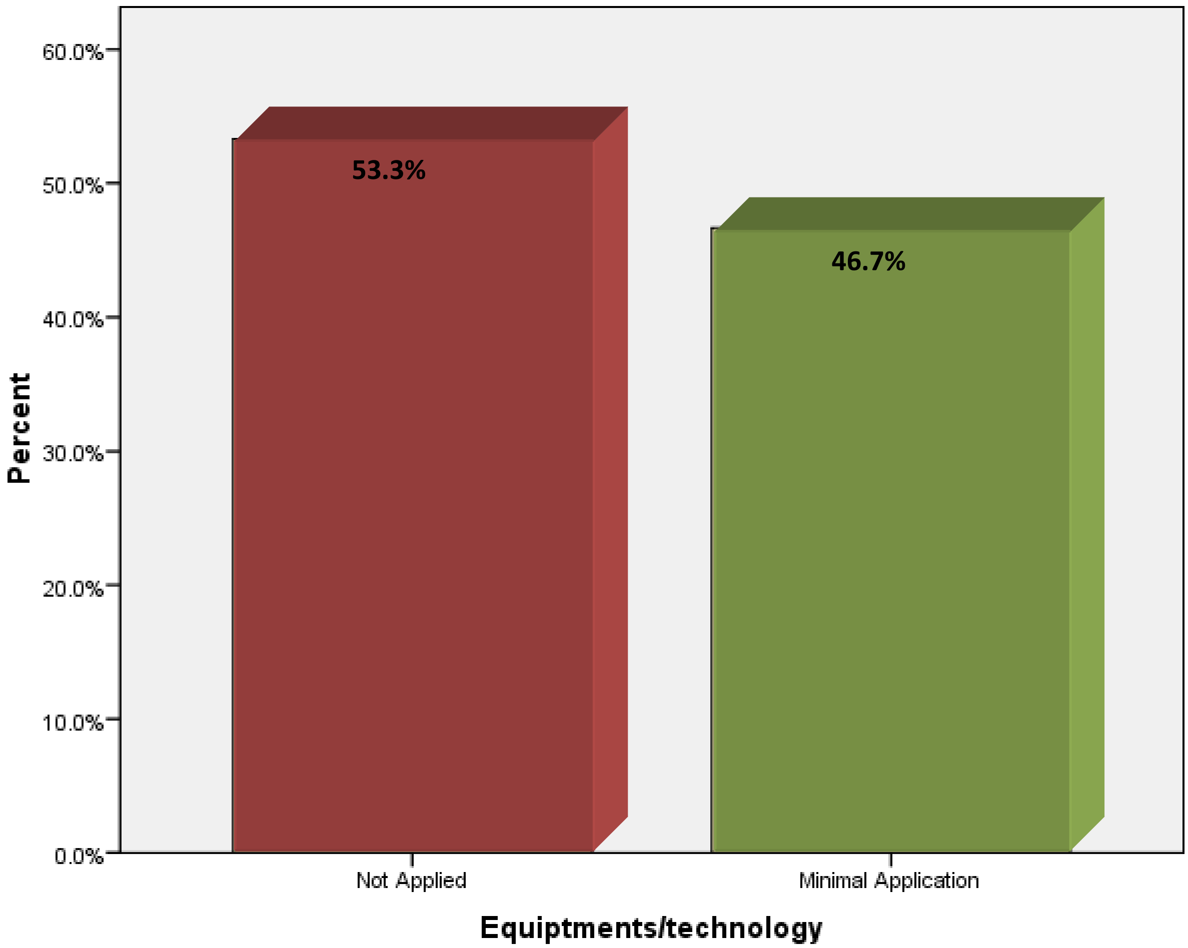

Figure 7: Summary of the degree of standardisation of the machinery/technology

Figure 7 above shows that half of the maize mill fabricators and maize processors did not apply the equipment/technology standard expectation for Hygiene in the food and drink manufacturing industry Code of Practice.

The inference was that the prevailing equipment /technology used by maize mill fabricators and millers were inadequate and could not pass the standard requirements as they did not adequately ensure that Equipment are designed and used in a manner that prevents contamination with contaminants, did not test the equipment for conformance, and no mechanism to control gauging and measurements.

This study concluded that the none and minimal application of standardization for the machines/ technology element, could adversely impact on other elements of standardisation such as input materials, manufacturing practices, human, machine maintenance and others are at the impossibility of implementing and achieving standardisation since their utilization follow machine designs and operation mechanisms to give desired outputs.

A comparison of factors of standardisation within the machine/technology element of standardisation gives the results in the Table 14 below.

Table 14: A cross tabulation of equipment/technology

			Is the facility kept clean and in good physical repair?		**Total**
			Not Applied	Minimal Application	
Are the facilities adequate as per the implementing guidelines or standards?	Not Applied	Count	2	12	14
		% of Total	4.4%	26.7%	31.1%
	Minimal Application	Count	8	23	31
		% of Total	17.8%	51.1%	68.9%
Total		Count	10	35	45
		% of Total	22.2%	77.8%	100.0%

The results in the Table indicate that the facilities do not meet the requirements of implementing the guidelines of the applicable standards giving an indication that even with cleaning these facilities high chances are that the intended quality requirement will not be met.

4.3. Quality of Output from the different Machines

The second objective of the study was to examine the quality of maize flour from milling machines in relation to Machine designs. Machine design in this study referred to the make and set up of the milling machines to ensure that the machine produces the desired quality of output.

This includes among others efforts to use mechanisms during the maize processing to eliminate or hamper the presence of any foreign matter in the final product. Thus data was collected from two machine design types with one having intermediate points with magnets in their design and the other not have an intermediate point(s) with magnets in its design.

To determine the quality of output which included parameters of flavors, iron content, odors, living insects, filth and extraneous matter, two methods were used.

(i) Physical methods for determination of physical attributes of the maize flour such as color, odor, filth, extraneous/objectionable matter were used. Specifically for the other contaminants or iron chips/filings, a strong magnetic field generated from a magnetic rod was used to detect their presence.

(ii) Chemical method of determining the total amount of iron content in the maize flour samples (refer to chapter 3) was used. The results of the experimental analysis are presented in Table 15.

Table 15: Results of experimental analysis maize flour from different maize mills

Source of test sample	Iron content	Flavor	Living insects	Filth	Extraneous matter	Comment for quality factors
Control sample	1.95	Normal	Absent	Absent	-	Pass
L_1	0.39	Normal	Absent	Absent	-	Pass
L_2	3.29	Normal	Absent	Absent	+	Fail
L_3	0.63	Normal	Absent	Absent	+	Fail
L_4	6.65	Normal	Absent	Absent	+	Fail
L_5	4.49	Normal	Absent	Absent	+	Fail
L_6	1.15	Normal	Absent	Absent	+	Fail
L_7	1.68	Normal	Absent	Absent	+	Fail
L_8	10.38	Normal	Absent	Absent	+	Fail
L_9	8.64	Normal	Absent	Absent	+	Fail
L_{10}	1.95	Normal	Absent	Absent	+	Fail
L_{11}	2.26	Normal	Absent	Absent	+	Fail
Certified	<0.05	Normal	Absent	Absent	-	Pass
Certified	<0.05	Normal	Absent	Absent	-	Pass

Key

L_i = Maize Milling Plant that uses locally fabricated machines

+ = Small Iron filings attracted to a magnetic rod seen

- = No evidence of contaminants in the maize flour

Results in Table 15 show that the samples from locally fabricated maize mills tested contained more iron content exhibiting itself in differing proportions / quantities by composition in the flour.

The differing proportions are a combination of the iron portion got from the soil by the plant as nutrients and that portion added by the milling process. These results also show that most of the milled products from locally fabricated milling machines contained extraneous / objectionable matter (contaminants) that led to a failed state of the overall Quality of the product/flour. This quality failure means that the product does not meet the minimum requirements of the standard due to the existence of contaminants mainly iron filings being attracted by a magnetic rod.

It was also noted that four samples passed the Uganda / East Africa Standard requirement wholly i.e. found with no contaminants or extraneous matter including iron filling attracted by a magnetic rod. Two of these samples were picked from the produce of one of the local companies (<0.05ppm), which incidentally happened to have been on the certification scheme of Uganda National Bureau of Standards. One other sample was the maize grains/seeds picked from the market (control sample) (1.95ppm), and another one was randomly picked from the market (0.39ppm).

Although the Uganda / East African Standard (US EAS 44) did not specify the minimum or maximum iron content in the maize flour, the results of iron content from the control sample were adopted as a bench mark in this study. This is was considered so because the control sample used was a composition of many different samples, that is to say, it presented an average value of characteristics including iron content from unprocessed maize and hence, making an assumption that the 1.95mg/kg of iron found in this sample was the amount absorbed from the soil in form of nutrients. Any excess from this value was taken as having resulted from the wear and tear of the metals used in processing hence its presence in the final product.

According to the results of flour analyzed from the laboratory, one of the samples passed all the test parameter requirements including that of contaminants/extraneous matter and with less the values of the benchmark sample, suggesting that the process of milling could have even lost the iron nutrient probably in the initial stages of milling.

The experimental analysis was carried out to ascertain the truth that indeed iron filings exists in the grounded maize flour on Ugandan market but not to get out all the filings of iron for quantification. This position was considered because the National and/or the Regional Standard used in the analysis does not allow for any extraneous objects/matter in the flour. Based on the assumption above that there is an average of 1.95mg/kg of iron in unprocessed maize and an average of 3.7736mg/kg in processed maize flour, giving an assumed value of iron filings in the flour as 1.82mg/kg, one can therefore imagine the amount of iron filings that gets into the human body from the ground maize/food which is frequently on the menu. The descriptive data of these findings on the amount of iron content in the maize flour as shown in the Table 16 below

Table 16: Descriptive results for iron content from locally fabricated maize meals

	N	Minimum (mg/kg)	Maximum (mg/kg)	Mean (mg/kg)
Iron Content	11	0.39	10.38	3.7736
Valid N (list wise)	11			

Descriptive statistics for results of iron content from the experiment was run and the findings revealed that from 11 samples, the minimum quantity of iron content was 0.39mg/kg while the maximum was 10.38mg/kg with a mean of 3.7736mg/kg. When we deduct the mean weight of iron filling from the control sample which had 1.95mg/kg we realize a net of 1.8236mg/kg of iron content in the maize flour consumed on the local market (as being locally milled). The implication was that for every 1 tone of the maize flour generated from locally fabricated maize mills, 1823.6mg (approximately 2grams on average) of hazardous heavy metal component of iron is consumed. A comparison was made for the results of samples tested from the different milling machines and the results are as shown in the Table 17 below.

Table 17: Results comparison Table

	Certified	N	Mean	Standard Deviation	F	Sig (p)
Iron Content	No	11	3.7736	3.38469	4.361	0.004
	Yes	2	.0400	.00000		

$P \leq 0.05$ – error level

Table 17 shows that there was a significant difference in the mean results for iron content for maize mills which were not certified (Mean = 3.7736) and those which were certified (Mean = 0.0400) suggesting that locally fabricated machines yielded more iron filings than certified maize mills ($F = 4.361$, $p = 0.004$). It was important and evident that the local fabricators need to design maize mills with designs which reduce or eliminate hazardous iron filings in the final product.

Note: The limitation of this analysis was that it was very hard to draw a line and be able quantify how much quantity of iron was from the soil as a mineral content or the contribution of processing in terms of additional iron. This however, could be studied further to reach the conclusion.

4.4 The Factors that Affect Standardization and hence Leading to the Existing Quality of Flour on Ugandan Market

The third objective of the study was to identify the factors that affect standardization and hence lead to the existing quality of flour on Ugandan Market. To achieve this objective the researcher purposively interviewed a selection of 12 stake holders from different backgrounds using open ended questions regarding input materials, human element and methods. The responses were arranged in themes and sub themes, entered into SPSS for analysis and the findings are presented below.

(i) Input Factors

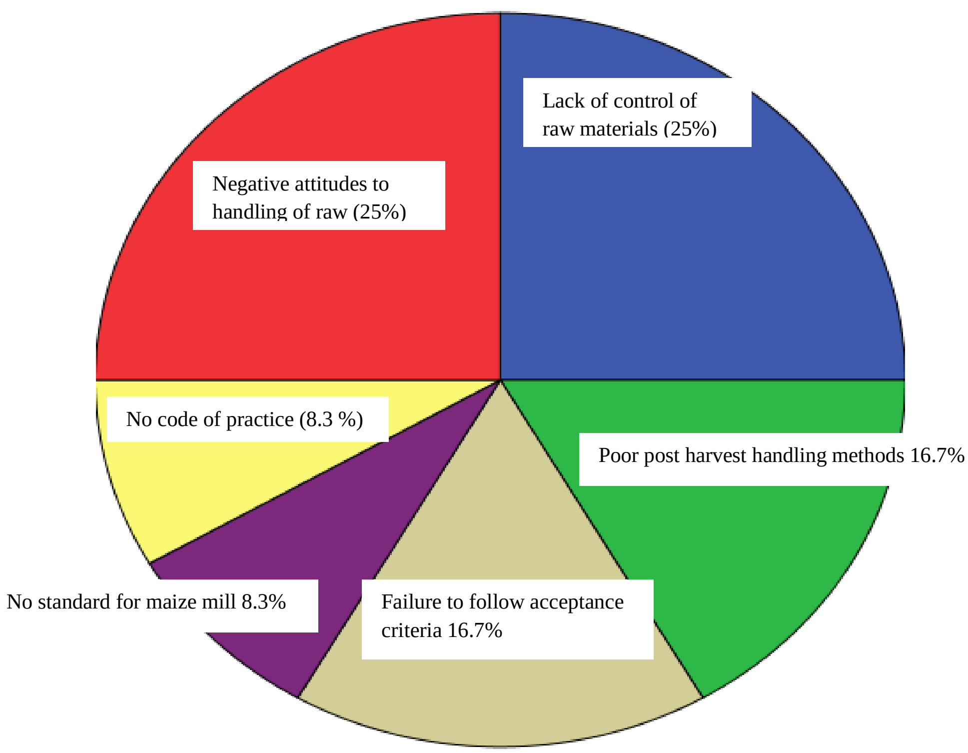

Figure 8: Input factors affecting standardisation among Maize SMEs

According to Figure 8 above, lack of control of raw material source and negative attitude to handling of raw material were the most dominant input factors affecting standardisation among maize mill fabricators and maize processors. The poor post-harvest handling methods and failure to follow acceptance criteria were equally cited as key factors affecting standardisation among Maize SMEs and were ranked second among the key themes. Other input factors that affect standardisation cited by the interviewees included no standards for maize mills and no code of practice in the milling sector.

The interview findings seem to be congruent with the quantitative findings revealed that 40% of the maize SMEs did not at all strictly follow the acceptance criteria while 60% followed it to the minimal level before accepting the raw materials (Ref. Table 4). In addition, eight respondents out of the twelve noted that whereas it may be difficult to have a standard for a complete machine, even standards for specific parts in the machine along with a code of practice in the fabrication of food handling equipment do not exist. They suggest that there is problem at input level of raw materials for the machines and their spare parts which affects standardization and the quality of the final product.

This view from the respondents agrees with the quantitative findings which revealed that 44.4% of the maize SMEs did not at all have the acceptance criteria for machine assemblies and spare parts while 55.6% followed criteria at a minimal level.

(ii) Human Element

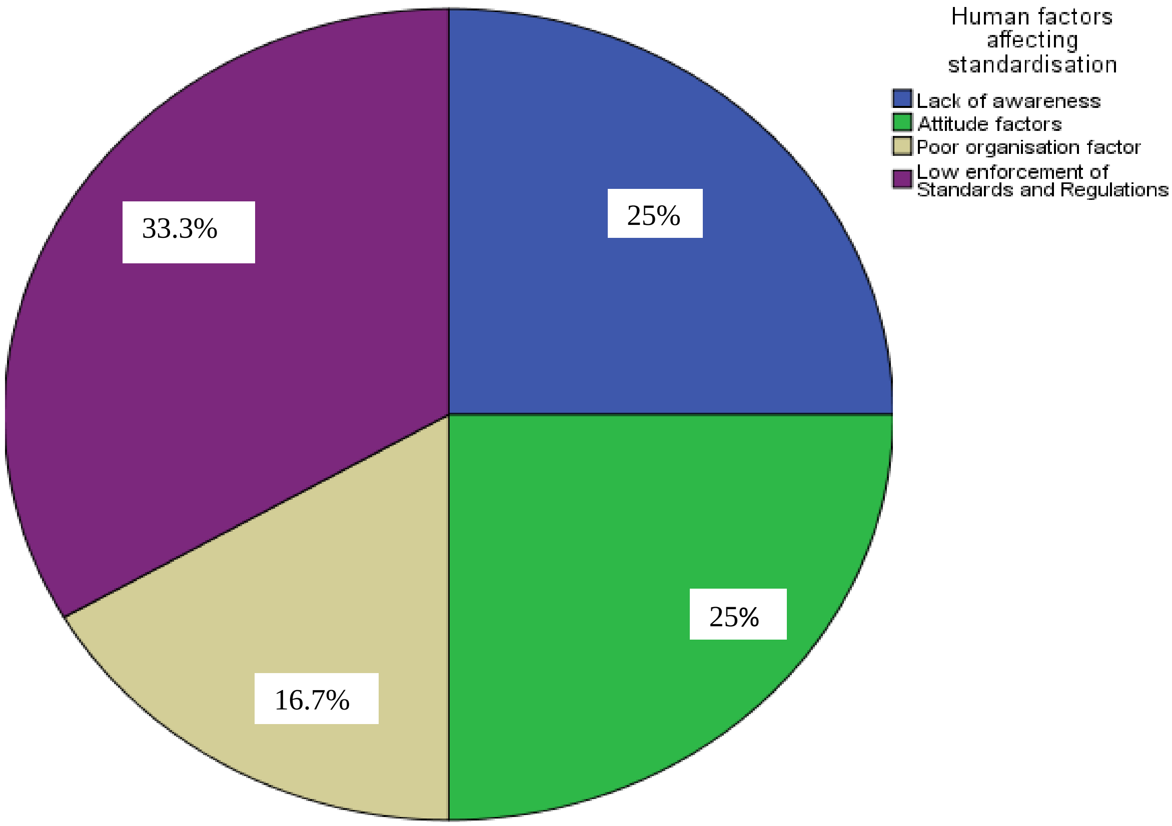

Figure 9: Human factors affecting standardisation among Maize SMEs

According to figure 9 above, it can be deduced that low enforcement of Standards and Regulations was the most dominant human factor affecting standardisation among maize mill fabricators and maize processors. This was followed by lack of awareness and attitude factors each representing 25% of the responses. The poor organization factor was one of the human factors that affect standardisation cited by the interviewee.

The interview findings relate to a great extent to the quantitative findings which revealed that 80% of the specifications in maize SMEs did not at all have in place any documented specifications for the raw materials while only 20% had the specifications documented only to the minimal level. (Ref. Table 2). This aspect particularly agrees with the statistical findings in the Maize milling SMEs survey process where it was noted that even when a good number of firms indicated that they had someone responsible for cleaning the premises, 40% did not at all have any cleaning done in the premises and only 60% did cleaning of premises to the minimal level an indication of an unfavorable attitude.

The different respondents' perspectives suggest that, there is an agreeable position of having a problem on the side of human element for standardisation to be achieved in small scale industry specifically grain millers which they attributed to different factors as pointed out in the above. This position relates to a great extent to the earlier results from the quantitative study that the majority of 82.2% gave attention to human resource development standard expectation on training to the minimal levels while 15.6% did not give attention to human resource at all.

(iii) Machines and Technology Element

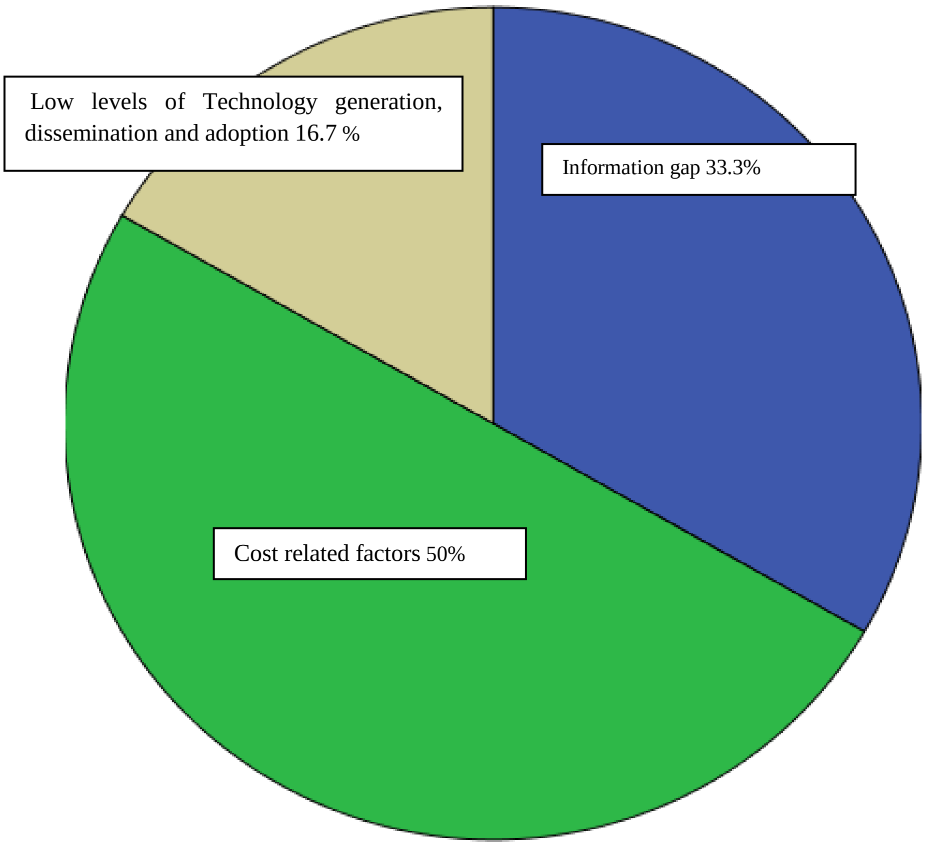

Figure 10: Machines and Technology affecting standardization

Figure 10 above shows that cost related factors were the most significant equipment and technology factor affecting standardisation among maize SMEs. These costs related to the cost of acquiring food grade machine inputs, up grading available machine inputs to meet the standard requirements, modifying existing machines and their designs to give standard output quality were high and the processor would not be getting any profits if he under takes these tasks.

Information gap was also identified as a key technology hindrance to standardisation practices specifically with most of the entrepreneurs not aware of the technology requirements in food manufacturing specifically what amounts to food safety in relation to food processing. In addition, technology generation, dissemination and adoption were identified as a challenge because of the informal none documented methods used in the sector. The interviewees expressed that if an individual finds his method of making a good equipment, he does not freely pass it on to other individuals in the sector neither does he document the method for future reference. They noted that generation of technology is still informal and rudimentally with no standard approach based on the existing research. This means that the originators of their own technology/machine have no formal way to disseminate the information they generate and that this is worsened by lack of motivation to pass on the knowledge to others. This means once individuals who have innovated some methods leave the sector through aging or death, their innovations end with them.

The qualitative findings relate greatly to the findings which revealed that 80% of the specifications in maize milling SMEs did not at all have in place any documented specifications for the raw materials while only 20% had the specifications documented only to the minimal level. The findings from the expert interviews particularly agree with the statistical findings in the Maize milling SMEs survey process where it was noted that even when a good number of firms indicated that they had some one responsible for cleaning the premises 31.1% did not at all have any cleaning done in the premises and 44.4% did cleaning of premises to the minimal level.

CHAPTER FIVE: DISCUSION OF RESULTS

5.1. Introduction

This chapter discusses the findings of the study on the standardization practices in indigenous maize processing mills/machines on the quality of flour output and gives the implication of the facts and how they can be utilized to solve the problems.

The chapter is divided into three sections:

- The first section discusses the study findings on the level of standardisation in maize milling SMEs.
- The second section discusses the findings of the study on the quality of output from the different maize mills designs.
- The third section discusses the study findings on the factors that affect standardization implementation in maize processing

5.2. The Level of Standardisation in Maize Milling SMEs.

5.2.1 Input Materials

The study found out that a reasonable number (3/10) of maize processing SMEs in Uganda did not apply any form of input materials standardisation at all while the majority (7/10) applied input material standardisation at the minimum level as indicated in Figure 3. This situation of the prevailing none and minimal application of standardization material input stage among maize processers breaches the nationally and internationally recommended manufacturing practices. This is because; this practice is most likely to affect the quality of final product and consequently the final consumers likely to face adverse health hazards from the consumption of the output flour of such a process.

The total lack of application or the minimal level of standards application for the input materials at this stage in the production in the maize processing SMEs indicates that these SMEs are not taking advantage of Gilani and Razeghi (2010) view that standardization is a prerequisite for meeting quality expectations, customer demands and expectations. The problem of standardisation however, seems to prevail in the SMEs even when there is an interest in some few SMEs to adopt and implement the standardisation concept. For example, the study found out that although a maize processing SMEs may have an established acceptance criterion for raw materials, it was unlikely to follow it strictly which compromises the quality of the final product.

This shows that maize processing SMEs are still far from the UNIDO (2006) view that in manufacturing once the initial stages of design and planning for quality have been well done, there should not be any problems in the process and the quality of the final product is guaranteed. The report goes ahead to highlight that during manufacturing, some common factors that affect the quality of the product in the system include machine and set-ups, operators, materials and components and these particular factors were looked at during the study and seem to lack control and implementation plan at SME level.

The above imply that, in all manufacturing and specifically in the fabrication of agro-processing machine settings, issues of design and planning for input materials, manufacturing practices and human resource should be give due attention at any stage in the process as they directly impact on the whole process hence final product quality.

5.2.2 Human Element and methods standardisation

The study revealed that a reasonable number (~2/10) maize processing SMEs in Uganda did not apply any human element and methods standardisation expectations at all while most of them

(~8/10) applied some form of human element and methods standardisation at minimal levels. (Ref. Fig. 4). The study therefore mean that the none and minimal application of standardization in human element and methods among these SMEs has a multiplier effect on other process players as it may equally affect the application of standards at raw material, in GMPs and GHPs since personnel is the gearing among all the factors required for standardisation.

This position on the inadequacies and consequences of the human factors of standardisation among maize SMEs relate to a great extent to Chow-Chua et.al. (2003) observation that failure to control and define responsibility and authority of personnel ultimately affects the final output. UNIDO (2006) had earlier indicated that most quality problems are caused primarily by lack of interest or care on the part of the worker in the production department. However, it is usually not the worker who can be blamed for this, since the conditions necessary to carry out the work correctly often do not exist.

5.2.3. Good Manufacturing Practices

The findings from the study indicate that SMEs in Uganda specifically in the maize milling sub-sector have minimum controls in regard to the GMPs. This is evidenced by the non-application of this aspect of GMPs among 4/10 SMEs, minimal application in half of the SMEs and only 1% who applied this standard average level (Ref. Figure, 5).

It was inferred that the GMP among maize mill fabricators and millers were inadequate and could not pass the standard requirements as they did not adequately comply with the general manufacturing practices such as specific codes of practices, internal and external test for conformance of processes and products.

The above gives an evidence of failure to control specifications as well as equipment designs for food safety achievement implying that these SMEs failed to benefit from the ideas put forward by Ropkins and Beck (2000) on the benefits of good manufacturing practices. The above characteristics of GMPs in the grain milling sector with these ratios may partly explain the existence of the extraneous matter in most of the locally ground maize flour as was evidenced in the experimental sample analysis.

5.2.4. Good Hygiene Practices

This idea of GHPs as put forward by Ropkins and Beck (2000) as a system and measure of maintaining hygiene and sanitation as explained in Chapter two, has equally a significant attribute on the safety of the final product. The study findings indicate that the maize milling sub-sector SMEs in Uganda have minimum attributes of GHPs requirement. This was evidenced by the non-application of this aspect of GHPs at (60%) and minimal application of this GMPs aspect at (40%), as in Figure 5. This has an indication that there is a more likelihood of having different contaminants such as micro-bio in the maize flour from locally made machines such as mycotoxins and others because of the storage factors. However, this aspect was not verified experimentally but a similar study done in neighboring Kenya established that consumers were actually exposed to dangerous mycotoxins in maize products These scenarios above request for a requirement of the hazard analysis and critical control point (HACCP) in the grain milling sub-sector of SMEs in Uganda if the sector is to benefit from the views put forward by Nguyen et al., 2004 on good food processing practices.

5.2.5 Technology/Machine Standardisation

It was found that all the millers covered in this study used hammers for processing the food; some with screens that cover the mill around 360 degrees and others (most popular designs) had screens around 180 degrees of the lower periphery as this allows easily made replacement screens to be used (Ref. Figure 2). Beater bars are often incorporated into the upper semicircle against which the grain impacts. All screens are made by perforating blank sheets of steel and are not commonly made in Uganda, and have to be imported. Screen replacement represents one of the main running costs of the mill. The rate of screen replacement depends on thickness of the steel and so because the most used are thin, there is frequent replacement. For example, a screen for a hammer mill with 0.5 mm holes would be made from 0.5 mm thick steel. The larger the hole size, and hence the thicker the steel, the longer the screen will last.

The study established that slightly more than a half maize milling SMEs in Uganda do not have any equipment standardisation and those who had some equipment standardisation application slightly less than a half had it at the minimal level of expectation as indicated in Figure 7. This implies that, the prevailing none and minimal application of equipment standardization among maize millers reflects that the process would compromise the quality of output as put forward by Elzinga et al., (1995).

The implication of these results is that quality of output may not be solely affected by or determined from the status of input materials, human factors, Hygiene Practices and Manufacturing Practices, nature and extent of the equipment used in production considering food grade material requirement for food processing but generally a contribution from the different factors within the production system as discussed above.

5.3. The quality of maize flour from milling machines in relation to Machine designs.

In this study, examination was made to establish the quality of output from grain mills in form of maize flour with respect to the available National, Regional and international standards. As presented in the results Table 15, it was found that the samples from locally made maize mills tested contained iron content exhibiting itself in differing quantities and forms in the flour.

It was noted that out of the 13 samples analyzed for conformance to the contaminants requirements of the National/regional standards, only 4 (30%) passed the Standard requirement wholly i.e. found with no contaminants or extraneous matter including iron filling attracted by a magnetic rod while the 70% failed the standard requirement with the failure being as a result of contamination or having objectionable matter and specifically iron filings attracted by magnet.

Those which passed included the maize grains obtained from the market and hence did not undergo machine processing and the flour obtained from the market (two different samples) of which one a produce of one of the local companies which incidentally happened to have been on the product certification scheme of Uganda National Bureau of Standards.

These findings on the quality of Maize flow from locally fabricated maize mills relates to a great extent to a study conducted in Ghana by Normanyo et al, (2009), where the effect of grinding mill/disc in regard to production of iron filings into the food consumed, found that iron filings are produced when the two disc surfaces would rub against each other which caused the surfaces to get blunt with use. The Normanyo et al, (2009) study concluded that when the desired texture of the material is to be very fine it could only be achieved when the gap between the discs was very close as to make contact with each other and this result in the production of iron filings as part of the food consumed. It was recommended that maize mill fabricators should include heavy metal detectors and removers in the machine design to prevent the presence of extraneous matter in the final product.

There was evidence that practices in these SMEs operations such as maintenance of the most worn out parts like the screens, hammers and couplings highly compromises the quality of the final product. In this study for example, it was noticed that there was a practice of impregnating some other metals in the screen whenever they develop holes before they are completely changed this automatically affects the final product quality since the different material introduced will behave differently from the originally planned at design.

Although the standard used in the analysis for the quality of flour from indigenous maize mills did not state the minimum or maximum iron contents, the effect of the iron matter obtained as filings could not be underestimated and the standard does not allow for any extraneous matter in the final product. This is because, whereas there is some iron content expected to be in grains specifically within the food as having obtained from the soil nutrients, iron which is in form of filings are not expected to be present in any food. The nature in existence and amount of iron present in a human body has to be seriously considered.

Effect of Iron in the Body

Iron can be got from many sources including but not limited to inhalation of tobacco smoke, asbestos workers and people who grind or weld steel, mine iron or paint with iron oxide powder could acquire high levels of iron in their lung tissues. These increase the risk of lung cancer since operators/actors spew particles containing iron into the air and partly because their lungs are chronically exposed to the spewed excess iron (Brody, 1997).

The relevance of iron to the human body has been investigated by many researchers with much of their works confined to issues of iron deficiency in the body. Iron deficiency is known to lower cognition in humans especially children, it affects learning, and it is considered as a nutritional problem that needs to be prevented and treated (Hulthen, 2003).

Iron serves as the key ingredient for healthy red blood cell production, it is the main component of hemoglobin which carries oxygen round the body and iron deficiency anaemia is considered a common problem for people with kidney disease (DPC, 2008, AAKP, 2005,). To keep the immune system healthy and promote normal brain cell functionality, iron is needed (Hillan and Bobroff, 2006).

On the other hand however, there exists a phenomenon of iron overload which occurs mainly as a result of over absorption, overconsumption and over retention of iron where the health disorders such as arthritis, diabetes, psychiatric illness, liver disease, cancer, heart disease, thyroid disease, infertility are related, (Cutler, 1994, Brody, 1997, Robinson, 1995).

Comparatively, there has been minimal focus on iron filings in grounded food material as a potential source of iron overload. This is partly due to the minute nature of the filings and more so the way and manner the food substance is ground by way of milling.

What this means is that, very gradually and slowly our health is being degraded by certain ways that we process our foodstuffs which we hardly realize. This aspect may be manifested by the trend at which cancerous related illnesses and effects are being detected in humans and this justifies a need to establish a system that guarantees the desired quality of output from agro-processing facilities. Hence Standardisation requirement

5.4. The factors that affect standardization and hence leading to the existing quality of flour on Ugandan Market

5.4.1. Input factors affecting standardisation

The study found out that the lack of control of raw material source and negative attitude to handling of raw material were the most dominant input factors affecting standardisation in the maize processing sub sector. Bas et al. (2007) equally noted that, besides knowledge, "attitude" is an important factor that ensures a downward trend of food borne illnesses. The poor post-harvest handling methods, failure to follow acceptance criteria, lack of standards for maize mills and absence of code of practice in the maize processing sub sector were some of the key significant factors affecting standardisation.

A study by Yapp and Fairman (2006) reports lack of money as SMEs focus on immediate survival rather than potential benefits derived over the long term; lack of time; lack of experience; lack of access to information, lack of support, lack of interest, lack of knowledge. SMEs have poor awareness of the relevance of legislation as key factors affecting standardization among food processing SMEs.

This study inferred that any move to the right in standardisation should focus on the removing the input bottlenecks targeting streamlining of the sources of raw material, attitudes, and development of code of practice.

5.4.2. Human factors affecting standardisation

The study found out that low enforcement of Standards and Regulations was the most dominant human factor affecting standardisation among maize mill fabricators and maize processors. This was followed by lack of awareness and attitude factors each representing 25% of the responses.

The poor organization factor was equally cited among the key factors affecting standardisation. The above findings agree with Griffith (2000) who stated that one of the major problems regarding the effective implementation of food safety practices is that employees in food industry often lack interest and they often have a negative attitude toward the food safety programmes.

Furthermore, a study by Jiju et al. (2005) cites low awareness about standardizations and lack of enough resources barriers which could be removed through use of ICT to access information. Christos et al. (2007) point out training, motivation, commitment and lack of expertise as a barrier to the effective implementation of Hazard Analysis and Critical Control Point in small businesses. Also recognized that the practical application of HACCP in SMEs can be hindered by factors such as the lack of time, expertise, training, motivation, commitment and funding.

5.4.3. Equipment/technological factors affecting standardisation

The study found out that cost related factors were the most significant equipment and technology factor affecting standardisation among maize SMEs. These costs related to the cost of acquiring food grade machine inputs, up grading available machine inputs to meet the standard requirements, modifying existing machines and their designs to give standard output quality were high and the processor would not be getting any profits if he under takes these tasks.

The raised factors affecting standardisation among maize processing SMEs relate to a great extent to what UNIDO report (2006) highlighted that common factors that can affect the quality of the product in the system include machine and set-ups, operators, materials and components. Information gap was also identified as a key technology hindrance to standardisation specifically with most of the entrepreneurs not aware of the technology requirements in food manufacturing specifically what amounts to food safety in relation to food processing. In addition, technology generation, dissemination and adoption were identified as a challenge because of the informal none documented methods used in the sector.

In complement of the above equipment and technology factor identified among maize processing SMEs, Taylor (2001) and Walker et al. (2003) identified absence of legal requirements and financial constraints as barriers to effective implementation of Hazard Analysis and Critical Control Point in small businesses. Christos et al. (2007) also recognized that the practical application of HACCP in SMEs can be hindered by factors such as the lack of time, expertise, training, motivation, commitment and funding.

CHAPTER SIX: CONCLUSIONS AND RECOMMENDATIONS

6.1. Introduction

This chapter presents the conclusions and recommendations of the study arising from the study findings and their discussion. The first subsection presents the conclusions while the last sub-section presents the recommendations of the study by providing the strategies for enhancing quality of manufacturing SMEs through standardization in maize milling technologies in Uganda.

6.2. Conclusions

The following are the conclusions drawn from the study:

1. The prevailing inputs, human factor, GMP, GHP and equipment/technological practices among local agro-processing specifically grain mills fabricators and millers were inadequate and do not meet the standard requirements for Hygiene and Code of Practice in the food manufacturing industry.
2. The design of locally fabricated agro-processing machinery does not adequately meet the Hygiene and code of practice in the food manufacturing industry thereby compromising the quality of the maize flour produced and consumed on the local market. The increasing consumption of food products from these locally fabricated food processing mills exposes consumers to adverse health risks arising from the presence of significant and harmful extraneous matter/contaminants in the form of iron filings.
3. The factors affecting standardisation in agro-processing SMEs can be grouped into three broad categories namely, Input Materials, Human and Equipment/Technological factors. In these, the key specific to In-put material factors include lack of standards for food mills and lack of code of practice in the milling sector. Lack of control of raw material source and

negative attitude to handling of raw material, poor post-harvest handling methods, failure to have and to follow input acceptance criteria were equally significant input factors affecting standardisation and are directly linked to absence of code of practice in food mill fabrication or its awareness. Key human factors affecting standardisation in food milling sector included low enforcement of Standards and Regulations, lack of awareness, poor organization factor while the Key equipment/technology factors affecting standardisation included cost of acquiring food grade machine inputs, information gap, low level of technology generation and dissemination.

6.3. Recommendations

As an objective number four of the study, the following recommendations are made based on the study findings:

1. Metal detectors should be incorporated with an automatic detection, rejection, attraction and removal mechanisms to eliminate any metal filings or contaminants for all agro-processing mills. Where this is not feasible, proper selection of material to be used in fabrication be done suitable enough to meet the US 28 EAS 39 requirements. This means that there is a need for specialized product design and development training and innovation to cater for this specialized and yet urgent requirement in the agro-processing sector.

2. Lead agencies such as the Uganda National Bureau of Standards, Ministry of Trade, Industry and Cooperatives, relevant NGO/Donors, educational institutions, agro-processing SMEs and other relevant stakeholders should ensure that an elaborate national food safety code of practice for the agro-processors and agro-processing machine fabricators is developed and enforced to cover requirements of input materials, human, GMP, GHP as well as food grade Equipment/Technology requirements.

3. UNBS in liaison with the relevant authorities should disseminate information to consumers and manufacturers on the significance of implementing a national food safety code of practice specifically in post-harvest handling, processing and after storage handling. Creation of enabling legal instruments is necessary to ensure enforcement of the standard expectations.

6.4. Areas for further research

This study was taken as one of the efforts to establish the extent of standards application in Small Scale Enterprises in developing countries and particularly in Uganda and gave attention to the chemical aspects of the final product; the following directions for further research are suggested.

i. Further research should explore the extent of contamination of the maize flour from microbiology effects as a result of post-harvest handling practices as well as the GMP and GHP situations within the maize milling sector.

ii. Determination of the main obstacles that hinder adoption of standardisation and how standardisation approach can be used to enhance innovation and intellectual property issues within the Small and Medium Enterprises in Uganda.

iii. Further research should be undertaken aimed at quantifying the average amounts of iron the maize plants get from the different soils in Uganda. This would give a guide on quantifying the amount of iron the processing adds into the maize flour.

REFERENCES

Avery S. (1998). "ComEd standardized safety supplies to cut MRO costs". *Purchasing,* 16, 203-204.

Baines, R.N., & Manning, L. (2004). "Effective management of food safety and quality", *British Food Journal*, 106(8), 598–606.

Bas, M., Yóksel, M., Havuooflu, T. (2007), "Difficulties and barriers for the implementing of HACCP and food safety systems in food businesses in Turkey", *Food Control*, Vol. 18 No.2, pp.124-30.

Brody, J. E. (1997). 'Personal Health: Iron Overload', Women's Health, Special Edition of The New York Times on the Web, March 5, 1997.

Caulcutt, R. (2001). "Why is Six Sigma so successful?" *Journal of Applied Statistics*, 28 (3/4), 301-306.

Chee, H., & Harris, R. (1998). *Global Marketing Strategy.* London: Pitman Publishing.

Chow-Chua, C., Goh, M., & Wan, B. T. (2003). "Does ISO 9000 certification improve business performance?" *International Journal of Quality & Reliability Management,* 20(8), 936 – 953

Christos, V. F., Dimitrios, P., Kafetzopoulos, E., & Psomas, L. (2007). "Assessing the critical factors and their impact on the effective implementation of a food safety management system", *International Journal of Quality & Reliability Management,* 26(9), 894 – 910

Chow-Chua, C., Goh, M., & Wan, T.B. (2003). "Does ISO 9000 certification improve business performance?", *International Journal of Quality & Reliability Management*, 20(8), 936 - 953

Codex Alimentarius Commission (CAC) (2001), "Revised guidelines for the application of the HACCP system in small and/or less developed businesses (SLDBs)", Joint FAO/WHO Food Standards Programme Codex Committee on Food Hygiene, Report of the 34th Session, Agenta Item 10, CX/FH 01/10, CAC, Rome.

Cutler P.(1994). "Iron overload and psychiatric illness". *Canadian Journal of Psychiatry;* 39, 8–11

Dowlatshashi, S. (1992). "Purchasing's role in a concurrent engineering environment", *International Journal of Purchasing and Materials Management,* 28, 21-5.

Ehiri, E., Morris, P., & McEwen, J. (1995). “Implementation of HACCP in food businesses: the way ahead”, *Food Control*, 6(6), 341-5.

Elzinga, D.J., Horak, T., Chung-Ye, L., & Bruner, C. (1995). "Business process management: survey and methodology," *Engineering Management, IEEE Transactions on*, 42(2), 119-128.

Ericson, T. (1996). "Towards a Test Improvement Model", Proceedings of the Fourth European Conference on Software Testing, Analysis & Review, Amsterdam, December 2-6.

Fairman, J. (2006). Implementing Standards-Based Education in Maine: Progress, Challenges, and Implications. A White Paper. Orono, ME: Center for Research and Evaluation, University of Maine.

Feinberg, M., & Ducauze, C. (1980). High Temperature Dry Ashing of Foods. *Journal of Analytical Chemistry*, 52 (1), 207–209.

Fuente, M., & Vries H.J. (1995). Normen, normalization en het MKB (Standards, Standardisation and SMEs), Netherlands Standards institute and EIM Business & Policy Research.

Ghobadian, A., & O’Regan, N. (2006). "The impact of ownership on small firm behavior and performance", *International Small Business Journal*, 24(6), 555-86

Gilani, P., & Razeghi, Y. (2010). "Global manufacturing: creating the balance between local and global markets", *Assembly Automation*, 30(2), 103–108.

Government of India, (2008). Ministry of micro, small, and medium enterprises. In Micro, Small, and Medium Enterprises in India-An Overview.

Griffith, C. J. (2000). *Food safety in catering establishments - Safe Handling of Foods*, Marcel Dekker, New York.

Hillan J., & Bombproof, L. B. (2006). ‘Facts about Iron’ Available at http://edis.ifas.ufl.edu.

Hulthen L. (2003). ‘Iron Deficiency and Cognition’ *Scandinavian Journal of Nutrition*, 47 (3), 152-156.

Ismail M. A., Taligoola H. K. and Nakamya R. (2008). Mycobiota associated with ISO 9000:2005, Quality management systems – Fundamentals and vocabulary

ISO 9001:2008 (E), Quality Management systems – Requirements

Jayaram, J., Vickery, S.K., & Droge, K. (2000). "The effects of information system infrastructure and process improvements on supply-chain time performance", *International Journal of Physical Distribution & Logistics Management,* 30(3/4) 314-330

Jayaram, J. and Vickery, S. K. (1998), Supply-Based Strategies, Human Resource Initiatives, Procurement Lead-time and Firm Performance. *International Journal of Purchasing and Materials Management,* 34: 12–24.

Jiju A., Maneesh, K., & Madu C. (2005). Six Sigma in Small and Medium Sized UK Manufacturing Enterprises: some empirical observations, *International Journal of Quality and Reliability Management*, 22(8), 860-874

John N. P. (2002), "The impact of purchasing and supplier involvement on strategic purchasing And its impact on firm’s performance", *International Journal of Operations & Production Management*, 22(9), 1032 – 1053

Kaaya, N.A., & Warren, S.L. (2005). Review of past and present research on Aflatoxin in Uganda; African *Journal of Food Agriculture Nutrition and Development,* 5(1), Available on line. www.ajfand.net

McCormack, K., Willems, J., van den Bergh, J., et.al (2009). "A global investigation of key turning points in business process maturity", *Business Process Management Journal,* 15(5), 792 - 81

Kifayah A., & Douglas D. (2008) “A review of six sigma implementation frameworks and related literature‖, In Proceedings of the International Multi Conference of Engineering and Computer Scientist, 91-21 March, Hong Kong,(2008)

Kurekov´a, E. (2001). Measurement process capability— trends and approaches. *Measurement Science Review*, 1 (1), 43–46.

Leenders, M.R.., Fearon, H.E., & Flynn, A.E., Johnson, P.F. (2002). *Purchasing and Supply Management,* 12th ed., Boston

Lewis L., Onsongo, M., & Njapau, H. (2005). Aflatoxin contamination of commercial maize products during an outbreak of acute aflatoxicosis in eastern and central Kenya. *Environmental Health Perspectives*. 113(12), 1763–1767.

Montgomery, D. (2004). *Introduction to Statistical Quality Control.* John Wiley & Sons, Singapore, 4th Edition.

Normanyo, E., Asiam, E. K, Amankwa-Poku, K. & Adetunde, I. A. (2009). “Redesign of a

Grinding Mill for the Minimization of Iron Filings Production" *European Journal of Scientific Research*, 36 (3), pp 418-436

Nguyen T., Wilcock, A., & Aung M. (2004). Food safety and quality systems in Canada: An exploratory study. *International Journal of Quality and Reliability Management,* 6 (21), 655-71.

Ostwald P., & Munoz. J. (1997) "*Manufacturing processes and systems".* Ninth edition.

Temple, P., & Williams. G. (2006). SMEs and standardisation in Europe. 23 Practices to promote the participation of craft and SME enterprises in standardisation and the use of standards.

Terrana, B. (2007.). The impact of reagent standardization on the quality of diagnostic devices. Medical device technology.

Porter, A.M. (2002). "Gillette's chief executive puts power into purchasing", *Purchasing*, 18, 28-30.

Robinson, A. (1995). Iron: A Double-Edged Sword. Fairview, TN: The Arthritis Trust of America

Ropkins, K. and Beck, A. (2000). "Evaluation of worldwide approaches to the use of HACCP to control food safety", *Trends in Food Science and Technology,* 11(1), 10-21.

Sánchez-Rodríguez, C., Hemsworth, D., Martínez-Lorente, A.R., & Clavel, J. G. (2006). "An empirical study on the impact of standardization of materials and purchasing procedures on purchasing and business performance", *Supply Chain Management: An International Journal* 11(1), 56 – 64.

Spangenberg, J.H. (2002). "The changing contribution of unpaid work to the total standard of living in sustainable development scenarios", *International Journal of Sustainable Development*, 5(4), 461–475.

Standards; the common European language, case studies small and medium sized companies by Swedish Standards Institute.

Stefania, T. (2010). Internationalization patterns among speciality food companies: some Italian case study evidence Department of Communication, Computer and System Science, University of Genoa, Genova, Italy

Taylor, E. (2001). "HACCP in small companies, benefit or burden", *Food Control,* 12(4), 217-222.

Temple, P. & Williams, G. (2002). Trading with and within Europe. The benefits of standards. European Committee for Standardization CEN. ISBN 92-9097-025-1.

Uganda National Bureau of Standards (US EAS 44:2011), Milled maize (corn) products – Specifications.

Uganda National Bureau of Standards (US 370:2002). Specification for Maize flour.

UNIDO, (2006) A Guide on Implementing ISO 9001:2000 on requirements for a quality management system

Wacker, J.G., Treleven, M. (1999), "Component part standardization: an analysis of commonality sources and indices", *Journal of Operations Management*, 6(2),219-44

Walker, E., Pritchard, C., & Forsythe, S. (2003). Hazard analysis critical control point and prerequisite programme implementation in small and medium size food businesses, *Food Control*, 14(3), 169-74.

Wessel G., & Burcher, P. (2004). "Six sigma for small and medium-sized enterprises", *The TQM Magazine*, 16(4), 264 – 272.

Yapp, C., and Fairman, R. (2006). Factors affecting food safety compliance within small and Medium-sized enterprises: implications for regulatory and enforcement strategies, *Food Control*, 17 42–51.

Normanyo, E., Asiam, E. K, Amankwa-Poku, K. & Adetunde, I. A.(2009). "Redesign of a Grinding Mill for the Minimization of Iron Filings Production" *European Journal of Scientific Research*, 36 (3), pp 418-436

Appendices

Appendix 1: Checklist used in gathering data from SMEs.

Factor of consideration in Material Inputs	**Level of Standardisation application in enterprises.**									
	Not applied		**Minimal application**		**Average levels of application**		**Pass the requirement**		**Total number, N=45**	
	F	%	F	%	F	%	F	%	F	%
i. Are raw materials inspected before they are stored for subsequent use?										
ii. Are there specifications for raw materials?										
iii. Are the specifications for raw materials documented?										
iv. Are there acceptance criteria for raw materials (e.g., grains will be accepted only if the moisture content is less than 14% - or non-conforming grain may be accepted but at reduced price).										
v. Are the acceptance criteria strictly being followed?										
vi. Are suppliers premises inspected to check on quality controls in place before accepting them to supply?										
vii. Are the acceptance limits set by the company at raw material inspection point are strictly being followed?										
viii. Is there an acceptance criterion for spare components? E.g. steel plates, screens, hammer carriers, hoppers, hammers, etc.										
ix. Is there an acceptance criterion for your machine assemblies? E.g. surface finishes.										
x. Is there a method you use to check and accept materials such as welding rods, paint										

	etc. used in your production?										
xi.	Is there a procedure in place for the segregation and handling of all items from reception through the entire manufacturing/ production to prevent damage and deterioration?										
xii.	Suppliers – Is each supplier/vendor of your raw material or component inspected / audited for proper product controls before supply?										
xiii.	Are finished products stored and handled in conditions which will avoid contamination and deterioration?										
	Human Elements and methods	**Not Applied**		**Minimal levels of application**		**Average levels of application**		**Passes requirement**		**Total Number N=45**	
		F	***%***	***F***	***%***	***F***	***%***	***F***	***%***	***F***	***%***
i.	Is your staff having enough skills to identify good/acceptable raw materials from bad/unacceptable raw material inputs that can affect the output product?										
ii.	Are there any training organized for your technical team in regard to quality requirement of the process and output?										
iii.	Is your technical team experienced to carry out simple maintenance to guarantee process and product quality consistent?										
iv.	Are there procedures followed while doing process maintenance checks?										
v.	Are there work instructions for your technical team at key quality check points?										

	Good Manufacturing Practices	Level of Standardisation application in enterprises									
		Not Applied		**Minimal levels of application**		**Average levels of application**		**Passes Standard requirement**		**Total Number N=45**	
		F	**%**	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**
i.	Is your technical team aware of good manufacturing practices in fabrication and/or milling processes?										
ii.	Are there internal standards in regard to manufacturing processes? I.e. specific codes of practice in the process.										
iii.	Are there external standards in use in regard to manufacturing processes at your premises?										
iv.	Are there any tests carried out internally for conformity analysis of the raw materials?										
v.	Are there any tests carried out externally on your product?										
vi.	Are key quality parameters at each inspection point clearly known by the personnel in charge?										
vii.	Is the frequency of inspection and testing at each inspection point understood and implemented?										
	Good Hygiene Practices	**Level of Standardisation application in enterprises.**									
		Not Applied		**Minimal levels of application**		**Average levels of application**		**Passes Standard requirement**		**Total Number N=45**	
		F	%	F	%	F	%	F	%	F	%
i.	Is there an individual responsible for plant sanitation (cleaning and disinfection)?										
ii.	Is the production premises and environment kept hygienic and systematic to ensure that the finished product does not get contaminated at all times?										

iii.	Are all utensils and equipment cleaned and sanitized at intervals frequent enough to avoid contamination of food products?										
iv.	Are the processing areas maintained free from insects, rodents and other pests?										
	Equipment/Technology	**Response with respect to equipment standardisation**									
		Not Applied		**Minimal levels of application**		**Average levels of application**		**Standard required levels**		**Total Number N= 45**	
		F	%	F	%	F	%	F	%	F	%
i.	Is the equipment designed and used in the process in a manner that prevents contamination with lubricants, contaminated water, metal fragment, etc.?										
ii.	Is the facility kept clean and in good physical repair?										
iii.	Do you have standard tests and checks for conformity of your final product (Machine & components) based on customer requirement?										
iv.	Do you have standard checks for conformity of your testing equipment?										
v.	Do you trace the consistence of your instruments and apparatus used in production process?										
vi.	When there is a need to re-do a component or part that is used in production, do you have a system to control your tooling practices?										
vii.	Is there a mechanism to control gauging and measurement in your production process?										
viii.	Are the facilities adequate as per the implementing guidelines or standards?.										

Appendix 2: Data sets for Objective 3.

Theme 1: Input Material factors - (Number of respondents, N=12)

Theme	**Respondents**	**Percentage**
Lack of control of raw materials	3	25%
Poor post-harvest handling methods	2	16.7%
Failure to follow acceptance criteria	2	16.7%
No standard of maize mills	1	8.3%
No code of practice	1	8.3%
Negative attitudes to handling of raw materials	3	25%

Theme 2: Human Element and Method Factors - (Number of respondents, N=12)

Sub-themes	**Response Rate**	**Percentage**
Lack of awareness	3	25%
Attitude factors	3	25%
Poor organizational factors/ enterprise culture	2	16.7%
Low enforcement of standards and regulations	4	33.3%

Theme 3: Machine and Technology Factors - (Number of respondents, N=12)

Sub-themes	**Response Rate**	**Percentage**
Information gap	4	33.3%
Cost related factors	6	50%
Low levels of technology generation, dissemination and adoption	2	16.7%

Appendix 3: Certificates of analysis from UNBS Laboratory