**Addis Ababa University**

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# Assessing Performance of National Quality Infrastructure on Cooking Utensil Products in Ethiopia

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SCHOOL OF MECHANICAL AND INDUSTRIAL ENGINEERING

This is to certify that the thesis prepared by Amaru Ayansa entitled: "Assessing performance of national quality infrastructure on cooking utensil products in Ethiopia" submitted in partial fulfillment of the requirements for the degree of Masters of Science (Industrial Engineering) complies with the regulation of the University and meets the accepted standards with respect to originality and quality.

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## DECLARATION

I here by declare that the work which is being presented in this thesis entitled "Assessing performance of national quality infrastructure on cooking utensil products in Ethiopia" is original work of my own, has not been presented for a degree of any other university and all the resources of materials used for the thesis have been duly acknowledged.

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This is to certify that the above declaration made by the candidate is correct to the best of my knowledge.

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# ABSTRACT

This study is focused on assessing the performance of national quality infrastructure (NQI) on aluminum cooking utensil products in Ethiopia. The quality of cooking utensil products is determined from each production process starting from raw material preparation, which is an aluminum circle sheet until the end product that is cooking utensil products. However, this product which is locally produced shows low-quality products, due to the lack of developing a standard for it. Therefore, to achieve a good quality product of cooking utensils, NQI pillars (standard, conformity assessment, metrology, and accreditation) play a high role. Hence, the objective of this study is to assess the performance of national quality infrastructure on cooking utensil products that are locally produced to improve the quality of the product and competitiveness in local and global markets. To conduct this study both primary and secondary data were collected from twelve manufacturers and different government offices. Primary data was collected by observation and 73 persons were interviewed through discussions. Secondary data was collected from different kinds of literature, articles, journals, and respective offices. From the data collection, the findings of this study suggested the lack of developed standards and these products are categorized under voluntary standard products due to that the way of quality control in this sector is weak. And the researcher evaluated the aluminum circle sheet and cooking utensil products manufacturing process concerning NQI pillar service on each production process for both production process. However, from ENQI pillars service, nothing is practiced or implemented in this sector, which means the relationship between manufacturers and ENQI service is weak. As a result, the low-quality product was achieved that cannot be competent in the local and global markets. Moreover, the health of a society can be affected because of a lack of the tests of the chemical composition of the product. To solve the above problems the researcher developed the NQI model for both the manufacturing process and proposed solution to improve the quality of the product and competitiveness in the local and global markets.


Keywords: NQI, Aluminium Utensils, Competitiveness, ENQI, Quality Infrastructure System

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# LIST OF ABBREVATION

NQI = National quality infrastructure

ENQI = Ethiopia national quality infrastructure

ESA =Ethiopian standard agency

ENMI= Ethiopian National metrology institute

ECAE= Ethiopian conformity assessment enterprise

MIDI= Metals industry development institute

MoTI = Minister of trade and industry

NAB = National Accreditation body

ENAO =Ethiopian national accreditation office

QI = Quality infrastructure

WTO =World trade organization

AL = Aluminum

NSB =National standard body

NMB =National metrology body

ISO= International standards organization

NAB =National accreditation body

QIS =Quality infrastructure system

# CHAPTER ONE

# Introduction

## 1.1 Background and Justification of the Study

Quality is an essential component of the competitive position of today's most successful companies. The rise of quality in the 1980s and 1990s has brought it to the forefront of the competitive strategies of every corporation[25]. Now a day's quality has become one of the most important consumers and producer decision factors in the selection among competing products and services. The phenomenon is widespread, regardless of whether the consumer is an individual, an industrial organization, a retail store, a bank or financial institution, or a military defense program. Consequently, understanding and improving quality are key factors leading to business success, growth, and enhanced competitiveness[24]. One of the Ethiopian manufacturers' products which is lack of compliance with the requirements of customers is aluminium cooking utensil products. That means low-quality products and competitiveness in the local and global market has occurred for this product. According to data assessment from different sources, lack of national quality infrastructure (NQI) or weak performance of NQI is the source of quality problems of cooking utensil products in any activities of manufacturers of the product. Therefore, this research is aimed to focus on and conduct assessing NQI performance on cooking utensils to improve the quality of the product and competitiveness.

The National Quality Infrastructure (NQI) is the institutional framework that establishes and implements the practice of standardization, including conformity assessment services, metrology, and accreditation to ensure the quality and safety of products and services offered in local and foreign markets[1].

Standards may simply be defined as a set of rules for ensuring quality; it defines how most products, processes, and people interact with each other and their environments. And to enhance competitiveness by offering proof that products and services adhere to requirements of governments or the marketplace. Quality and standards are inherently linked. Quality is the degree to which the innate characteristics of a product, process, or person fulfill stated and unstated customer requirements and expectations; comply with stated norms, regulations, and laws; or both. Standards are often used to codify technological requirements expected by

customers or governments, making them an essential element in the effort to upgrade quality in a country.

Standards are used to codify the technical characteristics and market preferences for products and processes, facilitating knowledge absorption and technological change. Standards have proven effective in promoting the adoption of desirable process and product characteristics (reliability, durability, and so on) and providing roadmaps to improve quality. For example, the international organization for standardization ISO 9001 standard provides an organization with a model to follow for the design, implementation, and assessment of quality management systems. At the national level, the quality infrastructure consists of national bodies for Accreditation, Certification, Standardization, Metrology and Testing[3]. The NQI comprises a variety of organizations each of which plays a role in establishing standards; evaluating whether products, process, or services fulfill specified technical requirements; and certifying that these requirements are met. The best practices approach to NQI as set forth by the World Bank is based on a decentralized system with the various bodies acting as legally autonomous units[2].

Conformity Assessment comprises testing, inspection, and certification of products or services. Testing is the determination of a product's characteristics against the requirements of the standard. Inspection encompasses the examination of product design, end product, or process, and the determination of its conformity with requirements. Certification is the formal substantiation by a certification body after an evaluation, testing, inspection, or assessment, that a product, service, organization, or individual meets the requirements of a standard.

Metrology is the science of measurement. It can be subdivided as follows. Scientific metrology is the development and organization of the highest level of measurement standards. Legal metrology is the assurance of correctness of measurements where these influence the transparency of trade, law enforcement, health, and safety. Industrial metrology is the satisfactory functioning of measurement instruments used in industry, production, and testing.

A national metrology institute establishes the national measurement system used to maintain, develop, and diffuse measurement standards for basic units and to diffuse metrological expertise to the economy. These institutes operate in the primary calibration market: they disseminate

measurement standards by providing calibration services to independent calibration laboratories and other organizations responsible for regulations and standards.

Accreditation is the procedure by which an authoritative body (the accreditation body) formally recognizes that an organization is competent to conduct specified conformity assessment services (that is, testing, inspection, or certification). The accreditation body evaluates the personnel and supporting the management system of the candidates for accreditation and can request practical tests for laboratories when relevant. Quality infrastructure, QI, refers here to all aspects of metrology, standardization, testing, and quality management including certification and accreditation.

The national quality infrastructure supports the development of all industrial branches given that it represents the basis for the safety and quality of all products, in all phases, from design, through production, to their placing on the market. To strong commitment to product safety and quality, as well as implementation of one of the basic principles of the World Trade Organization Agreement on Technical Barriers to Trade (WTO/TBT Agreement) - ensuring that technical regulations and standards, and the relevant conformity assessment procedures, do not create unnecessary obstacles to international trade [7].

Currently, the World Bank is supporting the government of Ethiopia in the development of its National Quality Infrastructure (NQI), which is the institutional framework that establishes and implements several interlinked activities among standardization, accreditation, metrology, and conformity assessment (testing, inspection, and certification). The proposed impact evaluation will be conducted in conjunction with the early developments of the NQI institutional capacity, analyzing how NQI and associated services can allow firms to both signal product quality to buyers and to upgrade product quality[8].

Underdeveloped national quality infrastructure (NQI) in a developing country like Ethiopia may negatively affect a firm's capability to explore commercial opportunities, to compete on global markets, and to participate in global value chains. Many firms face difficulties in demonstrating compliance with quality requirements and trade rules required by trading partners. Given the Ethiopian government's strategic emphasis on the growth of light

manufacturing, fostering product quality upgrading and awareness of and adherence to international product standards is crucial [2].

However, complying with better product standards and quality practices is not a simple matter for aluminum cooking utensils and aluminum circle sheet products manufactured in Ethiopia. Cooking utensil products are used for cooking food at every kitchen and it is a very important product for all houses. Hence, as its importance, the government did not give attention to the quality of this product manufactured in the country. To identify the root cause of low quality of the product, assessing primary and secondary data from manufacturers and respective bodies and evaluation of the production process concerning NQI pillars are conducted. Finally, the researcher has proposed a NQI model for cooking utensils and aluminum circle sheet products to improve their quality and competitiveness in domestic and international markets.

## 1.2 Problem statement

According to the discussion the researcher has made with various factories' managers ( such as Ato Nega Tilahun from Desgeneral trading industry, Ato Tadesse Atiliye from Majet industry, Mr.Sherma from Ethal industry, and Ato Biniam Almaw from Kolfehousehold), the factories are unable to produce cooking utensil products as per the required national standards. Even though the factories mark the company logo on their final products upon their sale, with the present quality of the products, the factories are unable to fulfill the requirements of both the local and global markets. Moreover, these factories use aluminum circle sheets as a raw material without any recognized standard. For instance, the thickness of the raw material fails between 0.6mm and 0.8mm, which is below the required standard level. This causes a low-quality product and excessive product damage during the production process. This inturn challenged the local and global competitiveness of the factories. The quality of AL circle sheet and AL cooking utensil product is low, because of the lack of the development of standards for both products. To produce a good quality product that is competitive in the market, the development of a national standard is essential, and this can be attained through an NQI pillars service practice in every activity of the production process of this sector. However, as long as the researcher's knowledge is concerned, up to date research works have not considered the effects of the NQI practices on the development of the required standards to enhance the AL utensils products' quality. That is, the existing performance of NQI pillars service on cooking utensil products, the gap of QI, and the

relationship between manufacturer and respective bodies with respect to QI service practice need to be clearly addressed for these factories. Hence, this research is indebted to develop an NQI model that integrates the various NQI pillars (standard, accreditation, inspection, testing, and calibration and proper adjustment practices) to enhance the quality and competitiveness of the AL utensils products producing companies in the country.

## 1.3 Research Question

To clearly address the affomentioned problems, the researcher has developed the following research questions.

a. What is the existing performance of NQI pillars service on cooking utensil products?
b. What is the gap of QI performance between cooking utensil manufactures and ENQI?
c. What is the relationship between manufacturer and respective bodies with respect to QI service practice?

## 1.4 Objective

### 1.4.1 General objective

The general objective of the study is to assess the performance of NQI on cooking utensil products that are locally produced to improve the quality of the product and competitiveness in local and global markets.

### 1.4.2 Specific objective

- To study the existing system of NQI of cooking utensil products those locally manufactured.
- To evaluate the production process of AL cooking utensil and AL circle sheet concerning NQI pillars.
- To develop the NQI model for cooking utensil and AL circle sheet products those locally manufactured and to recommend the ways to improve the quality of the product and competitiveness of the factories in the local and global market for this selected product.

## 1.5 Significance of the study

The study provides benefits for the cooking utensil product sector in identifying at which NQI pillars are the root cause for low quality product occurred and to satisfy the customers by improving the quality of the product. This study helps society by creating awareness, as they know and protect themselves from unsafe products which can affect their health. Ethiopian NQI authoritative bodies by themselves benefit from this research to identify their weaknesses and to improve. This study also helps as a reference for other researchers those going to conduct similar studies.

## 1.6 Scope of the study

The scope of study is to assessing performance of NQI in Ethiopia by focusing on aluminum material type products which is cooking utensil products and AL circle sheet which used as raw material of cooking utensils, those produce locally inorder to improve quality of the product and competitiveness in the market.

## 1.7 Limitation of the study

Lack of related articles and literatures conducted with respect to NQI pillars service for Cooking utensil products in order to develop concurrent literature review. And Lack of well organized data of cooking utensil products which shows quality control mechanism during data collection from manufacturers and lack of standard development for this product by ESA, inorder to evaluate performance of the product per its standard.

## 1.8 Organization of the study

The study is organized in five chapters. The first chapter begins with an introduction and background of the study. Statement of the problem and objective of the study also discussed in this chapter. Chapter two is literature review that discusses about the fundamental concepts of NQI and its elements, the general overview of the existing situation of NQI of Ethiopia. This chapter gives the theoretical background of the thesis work.

Chapter three is Research design and methodology of the study in which major data collection techniques are discussed and the overall flow framework of the study is presented. Chapter four data collection is presented and well organized to come up with main source of quality problems

area of cooking utensil product. Analysis and discuss the study based on data collection, evaluate the existing frame work of cooking utensil and AL circle sheet and develop new structure of frame work model for both cooking utensil product and AL circle sheet in this chapter. Chapter five conclusions and recommendation part of the study.

# CHAPTER TWO

## 2 Related Literature Review

### 2.1Quality Concepts

Quality is perceived differently by different people. Yet, everyone understands what is meant by "quality." In a manufactured product, the customer as a user recognizes the quality of fit, finish, appearance, function, and performance[27]. The quality of service may be rated based on the degree of satisfaction by the customer receiving the service. The relevant dictionary meaning of quality is "the degree of excellence." However, this definition is relative in nature. The ultimate test in this evaluation process lies with the consumer. The customer's needs must be translated into measurable characteristics in a product or service. Once the specifications are developed, ways to measure and monitor the characteristics need to be found. This provides the basis for continuous improvement in the product or service. The ultimate aim is to ensure that the customer will be satisfied to pay for the product or service. This should result in a reasonable profit for the producer or the service provider. The relationship with a customer is a lasting one. The reliability of a product plays an important role in developing this relationship.

Today, there is no single universal definition of quality. Some people view quality as "performance to standards "others view it as "meeting the customer's needs" or "satisfying the customer." Quality is conformance to requirements (Crosby), Quality is fitness for use (Juran), Quality should be aimed at the needs of the consumer, present, and future (Deming), Quality is the total composite product and service characteristics of marketing, engineering, and maintenance through which the product and service in use will meet the expectations of the customer [28,29].

## 2.2 Overview of National quality Infrastructure (NQI)

A variety of definitions of National Quality Infrastructure (NQI) have been provided in the literature as follows and it has been considered as an approach to infrastructure for quality. National Quality Infrastructure (NQI) is the institutional framework that establishes and implements the practice of standardization, including conformity assessment services, metrology, and accreditation to ensure the quality and safety of products and services offered in local and foreign markets[1].

According to Keller and Kellermann (2014), the term "quality infrastructure" (QI) refers to the policy and institutional framework that governments establish to provide evidence that products and services meet the requirements set by regulatory authorities and the market place. In this case QI framework describes a way of measuring, standardizing, assessing and certifying the products and services businesses produce. Racine in his book has defined the term national quality infrastructure as the complete chain of public and private institutions required to establish and implement the standardization, metrology, inspection, testing, certification, and accreditation services needed to ascertain that products and services meet defined requirements,whether demanded by authorities or the market [23]. Quality infrastructure relates to all the fields of metrology, standardization and testing, of quality management and conformity assessment, including certification and accreditation. Quality infrastructure is a "code" which gives information only to experts on the existing relationships[11].

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national quality infrastructure as the complete chain of public and private institutions required to establish and implement the standardization, metrology, inspection, testing, certification, and accreditation services needed to ascertain that products and services meet defined requirements, whether demanded by authorities or the market. Quality infrastructure relates to all the fields of metrology, standardization, and testing of quality management and conformity assessment, including certification and accreditation. Quality infrastructure is a "code" which gives information only to experts on the existing relationships[11].

According to reference [2], quality infrastructure (QI) can be defined as the combination of the institutional network, either public or private, and the legal framework that:

- regulates, formulates, edits, and implements standards (that is, establishes rules for the common and repeated use of standards to obtain an optimal order in a given context considering current and potential problems)
- provides evidence of its fulfillment (that is, a relevant mixture of governmental market surveillance, inspections, tests, certification, metrology, and accreditation).

The QI has the aim of improving the equivalence of products, processes, and services for desired purposes; of impeding commercial barriers; and of facilitating technical cooperation.

Quality Infrastructure was coined by the International Technical Cooperation of PTB, replacing the formerly used acronym MSTQ: Quality infrastructure refers to all aspects of metrology, standardization, testing, quality management, certification and accreditation that have a bearing on conformity assessment (abbreviated as MSTQ)[3].

## 2.3 Elements of NQI

Industrial countries rely on many standards and technical regulations for their trade-related activities. If developing countries wish to enter the global market, they must be able to count on standards-related facilities including access to standards and technical regulations, metrology, testing, quality assessment, certification and accreditation. These elements are the components of what we call a National Quality Infrastructure.

Current global trade is based mainly on technology-intensive manufactured goods, not raw materials. Each and all of the QI components are essential to production and trade, and they are closely related. There cannot be a sound QI and thus a sound basis for global trade, without each

and all of them, even though they may exist at different degrees of development [4]. If developing countries want to attract foreign investments, they must keep in mind that infrastructure and this includes quality infrastructure is one of the key factors foreign investors will consider. In the case of a national quality infrastructure, they must at the very least: ensure access to international standards and technical regulations, guarantee reliable measurements, and set up a system that will allow accreditation of their testing and certification facilities in such a way that the results of these bodies will be internationally accepted. A QI also supports local industries and consumers. In most cases, the countries have to enforce standards and technical regulations that conform to international requirements. For instance, when exporting agricultural and food products, it is necessary as a minimum to demonstrate compliance with international sanitary, phytosanitary and safety standards. Other specifications must also be met such as those related, for example, to packaging and labeling.

### 2.3.1 Standards

Standardization contributes considerably to development and improvement of production and marketing of products, implementation of activities, i.e. rendering services, improving quality of products, processes and services, their standardization,compatibility and interchangeability, improving protection of life, health and safety of people and property, environmental protection, as well as promoting international trade by preventing and removing unnecessary technical barriers[10].

Standards are used to codify the technical characteristics and market preferences for products and processes, facilitating knowledge absorption and technological change. Standards have proven effective in promoting the adoption of desirable process and product characteristics (reliability, durability, and so on) and providing roadmaps to improve quality. Standards are documented agreements that translate such desired characteristics into dimensions, tolerances, weights, processes, systems, best practice and other specifics so that products and services that conform to their requirements provide confidence to buyers and users. For developing countries, international standards developed on the basis of worldwide consensus by experts in the field constitute an important source of technological know-how. By defining the characteristics that products and services will be expected to meet on export markets, international standards give developing countries a basis for making the right decisions when investing their scarce resources.

Within a QIS, standardization is usually the responsibility of a National Standards Body (NSB) that may represent the country's interests within organizations such as ISO (the International Organization for Standardization). The NSB may provide national delegations to participate in the development of standards that are of key importance to their country's economy [7]. Whether or not the NSB participates in the development of a standard, it is free to adopt and translate international standards as national standards. By using international standards, it ensures that the country benefits from international, state-of-the-art knowledge and that locally produced products will meet the requirements demanded by export customers.

For consumers, conformance of products and services to international standards provides assurance about their quality, safety and reliability.

For example, the International Standards Organization ISO 9001 standard provides an organization with a model to follow for the design, implementation, and assessment of quality management systems[5], [6].

Standards might be barriers to foreign markets for small firms or they can complicate access for suppliers of large corporations. A first problem is the lack of awareness and information about local firms regarding opportunities and specific requirements of international buyers. Another barrier is the cost of the certification process, which normally includes a profound organizational change process within the firm[26]. While the adoption of certain environmental and labor standards may be a useful strategy for product differentiation for certain firms, it may not be efficient for the whole sector and may block existing comparative advantages.

Therefore, to tackle this situation the national standards body plays an important role in determining which standards the country should adhere to the base on the existing economic environment and goals. According to many good practices across the world, limited set of technical regulations is developed by the government to protect consumers' health, safety, and the environment, often by designated regulatory agencies under the ministries, with no involvement of the national standardization body. Moreover, reviews of technical regulations should ensure that they do not impose technical barriers to trade and unnecessary constraints to businesses [1].

**Benefits of standardization**

**For manufacturer**

- Rationalization of the manufacturing process, reduction of cost and simplification of operations
- Elimination or minimization of material and labor wastage
- Minimization of inventories of both raw material and finished products
- Improved productivity and competitiveness
- Customer confidence and sustainable market

**For business person / organization**

- The provision of a workable basis for acceptance or rejection of goods or consequential disputes, if any
- Minimization of delays, correspondence, etc., resulting from inaccurate or incomplete specification of materials or products.

**For customer**

- Assurance of the quality of purchased goods or received services
- Justification for better value for money
- Convenience for settling disputes, if any suppliers

**For researcher (scientist/technologist)**

- Provision of starting point for research and development for practical application and further improvement or innovation

**For government**

- Supports the technical aspects of economic, societal and environmental policies and contributes to sustainable development
- Serves to enhance industrial productivity, competitiveness and sustainable development
- Facilitates for regulatory compliance and offers the means for consumer protection
- Enhance the market access opportunities and achieving maximum overall economy

Generally standardization contributes considerably to development and improvement of production and marketing of products, implementation of activities, i.e. rendering services, improving quality of products, processes and services, their standardization, compatibility and

interchangeability, improving protection of life, health and safety of people and property, environmental protection, as well as promoting international trade by preventing and removing unnecessary technical barriers[15].

### 2.3.2 Conformity assessment

Conformity assessment is the name given to the processes and procedures that are used to demonstrate that a product or a service, management system, an organization or personnel meets specified requirements. These requirements are usually stated in international standards developed by organizations such as ISO (International Organization for Standardization). The requirements for conformity assessment activities themselves are also given in international standards and this helps to ensure consistency worldwide, as well as cross-border acceptance of results. The use of international standards thus harmonizes conformity assessment activities throughout the world. This has far-reaching benefits for international trade in general. Agreements among nations or regions on the mutual acceptability of requirements, assessment methods, inspection or test results, etc., can all help to reduce or remove technical barriers to trade. These are requirements and rules – often defined in regulations - relating to importation and market access that vary from country to country and may bar a foreign product from entering a national market.

The World Trade Organization's Agreement on Technical Barriers to Trade (WTO TBT Agreement) was established to ensure that technical regulations and standards, and the procedures for assessing conformity with them, do not create unnecessary obstacles to international trade. The WTO TBT Agreement promotes the recognition by countries of each other's conformity assessment results as a way of reducing barriers to trade. It emphasizes that confidence in the reliability of conformity assessment results is a prerequisite to recognition of assessments. Therefore, a QIS in a developing country that is able to demonstrate the conformity of the nation's products and services to international standards, and also to provide confidence in local conformity assessment activities, makes a significant contribution to the competitiveness of nation's economy and industry[7].

Conformity assessment services are usually performed by organizations specializing in one or other activities, of which the main ones are described below. They may supply their services on a commercial basis, or they may be operated or mandated by the government.

Testing evaluates the performance of measurements with certain instruments and devices to assess a product or process according to a specified procedure. And also determination of the characteristics of a product in comparison with the requirements of a standard. A product is tested against a specific set of criteria, such as performance or safety. Tests can vary from a simple visual or nondestructive evaluation (for example, tests with x-rays or pressure tests after which the products can be used) to a totally destructive analysis (for example, chemical, mechanical, physical, or metallurgical tests after which the products cannot be used anymore) or any combination of both.

Inspection is the examination of the design of products, services, procedures, and installations and the evaluation of their conformity with general or specific requirements in the form of laws, technical regulations, standards, and specifications. Private clients, organizations, and state authorities may contract for inspections.

Certification is when a certification body gives written assurance that a product, service, process, personnel, organization or management system conforms to specific requirements. That means certification provides assurance of the compliance of a product or process with a specific standard. The most well-known examples are the certification of quality management systems and environmental management systems as conforming, respectively, to the ISO 9001 and ISO 14001 standards. More than a million business and public sector organizations worldwide have had their management systems certified to one or both of these standards. Product certification may consist of initial testing of a product combined with assessment of its supplier's quality management system. This may be followed up by testing of samples from the factory and/or the open market. Other product certification schemes comprise initial testing and surveillance testing, while still others rely on the testing of a sample product - this is known as type testing. The type of certification scheme chosen will depend on factors such as the degree of potential risk to consumers and users of the product[7],[2]. According to Racine (2011),internationally recognized certification has enabled the company to access more sophisticated buyers who can settle their accounts on time. It has also allowed its buyers to charge a higher price for its product and has facilitated the export procedure.

Generally Conformity assessment activities hence provide a vital link between standards and product, process and service.

### 2.3.3 Accreditation

The independent confirmation of the (technical) competence of an individual or an organization that delivers specific services (for example, calibrations, tests, certifications, and inspections). Accreditation is the process by which an authoritative body gives formal recognition that a body or person is competent to carry out specific tasks. It is thus the formal confirmation, based on international standards, by an independent third party, that a body is competent to perform certain tasks. Within a QIS, the body made responsible for accreditation will evaluate the competence of product, management system and personnel certification bodies, testing laboratories and inspection bodies. Its official approval known as "accreditation"will indicate to customers and users of the services of these organizations that they can have confidence in their work. Accreditation ensures that conformity assessment activities have been performed by competent bodies in accordance to appropriate standards and best practices. It guarantees the quality of test data and provides a sense of discipline that is internationally accepted as well [8].

Accreditation is often the responsibility of a national accreditation body (NAB) that may seek recognition of its accreditations within the frameworks of the International Accreditation Forum (IAF) and International Laboratory Accreditation Forum (ILAC).IAF and ILAC promote and manage "mutual" or "multilateral" recognition "agreements" or "arrangements" (MRA) where by the parties involved agree to recognize the results of each other's testing, inspection, certification or accreditation. MRAs can be an important step towards reducing the multiple assessments that products, services, systems, processes and materials may need to undergo, especially when they are traded across borders. Since MRAs facilitate the acceptance of goods and services everywhere on the basis of a single assessment in one country, they contribute to the efficiency of the international trading system to the benefit of suppliers and customers alike[7].

### 2.3.4 Metrology

Metrology is tasked with ensuring reliability and accuracy of results of measurements traceable to the international system of units (SI). That can be achieved with use of accurate measuring tools compliant with requirements established on the international level that ensure measurement results traceable to the national standard and from there to the international standard.

Metrological activities are greatly significant for ensuring quality of industrial processes, reliability of laboratory research, safeguarding the health and safety of people, safety of traffic

and property, protection of consumers in purchasing relations as well as control of protection of living and working environment[10].

Metrology encompasses fundamental, legal and industrial metrology.

Fundamental metrology refers to establishment, development and preservation of standards with scientific methods (e.g. Establishing a meter, as a unit of measurement of length, with a laser);

Legal metrology is the part of metrology referring to legally stipulated activities relating to units of measurement, measuring tools and measuring methods used in the function of goods and services turnover, protection of health and general safety, protection of environment,control and safety of traffic and other. It encompasses the following activities: assessment of conformity of measuring tools with stipulated requirements; metrological surveillance (as a specific type of market supervision); examination of previously packed products; supervision of work of authorized bodies and coordination of holders of national standards.

Industrial metrology ensures accuracy of measuring tools used in production processes and examination procedures (e.g. Devices measuring hardness of materials used in production processes)

National metrological institute holds the primary role for ensuring that metrological system works. Metrology system plays an essential role in this system as it ensures that the accuracy and precision of measurements involved in conformity assessment processes can be traceable with confidence to a trustworthy measurement authority. Metrology allows for calibration, which determines the relationship between an instrument's input and output[8]. Calibration is a basic tool in ensuring the traceability of a measurement is the calibration of a measuring instrument, measuring system or reference material. Calibration determines the performance characteristics of an instrument, system or reference material. It is usually achieved by means of a direct comparison against measurement standards or certified reference materials.

A calibration certificate is issued and, in most cases, a sticker is provided for the instrument.

The four main reasons having an instrument calibration are to establish and demonstrate traceability, to ensure readings from the instrument are consistent with other measurements, to determine the accuracy of the instrument readings and to establish the reliability of the instrument i.e. that it can be trusted. Calibration laboratories help firms to ensure that their equipment allows

them to manufacture products in accordance with buyer requirements. To play a credible role in the conformity assessment system, testing and calibration laboratories and inspection bodies must display many of the same characteristics as certification bodies, notably, impartiality, objectivity, and confidentiality. Objectivity relies heavily on the procedures guiding the evaluation process, the equipment used, and the skills and qualifications of staff. Equipment and measurement systems must be calibrated to other internationally accepted metrological references to ensure traceability [1]. In modernizing a metrological framework, it is important to conduct a needs and gap assessment of the measurement standards currently in place, what they cover, whether they meet requirements and at what level of accuracy. A new approach for the selection of equipment and reference standards needs to be applied in market economies.

## 2.4 Benefits of national quality infrastructure in developing economy

A functioning national quality infrastructure helps increase competitiveness in manufacturing and service delivery. This, in turn, increases productivity, helps create jobs, encourages investment and can promote more careful use of natural resources. A national quality infrastructure also helps to bring about improvements in health care and a more equal distribution of national wealth [13].

The QIS provides benefits to everyone in the supply and demand chain. This includes the consumer, manufacturer and the supplier[14].

Consumers benefit because the QIS provides confidence that the products and services they purchase are fit for their purpose.Manufacturers and suppliers benefit because the QIS promotes their use of international standards to ensure that their products and services meet state of the-art requirements, and that their business processes are modeled on management system standards recognized worldwide.Regulators benefit because the QIS helps them to identify and specify the standards and conformity assessment processes they can use to ensure that public interest requirements, such as health, safety and environmental, are being met. The regulator will often make conformity assessment obligatory in these fields and may prohibit the sale of nonconforming products and services.The government benefits because the QIS puts at its disposal a system for stimulating the economy, increasing the competitiveness of its industry on global markets, using resources efficiently,sharing technological know-how,tackling environmental and climate-related challenges, and for fulfilling its responsibilities for public health and safety, including food safety.

## 2.5 Importance of the modern quality infrastructure system

The basic premise of modern industrial production and international trade in goods is conformity of products and production processes with the requirements of quality and safety. To achieve this goal, each country needs to develop its own quality infrastructure system, which will serve as a framework for enhancing safety of industrial products on the market and protection of other public interests[15]. An effective and efficient national quality infrastructure system is a prerequisite (essential) for:

a) Placing safe and quality products on the market and ensuring high level of consumers' rights protection;

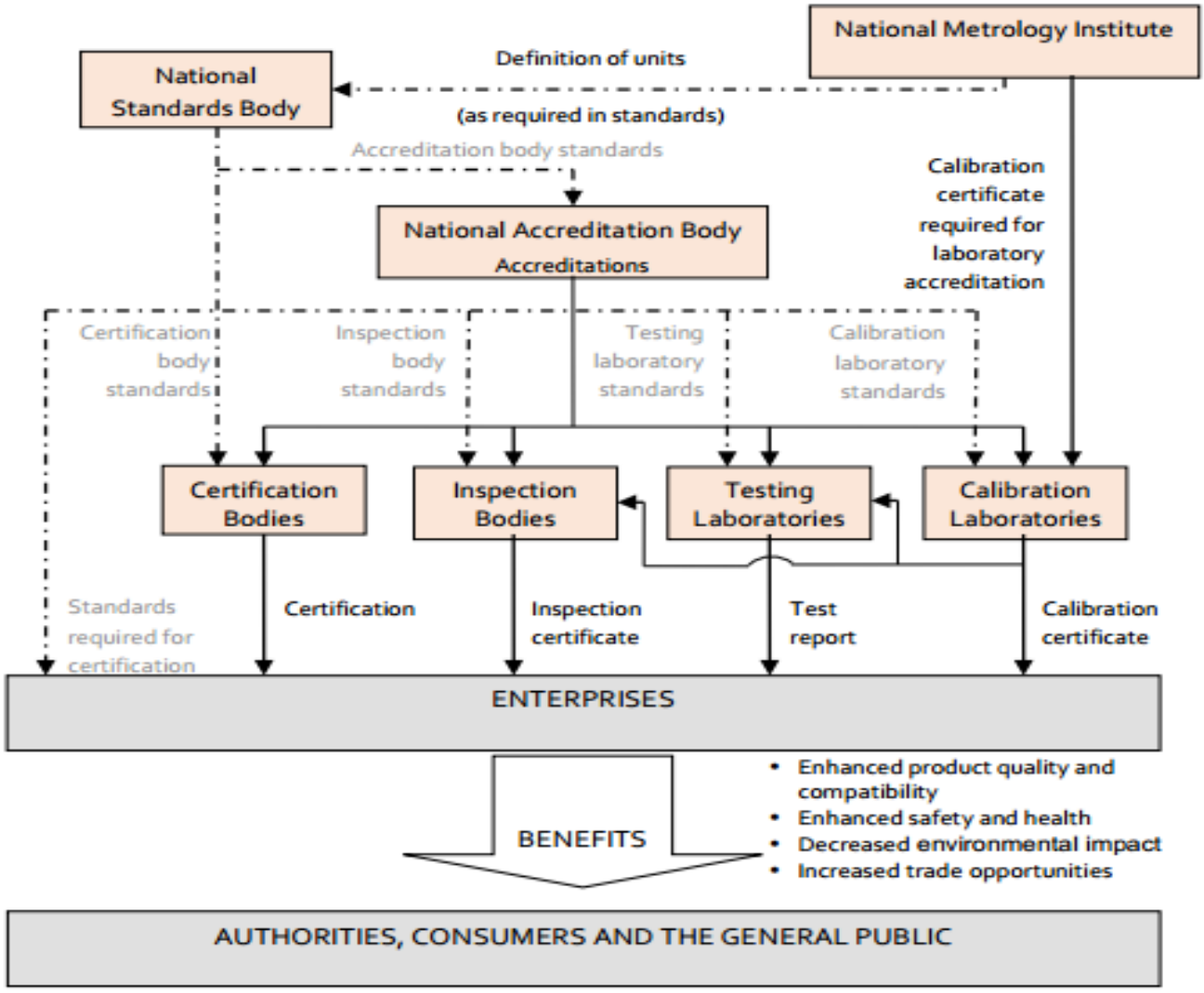
b) Free movement of goods and removing technical barriers to trade;

c) Easier access of national producers to international markets;

d) Achieving higher level of industry innovations and competitiveness;

e) Sustainable economic development and environmental protection.

To facilitate consumers' access to safe and quality products, a product has to conform to specified requirements, standards and other technical specifications. It means that the product has been designed, produced and inspected using the national QI system and that its conformity has been verified. Free movement of goods on the international market, without unnecessary technical barriers, is achieved through implementation of the World Trade Organization Agreement on Technical Barriers to Trade (WTO/TBT), and through other bilateral and multilateral agreements on mutual acceptance of industrial products and conformity assessment.




***Source:*** World Bank 2007.

Figure 2.1 National Quality Infrastructure

Here it is named a general NQI model since it represents a general framework of a manufacturer but it can be customized for a specific product depending upon its type and priority areas. In this section we will learn in short the general model of NQI and in analyzed and discussion of the study production process of AL cooking utensil and AL circle sheet customizing this general model to each process has been analyzed. The general NQI model has four pillar areas as discussed in above literature.

Table 2.1 National Quality Infrastructure Institutions and Service Outputs, [source 18]

| Domain | Description of service | Institution(s) |
|---|---|---|
| Standards | Publication of a formal document (standard), generally developed by consensus, containing the requirements that a product, process or service should comply with.<br>Standards are considered essentially voluntary in themselves. Suppliers can therefore choose whether to use standards or not. It is only once they are called up in a contract, for example, or referenced in a technical regulation, that compliance with standards becomes a legally Binding obligation. | -National Standards Body (NSB)<br>-Sectoral Standards Development Organizations (SDO)<br>- Industry-based Standards organizations<br>-Note: Although most NSBs are public organizations, a few Private NSBs exist. The SDOs are mostly private. |
| Metrology | The technology or science of measurement. Metrology can be subdivided into scientific metrology (the development and organization of the highest level of measurement standards),<br>legal metrology (the assurance of correctness of measurements where these have an influence on the transparency of trade, law Enforcement, health and safety) and industrial metrology (the satisfactory functioning of measurement instruments used in industry, production and testing). | -National Metrology Institute (NMI)<br>-National Calibration Service<br>-Calibration Laboratories (public or private)<br>-Legal Metrology Department (LMD)<br>-Note: The NMIs are invariably public Organizations and so are, by definition, the LMDs. Calibration laboratories May be public or private. |
| Accreditation | The activity providing independent attestation as to the competency of an individual or an organization to offer specified conformity assessment services (e.g. testing, inspection or certification) | -National Accreditation Organization/Body<br>Note: This is usually a public organization |
| Inspection | The examination of a product design, a product, a process or an installation and the determination of its conformity with specific requirements or, on the basis of professional judgment, with general requirements. Inspection such as import inspection is often conducted on consignments, to ensure that the whole consignment is equivalent to the product sample tested | -Import inspection agencies<br>-General inspection Agencies<br>-Note: These can be Public or private agencies. |

| | | |
|---|---|---|
| Testing | The determination of a product's characteristics against the requirements of the standard. Testing can vary from a non-destructive evaluation (e.g. X-ray, ultrasound, pressure testing, electrical, etc. where after the product is still fit for use) to a totally destructive analysis (e.g. chemical, mechanical, physical, microbiological, etc. where after the product is no longer fit for use). | -Testing laboratories<br>-Pathology laboratories<br>-Environmental laboratories<br>-Note: These can be public or private laboratories. |
| Certification | The formal substantiation by a certification body after evaluation, testing, inspection or assessment, stating that a product, service, Organization or individual meets the requirements of a standard. | -Product certification Organizations<br>-System certification Organizations<br>-Note: These can be public or private organizations. |

## 2.6 Aluminum production and definition

Aluminum is the world's most abundant metal and is the third most common element, comprising 8% of the earth's crust. The versatility of aluminum makes it the most widely used metal after steel. Although aluminum compounds have been used for thousands of years, aluminum metal was first produced around 170 years ago.

In the 100 years since the first industrial quantities of aluminium were produced, worldwide demand for aluminium has grown to around 29 million tons per year. About 22 million tons is new aluminium and 7million tons is recycled aluminium scrap. One hundred and twenty-five years ago, Charles Martin Hall discovered a method to create aluminum by separating it from bauxite ore through electrolysis. Nearly 75 percent of the aluminum produced since then is still in use today a testament to the material's durability and recyclability [16],[17].

Aluminium is one of the lightest engineering metals, having strength to weight ratio superior to steel. By utilizing various combinations of its advantageous properties such as strength, lightness, corrosion resistance, recyclability and formability, aluminium is being employed in an ever-increasing number of applications. The major advantages of using aluminium are tied directly to its' remarkable properties.

**Strength**- Aluminium has a density around one third that of steel and is used advantageously in applications where high strength and low weight are required. This includes vehicles where low mass results in greater load capacity and reduced fuel consumption.

**Corrosion Resistance** - When the surface of aluminium metal is exposed to air, a protective oxide coating forms almost instantaneously. This oxide layer is corrosion resistant and can be further enhanced with surface treatments such as anodizing.

**Electrical and Thermal Conductivity** -Aluminium is an excellent conductor of both heat and electricity. The great advantage of aluminium is that by weight, the conductivity of aluminium is around twice that of copper. This means that aluminium is now the most commonly used material in large power transmission lines.

The best alternatives to copper are aluminium alloys in the 1000 or 6000 series. These can be used for all electrical conduction applications including domestic wiring. Weight considerations mean that a large proportion of overhead, high voltage power lines now use aluminium rather than copper. They do however, have a low strength and need to be reinforced with a galvanized or aluminium coated high tensile steel wire in each strand.

**Light and Heat Reflectivity**- Aluminium is a good reflector of both visible light and heat making it an ideal material for light fittings, thermal rescue blankets and architectural insulation.

**Toxicity**- Aluminium is not only non-toxic but also does not release any odours or taint products with which it is in contact. This makes aluminium suitable for use in packaging for sensitive products such as food or pharmaceuticals where aluminium foil is used.

**Recycling** - the recyclability of aluminium is unparalleled. When recycled there is no degradation in properties when recycled aluminium is compared to virgin aluminium.

Furthermore, recycling of aluminium only requires around 5 percent of the input energy required to produce virgin aluminium metal.

**Aluminium production**

Aluminium is extracted from the principal ore, bauxite. Significant bauxite deposits are found throughout Australia, the Caribbean, Africa, China and South America. Open cut techniques are commonly used to mine the bauxite.

The bauxite is purified using the Bayer process. This process involves dissolving aluminum trihydrate to leave alumina plus iron and titanium oxides. The iron and titanium oxides are by-products of the process and are often referred to as ‘red mud’.

Alumina- Bauxite is the most important aluminous ore for the production of alumina. Bauxite occurs close to the surface in seams varying from one meter to nine meters, formed as small

reddish pebbles (pisolites). Bauxite contains 40 to 60 mass% alumina combined with smaller amounts of silica, titania and iron oxide. Alumina is mainly extracted from bauxite using Bay Process.

Figure 2.2 Bauxite or Aluminum ore

Bauxite is crushed, dried and ground in special mills where it is mixed with a small amount of water. This process produces a thick paste that is collected in special containers and heated with steam to remove most of the silicon present in bauxites. At an aluminium smelter, alumina is poured into special reduction cells with molten cryolite at 950℃. Electric currents are then induced in the mixture at 400 kA or above; this current breaks the bond between the aluminium and oxygen atoms resulting in liquid aluminium settling at the bottom of the reduction cell.

Figure 2.3 Aluminum ingot

Primary aluminium is cast into ingots and shipped to customers or used in the production of aluminium alloys for various purposes. International standards distinguish two types of unalloyed aluminum: “pure aluminum”of 99.0–99.9% and “high-purity”aluminum of at least 99.97%, which is produced by further refinement.

## 2.7 Cookware Material: Aluminum

According to incomplete statistics, about half of the world's cooking utensils are made of aluminum. The heat efficiency of cooking is as high as 93%, while stainless steel and cast iron are only 1/3 of aluminum. The use of aluminum circles to manufacture cookware will greatly increase the physical and chemical properties of the cookware, so that the electrical conductivity, thermal conductivity, heat resistance and other characteristics of the cookware can be improved, providing a guarantee for the production of a good diet.

Compared to other metals, aluminum (also known as aluminium) is highly thermally conductive (pound for pound, aluminum delivers the highest thermal conductivity of all cookware materials), cheap, and low-density, but not particularly hard or strong. Heat treatment and other techniques can strengthen and harden aluminum, but such techniques can also make machining and forming pots and pans harder as well. Aluminum has advantages over other materials due to better strength with lower weight, higher heat conductivity, resistance to heat, and easy softness to shape. To distribute heat quickly and evenly makes aluminium one of the best metals for use in cookware. Apart from being an excellent heat conductor it is light and rust-resistant. Compared to stainless steel, aluminium is relatively soft and not very scratch-resistant.

**Advantages of aluminum cookware**

- Efficient heat conduction – the heat is conducted quickly and evenly through the material.
- Quick heating is energy-saving. Even heating helps prevent the food from getting burnt.
- Aluminum is a lightweight material which makes the pots and pans easy to handle.
- Rust-resistant.

Generally aluminium cooking utensils are manufactured from raw material which is called aluminium circle sheet through necessary production process.

### 2.7.1 Aluminum circle sheet material

Cookware, as the most concentrated product with aluminum circles, is actively improving the manufacturing level to ensure the optimization of process performance, making aluminum circles show more advantages in cookware manufacturing.

The most advanced equipment for the production of aluminum circles is the aluminum circle unwinding and blanking production line. This automatic production line is fully automatic

aluminum circle production equipment, which can effectively improve the material utilization rate, far superior to other circles. The aluminum circle unwinding and blanking production line equipment can directly complete the circle punching and blanking without cutting and cutting on the aluminum coil. The products are widely used in the aluminum processing circles of the aluminum processing industry. Chemical composition of aluminum product for manufacturing of cooking pot standard implemented in Kenya is as shown in table.

Table 2.2 Chemical composition of aluminum cooking pot Source:-[Kenya standard]

| Composition Element | Composition limits are in % |
|---|---|
| Aluminum (AI), min. | 98.00 |
| Copper, max. | 0.1 |
| Iron (Fe), max. | 0.95 |
| Silicon (Si), max. | 0.95 |
| Manganese (Mn), max. | 0.1 |
| Zinc (Zn), max. | 0.2 |
| Titanium (TI), max. | 0.2 |
| Magnesium (Mg), max. | 0.2 |
| Lead (Pb), max. | 0.005 |
| Note: The sum of the composition of all the elements on testing shall be 100 %. | |

As seen above table shown that chemical composition standard for aluminimium cooking utensil products. Each chemical composition as we can see it is the maximum percentage , and Kenya's manufacturers are manufactured aluminuim cooking utensils based on this standard. In this country the minimum thickness of AL circle sheet is 0.7mm and above based on diameter of manufactured products. So that in Kenya manufacturing sector NQI is implemented and now they are on well practices of QI service. However , in Ethiopia not the matter of availability of NQI rather than matter of implemtation or lack of practice . Therefore, it is weak or low performance, in this sector.

## 2.8 Previous studies and Gap analysis

From assessment of previous study concerning to NQI performance in AL cooking utensil and AL circe sheet sector shown that weak practice of NQI pillars. So that this study can be taken as the frist study for this sector those locally manufacturered. However, in coffee sector, was studied in Ethiopia "The Performance of Ethiopian National Quality Infrastructure In Ethiopian Coffee Value Chain" author by Dagne Tsagaye, October , 2017. Objective of the study was assessing the performance of Ethiopian NQI in Ethiopian coffee value chain to improve quality of coffee for the sake of competitive in local and global market and to increase income. The study conducted through primary and secondary data collection and focusing on specifically on production and primary processing activities in coffee sector. From the findings of the study, since standards are available in all activities of production and primary processing, it is not responsible for the existence of root causes that resulted coffee quality defects, except lack of standards for coffee cherries grading and weak implementation of the whole standards. weak metrology performance is identified in calibrating, adjusting and maintaining machines used during pulping, hulling and husking, and in calibrating moisture testers used for measuring the drying level or moisture contents of coffee.Weak performance of conformity assessment,and lack of accreditations performance is observed through all activities. To solve the problems within the performance of ENQI elements in production and primary processing activities of coffee value chain, the researcher has proposed a new working framework that can link the two sectors (NQI sector and coffee sector) to work cooperatively based on the findings.

According to this in AL cooking utensil and AL circle sheet NQI performance assessed based on production process. Hence the production process in cooking utensil is different from coffee process. And in coffee sector standard is developed ,and others NQI elements are available but lack of implementation is occurred. However, in cooking utensil products sector did not developed the standard and non of NQI service pillars is practiced.

Therefore, in AL cooking utensil and AL circle sheet NQI performance assessment is different from in coffee. In cooking utensil based manufacturing process and in coffee based farming process. Also frame work model developed for cooking utensil and AL circle sheet is different, inorder to show for standard development and practice of all NQI pillars through manufacturing process.

# CHAPTER THREE

# 3 Research Design and Methodology

## 3.1 Research design

To answer the research questions and to achieve objectives of the study an appropriate methodology is designed as follows.

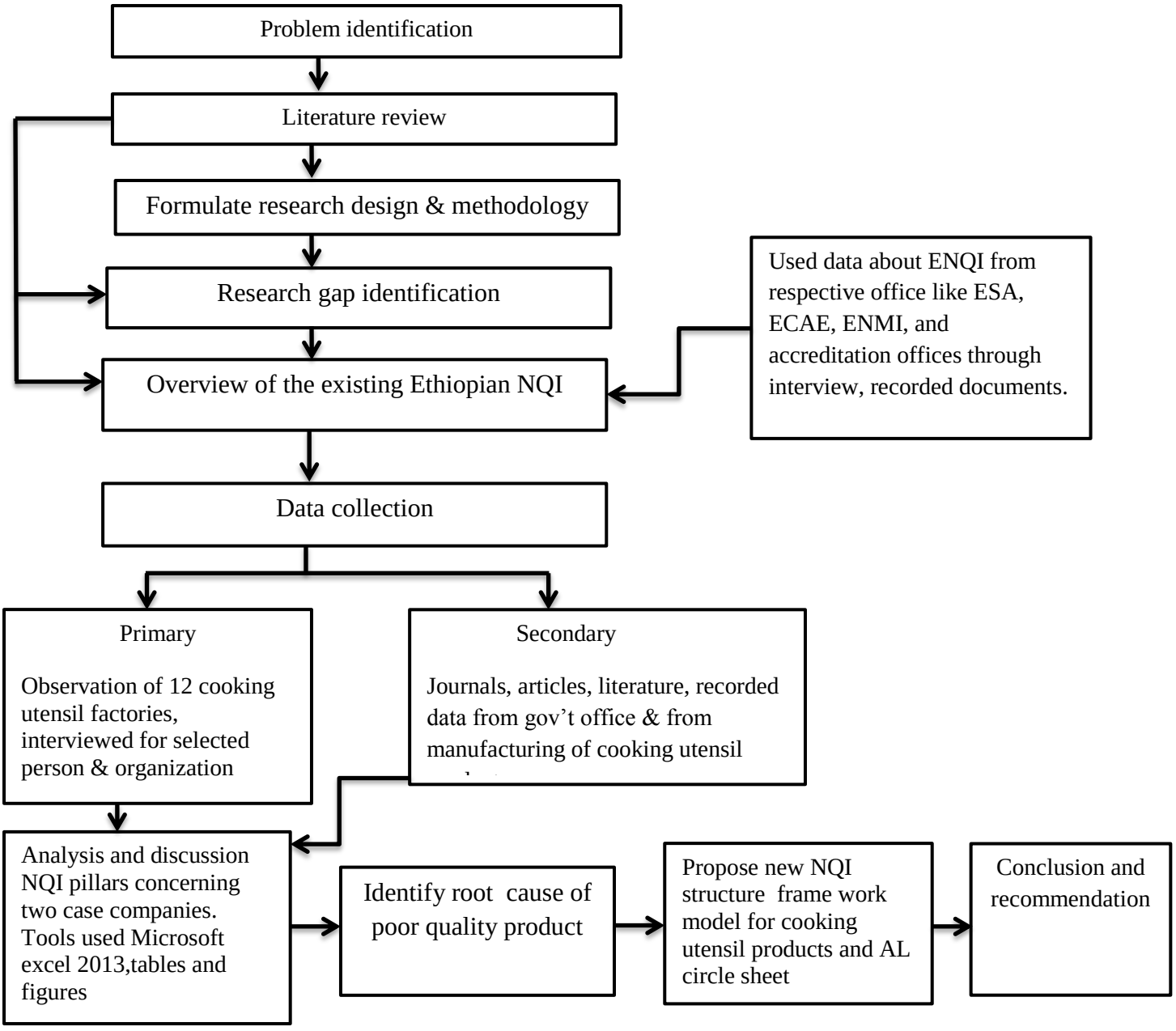



Figure 3.1 Methodological frame work

## 3.2 Research Method

To assess the performance of NQI elements (standards, metrology, testing, certification and accreditation) for cooking utensil product sector, and can be achieved objective of the study through, literature reviews, data collection, case studies, analysis, formulate proposed solution, conclusion and recommendations.

### 3.2.1 Data collection Techniques

In data collection, both primary and secondary data was used.

**a) primary data collection**

In primary data collection, first hand data are collected by using observation and interview, rather than questionaries distribution. Because, during questionaries distributions and collections, getting reality data is very rare. To get truth data and to achieve good analysis of the study direct observation and interview method was choosen.

**Observation:-** by visiting twelve cooking utensil product manufactures, and assessed the quality control technique they used to check the quality status of their products. And also by attending how to inspect the quality of their raw materials, all production process including till packing of the products in both AL circle sheet and AL cooking utensil manufacturing process.

**Interview:-** Under this data collection method, structured interview questions were prepared and conducted with manufacturer's quality control department, managers and experts those were selected.

Therefore, interview made with ENQI organization managers and experts through discussion such as Ethiopian standard Agency, Ethiopian conformity Assessment enterprise, Accreditation office and National Metrology Institute, In addition Ethiopian Revenue and Customs Authority, Minister of trade and industry and Metals industry development institute. Hence total numbers of interviewed from manufacturers are **15** managers and **42** experts and from Authority organization **3** managers and **13** experts, from manufacturer and authorities total **73** persons are interviewed**.**

**b) Secondary data collection**

In secondary data collection to assess the effort made by different researchers towards investigation factors influencing preference quality of the products, different literatures ,journals, articles, and also list of standards, guidelines, procedures, annual reports, documented files during works, from manufacturers and government offices.

### 3.2.2 Data Analysis Techniques

Responses of the interviews, data from observations and secondary data collected from the respective bodies used as an input for the data analysis. These data are used to identify the main root causes for low quality of cooking utensil that unable to competitive in the market.

Moreover, this analysis was done by concerning to NQI pillars service, identified the root cause of low quality product, and frame work model was developed for both AL cooking utensil and AL circle sheet production process and proposed the solution of the problems. Based on above data, analysis and discussion was done and as a tool by using Microsoft excel 2013, tables and figures.

# CHAPTER FOUR

## 4 Data presentation, Analysis and Discussion

Both primary and secondary data were collected from different source which are relevant to solve the problems of this thesis work and to develop comprehensive solutions to the performance of NQI in AL cooking utensil and AL circle sheet products sector. The secondary data was collected from govervenment office and manufacturers and the primary data was collected with direct observation of manufacturers production process and interviewed the experts and managers those related to their work.

The followings are the lists of originations from which data was collected to solve the problems mentioned in this study and discussed one by one what type of data collected from each other.

- Ethiopian Standard Agency (ESA)
- Ethiopian Conformity Assessment Enterprise (ECAE)
- Ethiopian National metrology institute (ENMI)
- Minister of Trade & Industry
- Ethiopian Revenue and customs Authority
- Metals Industry Development Institute
- From 12 manufacturer of cooking utensil products

### 4.1 Data collected from local manufacturers

Different data was collected from 12 Local manufacturers of cooking utensils starting from their production process until packing of end product. From all of them except one factory they are imported raw material which is aluminium circle sheet from different countries, like china, India, Pakistan and others to produce cooking pot products. Only one factory is manufactured aluminium circle sheet as the country and used to produce cooking utensil and sells for others for those produce cooking utensil products. Those industry producers of cooking utensil are list below with in their annual designed capacity in table form.

Table 4.1 Local manufacturers of cooking utensil products

| No. | Industry name | Annual Design capacity (ton) | Address |
|---|---|---|---|
| 1. | Des general trading | 2500 | Alemgena |
| 2. | Kolfe house hold | 1480 | Kolfe |
| 3. | Silver star | 1182 | Alemgena |
| 4. | Majet house hold | 5808 | Tatek |
| 5. | Amdamika'el gadisa house hold | 800 | Kality |
| 6. | Forteenesh house hold | 200 | Alemgena |
| 7. | Ethal Aluminum Manufacturing plc | 2700 | Dabre Birhan |
| 8. | Agm house hold | 1800 | Tatek |
| 9. | Kedir Ibrahim house hold | 1095 | Sebata |
| 10. | Hilmen aluminuin plc. | 620 | Alemgena |
| 11. | Alfakeb aluminum and metal ware products plc | 1750 | Akaki kality |
| 12. | Gena moges international trading plc | 2600 | Burayu |
| Total annual design capacity (ton) | | **22535** | |

All above industries have similar technology or production process to producing cooking utensil products. From above manufacturers Ethal aluminium manufacturing is the only manufacturer of AL circle sheet as the country which located at around 130km far from Addis Ababa, dabre berhan town. This factory use AL scraps and AL ingot to produce aluminium circle sheet through different production process.

**Production Process to manufacturing of aluminum circle sheet**

Aluminum scrap would be melted with aluminum Ingot through melting furnace mechanism by applying required temperature. The molten aluminum poured into prepared molds.Then it would pass through rolling process which is hot rolling and cold rolling to achieve required thickness. Finally the aluminuim circle sheet made using AL circle cutting machine or blanking machine. All production process of AL circle sheet is shown below figure 4.1 but in this production process the manufacturers use only visual inspection in all process and there is no laboratory for test or inspection the product.

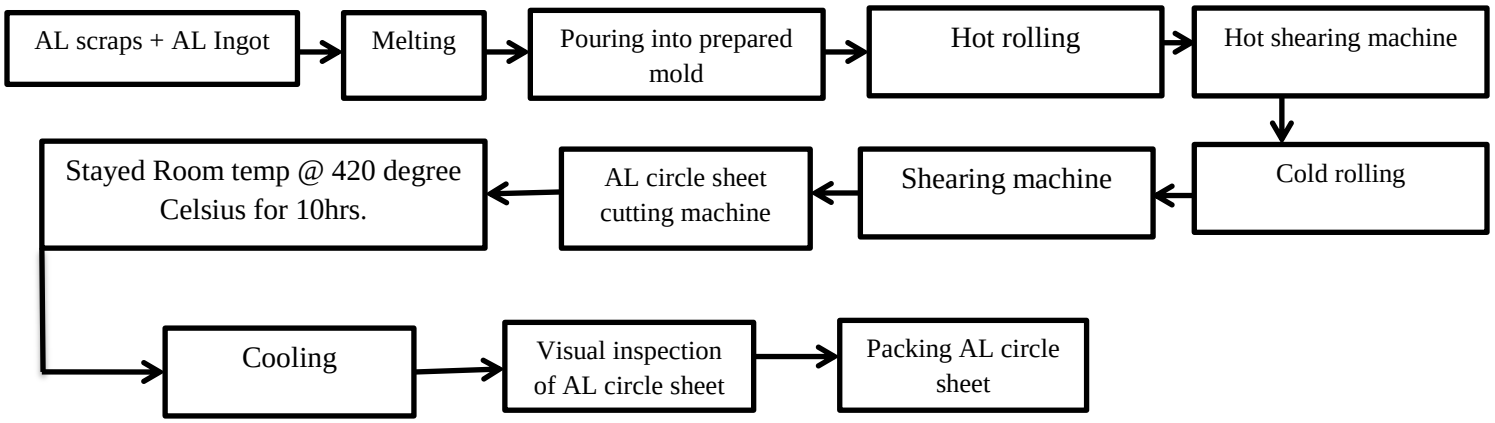



Figure 4.1 Process flow of aluminum circle sheet manufacturing

The above production process is processed by Ethal Aluminium manufacturing plc. Hence from initial production process to packing of end product this industry used only visual inspection quality control. There is no any testing or inspection of the material or process, such as chemical composition of the product, strength, and others. The factory is huge, but doesnot has any quality control department. Hence from field study finding, the company produces only experience based and very thick material which is fail between 0.6mm and 2.4mm thickness of aluminum circle sheet. During the manufacturing process there is excessive amount of products are damaged or defects due to lack of quality raw material like aluminium scarps, lack of skilled labor, lack of appropriate setting or keep well the product, etc.

AL scrap AL ingot AL circle sheet

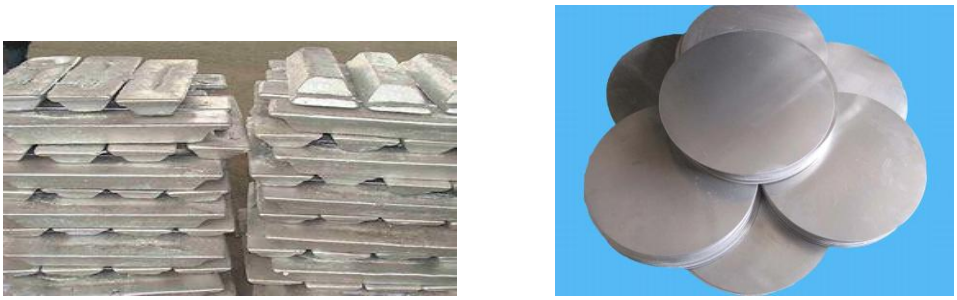


Figure 4.2 AL ingot and AL circle sheet

**Cooking utensil products manufacturing process**

The production process of the cookware mainly includes cutting, deep drawing, splicing, whole bottoming and cleaning. Main production process including blanking, deep drawing, trimming, the whole bottom and cleaning.

**In the blanking process** the metal materials produced by the cookware are first screened. Since the cookware needs to maintain good thermal conductivity and to achieve chemical stability during the high temperature grilling process, the metal materials produced by the cookware have a strict scope of investigation.

As a metal with extremely high thermal conductivity, aluminum does not rust and maintain resistance to various corrosion.

**The deep drawing** is mainly done by means of a mold on a **hydraulic press**. The production mold basically has two kinds of concave molds and convex molds, or static molds and dynamic molds. The deep drawing process is to force the material to pull down in the die by pressing down the punch, and gradually form the shape of the cookware.

The selection of the mold satisfies the wear resistance, the toughness, the fatigue fracture property is not outstanding, the tempering stability is better, the cold and hot fatigue resistance, and the corrosion resistance are satisfied. In this stage the raw material used is aluminum circle with different diameter size and thickness based on the required product.

**Trimming** after the process done on the press machine trimming will be the next step used to remove extra edges and to give proper shape of pressed product.

**Polishing/sanding** this process used to make surface finish using polishing soap to internal and external surface the product. Some products washed with soda water and then pure water for treatment.

**Packaging,** after passing through all the above processes the product will pack and be ready to deliver to client.

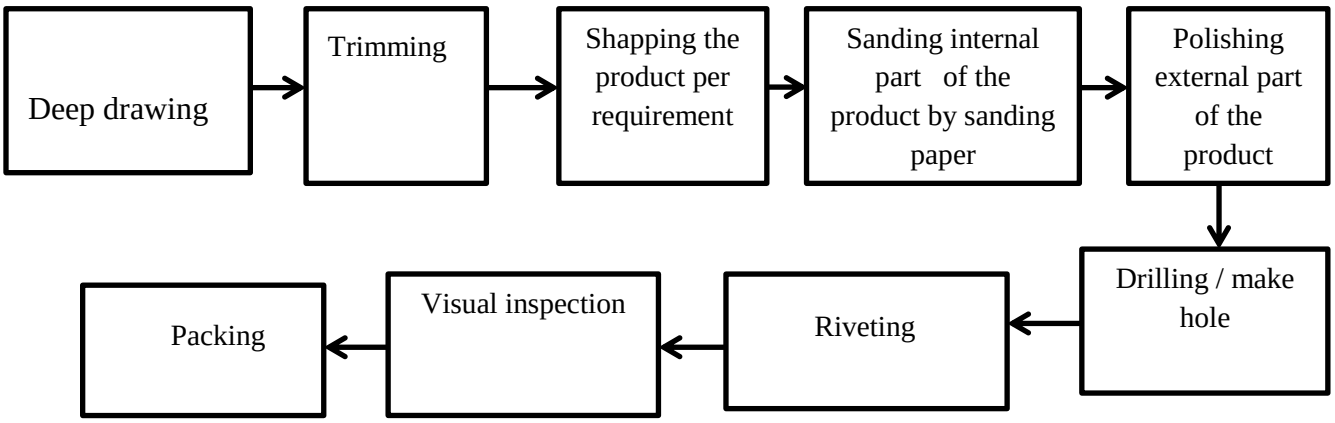



Figure 4.3 Process flow of aluminum cooking utensil products manufacturing

Therefore local manufacturer of cooking utensils products, are manufactured different utensil product with their shape and size based on customers' requirements, and they are distributed to regions and rural area according to the site of their retailers.

From above process flow except visual inspection, there is no quality control ways, in all cooking utensils manufacturing. In otherhand,due to weak performance of NQI,during production process in this sector, excessive damaged products incurred on each process. A damaged product during process which is collected from twelve industries is as follows in below table.

Table 4.2 Damaged product data's from each production process of manufacturers

| No. | Industry name | Process type which is damaged occurred in kg per day and per month | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Pressing (kg) | Trimming (per kg) | Rolling (per kg ) | Sanding /polishing (per kg) | Riveting (per kg) | Others (kg) | Total kg/day | Total per month |
| 1. | Desgeneral trading | 60 | 10 | 30 | 35 | 10 | 10 | **155** | **4030** |
| 2. | Kolfe house hold | 38 | 6 | 5 | 10 | 5 | 9 | **73** | **1898** |
| 3. | Silver star | 25 | 4 | 6 | 15 | 4 | 7 | **61** | **1586** |
| 4. | Majet house hold | 20 | 3 | 7 | 16 | 5 | 12 | **63** | **1638** |
| 5. | Amdamika'el gadisa house hold | 40 | 8 | 12 | 18 | 7 | 17 | **102** | **2652** |
| 6. | Forteenesh house hold | 22 | 3 | 9 | 14 | 6 | 10 | **64** | **1664** |
| 7. | Ethal Aluminum Manufacturing plc | 100 | 20 | 30 | 50 | 21 | 30 | **251** | **6526** |
| 8. | Agm house hold | 22 | 5 | 8 | 16 | 3 | 11 | **65** | **1690** |
| 9. | Kedir Ibrahim house hold | 18 | 3 | 10 | 12 | 4 | 13 | **60** | **1560** |
| 10. | Hilmen aluminuim plc. | 21 | 2 | 6 | 10 | 1 | 5 | **45** | **1170** |
| 11. | Alfakeb aluminum and metal ware products plc | 23 | 3 | 7 | 8 | 2 | 6 | **49** | **1274** |
| 12. | Gena moges international trading plc | 26 | 4 | 6 | 10 | 5 | 9 | **60** | **1560** |

From all 12 industries the total damaged products per day incurred due to different reason is **1048** kilograms. Therefore based on this information working days per month is 26 day, hence 1048 * 26 = 27248 kg per month losses or **27.25** ton.

Hence from finding of the study during data assessing about quality of utensil products from 12 manufacturers the reasons behind of damaged products summarized as follows.

Cause of defects or damaged products

- Low quality of raw material industries used/ which didn't based on national standards.
- Lack of well adjustment machineries
- Lack of skilled labor
- Technology they used
- Lack of well setting or keeping the product, and lack of NQI pillars practice ,etc

## 4.2 Background of Ethiopian National Quality Infrastructure (ENQI)

The National Quality Infrastructure (NQI) guarantees reliable industry standards and norms in order to ensure high-quality products are available for Ethiopian consumers and the export sector. The NQI organizations take international standards and guidelines as their point of reference, for example to certifying Ethiopian products. In that way, the Ethiopian industry is supported in increasing its competitiveness in international markets. Now days, since the Ethiopian economy is experiencing strong growth and is also becoming increasingly active in international markets, demands for good quality of products, services and processes are increasing. To answer this demand, the country needs a well-functioning quality infrastructure so that international standards and industrial norms can be enforced. Therefore,the Ethiopian Government is reforming the NQI.

This reform is supported by the German development cooperation. Also the reform was made to comply with the rules of the World Trade Organization (WTO), by reconstructing Quality and Standards Authority of Ethiopia (QSAE) into four separate organizations in February, first 2011 and put them under the direction of the Ministry of Science and Technology [19]. they are an Ethiopian Standard Agency (ESA), Ethiopian Conformity Assessment Enterprise (ECAE), Ethiopian National Metrology Institute (ENMI) and Ethiopian National Accreditation Office (ENAO). The Ethiopian parliament also has adopted the NQI reform, which is now being implemented. The new structure meets WTO requirements. Better quality products and services increase the consumers' standard of living and the competitiveness of the Ethiopian economy.

Ethiopian Standard Body has undergone several structural and name changes since its first birth back in 1970, and Ethiopian Standard Agency (ESA) was established as per the latest restructuring, as per Ethiopian Council of Minister Regulation No. 193/2010. ESA is the National Standards Body (NSB) of Ethiopia, responsible for developing, publishing and maintaining national Ethiopian Standards. It represents Ethiopia in the international standardization affairs - member of the ISO and other international and regional standardization bodies. It also, in collaboration with concerned regulatory bodies, develops compulsory/ mandatory Ethiopian Standards and Regulations which are to be approved by the National Standardization Council. Besides, it carries out promotional activities, training and technical supports to facilitate for the

implementation of standards. It is the owner of and administers certification schemes and the National Standard Mark, and also is responsible for the administration of National Quality Award System [20].

The National Metrology Institute (NMI) of Ethiopia is established by the Council of Ministers regulation No. 194/2010 since 10th February 2011. The Institute has a responsibility to develop a national metrology system compatible with the international metrology system and ensure technology transfer in the sector, establish and implement a system that enables to compare Ethiopian National Measurement Standards and Certified Reference Materials with international Measurement Standards and to maintain and disseminate them, support education and research activities in the field of metrology, build national capacity for maintenance of scientific instruments and provide maintenance services, and provide technical training, consultancy and information services on scientific equipment with a view to supporting users to carry out their duties. National calibration services also given by this institute [21].

The Ethiopian Conformity Assessment Enterprise (ECAE) was established as a federally owned public Enterprise, governed by the Ministry of Science and Technology to organize robust Certification, Inspection and Laboratory testing Services. ECAE is at present the major conformity assessment organization in the country, providing inspection, testing and certification services to public and private industries and it is the only national certification body which has certification capabilities in the areas of the System Certification (ISO 9001) and Product Certification [19].

Ethiopian National Accreditation Office (ENAO) was established as an autonomous federal government office having its own legal personality with the mandate to accredit the competence of Conformity Assessment Bodies (CABs) to perform specific activities, such as test, calibrations, certifications or inspections as formal third-party recognition. As the national accreditation body, ENAO is responsible to give accreditation services to laboratories (test and calibration), certification and inspection bodies, both domestic and foreign, that operate both within the borders of Ethiopia and outside its borders in countries where either no national accrediting body exists or lacks the capability to accredit in a specific field. Also, it establishes an accreditation symbol which may be used by accredited organizations in accordance with ENAO requirements; conduct surveillance assessments on accredited organizations; maintain and

publicize directories of accredited, suspended and revoked organizations; and ensure that relevant regulatory bodies are informed of updates regarding the accreditation status of ENAO's accredited organizations.

Moreover, it cooperate with relevant stakeholders to develop integrated and internationally recognized quality infrastructure where in accredited organizations' services are recognized globally; develop accreditation services that promote, develop and maintain good regulatory practices; represent Ethiopia's interests in international forums concerning accreditation through bilateral and multilateral agreements, and offer trainings related to accreditation services to bring high level of competency. In turn, ENAO itself shall maintain conformance with ISO/IEC 17011 standards [22], [19].

The four Institutions, which are described above, deal with so called voluntary parts of NQI.

The mandatory part of the new NQI landscape is allowed to put sanctions to substandard activities and fall under the premises of Ministry of Trade (MoT). There are three Institutions under the premises of Ministry of Trade working belongs to these targets. The first is an inspection and Regulatory Affairs Directorate, which is established to overcome the product and service quality problems and to avoid the problems observed in the prevailing market system.

## 4.3 Data which collected from respective bodies (government office)

The researcher has tried to assess and collected the data's which can be used as input for the work from different respective bodies as follows.

### Ethiopian National standard agency

The Ethiopian National Standard Agency is responsible to develop and publish Ethiopian standards. And also they develop standards for voluntary and mandatory products.

According to a discussion held with the manager since April 01,2019 currently ESA is developed around 10,000 standards, from them only around 230 standards are categorized under mandatory, like foods, pharmaticals,etc. Others are voluntary standards. From them during assessment of cooking utensil product standards, did not have standard or not develop standard for this product according to ESA catalog list. Thus why ESA categorized cooking utensil products under voluntary standards.

Not only cooking utensil product but also AL circle sheet which is used as raw material for this product has no standards, per Ethiopian standards.

According to assessement current situation of ESA they have only the ability to prepare standards as per requirements, with supporting of technical committee and with different others respective bodies and stakeholders. But after improved and develop one standard they have no the power to make enforcement for continual implementation, the power is given for others authorities bodies.

Hence sometimes mandatory standards show lack of responsiveness and out of controlling as per its standards and distributed in society.

- **Data from Ethiopian conformity assessment Enterprise**

As discussed in background of Ethiopia NQI, ECAE is making certification, inspection and test according to ESA prepared specific standards per product type. During assessment and discussion with manager and experts, they work based on customer requirements those can be come from regulatory body, or privates. So based on this for about cooking utensils product and aluminum circle sheet still anybody did not propose for test, certification and inspection for ECAE. Thus why it did not has standards and no body caries about quality of this product.

The relation ship between manufacturer of utensils and ESA, ECAE is low, or completely they have no any communications according to responding during discussion.

Due to lack of developed standard for this product, poor quality product is incurred and distributed to the market. Not only poor quality it can be affected human healthy, due to unbalanced or lack of test chemical composition of aluminum cirle sheet products.

- **Data collected from Minister of trade & industry**

From Authorty bodies those are controls the product quality based on prepared standard for those are locally manufactured and imported product is handle by Minister of trade and industry.

Most of the products which have Ethiopian mandatory standards are regulated by this minister. Ethiopia has about 230 mandatory standards that all the exported and imported products shall meet the stated quality standard requirements and also controlled by the regulatory bodies by using competent conformity assessment bodies results.

These products shall also use the quality mark of Ethiopia on their products or products packages when their quality is approved by authorized body. According to discussion held with general

manager of export and import product quality control, the existing system to control or regulate the export products, it is good,Whereas the system currently used to regulate or control the imported products have so many limitations to control the entrance of the substandard products (i.e. the products that do not meet the stator or mandatory quality requirements).

The quality control for imported products is made for only the products that have mandatory standard requirements and regulated. AL Cooking utensil products and AL circle sheet during imported, there is no quality control ways data or information's needed to measure the quality of them.

- **Data from Ethiopia Revenue and Customs Authority**

The main work of these body controls products those are imported and exported with their necessary taxation.

As mention above they did not focus on quality control products those did not mandatory standards, they made only documentation confirmation during imported.The products those did not mandatory based on supplier and importer organization agreements. Therefore, the utensil products did not check any quality control during imported including AL circle sheet, because it is not mandatory. And the government also gives attention only for those products are mandatory standard. Here is imported data of cooking utensil products for last six years which is collected from custom office.

Table 4.3 Summary of Imported cooking utensil products from 2014-2018

| **year** | **Qty Ton** |
|---|---|
| 2013 | 1671 |
| 2014 | 2018 |
| 2015 | 2541 |
| 2016 | 2980 |
| 2017 | 3025 |
| 2018 | 3465 |
| Total | **15700** |

As shown in above table 4.3 the demand of product is high, which is increased from year to year. Eventhough with out any consideration of quality control or inspection or without any certification comformation from campany manufacturered just simply imported this product.

## 4.4 Analysis and Discussion with Respect to Pillars of NQI Practice in Cooking Utensils Manufacturing Sector.

To analysis and discussion this study the researcher used two case companies those manufacturer of aluminum cooking utensil and aluminuim circle sheet to evaluate the production process in both sectors concerning to NQI pillars service.

## 4.5 Case company for aluminum cooking utensil products manufacturer (Des general trading plc.)

Des general trading plc was founded in 1990 by owner and general manager Desalegn Tesfai and located at Alemgena town which is 20km far from Addis Ababa. Des general trading was founded with the vision of eliminating the import of cooking utensil products and satisfying the existing demand by manufacturing affordable high quality cooking utensil products here in Ethiopia. Presently the annual design capacity of the factory is 2500 ton and 320 employees. As mentioned above the main product type of factory is cooking utensil products with different size and shapes.

This factory is used aluminum circle sheet as raw material which is local and imported from other countries, like Pakistan, India, china etc. locally they buy from Ethal aluminum factory which is Indian investor and AL circle sheet manufacturer as the country. Therefore, des general trading converting these product into cooking utensil product through different process as mentioned in fig 4.2. Those are pressing, trimming, rolling or shaping, sanding, polishing, drilling, riveting and packing. Hence during this production process some damaged products occurred per day per kilogram also shown in table 4.2. Therefore, to evaluate each production process of utensil product manufacturing concerning to QI service summarized as follows in table form.

Table 4.4 Cooking utensil product manufacturing process concerning to QI service

| Flow Process production | Damaged product incurred per day /kg | NQI elements | | | | | Challenges occurred for manufacturers |
|---|---|---|---|---|---|---|---|
| | | Standards | Testing | Inspection | Certification | Metrology | |
| Deep drawing ↓ | 60 | Has no Ethiopian standards or standard did not developed for this product | There is no making chemical composition test and strength of the material before | AL circle sheet inspected only visual | There is no certifying system the manufacturers used, whether raw material or their operators | There is no calibration system for their machines or instruments,but maintained their machineries by their own,rather than by recognized body | -To competent in local and global market -To get certified employees -unavailablity of raw material -High payment for tested and certified their product |
| Trimming ↓ | 10 | No standard | No need to test at this level | only visual inspection | Operated by uncertified person | No calibration for machines | |
| Shaping the product per Requirement ↓ | 30 | Has no recognized standard but, based on machine mold | No need of test during this process | visual inspection | Operated by Uncertified person and uncertified production process | No calibration for all machineries | |
| Sanding internal part of the product ↓ | 18 | Has no standard to sand the product, based on experience | No way of test sand paper | Visual inspection | made sanding by Uncertified person | no way of measurement | |
| Polishing external part of the product ↓ | 17 | No any standard followed | No test mechanism | Visual inspection only, not inspect thickness | By uncertified person operated the machine | No machine calibrated, only maintenance is done after fail | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Drilling / make holing ↓ | 0 | drilled based on rivet thickness estimation , but didn't has recognized standard | No need test & didn't take place | Visual inspection occurred, rather than inspected hole of size as it correctly drilled | Uncertified operators | Lack of drilling machine calibration | |
| Riveting ↓ | 10 | Manual riveting is take place | No necessary to test | rather than only visual it needs recognized inspection as properly tighted | Uncertified person | No any measurement for riveting | |
| Visual inspection ↓ | 10 | To inspect properly has no any standard | No test is needed | Visual inspection is take place,rather than supported by recognized laboratory | Inspected by uncertified person & uncertified product is take place | Calibration is needed for laboratory insruments if recognized laboratory is take place | |
| Packing | 0 | No ESA logo on packing or on product | No made any test | Visual inspection take place again | Uncertified product is occurred | No need metrology for packing | |

In above table 4.4 production process of cooking pot products with respect to QI service evaluation there is no any practice of pillars occurred. That means from four NQI elements any element is not implemented or practiced in this manufacturing sector. In this production process before deep drawing the AL circle sheet need to be test or inspect based on standard,and the main role played at this point for success of next production process of the product. Before starting to deep drawing AL circle sheet need making chemical composition test,to know the composition of the material and to take action if it is unbalanced chemical composition. Because if it did not unbalanced may can be affected human health by dissolving in food,and also inspection is neccessary to check the strength of the material,thickness, size and others according to its requirements. To produce good quality product, used quality raw material is essential. Operated by certified person also can be improve quality of the product by decreasing defect products and machine failarities.

Generally all above weak performance of NQI is summaried in table form inorder to show how should be applicable QI service in this production process.

Table 4.5 Summary of cooking utensil production process expected with respect to NQI pillars

| Flow production Process | NQI elements | | | | |
|---|---|---|---|---|---|
| | Standards | Testing | Inspection | Certification | Metrology |
| Deep drawing ↓ | Measured AL circle sheet based on standard before process | Chemical composition test is first activities | Strength and thickness of material should be inspect by instruments | Should be operated by certified person and used certified raw material | calibration of machines and instruments make by recognized body |
| Trimming ↓ | Need standard for machine adjustment | Test is unnecessary at this process | Inspect the product charactized by using different instruments rather than visual inspection | Inspection and machine operation have been done by certified person | Machine maintain and calibration have been done by recognized body |
| Shaping the product per Requirement ↓ | Adjust machines based on standard | Test is unneccessary | Inspect the product by using instruments | Machine operated by certified person | Calibration and maintenece of shaping machine have been made by recognized body |
| Sanding internal part of the product ↓ | Made sanding based on standard rather than experience and technical training is neccessary | Test sanding material as it is safe from dangerous chemical | Inspect the product properly by using different instruments whether the product is scratch during sanding | Sanding activity is done by certified person is better, to decrease scratch product | For sanding paper role of metrology is low |
| Polishing external part of the product ↓ | Based on standard the product shouldbe polished | Role of test is low at this stage | Inspection is necessary to control scratch products | Polishing activities should be done by certified person to keep thickness of the product | Calibration is necessary for Polishing machine |
| Drilling / make holing ↓ | Drilled based on prepared standard, for rivete size | Unnecessary to test | Inspection is take place whether it is drilled properly or not | Drilling by certified person is better to decrease defect product and to balance drilled holes with the size of rivets | Drilling machine should be calibrate by recognized body |
| Riveting ↓ | Should be tighted based on prepared hole | Test is not take place | Inspect as it is riveted properly | certification is no matter at this stage | Automatic riveting is better than manual |

| | | | | | |
|---|---|---|---|---|---|
| Inspection of cooking utensil ↓ | - | Final product which is cooking utensil have been tested based on its standard | Inspect the final product by using instruments like caliper and others rather than only visual inspection | Final product have been certified by recognized body, before distribute to the market | No need of metrology during this stage |
| Packing | On final product or on packing material ESA logo mark | - | Finally inspected the end product before packing | Check the product whether certified or not before packing is take place, to becompetent in local and global market. | ’’ |

## 4.6 Case company for aluminum circle sheet manufacturer (Ethal Aluminum manufacturing plc.)

Ethal aluminum manufacturing plc was established in 2000 E.C by Indian investors and located at Debra Birhan town which 130km far from Addis Ababa.The main product of this manufacturing is producing aluminum circle sheet which is help as raw material to produce cooking utensil products, and also this company produce cooking utensil from this raw material.

To produce aluminum circle sheet the factory used aluminum scraps which is collected from the local market and aluminum ingot through furnace melting system by applying requirement temperature. The production process follow is as mentioned in fig 4.1

During melting process of the production there is no making chemical composition test of the product, and melted it only estimation based. At once melting capacity of furnace average 6500 kg and it takes from 5hr to 6hr with adjustment temperature. The company imported only aluminum ingot previously, but know start prepared at own workshop aluminum ingot, from aluminium dross. From finding of observation during AL ingot preparation,again there is no recognized standard for chemical composition test of AL ingot. Generally the production process of aluminum circle sheet with respect to QI service was evaluated and summarized as follows in table form.

Table 4.6 Aluminum circle sheet product manufacturing process with respect to QI service

| Flow Process production | NQI elements | | | | |
|---|---|---|---|---|---|
| | Standards | Testing | Inspection | Certification | Metrology |
| AL scrap + AL ingot ↓ | Did not developed standards | No chemical composition test of AL ingot done | No scrap inspections made(separation from unnecessary material) | There is no certification system of process,product or service and operated by uncertified person | There is no calibration system for their machines and instruments |
| melting ↓ | There is no recognized standard,only exprience based melting | No testing is take place during melting process | Visual inspection | Uncertified process and operators | There is no calibration take place by respective bodies |
| Pouring into prepared mold ↓ | No recognized standard | No chemical composition testing from melted,before pouring | Visual inspection is take place | Operated by uncertified person | No machine calibration |
| Hot rolling ↓ | No thickness standard , rather than machine setting according to they need | Testing is unnecessary during this process | No material inspection is take place | uncertified operator, process, products & service | Only machine repair is take place, after failed, and it is not maintained by recognized body |
| Hot shearing ↓ | Based on company exprience | No need of tests | Visual inspection take place | uncertified operator | " |
| cold rolling ↓ | No standard developed | No test is necessary | Visual inspection | uncertified person | " |
| Shearing machine ↓ | Machine setting based | No test is needed | Visual inspection | uncertified person operate | There is no measurement or instrument calibration |
| Al circle sheet cutting machine ↓ | Machine setting based | No test needed | visual | Operated by uncertified person | No calibration for machine |
| Visual inspection ↓ | Has no developed standard | No laboratory test | There is no laboratory for test & inspection | uncertified person & product by recognized body | No product measurement system |

| | | | | | |
|---|---|---|---|---|---|
| Packing | No ESA logo marked on product or on packing material | No need of test | Visual inspection | Finally uncertified product is distributed to the market | No need of metrology |

According to shown in above table 4.6 there is low practice of QI service in all production process. The company produce based on own experience and local market demand. Hence there is no regulatory body for company production process, and there is no quality control department or laboratories in the Ethal aluminum manufacturing plc. During melting for both production i.e. AL circle sheet and AL ingot has different chemical composition which can be affected human healthy. So that to eliminate higher composition, melting production process standard have been prepared by respective body for protection of human healthy and to produce good quality product. According to justification of different research aluminum cooking utensil chemical composition simply can be affected human healthy. for example lead is dangerous chemical for human healthy and risk factors for different diseases such as high blood pressure, highypertation, cancer etc.

Table 4.7 Summary for AL circle sheet production process expected concerning to NQI pillars

| Flow Process production | NQI elements | | | | |
|---|---|---|---|---|---|
| | Standards | Testing | Inspection | Certification | Metrology |
| AL scrap + AL ingot ↓ | Need standard for AL ingot | Chemical composition for AL ingot | AL scrap have been separated from unnecessary material | Used certified raw material | Calibration of machine and instruments is essential |
| Melting ↓ | Melting based on standard | Chemical composition is have been done based and made it balance,by elimination of higher composition | Inspect the product during melting process | Certified the production process and have been operated by certified person | Calibrate the instruments which used at laboratories for conformity assesment |
| Pouring into prepared mold ↓ | - | Before pouring into the mold test is essential based on standard | Instrumental inspection of the product is needed | Have been operated by certified person | Insruments and tools have been calibrated by recognized body |
| Hot rolling ↓ | Make thick based on machine adjustment | Test the product | Inspect thickness of the product | Certified the process and operators | Hot rolling machines and tools have been calibrated |

| | | | | | |
|---|---|---|---|---|---|
| Hot shearing ↓ | - | - | Inspect thickness of the product | Have been Certified the process and operators | Machine and tools need calibration |
| Cold rolling ↓ | - | - | Inspect the product | Certified the process and operated by certified person | Machine and tools need calibration |
| Shearing machine ↓ | - | Test the product charectarized | Inspection is take place | " | " |
| AL circle sheet cutting machine ↓ | Cut the product based on standard | " | Inspect thickness, size and strength of the product by using different instruments | The final product should be certified by recognized body | All machineries and instruments should be calibrated by recognized body |
| Inspection of AL circle sheet ↓ | - | Test AL circle sheet by recognized body | " | AL circle sheet have been certified by recognized body before distribute to the market | " |
| packing | Mark on the product or on packing material ESA logo | - | Inspect packing material | - | - |

According to discussed in above table expected NQI elements in aluminum circle sheet production process have been worked as shown, to improve product quality and to be competitive in local and global market. And also to protect human healthy by producing safe product.

## 4.7 Proposed solution to the problems

According to assessing the performance of QI service on cooking utensil products during data collection from respective bodies and manufacturing sectors, there is a gap between them on practicing quality infrastructure service. According to assessed data from ESA lack of standard development for this product is affected to practice QI service, in production process and service.

So that understanding of manufacturers about pillars of NQI service and its benefits is very low and also no practice of pillar is known for this sector. Therefore, the manufacturers did not have any idea about pillars, like standards, conformity assessment, accreditation and national metrology, with their function and as benefits for their production process and to keep quality of the product. In both manufacturing sector i'e, aluminuim circle sheet manufacture and aluminium cooking utensils the practice of NQI service is weak. And poor quality products achieved due to lack of well practice or lack of awareness advantage of quality infrastructure service in society and in cooking utensils sector.

Up to date from NQI pillars ESA, technical regulation/ standards did not develop for cooking utensil products and AL circle sheet,and there is no technical training, lack of creating awareness, ECAE did not made inspection,test and certification for this sectors, ENMI, did not made calibrations and accreditation office did not give any recognition for this sector with concerning to production process and quality of the product.

Therefore,from four pillars of ENQI service the main root cause of low quality product and competiveness in global market of this product sector is lack of development of standard.

To overcome these problems, the researcher has tried to draw working framework model for existing situations in both manufacturing process to show the gaps and develop the new working framework to fill those gaps. These two working framework model in both production process are presented in figures 4.4 ,4.5,4.6 and 4.7 as follows within its detail explanation.

## 4.8 Existing frame work for aluminum circle sheet production process

Here below figure shows as the existing frame work of local aluminum circle sheet manufacturer

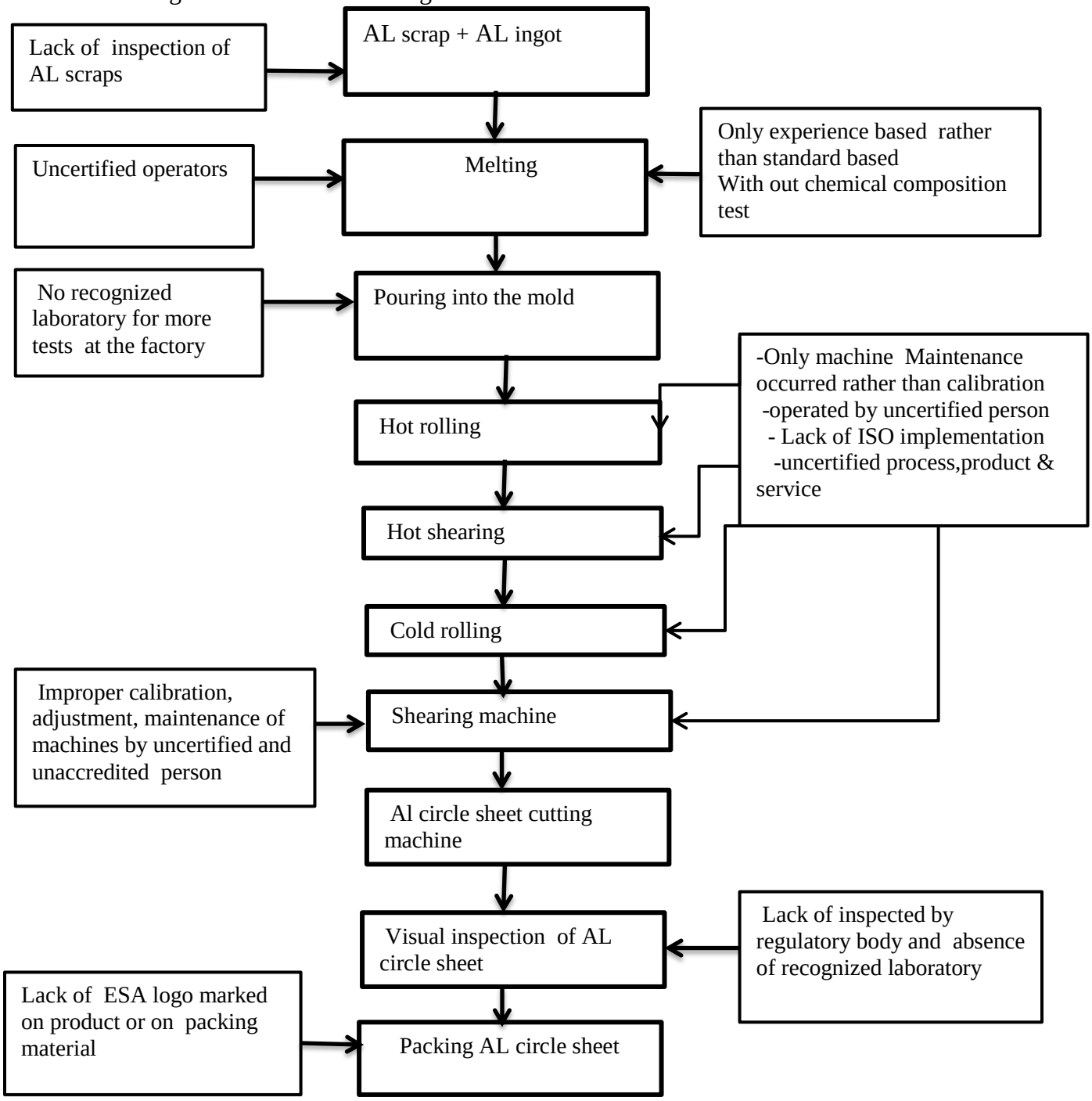



Figure 4.4 The existing frame work of aluminum circle sheet production process

As shown above figure 4.4 from existing frame work there is absence of NQI pillars practice to achieve good quality product during production process of AL circle sheet. Hence it affects to competent in local and global market for this product. Although can be affected human healthy due to unknown the amount of chemical composition of the product and the service life of the product is short and unsatisfied during usage. From existing process before going to be melting AL scrap with AL ingot there is no any inspection or separate unnecessary metal scraps those can be affected human healthy. And after melting there is no chemical composition test laboratory and all process worked by uncertified persons,all process is uncertified. Also all machineries are mainted by uncertified and unaccredited person rather than certified and calibrated by respective bodies. The final product which is AL circle sheet has no any standard for thickness and strength of the material as well as chemical composition of it. Out put is uncertified product and does not stamped by ESA mark or logo on final product.

## 4.9 Proposed frame work model for aluminum circle sheet with respect to NQI

Below figure 4.5 is shown the proposed frame work model for AL circle sheet manufacturing concerning to NQI, in order to achieve good quality product and competitive in global market.

First of all after AL scraps are collected from market separeting unnecessary metals from it and test chemical composition of AL ingot, and melt by certified person. develop standard by ESA and with others stakeholders. chemical composition test is necessary during melting process based on develop standard,before going to be poured into mold through recognized laboratory by certified and accredated person. Again prepare standard for AL circle sheet thickness, and during process the manufacturer follow and out the product with in standard range and if not, take correction. calibrate all machineries by NMI, as per required or scheduled. Finally before distributed to the market inspect the end product by regulatory bodies and marked on the product ESA logo. Therefore, all NQI pillars of Ethiopia have to take responsibilies for this product sector in order to improve quality of product and to safe healthy of society. If respective bodies take responsibilities and enforced the manufacturers as they have to follow up the prepared frame work model or standard of this product and try to modified from time to time, affected human healthy by different disease like, cancer,blood pressure, kidney stone etc, can be decreased and the product can be competent in local and global market.

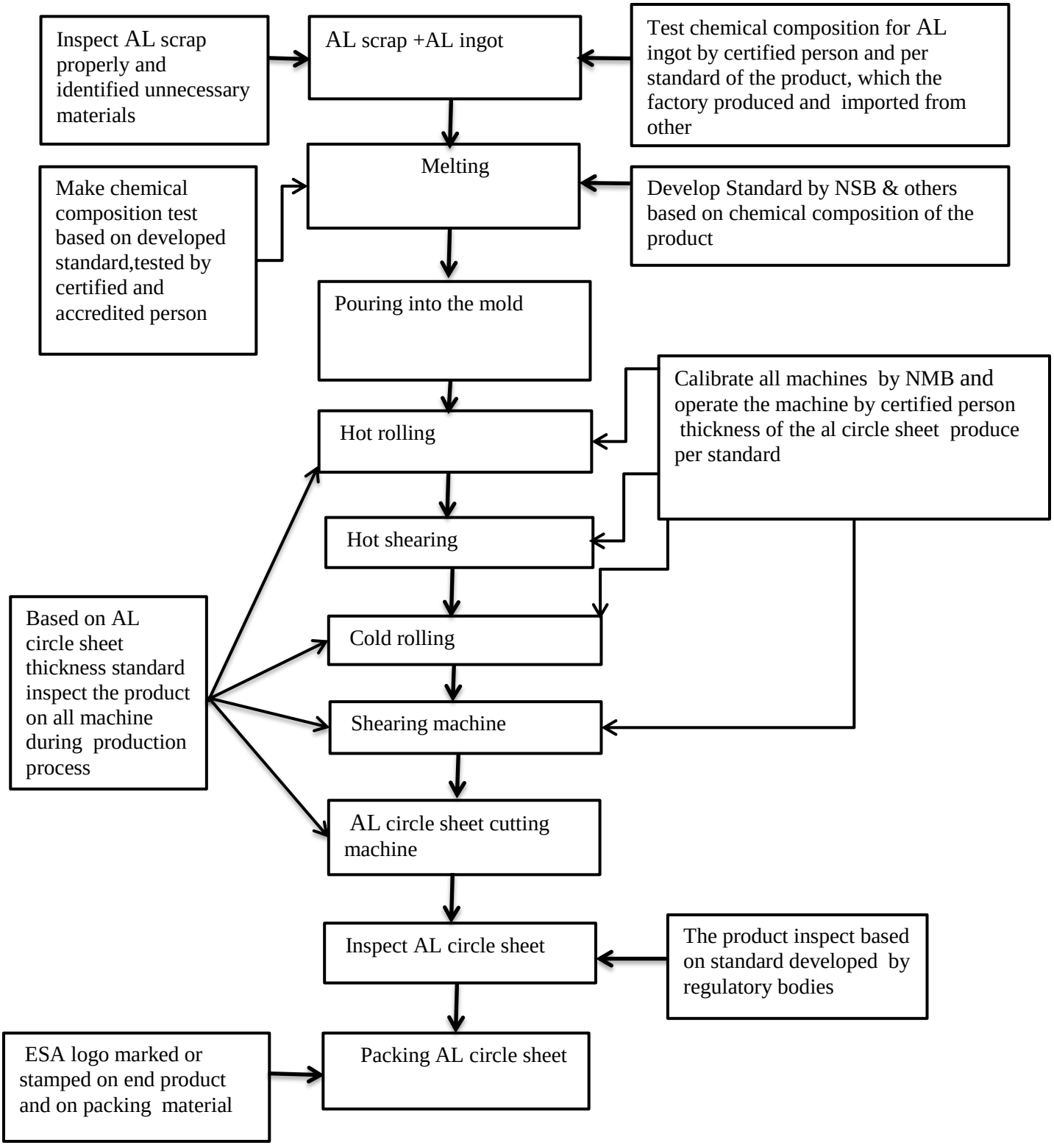



Figure 4.5 Proposed frame work model for AL circle sheet with respect to NQI service

Therefore,the researcher has tried to develop the above frame work model for AL circle sheet manufactures concerning to NQI pillars in the future and for good quality product achievement.

## 4.10 The existing aluminum cooking utensil products frame work

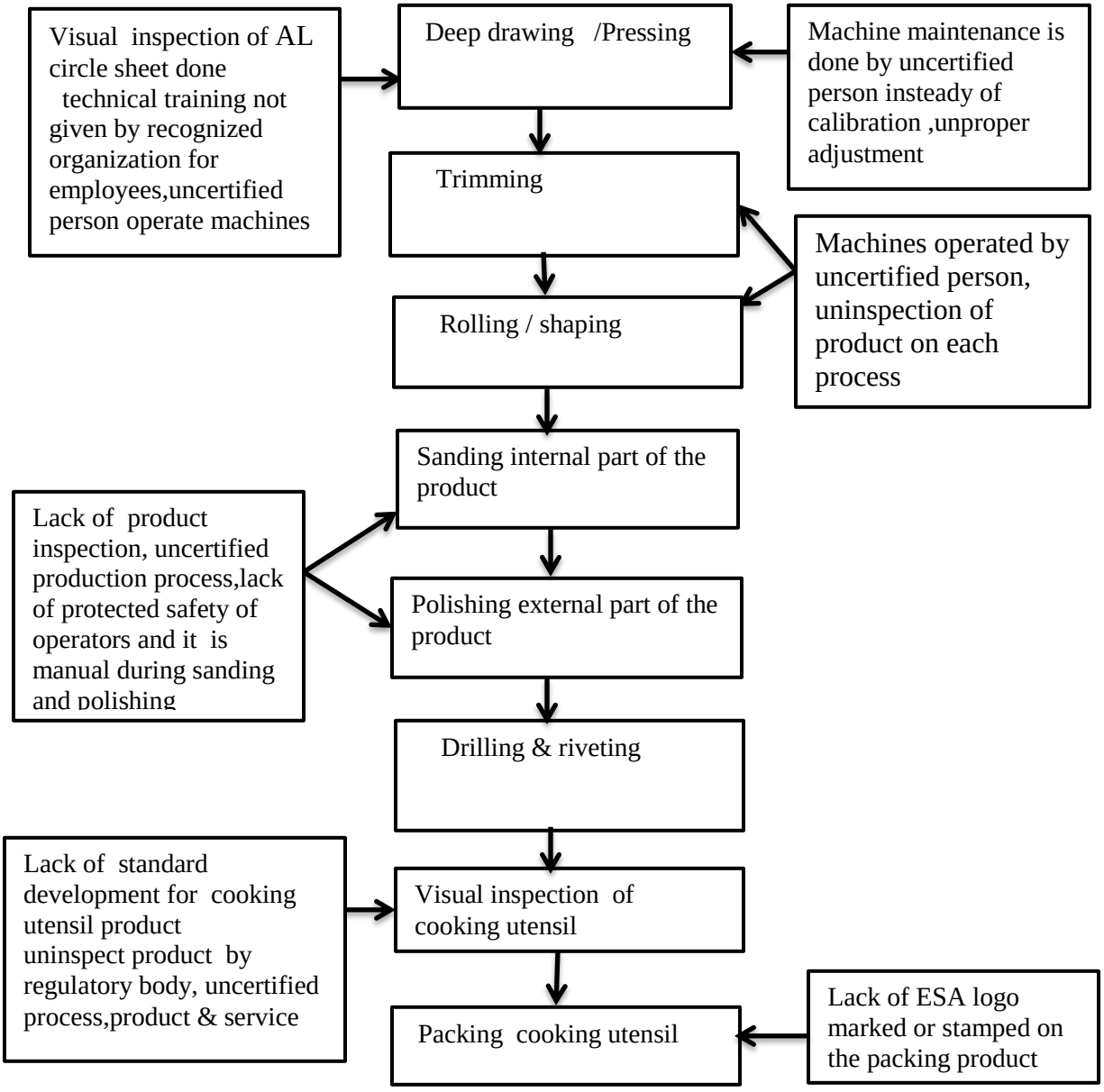



Figure 4.6 Existing frame work for cooking utensil production process

As shown in fig above fig 4.6 to produce aluminum cooking utensils products the process starts from AL circle sheet which is imported from different countries and local supplier. Before going to factory there is no body made inspection for AL circle sheet thickness, strength and chemical composition of the material, because of lack of develop standard for AL circle sheet and lack of

regulatory bodies give attention for this product. As we can see from flow process of the product there is no any quality control ways,except visual inspection. This show that the relationship between manufacturers and respective body of Ethiopia (NQI) is low and lack of awereness creation for manufacturers. Generally from existing frame work the finding shows lack of develop standard, lack of inspection, lack of test and uncertified person and uncertified product/process, service, mainetenance machine by unaccredited person rather than calibrate by recognized body.

## 4.11 Proposed model frame work for aluminum cooking utensils production process

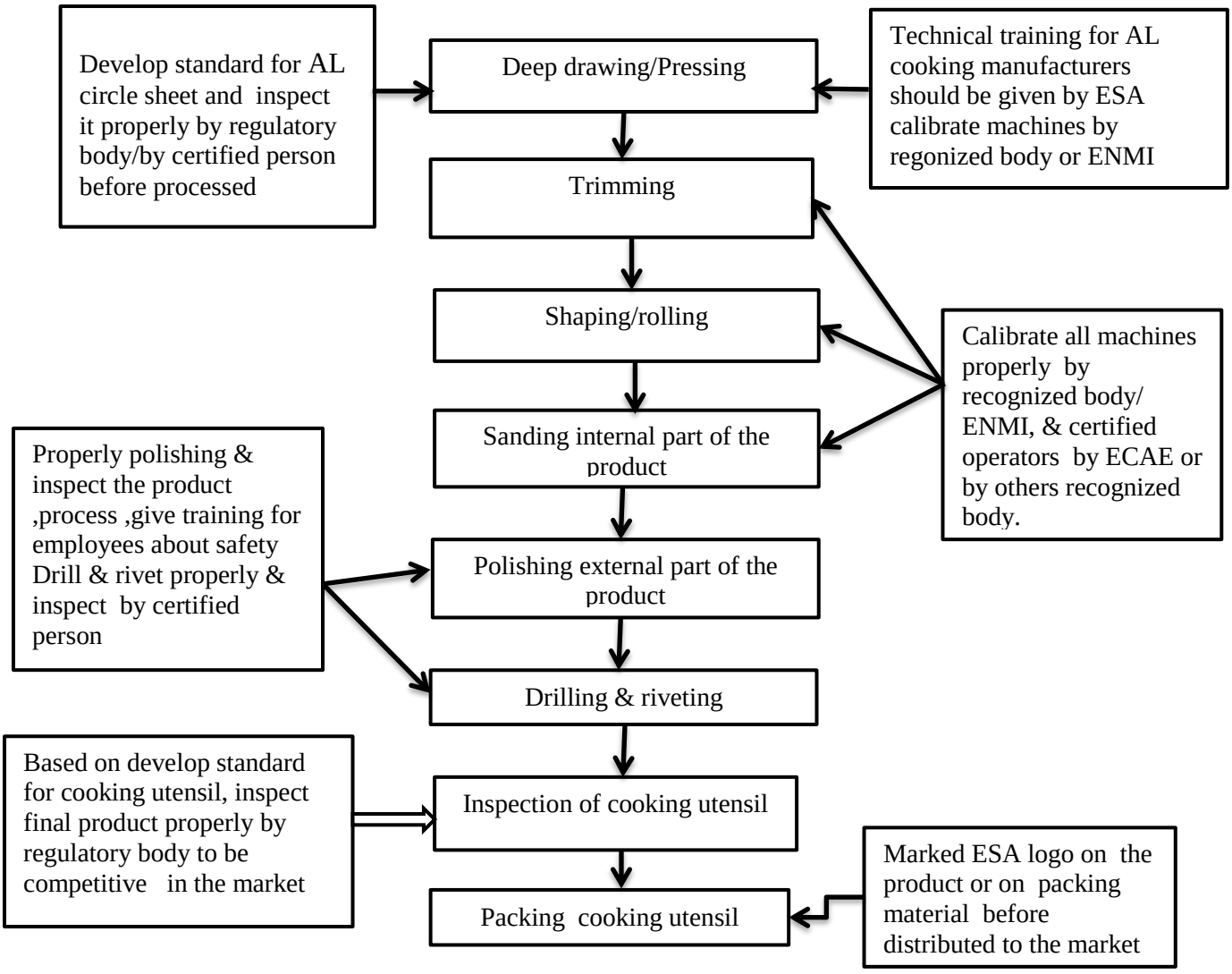



Figure 4.7 Proposed frame work model for AL cooking utensil products

As shown in fig 4.7 before AL circle sheet going to be deep drawing inspect the thickness and strength of the material based on standard develop and test chemical composition of aluminum

circle sheet by using expectorymeter machine. The material tests by certified person who get certification by recognized bodies and all machineries should be calibrate by recognized body or by certified person. At each process which shown in fig 4.7 properly inspect thicknesses of material by certified person. For inspection only visual is not enough rather than inspection by different insruments with in recognized laboratory. Technical and safety training is needed for employees which given by recognized bodies and process,product and operators should be certified, to produce quality product.

Therefore, according to assessing in both manufacturing, i,e AL circle sheet and AL cooking utensil production process NQI service practice is weak. The relation ship between manufacturers with Ethiopian NQI is low,and due to that low quality product is distributed to market, not only that, indirectly health of society also affected. During imported cooking utensils, or AL circle sheet and AL ingot there is no any inspection done,by regulatory body at all port of location. This shows that lack of understanding advantage of NQI for this sector as manufacturer and government. Therefore,until the government did not understand and make policy, and create awareness for all, society cannot be safe own healthy from unsafe material.

Generally for this product the government have to be make policy for locally manufactured this product, create awareness for society and protect country market from low quality product and protect health factor of society, and focused on quality of cooking utensil products to improve competiveness in local and global market.

❖ **Summary inorder to be competent in the market**

- Cooperation of manufacturer is essential to generate idea and to make enforcement or to propose standard preparation for ESA,as cooking utensil product need national or international standard.
- The product, process/service should be certified by recognized body whether government or private.
- Based on standard develop the manufacturers should have to make inspection, test their products and calibrate instruments and machineries according to its requirement by recognized bodies.
- Production should be operated by certified person and upgrade by technical training which is given by recognition organization.
- The manufacturers have to be honest for their product quality and in protection of society healthy, safety and environment and should have to be take responsibilities to inform for respective bodies if any manufacturers distribute low quality product.

Therefore, through all above mentioned activities and if the manufacturers implement NQI pillars, they can be improve quality of products and can be competitive locally and internationally.

# CHAPTER FIVE

# 5 Conclusion and Recommendation

## 5.1 Conclusion

This study is focused on assessing NQI performance on cooking utensil products those locally manufactured by assessing manufacturing sectors,which is cooking utensils and aluminuim circle sheet manufacturers,and ENQI sector. So according to reasercher assessment through interview and discusscion, field observation and secondary data, there is a gap to practice NQI pillars service in cooking utensil manufacturing sector, i'e the relation ship between manufacturer and Ethiopian NQI service is weak. From four pillars of NQI none of them is implemented for cooking utensils sectors (standard,confirmty assessment ,national metrology and accretation ). Due to that during importation regulatory body did not inspect the quality of this product,like thickness of the material, strength and chemical composition of the product. According to data assessment from local manufactures due to low quality of raw material they used and lack of NQI service practice, during production process around 27.25ton product is damaged per month. Even though healthy of society is not protected or can be affected easily,especially by chemical dissolved into food from AL cooking utensils which is produced from local aluminuim circle sheet.

In order to solve the current problems with in the performance of ENQI elements in production process activities of cooking utensils and aluminium circle sheet the researcher has proposed a new framework model that can help in both manufacturing process to work based on the above findings. And the researcher hopes that if the manufacturer used this framework model in their own aspects, the performance of NQI elements in the cooking utensil product sector will improve, the product defects will decrease, quality of cooking utensil products will improve and healthy of society will be protected.

## 5.2 Recommendation

Based on assessment of NQI performance for cooking utensils in Ethiopia and gap identification the following recommendation is given for manufacturers and for authority bodies (NQI) of Ethiopia.

- The manufacturers and ENQI should be working cooperatively and develop the standard for cooking utensil products by considering thickness and strength of the material as well as chemical composition to be compitative in local and global market. Espicially if the chemical composition of aluminum cooking utensil didnot based on standard, during manufacturing of aluminum circle sheet, it can be affected human healthy,by dissolved in food. For example if lead is above standard it is highly affected human healthy by increasing blood pressure, and the amount of lead must be less than 0.005% according to shown in different research studied and standard developed.
- NQI , of Ethiopia like ESA, ECAE, Accreditation and NMI should be create awareness for this sectors which means for AL cooking utensils and AL circle sheet manufacturers.
- The manufacturers of both products should have to be used the proposed frame work model for their production process.
- Government have to be developing quality policy as the country,to protect market share from low quality product and follow up on implementation,and regulatory bodies have been take responsibilities.
- ENQI and others Authority bodies must be worked by integration and follows AL cooking utensil and AL circle sheet manufacturers as they have to be produce respected quality products, with fair price, and can be competitive in local and global market. And also must be taken responsiveness for society safety, healthy and environmental protection at all.

## 5.3 Future Research Area

Generally this study is focused on assessing performance of NQI on aluminuim cooking utensil products by considering only two production process that cooking utensil product manufacturing and aluminuim circle sheet manufacturing process. In both process the researcher tried to evaluate performance of NQI service and tried to identify some gaps, which is a main root cause of low quality products achievement. Hence,due to time and budget constraints covers only production process of AL circle sheet and AL cooking utensils production process for those locally manufactured. Future researcher can be consider another parameters which can be affected the quality of the product, by considering both imported and locally manufactured with its prices. Also,can be assessing the performance of ENQI elements in another case company specially in metal sector which have similar gap is open for future research work as well.

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