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Costing of Poor quality at food Manufacturing Organizations in Palestine: Model Building and Application

By: Bassam Abdel-Haleem

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BirZeit University - Palestine
June 2005

BIRZEIT UNIVERSITY
Birzeit, Palestine

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Submitted in partial fulfillment of the requirements for the Masters Degree in Business Administration from the Graduate Faculty at Birzeit University Palestine

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ACKNOLLEDGEMENT

I would like to express my gratitude to all those who gave me the possibility to complete this thesis.
I want to thank my supervisor Dr. Naser Abdelkarim whose help and lasting encouragement helped me in all the time of research and writing of this thesis. I have furthermore to thank the supervisory committee, Dr. Munther Najem and Dr.Amjed Al Ghanim for their support and encouragement.

My deep appreciation to Sinokrot Food Company and its staff represented by eng. Mazen Sinokrot the general director for allowing me conduct this research at their premises and for the great assistance they provided for me in all the time of research.

My special thanks for my parents for their prays, encouragement and support.

Lastly, my profound thanks to my wife Raja' who has been a source for encouragement and endless support. My love to my helpful son Rami and my sweet daughter Yara for sharing with me this experience, words cannot express the gratitude and love I have for them.

Thank you all

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ملخص

بالرغم من الأوضاع الاقتصادية الصعبة في الأراضي الفلسطينية، لازال قطاع الصناعات الغذائية من القطاعات الواعدة في فلسطين. حيث يساهم هذا القطاع في تنمية كل من الاقتصاد الوطني الفلسطيني والمجتمع الفلسطيني من خلال زيادة مساهمته في الناتج القومي وخفض معدل البطالة. ولكن نتيجة لسياسة السوق المفتوح والتجارة الحرة، فان المنافسة المتزايدة لمنتجات هذا القطاع من قبل المنتجات المماثلة المستوردة تعتبر من العوامل الرئيسية التي تهدد حصة هذا القطاع من السوق الفلسطيني. وحتى يكون بإمكان هذا القطاع زيادة قدرته التنافسية وحصته من السوق الفلسطيني، فان خفض تكاليف الجودة الملازمة للعملية الإنتاجية مع المحافظة على مستوى مقبول من جودة المنتجات تعتبر من الأساليب الفعالة وفق ممارسات عديدة سابقة والتي من الممكن لهذا القطاع نهجها وصولا للأهداف المرجوة أعلاه.

إن الهدف من هذه الدراسة هو بناء نموذج لاحتساب تكاليف الجودة مبني على أساس حساب تكاليف النشاطات لتحديد وتصنيف تكاليف الجودة الملازمة للعمليات الإنتاجية في قطاع الصناعات الغذائية في فلسطين، وذلك لجلب انتباه إدارات هذا القطاع لهذه التكاليف من خلال ترجمتها إلى أرقام مالية. كما تهدف الدراسة إلى تحديد المجالات التي تتركز فيها هذه التكاليف من خلال تطبيق النموذج على حالة دراسية عملية، وذلك لاستهداف تلك المجالات كفرص للتحسين والتطوير من حيث خفض تكاليف تلك المجالات وتحسين جودة الإنتاج.

لتحقيق أهداف هذه الدراسة والإجابة عن أسئلتها، تم اعتماد الطريقة النوعية (الوصفية) أولا من خلال المراجعة الأدبية للعديد من الممارسات السابقة في مجال تحديد وتصنيف تكاليف الجودة في قطاع الصناعة بشكل عام في العديد من دول العالم، وكذلك الأساليب والنماذج والطرق المتبعة لتصنيف وحساب هذه التكاليف. بعد ذلك تم بناء نموذج لحساب تكاليف الجودة الملازمة للعمليات الإنتاجية في قطاع الصناعات الغذائية في فلسطين مبني على أساس حساب تكاليف النشاطات، حيث تم بناء النموذج بناء على نماذج وأساليب وممارسات سابقة متبعة وبما يتلاءم مع تجارب وبيئة الحالة الدراسية بشكل خاص وقطاع الصناعات الغذائية في فلسطين بشكل عام. وأخيرا تم اعتماد المنهج التحليلي (الميداني) من خلال تطبيق النموذج على حالة دراسية عملية بهدف اختبار النموذج وجمع وتحليل بيانات تكاليف الجودة.

أظهرت نتائج هذه الدراسة وجود تكاليف جودة ملازمة للعمليات الإنتاجية في هذا القطاع مصنفة إلى تكاليف وقائية، تكاليف فحص ومراقبة خلال العملية الإنتاجية، تكاليف ناجمة عن فشل في الإنتاج خلال العملية الإنتاجية وتكاليف ناجمة عن عدم مطابقة الإنتاج لمتطلبات السوق والمستهلك. كما أظهرت بان تكاليف الجودة الناجمة عن فشل في الإنتاج تشكل ما نسبته 96% من إجمالي تكاليف الجودة وان تكاليف الإنتاج المعاد تصنيعه والتي هي جزء من تكاليف الجودة الناجمة عن فشل في الإنتاج تشكل الجزء الأكبر

من هذه التكاليف، حيث بالإمكان استهداف هذا الجزء كفرصة حيوية للتحسين والتطوير وخفض إجمالي هذه التكاليف.

وأخيرا وللتعبير عن هذه التكاليف كرقم مالي، فقد أظهرت نتائج الدراسة بان تكاليف الجودة تشكل ما نسبته 9% من إجمالي المبيعات وما نسبته 14.11% من إجمالي تكاليف التشغيل المتغيرة. من خلال تحليل اثر هذه النسب على نقطة التعادل فقد أظهرت نتائج الدراسة بأنه في حال التخلص من هذه التكاليف من خلال اتخاذ خطوات لتحسين وتطوير ملائمة سيكون بالإمكان خفض نقطة التعادل بمقدار 19.11%.

وعليه، فتبين من الدراسة بان تطبيق قطاع الصناعات الغذائية لنماذج تكاليف مبنية على أساس حساب تكاليف النشاطات يعتبر من الوسائل الفعالة التي يمكن لهذا القطاع نهجها لخفض تكاليف الجودة وتحسين جودة الإنتاج من ناحية ورفع القدرة التنافسية من ناحية أخرى.

ABSTRACT

Keywords: Costs of poor quality (COPQ), Activity-based costing (ABC), Prevention and Appraisal costs, Internal and External failure costs, Break-even point

Despite the deteriorated economical situation, the food-manufacturing sector in particular is one of the promising sectors in Palestine, for the reason that it contributes to the development of national economy and society by increasing its share of gross value added and decreasing the unemployment rate.

In today's open and free trade market, the increased competitiveness is one main issue threatening the food manufacturing sector market share, in particular. Therefore, reducing COPQ while ensuring an acceptable level of products quality is one effective approach that food-manufacturing sector can follow to raise its competitiveness capacity and gain more market share.

The purpose of this study is to build an activity-based COPQ model to be implemented at the food manufacturing sector in Palestine. Then, to apply the model by means of conducting one real case study aiming to identify, categorize and express existing COPQ in dollar amount in order to open the eyes of managers on such costs. Moreover, to explore areas where to initiate improvement projects that can help food-manufacturing sector reduce costs and improve quality.

For meeting study objectives as well as examining the questions raised in this study, the study procedures can be divided into three main stages. ***Firstly***, a preparatory study through an extensive literature review was conducted. It involves relevant issues such as COPQ concepts, existing approaches used for assessing, categorizing and measuring quality costs, and the situation of Palestinian manufacturing sector. ***Secondly***, an activity-based COPQ model, upon which work is based, was built based on existing approaches and models used for assessing, categorizing and measuring COPQ. Then, it was refined to suit the food manufacturing sector's experiences and environment. ***Finally***, the model was applied by means of conducting one real case study under actual conditions at one of the top large and well-developed food manufacturing organizations in Palestine. The model primarily examined the COPQ existing at the selected case, and prioritized the identified COPQ areas that are considered as opportunities for cost reductions and quality improvement.

The results reveal that the four categories of the COPQ do really exist at food manufacturing sector in Palestine and can be determined systematically in terms of prevention, appraisal, internal and external failure costs by using developed activity-based COPQ models that suit organization's experiences and environment. Total internal failure costs category is found to account up to 96% of the total COPQ where material rework costs constitute the highest portion of the total internal failure costs, which then considered as a vital opportunity for costs reductions. Furthermore, it is found that total COPQ account up to more than 9% of total gross sales, whereas they account up to 14.11% of total variable operating costs. As for the effect of COPQ on break-even point, it is found that if such costs were eliminated the break-even point will decrease by 19.11%. As a result, it is found that the built-on activity-based COPQ model introduced in this study is to be considered as an effective technique, when implemented appropriately, that food manufacturing organizations in Palestine can apply and implement to reduce costs and improve quality.

CHAPTER ONE

INTRODUCTION

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INTRODUCTION

1.1 Overview

Developing, producing and marketing goods and services as such involve costs. Organizations have to take some of these costs if they are to produce any goods or services and if they are to generate any revenue. These costs are normally known as costs of quality (COQ) or costs of poor quality (COPQ) which to varying degrees can be avoided or reduced, depending on how efficiently the business is conducted with regard to product quality.

Costs of poor quality (COPQ) may be defined as costs, which would be eliminated if all products and processes were perfect. These costs include internal failure costs, external failure costs, appraisal costs and prevention costs. Feigenbaum (1991) divided the COPQ into two major categories, namely, costs of control (prevention and appraisal costs) and costs of failure of control (internal failure and external failure costs). Others called them costs of conformance (Prevention and appraisal costs) and failure costs or costs of nonconformance (Internal failure and external failure costs). Since categories of COPQ vary concerning type of organizations if they are services organizations or manufacturing, or others, manufacturing organizations must understand them, examine the sources of their occurrence, and initiate COPQ programs to avoid or reduce them.

Empirical evidences and prior studies, as outlined in chapter two, advocate that many organizations implemented COPQ programs and achieved considerable savings. Moreover, those organizations have demonstrated that implementing programs based on costs of quality reduces design, production and development costs because money is no longer spent on waste and rework.

Therefore, many COPQ programs based on organizations' experiences and environment were developed. They focus on identifying quality costs' elements, collecting data in terms of the four COPQ categories, and analyzing the COPQ data by each category, department or product.

Based on COPQ information organizations can obtain when implementing COPQ, they can identify COPQ improvement projects and initiate appropriate improvement plans to reduce these costs.

Such COPQ programs have one weakness, is the inability to provide proper visibility in the areas of direct and indirect overhead costs (Innes, Mitchell, Yoshikawa 1994). Another weakness is the difficulty of tracing the root causes of resources consumption from the reported cost data by employing the traditional costing systems. This is because the traditional costing systems don not require careful study of how each task (activity) completed, they can only tell how expensive the end results are. This limits their ability to identify COPQ improvement projects. In addition, significant quality costs may be hidden or neglected because of incomplete root-cause analysis.

Therefore, a need for developing new costing systems has emerged in order to implement effective COPQ programs or models. These programs should be able to help identify root causes of resources consumption and initiate appropriate improvement projects to reduce quality costs as well as to improve quality. Thus, developing a costing system based on activity-based information may lead the way for developing new costing systems.

The activity-based costing system is one of such new developed systems (Kaplan and Atkinson, 1998). It involves identifying activities and assessing resources used to perform the identified activities, allocating assessed resources to these activities, the choice of cost drivers, and the means by which the cost drivers are linked to production line or other cost objects. This enables managers to obtain product costs information that could be used for developing and implementing appropriate COPQ programs that suit an organization's specific experiences and environment.

When considering the real situation at manufacturing organizations in Palestine, a prior study conducted by Naser Abdelkarim and Rasheed Alkukhon (1997), as outlined in chapter two, advocates that most of those organizations do implement traditional cost accounting systems. The study reveals that (50%) of those organizations do implement operation costing system, while others do implement process costing system. Moreover, the study reveals that ways of assigning overhead costs under both systems differ among those organizations.

As known, such costing systems establish cost accounts by the categories of expenses instead of activities, while most of COPQ measurement methods are activity/process oriented. This means that the above stated traditional cost accounting systems used at manufacturing organizations in Palestine do not provide appropriate quality related data and benefits resulting from improved quality are not measured. This indeed may lead managers to make poor decisions due to inappropriate allocation of overhead or "indirect costs". On the other hand, as outlined in chapter two, most of those organizations often do not even have any quality budget and do not attempt to monitor quality costs. Even though most managers of those organizations claim that quality is their top priority, only a small number of them are aware of quality. Moreover, even those who are aware of quality, they think of it only as a marketing tool for selling more. They rarely think of it as a cost reduction and a profitability-improving tool.

Therefore, this study aims to build an activity-based COPQ model (program) that may help the food manufacturing organizations in Palestine identify, categorize and determine costs of poor quality (COPQ) existing at manufacturing organizations in Palestine, particularly at food manufacturing organizations. Moreover, prioritize the identified existing COPQ, which may be considered as opportunities for cost reductions and quality improvement as one-step forward to initiate improvement projects.

Based on food manufacturing organizations' practices in Palestine and costs of poor quality models formulated by others, an activity-based COPQ model is introduced in this study to achieve the above-mentioned objectives. Since categories of COPQ vary concerning type of organizations if they are services organizations or manufacturing, or others, the introduced model was refined to suit the food manufacturing sector's experiences and environment.

1.2 Study objectives

Reporting costs of poor quality can help organizations identify new areas of costs where action is worth taking. Implementing COPQ programs within an activity-based costing perspective represents the next wave in reporting accurate costs of poor quality as a need for cost reductions, improving quality, and raising competitiveness capacity.

The primary objective of this study is to build a COPQ model within an activity-based costing (ABC) perspective to be implemented at food manufacturing sector in Palestine. **Moreover, to apply this model by means of conducting a real case study at one of the top large and well-developed food manufacturing organizations in Palestine.** Therefore, this **model will tackle several issues, such as:**

- ***Identifying, categorizing and determining COPQ, which exist at food manufacturing organizations in Palestine, as well as detecting COPQ areas that contribute the highest portion of such costs.***
- ***Demonstrating the significant role that activity-based COPQ programs, when implemented effectively, can play in prioritizing areas where to initiate improvement projects.***
- ***Understanding the costs of poor quality and their significant impact on competitiveness capacity and continuous improvement.***

Since the main purpose of this study is to recognize and analyze COPQ existing at food manufacturing organizations in Palestine throughout a built-on activity-based COPQ model, the study will try to address this main question:

◆***Which categories of COPQ at food manufacturing organizations in Palestine are to be identified as opportunities for both quality cost reductions and quality improvement?***

In addition, the study will try to address the following sub-questions that frequently rise in such or related studies, which might help in answering the main question of this study. These questions are:

◆***What existing COPQ categories could be identified and determined at food manufacturing organizations in Palestine?***

◆***What percentages do identified existing COPQ categories contribute to, regarding total COPQ?***

◆***Will it have an emphasis to strengthen the importance and effectiveness of the implementation of quality costing systems throughout the food manufacturing organizations in Palestine?***

◆***Will it have an emphasis to recommend and advise the food manufacturing sector in Palestine to implement activity-based COPQ models?***

1.3 Importance of the study

In today's open and free trade market, the competitiveness capacity is a critical issue for manufacturing organizations in Palestine, particularly for food manufacturing organizations. According to surveys conducted by Palestinian Bureau of Statistics (Economy Survey Series- Main Results, 2003) as well as those conducted by Palestinian Federation for Food Industries (2005), the surveys results reveal that the market share of the locally produced processed food contributes to about 40 percent of the processed food market in Palestine. This indicator shows what degree of competitiveness facing the locally produced processed food in the Palestinian processed food market and what food manufacturing organizations in Palestine must do either to gain more market share or at least to be as well in the market.

Regarding today's market increased competitiveness, improving product quality, and managing quality-related activities that drive costs within organizations' boundaries are considered the foremost vital competitiveness capacity drivers. Another reason to justify this study stems from the fact that most of the manufacturing organizations in Palestine lack the experience to estimate the COPQ, and even to recognize these costs due either the low level of quality awareness if they have or the misunderstanding of the relationship between improving quality and the costs of poor quality. Hence, most of these organizations think of quality as costing more and selling less, or just as a marketing tool for selling more regardless what end costs are.

Therefore, this study aims to raise awareness level regarding COPQ among manufacturing organizations in Palestine, particularly among food manufacturing organizations. Also, to open the eyes on the dollar amount of such costs that may enhance these organizations to implement the COPQ model introduced in this study or other models that suit an organization's specific experiences and environment.

1.4 Study limitations

Due to the current political situation in West Bank and Gaza, the study was limited to food manufacturing sector and was not expanded to other manufacturing sectors because it comprises a high portion regarding number and size of operating manufacturing organizations. In addition, it is a relatively developed sector among other sectors regarding quality standards.

Moreover, the built-on model was applied by means of conducting only one real case study selected from food manufacturing sector, because a considerable time and effort was needed to build and refine the introduced COPQ as well as to analyze the selected case. Furthermore, the introduced model was applied for a period of two months. Therefore, the study results are less to be generalized.

1.5 Terms definition

Since the main objective of this study is to understand the significant role that the implementation of activity-based COPQ models can play in recognizing, categorizing and analyzing COPQ as well as identifying and prioritizing areas where to initiate improvement projects. Therefore, this significant role is examined at manufacturing sector in Palestine, particularly at food manufacturing sector.

By defining the terms of the study, the understanding of the COPQ concepts may become clearer:

Quality: "the ability of a set of inherent characteristics of a product, system or process to fulfill requirements of customers and other interested parties" (ISO 9001:2000).

Costs of poor quality (COPQ): " costs incurred in the design, implementation, operation and maintenance of quality management system, the costs of resources committed to continuous improvement, the cost of system, product, and service failures, and all other necessary costs and non-value added activities required to achieve a quality product or service " Dale and Planket, 1995).

Prevention costs: "costs of activities that are specifically designed to prevent poor quality" (Campanella, 1990).

Appraisal costs: "costs of activities designed to find quality problems ensuring that the right quality is achieved" (Campanella, 1990).

Internal failure costs: "costs of failures and defects which are discovered before the goods or services reach external customers" (Lenart Sandholm, 2000).

External failure costs: "costs of failure and defects which are discovered by external customers" (Lenart Sandholm, 2000).

Total cost of poor quality: "costs of prevention, appraisal, external failure and internal failure costs" (Campanella, 1990).

Activity-based costing system (ABC): "an accounting methodology and a management tool that helps identify business activities that consume valued resources" (Kaplan and Atkinson, 1998).

Unit-level activity: "represents work performed for every unit of product or service produced" (Charles T., Srikant M. and George Foster, 2003).

Batch-level activity: "represents work performed for a group of units of products or services rather than to each individual unit of product or service" (Charles T., Srikant M. and George Foster, 2003).

Product-level activity: "represents work performed to support individual products or services regardless of the number of units or batches in which the units are produced" (Charles T., Srikant M. and George Foster, 2003).

Facility-level activity: "represents work performed that cannot be traced to individual products or services but support the organization as a whole" (Charles T., Srikant M. and George Foster, 2003).

Cost driver: "a factor that causes or (drives) an activity cost" (Maher and Deakin, 1994).

CHAPTER TWO

LITERATURE REVIEW AND PRIOR STUDIES

CHAPTER TWO

LITRATURE REVIEW AND PRIOR STUDIES

Introduction

This study first takes in-depth look into quality: what does quality mean (how it has been defined), what are the costs of quality, what are the approaches (Costs of Quality Models) in which organizations can set about assessing, categorizing and measuring quality costs, what is the effect of quality awareness level among organizations on quality improvement level , and finally why should organizations develop COPQ programs (models) within an activity-based costing (ABC) perspective for assessing, categorizing and measuring COPQ.

2.1 Conceptual framework:

2.1.1 Meaning of quality:

Quality means different things to different people and organizations. Some believe quality is a new concept, which has emerged in the market recently. But the concept of quality has been since the beginning of time. Artisan's and craftsmen's skills and the quality of their work are described throughout history. Typically, the quality intrinsic to their products was described by some attribute of the products such as strength, beauty or finish. However, it was not until the advent of the mass production of products that the reproducibility of the size or shape of a product became a quality issue. Quality was obtained by inspecting each part of a product and passing only those that met specifications. This was true until 1931, when Walter Shewhart, a statistician at Hawthorne plant at Western Electric, published his book Economic Control of Quality of Manufacturing Product (Van Nostrand, 1931). This book is the foundation of modern statistical process control (SPC) and provides the basis for the philosophy of total quality management or continuous process improvement for improving processes.

Juran (1988) defines quality as: "Fitness for purpose or use", which means that a fundamental feature of products (regardless of whether they are goods or services) is that they should be fit for their intended use. By this definition, thinking is solely a bout the way the customer uses the products. The term "use", however should be broadened to also include activities which take place prior to use by the customer. For example, each production operation may be regarded as the user of the product, while it is in the production. At each phase, the production should be of such quality that it is fit for use in all the subsequent phases, that is to say, in production operations, packaging, storage, distribution and end use. Not only external use but also internal use should be taken into consideration in an organization's of quality activities. So, the quality of a product may therefore be defined as its fitness for purpose or use.

Feigenbanm (1956) defines quality as: "Product and service characteristics as offered by design, marketing, manufacture, maintenance and service that meet customer expectations ". This means that a customer who buys a product has certain expectations, which are influenced by several factors, such as: the purpose or the internal use, the appearance and performance of the product, the goodwill the company enjoys as well as the products price. A high price leads customers to expect more than a low price would. If when it is used, the product meets these expectations, the customer will probably be satisfied and judge the products to be of good quality (or at least acceptable quality). If expectations are not met then the customer will be likely to regard the product of being of poor quality. Therefore, the quality of a product may be defined as its ability to satisfy customer expectations.

The "quality guru" Dr. Edward Deming (1982) defines quality as: "A product or service nature or features that reflect capacity to satisfy express or implied statements of needs".

The American National Standards Institute (ANSI) defines quality as:" the totality of features and characteristics of a product or service that bears on its ability to satisfy given needs".

Both definitions by Deming (1982) and the American National Standards Institute mean that the reasons why customers demand particular products is that they wish to have their needs satisfied. If those needs are satisfied, then it is highly likely that the customers will also be satisfied and regard the products as being of acceptable quality or even of very good quality. In some cases, the customer even thinks about this, but takes it for granted. But if it turns out that the products do not satisfy the needs, the customer will probably react and regard the products of being of poor quality. Consequently, the quality of a product may therefore by defined as its ability to satisfy customer needs. According to Lars Sorqvist (1997), Noriaki Kano- the Japanese quality expert- advocates that there are three types of need, which together determine the customer perception of quality. First , the stated needs that the customer expects to be satisfied and regards as important, and can be identified by means of customer surveys and form the basis for the specification that is then drawn up. Satisfying these needs leads to satisfied customers. Second, the implied needs that considered to be so fundamental and obvious that the customer does not even mention them when asked. It is considered to be obligatory to satisfy these needs, and doing so, therefore, does not create greater customer satisfaction. On the other hand, in the event of failings in this respect, customer dissatisfaction will increase dramatically. Information about implied needs cannot be obtained by means of customer surveys, but most of them nevertheless tend to be obvious. Third, the unconscious needs that the customer is pleasantly surprised when his/her unconscious, latent, needs are satisfied, which often leads to marked increase in the value of the products in the customer's eyes. In this way the organization can gain a valuable competitive advantage and more loyal customers. Information about unconscious needs cannot be obtained by means of traditional customer surveys. Methods of an experimental nature must be used.

The International Standardization Organization (ISO) defines quality as "the ability of a set of inherent characteristics of a product, system or process to fulfill requirements of customers and other interested parties" .

The ″quality guru″ Philip Crosby (1979) defines quality as: ″there is no subjective, aesthetic concept of good quality. Quality is conformance to requirements".

Both definitions by Crosby (1979) and the International Standardization Organization (ISO) mean that if members of the public are asked what they understand by the term quality, answers might be some thing like (Value for money, Durability, Looks good, Superior, Reliability, Functionality, etc.).

It might be agreed that products or services of high (good) quality should have those characteristics. But all those definitions (answers) have one major drawback; they are very personal statements. What is superior to one person may be inferior to other.

″Quality is primarily a business problem, not a technical problem, the survival of the industrial company depends on its ability to meet the quality needs of society" (Juran, 1988), which means that quality is not "a brand-new idea" to organizations. But what is new to many organizations is that quality represents a competitive weapon, which enables it to improve performance and competitiveness. Furthermore, it is widely accepted that organizations do not have a choice about whether or not to embark on quality improvement programs; in a long run it is necessary for survival. However, according to "quality guru" Dr. Edward Deming (1982), there is always a choice: "Survival is not a necessary; you don’t have to do it". That is harmonized with the content of the above stated definitions by Philip Crosby and ISO, which means that understanding by the term quality are very personal statements. What is superior to one person is inferior to other.

Professor David Carvin, http://www.reinholm.com/quality.htm, has divided all different definitions (views) of quality into "five approaches to quality":

❶ The transcendent approach, what view quality as synonymous with innate excellence. According to this approach, quality is being defined as the best possible, in terms of product or service's specification.

❷ The manufacturing–based approach, what is concerned with making error free products or providing error free services, which conform to their design specification.

❸ The user–based approach is concerned that the product or service is fit for its use or purpose.

❹ The product–based approach. This approach view quality as a measurable set of characteristics that is required to satisfy the customers.

❺ The value–based approach. This approach contends that quality should be perceived in relation to price.

What have been discussed earlier is the concept of quality in relation to products (regardless of whether they are goods or services) which an organization produces and supplies. But today the concept also includes supplementary services and all other aspects of the business. The focus is thus on quality in all areas of the organization under the concept most commonly referred to is Total Quality Management (TQM), which also includes the quality of all internal processes and functions as well as the involvement of every one in the organization . Therefore, most organizations on today's intensely competitive markets endeavor to increase customer satisfaction and reduce costs throughout all areas of their business. This has resulted in the concept of quality being broadened to include both external and internal customers.

The routes to better quality have been and still are circuitous and ill-defined. There is great uncertainty over what needs to be done and a number of trendy and popular methods have therefore sprung up over the years. One fundamental reason for this uncertainty is that the goals and the results achieved are often very diffuse. Quality itself is subjective. Attempts are made to define and pin-down the concept, but from the organization's overall perspective there is still in many cases considerable uncertainty over the significance of quality and changes in quality levels.

2.1.2 Costs of quality (COQ)

"Because the main language of [corporate management] was money, there emerged the concept of studying quality–related costs as a means of communication between the quality staff departments and the company managers" (Gryna, 1988).

Quality costing as a quality management technique has been around for nearly four decades, since the seminal paper of Feigenbaum (1956).

Quality is a measurable, as are its costs. Philip Crosby (1979), in Quality is Free, writes that the cost of quality is "the expense of non-conformance...the cost of doing things wrong". Some prefer the term "costs of poor quality" (COPQ) because that implies what happens when continual improvement efforts are derailed or postponed. As A.V. Feigenbaum, an early writer on the subject states, in Total Quality Control (1991): "Today we not only recognize the measurability of quality costs but that these costs are central to the management and engineering of modern total quality control as well as to the business strategy planning of companies and plants".

Juran, one of the world's leading theorists has been advocating the analysis of quality–related costs since 1951. He believed that a new approach was needed for quality control department to sell their quality control programs to management. Consequently, he introduced the concept of costs of poor quality (COPQ) (Juran and Gryna, 1988). He defined COPQ as those costs incurred because of poor quality that would not have been incurred if every aspect of a product or service were perfectly correct the first time and every time- no deficiencies. These COPQ include internal failure costs, external failure costs, appraisal costs, and prevention costs.

Feigenbaum (1991) made it one of the core ideas underlying the Total Quality Management movement. Like Juran, he also proposed the costs of quality concept to secure commitment from senior management to develop and implement quality improvement projects. In fact, as stated above, he explained that they are central to management and engineering of modern total quality control, as well as to business strategy planning. He divided the COPQ into two major categories, namely, costs of control (Prevention and Appraisal costs) and costs of failure of control (Internal failure and External failure costs).

Similarly, Philip Crosby (1984), the cost of poor quality is a blessing and serves the unique purpose for focusing attention on quality management when used as a management tool. Consequently, he defined the COPQ into cost of conformance (Prevention and Appraisal costs) and failure costs (Internal and External failure costs). He considers "everything that would not have to be done if everything were done right" as the price of non-conformance, and sees non-conformance as a bacteria that must be treated with antibodies to prevent problems from recurring.

Others called the COPQ costs of conformance (Prevention and Appraisal costs) and costs of non-conformance (Internal and External failure costs) (Louisiana State University, 1997).

According to Julian Ellis and peter Butcher, www.ellisdev.co.uk/ellisdev/textile technology/quality systems/garment , for an organization to stay in business, its product quality should satisfy its customers at the price they are prepared to pay. Failure to maintain an adequate quality standard can therefore be disastrous. But maintaining an adequate standard of quality also costs effort. From the first investigation to find out what the potential customer for a new product really wants, through the processes of design, specification, controlled manufacture and sale, to the arrangements for after sales service to the customer, effort is being spent on ensuring that the organization's product and reputation are good. If it is spent wisely, it can result in savings greater than the increase in costs, and hence in an improvement to profits. As products become more and more complex, and as customers become more conscious of the effects on their economics of receiving a proportion of defective items, the effort required must continually increase. The costs represented by this effort can be a significant proportion of the products sales value, and hence any manufacturing organization should be interested in making sure that it is getting good value for its expenditure. This can only happen if a manufacturing organization has studied what the costs are, how they are higher than they ought to be. If they are higher than they should be it must consider ways in which they can be reduced. They divided the quality costs into three main groups. First, there are costs associated with attaining or setting an adequate quality standard, sometimes called prevention costs. They are incurred largely in advance of production, when the quality standard is set. Insufficient money spent at this stage on, for example, design and development may give rise to unnecessarily high costs later. Second, there are costs associated with maintaining an adequate quality standard, sometimes called appraisal costs. These are the costs associated with keeping the work manufacturing and buying functions up to the quality specified in the design. Third, there are costs associated with putting right any departure form standard, sometime called failure costs. These include the costs of scrap, reprocessing, and guarantee claims. They are the costs, which arise as a result of shortcomings in, or insufficient expenditure on, the other two groups. They may be caused on the one hand by poor design, poor product engineering, and poor operative training or, on the other hand, by bad workmanship, or slipshod inspection at the appraisal stage. It is more important to recognize the changes deliberately made in these costs as action is taken to bring quality under control.

According to Lennart Sandholm (2000), an organization will incur costs. Such costs to varying degrees can be avoided or limited, depending on how efficiently the business is conducted with regard to product quality. These costs are normally known as quality costs that include the costs of attaining a given quality level (prevention costs) as well as those costs which are due to poor quality. The latter category is known as costs which would be eliminated if all products and processes were perfect. This means that poor quality costs include:

● Appraisal costs, the costs of ensuring that the right quality is achieved.

● Internal failure costs, the costs of failures and defects which are discovered before the goods or services reach external customers.

● External failure costs, the costs of failure and defects, which are discovered by external customers.

● Hidden costs include, to mentioned some examples, the time managers and others have to spend on quality problems, re-planning that is needed, the time spent waiting, extra sales campaigns, loss of good will. However, it is important to be aware that a high proportion of poor quality costs are hidden.

According to Campanella (1990), there are six useful definitions of COQ:

● Prevention costs, costs of activities that are specifically designed to prevent poor quality.

● Appraisal costs, costs of activities designed to find quality problems, such as code inspections and any type of testing.

● Failure costs, costs that result form poor quality, such as the costs of fixing bugs and the costs of dealing with customer complaints.

● Internal failure costs that arise before an organization supplies its product to the customer.

● External failure costs that arise after an organization supplies the product to the customer.

● Total cost of quality, the sum of all the costs (Prevention + Appraisal + Internal failure + External failure).

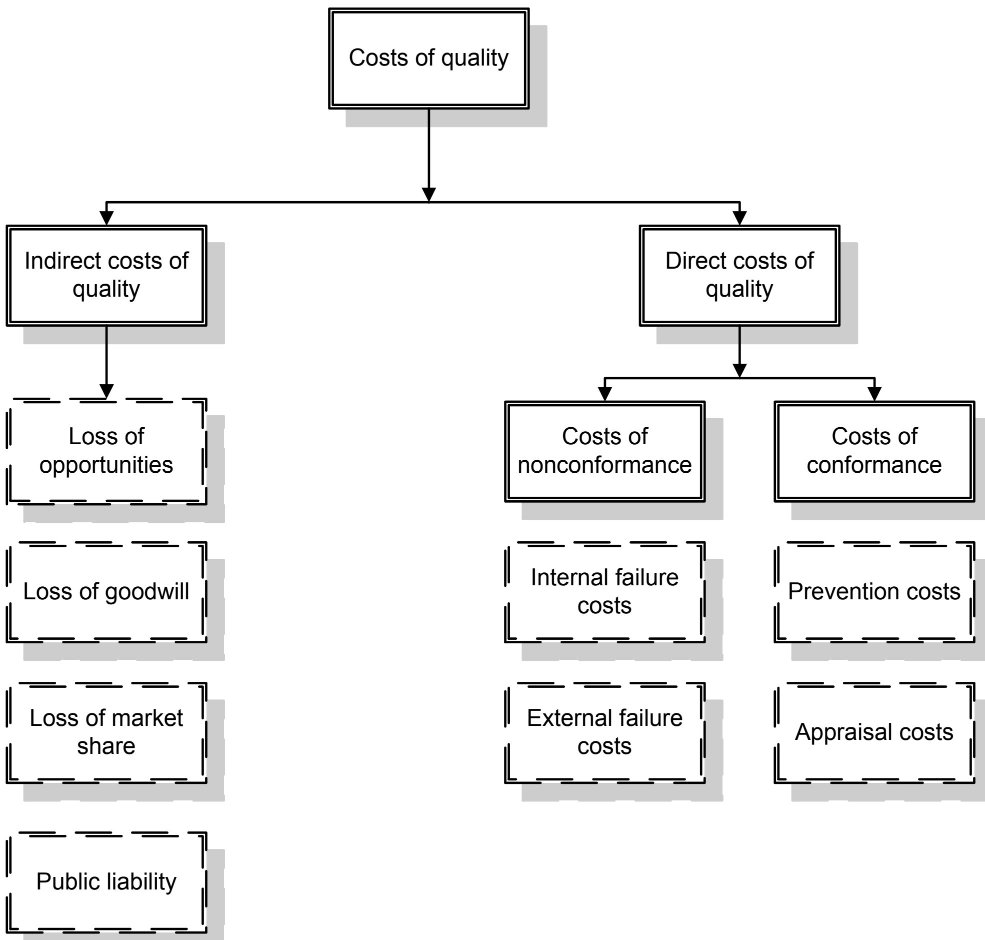
According to Gryna (1988), quality costs are the costs associated with preventing, finding, and correcting defective work. Many of these costs can be significantly reduced or avoided. One of the key functions of a quality engineer is the reduction of the total costs of quality associated with a product.

There is no general agreement on a single broad definition of quality costs (Machowski and Dale, 1998). However, COQ is usually understood as the sum of conformance plus non–conformance costs. Costs of conformance are the price paid for prevention poor quality (Inspection and quality appraisal). Costs of non–conformance are the costs of poor quality caused by product and service failure (rework and returns).

According to Dale and plunket (1995), it is now widely accepted that quality costs are the costs incurred in the design, implementation, operation and maintenance of quality management system. Moreover, they comprise costs of resources committed to continuous improvement, cost of system, product and service failures, and all other necessary costs and non–value added activities required to achieve a quality product or service.

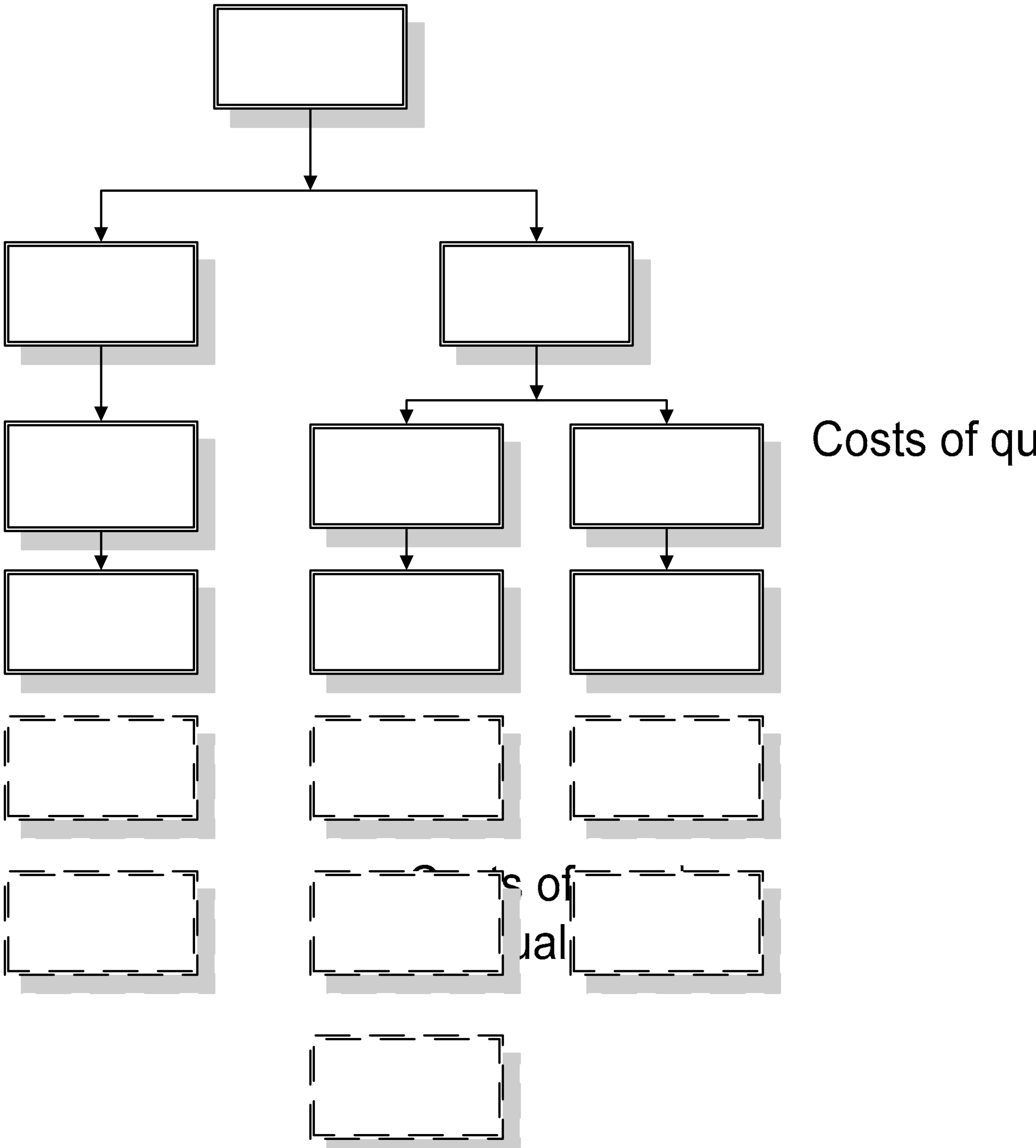
Regarding all different views categorizing the costs of quality, these costs cover a wide area; they can be internal or external costs, direct or indirect costs. Therefore, many basic models categorizing costs of quality were developed. Some based on direct and indirect costs as shown in Figure 2.1, while others based on external and internal costs as shown in Figure 2.2.

Figure 2.1- A basic Model Categorizing Costs of Quality based on Direct and Indirect Quality Costs.



(Source: www.universe1.fsbusiness.co.uk/quality costs.htm)

Figure 2.2 – A basic Model Categorizing Costs of Quality based on Good and Poor Quality Costs.



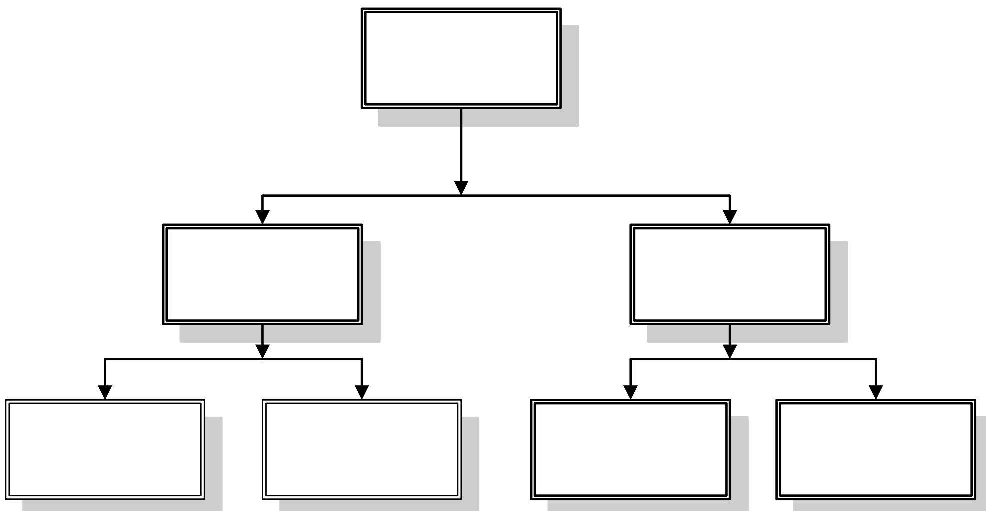
(Source: Westgard Jo and Barry Pl, 1986)

Direct costs of
quality

In

Regarding manufacturing organizations, all the costs associated with quality are described by the industrial model for "quality–costs" (Feigenbaum, 1954), which includes the costs of good quality (Preventive costs and Appraisal costs) and the costs of poor quality (Internal and External failure costs), as shown below in Figure 2.3.

Figure 2.3 – The Industrial Model for "Quality-Costs" at Manufacturing Organizations



(Source: Feigenbaum, 1956)

Concerning industrial model, the costs of good quality are the planning and design of the processes, the training of the line workers, and the time and effort in measuring and monitoring the quality of the product. The costs of poor quality are the rework and waste of a production process- doing things over to get the product right, or scraping the product altogether.

Costs of qu

Moreover, the cost elements of various types at manufacturing organizations may be classified within the three main categories of poor quality costs (Appraisal

Costs of good
quality

costs, internal failure costs, and external failure costs) as following (Lennart Sandholm, 2000):

● Appraisal costs comprise the costs of checking materials, parts and products satisfy the quality requirements, regardless of whether the inspection or test takes the form of 100 % inspection or sampling inspection, and regardless of whether the individuals who perform these activities belong to quality control department or any other department.

Appraisal costs include the following costs:

- Inspecting and checking the quality of goods when they arrive from the supplier.
- In–process inspection, checking parts and products during the manufacturing process.
- Final inspection, checking that finished goods satisfy quality requirements.
- Product–oriented quality audit, studying the quality of finished products with the aid of a quality rating.
- Special inspection, carrying out routine life tests, lab tests and similar checks on products drawn from current production.

● Internal failure costs comprise the costs of products, parts and materials, which do not conform with the quality requirements, if these non-conformities are discovered internally, i.e. by the manufacturing organization itself before they are shipped to external customers.

Internal failure costs include the following costs:

- Scrap–Products, parts and materials those could not be used because they do not satisfy quality requirements.

- Rework–Reworking, adjusting or repairing products, parts and materials to enable them conform to quality requirements.

- Retesting–Checking products, parts and materials that have been reworked.

- Screening–Sorting and separating out non-conforming units from batches where a sampling inspection or some other procedures have shown that the defect rate is not acceptable.

- Analysis of defects – Analyzing defects to find out the causes.

- Downgrading–Reduction in value due to the downgrading of first grade products to seconds.

● External failure costs comprise the cost of failures and defects that are discovered after goods have been delivered to external customers.

External failure costs include the following cost:

- Complaints–Collecting, processing and analyzing complaints. This item also includes the cost of compensating customers who have complained.

- Guarantees–Repairing and replacing products those are under guarantee.

- Allowances–Giving allowances to customers who receive faulty products.

- Recalls–Recalling or withdrawing products that could cause damage.

- Loss of goodwill–External failures can lead to loss of reputation, which has a price for the company.

The cost elements indicated above should only be seen as guidelines. Circumstances can differ from organization to organization so that in one organization some elements can be excluded although they may be important in other organization.

It might be agreed upon what stated above that at manufacturing organizations every stage is involved, from design to production, from delivery to customer service etc. The use of obsolete stock, any delays during the processes, scrap, raw materials not conforming to specification, all could impact on an organization's efficiency. This could result for example in re-work, a major quality cost itself. Inevitable costs that are incurred during the production stage are passed onto the customer. More importantly the loss of customer good-will could be even greater. One unhappy customer could tell ten other people resulting in the loss of 10 possible sales, in other words the losses can never be quantified.

Regarding all different views categorizing the costs of quality, any organization that produces products (regardless of whether they are goods or services), must monitor its quality. To achieve quality "it costs". These quality costs must be carefully managed ensuring that they do not go out of control. By keeping quality costs under control, any adverse effects can be kept to minimum, which will help to ensure that the effects are desirable.

From that point a number of organizations are keen to develop their knowledge of COQ concept to help them better understand the effectiveness of their decisions on wastage and save money. Some are now seeking both theoretical advice and practical evidence about quality-related costs and the implementation of quality costing systems (approaches for assessing and measuring costs of quality). Others are developing formalized quality costing systems, which indeed help organizations understand that quality is global and is not just about checking into products. Moreover, such formalized systems can help managers cut the true costs that are involved in getting quality right first time, since they are the only people with the authority to change the system to reduce quality costs. This is especially apparent when published figures by the National Economic Development Organization (NEDO) like 10%-20% of organizations total sales values accounted for quality-related costs. Many of these costs are failure and appraisal costs that account for up to 95% of quality costs. However, such costs should be seen as avoidable, i.e., if failure costs are reduced the appraisal costs will dramatically reduce.

2.1.3 Approaches (Models) for assessing and measuring costs of quality

There are a wide variety of ways (approaches) in which organizations can set about assessing (collecting) and measuring quality costs. It is usually argued that the approach is taken is dependent upon the objectives of the exercise and the audience for the resulting data (Dale and Plunkett 1995).

Quality experts have different opinions on assessing and measuring COQ.

Dr. Edward Deming (1982), perhaps the best-known advocate of quality management, believed that the cost of non-conformance (and the resulting loss of goodwill) was so high that evaluating cost of quality was unnecessary. He saw absolutely no value in financial measures related to quality. While for Deming measuring COQ was a waste of time, J.M Juran and Philip Crosby saw a need for it. They believed that as defect prevention was increased, the cost of rework would decrease by much more than the increase in prevention costs. The net result was lower total costs and thus "quality is free" (Crosby, 1979).

Prior studies show that a much of earlier research has been dedicated to the more theoretical aspects of quality costs, such as optimization theories and methods of statistical analysis. Relatively few researchers have concentrated on the actual measuring, i.e. how the information on quality costs is obtained. However, it has been revealed in practical applications that the greatest problem is to obtain this information in a reliable way, without it requiring much work. Without input data of good quality, most applications and methods will provide misleading results. This was the reason for the study conducted by Lars Sorqvist (1997). Hence, the purpose of the study was to develop a model for measuring the cost which arises in companies and other organizations as a result of poor quality. The study divides the measurement of the cost of poor quality into the following two phases:

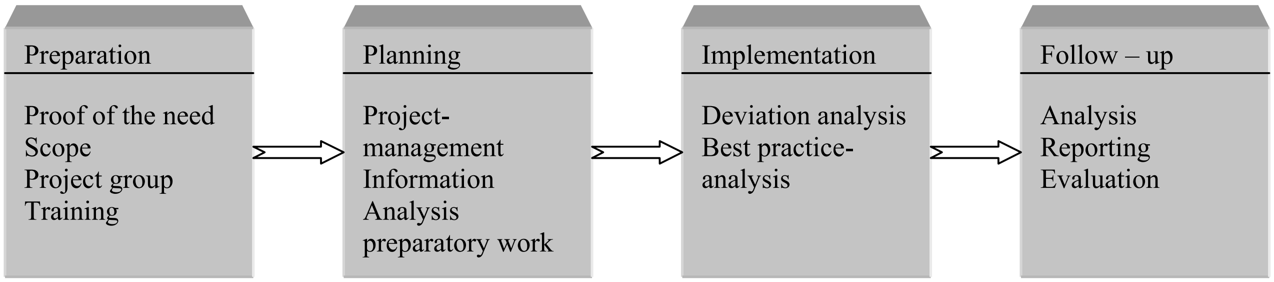
► *Phase 1: Assessing COPQ*

The purpose of the assessment phase is to identify and determine the cost of poor quality for all the organization’s activities. This is based on whatever information is available, together with estimates.

The work is best to be carried out with the participation of individuals (including some from the financial department) who are well informed about the different areas of the organization’s business.

The result of the assessment is best to be used to demonstrate to top management, in the first instance, the immense potential that exists to significantly improve profitability by reducing the costs of poor quality. The different steps in the identification survey are shown below in Figure 2.4.

Figure 2.4- Method for assessing costs of poor quality



(Source: Lars Sorqvist, 1997)

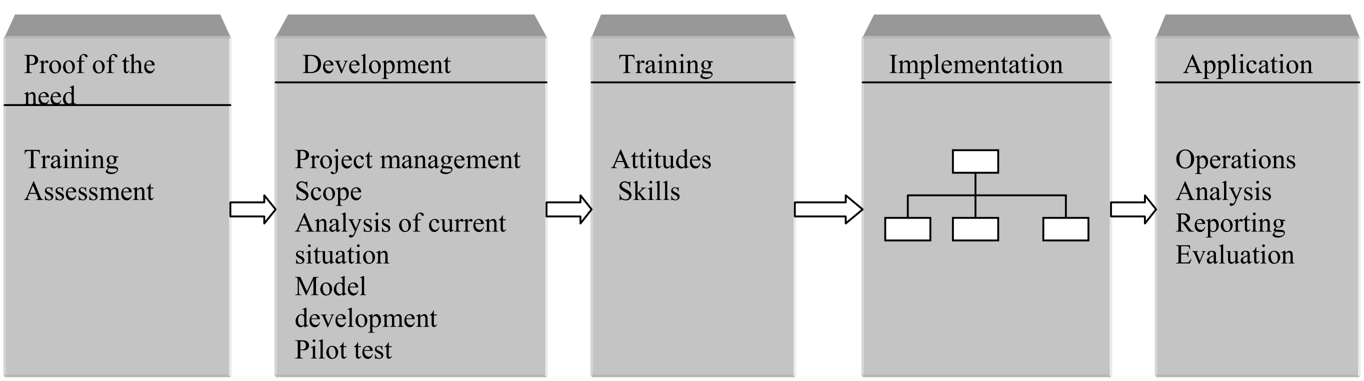
► *Phase 2: Designing a system for measuring COPQ*

In some manufacturing organizations, measuring systems (models) are used for the continuous measurement of the costs of scrap and rework in production. Within other parts of the business measuring the costs of poor quality with the help of measuring systems demands usually a great deal of work.

In order to arrive at a measuring system that works it is essential that the personnel concerned are well informed as to the purpose. In this context it is important to provide training. Measuring systems are best used for cost elements where follow–up is important in on–going improvement projects.

The Methods of approach for the design of measuring systems are shown in Figure 2.5.

Figure 2.5- Method for designing systems to measure costs of poor quality (Lars Sorqvist, 1997)



Similarly, the quality costs committee at the American Society for Quality (ASQ) suggested a five-stage process to develop a COPQ program involving the following steps (ASQC 1986, Dale and Plunkett 1991):

● Planning the system.

● Building the quality cost elements checklist.

● Collecting and grouping data.

● Standardizing reporting formats and methods.

● Analyzing reports, identifying improvement programs, and tracking results.

The purpose of this process is to develop a COPQ program that focuses on formulating appropriate goals and objectives, identifying quality cost elements based on the organization's experience and environment, collecting data in terms of the four COPQ categories, and analyzing the COPQ data by each category, department, product, or other groupings . Based on this information organizations can identify the COPQ improvement projects and develop appropriate implementation plants to reduce costs of quality.

The process advocates that COPQ data collection must be cross-functional and cross-departmental activity. Moreover, it needs a team approach; a team should be formed comprising of quality specialists and the staff/or managers from the concerned departments who should take the responsibility for identifying COPQ elements and collecting time and resources actually spent on them. COPQ data must be presented in appropriate ways depending on the use. For example, senior management may want to examine COPQ data and information by division or by plant and product, whereas departmental managers may want to examine such costs data by their departments. Similarly, they may want to see the plant's product COPQ data as a percentage of value-added.

However, whether the developed approach is based on these or similar processes it should be always tailored to meet the needs of the organization (Dale and Plunkett, 1995).

Whilst there is a reasonable a mount of practical 'hands-on' advice in the quality costing literature (Groocock 1980, Juran 1974, Peet 1990, Whitehall 1986), there are few published examples of a practical nature. These examples (COPQ models) were developed based on traditional costing systems. They give specific details on costs included or excluded in main element groupings in the chosen cost categorization. Moreover, they show how the costs were collected. On the other hand, they lack the ability to provide proper visibility in the areas of direct and indirect overhead costs (Innes, Mitchell, and Yoshikawa 1994). In addition, they lack the ability to trace the root causes of resources consumption from the reported costs data. This is because the traditional costing systems do not require careful study of how each task is completed; they can only tell how expensive the end results are. This limits their ability to identify COPQ improvement projects. In addition, significant quality costs may be hidden or neglected because of incomplete root-cause analysis. Therefore, there is a strong need for developing new costing systems in order to implement effective COPQ programs. These programs should be able to help identify root causes of resources consumption and formulate improvement action plans to reduce quality costs. Thus, the purpose of this study is to fill the gap by developing and implementing an effective COPQ program (model) within an activity-based costing perspective at one well-known food manufacturing organizations in Palestine that can help these organizations identify, categorize and determine existing COPQ at their premises, and may lead the way for developing new costing systems.

2.1.3.1 Quality costs models

COQ models can be classified into four groups of generic models as shown in Table 2.1. These are:

P–A – F (Prevention, Appraisal, and Failure) or Crosby's model, opportunity cost models, process cost models and ABC (activity-based costing) models.

Table 2.1-: COPQ models and cost categories

Generic model	Cost/ activity category	Publications developing or dealing with the model
P – A – F models	prevention + appraisal + failure	Feigenbaum 1956 , Purgsolve and Dale 1995, Merino 1988 , Fruin 1986 , Thompson and Nakamura 1987 , Denzer 1978 , Chang et al. 1996 , Sorqvist 1997 , Plunkett and Dale 1988 , Tatikonda and Tatikanda 1996 .
Crosby's model	conformance + nonconformance	Suminsky 1994 , Denton and Kowalski 1988
Opportunity or intangible cost models	prevention + appraisal +failure + opportunity	Sandoval –Chavez and Beruvides 1998, Modarres and Ansari 1987
	conformance +nonconformance +opportunity	Carr 1992 , Malchi and McGruk 2001
	tangibles + intangibles	Juran et al. 1975
Process cost models	conformance + nonconformance	Ross 1977 , Marsh 1989, Goulden and Rawlins 1995 , Crossfield and Dale 1990
ABC models	Value–added + non value–added	Cooper 1988 , Cooper and Kaplan 1988, Tsai 1998 , Jorgenson and Enkerlin 1992

Most of the cost models are based on P-A-F classification (Plunket and Dale 1988, Machowski and Dale 1998, Sandoval-Chavez and Beruvides 1998). It was Joseph Juran (1951) who first discussed the cost of quality analysis and became a pioneer of quality costing, and it was Armand Feigenbaum (1956) who identified four quality cost categories: prevention, appraisal and failure (internal and external). Prevention costs are associated with actions taken to ensure that a process provides quality products and services. Appraisal costs are associated with measuring the level of quality attained by the process, and failure costs are incurred to correct quality in products and services before (internal) or after (external) delivery to the customer. Juran later highlighted the traditional tradeoff that contrasts prevention and appraisal costs with failure costs (Juran, 1988). The basic suppositions of the P-A-F model are that investment in prevention and appraisal activities will reduce failure costs, and that further investment in prevention activities will reduce appraisal costs (Porter and Rayner 1992, Plunket and Dale 1987). The objective of a COQ model is to find the level of quality that minimizes total costs of quality. Feigenbaum's and Juran's P-A-F scheme has been adopted by the American Society for Quality Control (ASQC, 1970), and the British Standards Institute as entailed in the British Standard (BS6143, 1990). Moreover, it is employed by most of the companies, which use quality-costing (Porter and Rayner, 1992).

The costs categories of Crosby's model (Crosby, 1979) are similar to the P-A-F scheme. Crosby sees quality as "conformance to requirements", and therefore, defines the costs of quality as the sum of price of conformance and price of nonconformance (Crosby, 1979). The price of conformance is the cost involved in making certain that things are done right the first time, which includes actual prevention and appraisal costs. Whereas the price of nonconformance is, the money wasted when work fails to conform to customer requirements, usually calculated by quantifying the costs of correcting, reworking or scrapping, which corresponds to actual failure costs. The model is used in companies that measure quality costs; however, most of the time it is only a different terminology describing a P-A-F model (Goulden and Rawlins, 1995), and the two costing structures are used interchangeably.

The importance of opportunity and intangible costs has been recently emphasized. Intangible costs are costs that can be only estimated such as profits not earned because of lost customers and reduction in revenue owing to nonconformance. Sandoval-Chavez and Beruvides (1998) incorporate opportunity losses into traditional P-A-F quality expenses. According to their approach, opportunity losses may be broken down into three components: underutilization of installed capacity, inadequate material handling and poor delivery of service. They express total COQ as revenue lost and profit not earned. Other authors like Modarres and Ansari (1987) also advocate that the P-A-F model can be expanded to accommodate extra dimensions that are identified as costs of inefficient resource utilization and quality design costs. Similarly, Carr (1992) includes opportunity costs, and he reports evidence of its successful use in quality programs. According to the above-mentioned approaches, quality costs are classified into three categories: costs of conformance, costs of nonconformance and costs of lost opportunity. Other authors address costs of lost opportunity as costs of lost customers derived from product failures that reach the market (Tatikonda and Tatikonda 1996, Heagy 1991). Similarly, Juran's model (Juran et al., 1975) also recognizes the importance of intangibles. His COQ scheme includes two measurable costs categories: tangible factory costs and tangible sales costs. Moreover, it suggests the inclusion of intangible internal benefits.

The process costs model developed by Ross (1977) and first used for quality costing by Marsh (1989) represents quality costs systems that focus on process rather than products or services.

Process costs are the total costs of conformance and nonconformance for a particular process. The costs of conformance are the actual process costs of producing products or services first time to required standards by a given specified process, whereas costs of nonconformance are the failure costs associated with the process not being executed to the required standards. These costs can be measured at any step of the process. Accordingly, it can be determined whether high nonconformance costs show the requirement for further expenditure on failure prevention activities or whether excessive conformance costs indicate the need for a process redesign (Porter and Rayner, 1992).

The process modeling method called IDEF (the computer-aided manufacturing integrated program definition methodology) developed by Ross (1977) is useful for experts in system modeling; nevertheless, for common use by managers or staff is too complex. Simpler methods were developed to overcome this limitation. Crossfield and Dale (1990) suggest a method for mapping quality assurance procedures, information flows and quality-related responsibilities. Goulden and Rawlins (1995) utilize a hybrid model for process quality costing where flowcharts are used to represent the main processes.

The use of a process costs model is suggested as a preferred method for quality costing within total quality management (TQM) as it recognizes the importance of process costs measurement and ownership. Moreover, it presents a more integrated approach to quality than a P-A-F model (Porter and Rayner, 1992). Goulden and Rawlins (1995) also suggest that analysts place emphasis on the cost of each process rather than on arbitrarily defined costs of quality under a P-A-F model. Moreover, the quality costs categorization is simpler and some researchers (Porter and Rayner, 1992) argue that it is also more relevant than the P-A-F scheme. The process model has wider application in that it facilitates the collection and analysis of quality costs for both direct and indirect functions. However, the process costs model is not in widespread use (Goulden and Rawlins, 1995).

Existing accounting systems are usually considered as poorly fitted for generating reports on quality measurements (Tatikonda and Tatikonda 1996, Sorqvist 1997a). They do not provide appropriate quality related data and benefits resulting from improved quality are not measured (Merino, 1988). Although, most COQ measurement methods are activity/process oriented, traditional cost accounting establishes cost accounts by the categories of expenses instead of activities. Thus, many COQ elements need to be estimated or collected by other methods. There is no consensus method on how to allocate overheads to COQ elements and no adequate method to trace quality costs to their sources (Tsai, 1998). An activity-based costing (ABC) model was developed by Cooper and Kaplan (Cooper 1988, Cooper and Kaplan 1988) to solve this problem. Under ABC, accurate costs for various cost objects are achieved by tracing resource costs to their respective activities and the cost of activities to cost objects. The ABC approach is actually not a COQ model. It is an alternative approach that can be used to identify, quantify and allocate quality costs among products, and therefore, helps to manage quality costs more effectively. Tsai (1998) proposes an integrated COQ-ABC framework, in which ABC and COQ systems are merged and share a common database in order to supply various cost and non-financial information for related management techniques. The long-term goal of ABC is to eliminate non-value added activities and to continuously improve processes, activities and quality so that no defects are produced.

2.1.3.2 Quality costs parameters

Many possible parameters can be used in COQ models. Johnson (1995) has published a large list of example elements, which could be included. However, there is no set structure and no accounting standard for quality costing; the decision on the cost structure of the COQ model is left to the judgment of quality managers or even quality data collectors. Therefore, the elements included in COQ models of various companies differ substantially. The same elements are often placed into different costs categories or are even defined in a different way in order to fit the different needs of the company (Sorqvist 1997a, Johnson 1995).

In order to identify costs of quality elements, some organizations benchmark or borrow elements from other companies, which have established COQ programs (Bemowski, 1991). Nevertheless, many quality experts say that COQ programs should be tailor-made for each organization such that they are integrated into a company's organizational structure and accounting system rather than just being borrowed (Campanella 1990, Johnson 1995, Salm 1991). Campanella (1990) emphasizes that decisions regarding which cost elements should be part of COQ and to which cost category they should belong are not as important as consistency. According to his view, companies should have a consistent set of comparisons that are made from period to period as the COQ program evolves; quality costs elements should be developed, deleted, modified, or combined as seems reasonable.

2.1.3.3 Quality costs metrics

COQ measurement systems should contain good feedback metrics. A mixture of global and detailed metrics has been suggested. The later actually measure the performance of COQ elements, while global quality metrics measure global performance. Some examples are given in Tables 2.2. The most frequently mentioned global metric in the context of COQ (Tatikonda and Tatikonda 1996, Slaughter et al., 1998) is return on quality (ROQ) which, defined as the increase in profit divided by the costs of quality improvement program. The other global metrics shown in Table 2.2 are suggested by other experts. Tatikonda and Tatikonda (1996) claim that successful companies measure ROQ as a basis for accepting quality improvement projects. Return on quality also serves as a tool to select a better alternative among competing improvement programs. Slaughter et al. (1998) modify ROQ for use in software environment and introduce three new quality metrics: return on software quality, costs of software quality, and probability index for software quality. Otherwise, very little has been published on metrics for COPQ.

Table 2.2- Examples of detailed and global metrics for COPQ

Detailed metrics	Global metrics
Costs of assets and materials	$\text{ROQ} = \dfrac{\text{increase in profit}}{\text{Costs of quality improvement program}}$
Costs of preventive labor	$\text{Quality rate} = \dfrac{\text{input- (quality defects + startup defects + rework)}}{\text{input}}$
Costs of appraisal labor	$\text{Process quality} = \dfrac{\text{available time-rework time}}{\text{Available time}}$
Costs of defects per 100 pieces	First time quality (% product with no rework)
Costs of late deliveries	
% of repeat sales	
Time between service calls	
# of non-conforming calls	
# of complaints received	

(Source: Andreas, S. and Vince, T., 2004)

2.1.3.4 Quality costs in Practice

No matter how great the interest of the academic community in COQ model is, and how much theoretical information and practical advice can be found, the situation in the real world is different. Companies rarely have a realistic idea of how much profit they are loosing through poor quality. Smaller firms most often do not even have any quality budget and do not attempt to monitor quality costs (Porter and Rayner 1992, Plunkett and Dale 1983). Large companies usually claim to assess quality costs (Schmahl et al., 1997); however, according to Tatikonda and Tatikonda (1996), even though most managers claim that quality is their top priority, only a small number of them really measure the results of quality improvement programs. Even in companies that do measure results, quality costs are grossly understated (Porter and Rayner 1992, Schmahl et al. 1997, Tatikonda and Tatikonda 1996). Companies measure visible and quantifiable costs such as scrap and warranty, but ignore significant costs such as lost of sales due to customer defection (Porter and Rayner 1992, Schmahl et al. 1997, Tatikonda and Tatikonda 1996). A high proportion of the costs have proven difficult to measure and have therefore remained hidden.

Measuring return on quality is not a common practice (Tatikonda and Tatikonda, 1996). Spending money on quality improvement programs without ever estimating expected benefits leads to investment with little or no impact on the bottom line. Even though quality is now widely acknowledged as a key competitive weapon, it seems that there is a lack of quality vision and commitment among top management.

2.1.4 Effect of quality awareness level on quality improvement level

A recent survey commissioned by the American Society for Quality (ASQ) found that eight of ten executives surveyed thought their costs of quality was 10% or less of their gross sales. Experts, including the Big Six CPA firms, however, calculate that a typical organization's costs of quality to be between 20%-40% of gross sales. Similarly, Gryna (1988) advocates that quality costs are huge, running at 20%-40% of sales.

Surveys carried out by the Swedish Institute of Public Opinion Research (SIPO) and the Association of Swedish Engineering (Lars Sorqvist, 1997), show that awareness of poor quality costs has grown greatly in recent years. Regular interviews have been held with Swedish manufacturers (industrialists) to find out how high they would assess the cost of poor quality to be in their organization. When these interviews were begun in 1988, these manufacturers felt that their quality costs were around 3 percent (on average), now, however, they judge them over 20 percent.

Case studies conducted by Lars Sorqvist (1997), show that poor quality costs in the region 9%-16% of the turnover of the business studied have been registered. This is far from being all of the total poor quality costs of these businesses, but it is considerably higher portion than has previously been measured. He advocates that knowledge of the cost of quality deficiencies, the cost of poor quality, is a useful aid to identify the problem areas in a business organization. By standing the breakdown of these poor quality costs, one gains the opportunity to carry out defective improvement activities, dealing first with the problems, which cause the highest costs. Once the organization's poor quality costs are determined this gives employees and management an insight into the usually remarkably high costs which are incurred when the quality level is not the intended one. This insight can have positive effects on both motivation and improvement activities. Thus, the costs associated with poor quality usually have a very significant impact on the profitability of the organization and in most cases influence the income, costs and assets of its business. This has been emphasized by Jukka Reinholm, www.reinholm.com/quality.htm, he advocates that total costs of quality at a manufacturing organization (on average) may be as high as 35% of turnover. Where at best "quality-oriented organization", total quality costs are 5%-10% of turnover. Similarly, Professor Eero E. Karjalainen, a well-known Finish quality expert, has estimated that an average Finish manufacturing organization spends about 15% of its income just to fix errors what they have done. Others like MD Risto Lintula and Bradely T. Gale emphasize this in a different way. MD Risto Lintula, Center for Excellence-Finland, www.laatukeskus.fi, advocates that 99% of quality is done by careful planning, while a research conducted by Bradely T. Gale (1994) shows that superior conformance to customer requirements reduces costs. Moreover, the research shows that when organizations perceived by the customer to have superior quality, they have three times more profitability than organizations perceived to have inferior quality. Furthermore, this scenario shows that organizations perceived to be improving faster than their competitors grow at a rate of 4% per year. Further, organizations perceived to have a constant level of quality grow at a rate of 2% per year, while organizations perceived to have quality levels that declined remained static in market share. Thus, tracking and acting upon the information generated by a quality costing system can provide vital information to the management review team for managing the system.

It might be agreed upon what stated above that organizations do not know what their quality costs are because they do not keep reliable statistics of costs of poor quality. Finding and correcting mistakes consume inordinately large portion resources. Typically, the costs to eliminate a failure in the customer phase are five times greater than it is at the development or manufacturing phase. Effective quality management and being well aware of quality issues decrease production costs because the sooner an error is found and corrected, the less costly it will be. Thus, an investment in quality control is inevitable for all organizations who wish to stay in business. Investing in quality in the form of training, equipment and personnel is the only sure path to survival in the very aggressive, competitive market that the economy has created.

According to Jim McConchie and Evan J. Roth, www.cimsys.co.nz/articles/cost of quality/htm, an investment in quality results in an increased awareness of quality assurance. It is not only the customer who benefits from increased awareness of quality assurance. To improve quality is to improve productivity. So an investment in quality might result in increased profitability, reduced manufacturing costs, increases competitiveness, increased job satisfaction, and reduced staff turnover. The cost of failures is extremely high when little or no quality control is practiced. As quality control is introduced, costs of failure decrease and the costs of control increase, but at a lesser rate.

Julian Ellis and Peter Butcher emphasize what stated above in a different way. they advocate that the most significant quality improvements will usually be achieved by concentrating effort on the areas of high costs, and hence studies have shown a fairly typical distribution of quality cost categories (such as 5%- prevention costs, 30%- appraisal costs, and 65%- failure costs. Failure costs, because they are typically the largest, will usually give the largest return for the effort involved in reducing them. An effective way of attacking failure costs is through a temporary increase in prevention and appraisal costs. Further, appraisal costs will usually be the next to come under attack. An analysis of all essential quality control operations will often show opportunities for reducing expenditures without reducing effectiveness. By improving the control of the process, 100 percent inspection may no longer be necessary. Total costs will be lowest when staff is aware of cost implications of their work. For example, good design saves costs not only at the design stage itself but also throughout production and testing; products are easier to make "right first time".

As stated above, the process of reducing failure costs may well involve increasing prevention and appraisal costs. However, there must clearly be a point beyond which it would be uneconomic to incur additional expense. Failure costs might possibly be eliminated but at considerable, possibly prohibitive costs in other areas, www.ellisdev.co.uk/ellisdev/textiletechnology/qualitysystems/garment.htm. Similarly, Jukka Reinholm, www.reinholm.com/quality.htm, he advocates that many organizations traditionally have expected to face quality failures, and have seen attempts to prevent all quality problems impossible, or at least as waste of time and money. They have believed that there is an optimum amount of quality level (effort) to be applied in any situation, which minimizes the total costs of quality.

It is common to those "traditional organizations" that they believe quality can be checked or inspected into the products. In such organizations, prevention costs represent only 5%-10% of the total quality costs. Organizations which fail to focus on quality lose market share, decline in reputation and find them to be in unfavorable situation against competitors.

Good quality can not be checked or inspected into the products or services. It must be planned and built-in to the processes or to the methods. Direct operators can only correct 15 percent of quality problems, the rest 85 percent are built-in the system (or lack of it). Checking and inspection are contributory elements in quality assurance. They provide information to enable the processes and methods of the quality systems to be evaluated. In manufacturing operation an error is relatively inexpensive to correct. May be some researching and rethinking is required. But if the error is not discovered, many other decisions may be made based on the original error. Then to fix the original error can be ten times more expensive. Therefore, awareness of high total costs of quality has forced organizations to review their quality strategies.

It might be agreed upon what stated above that knowledge of COQ/COPQ analysis is strength, allows objective decisions to be made, can be used to monitor performance, and help managers decide to what level cost reduction targets should be set for quality improvement projects. In addition, COQ/COPQ links improvement actions with associated costs, and customer expectations, and this is seen as the coupling of reduced costs and increased benefits for quality improvement. Expenditures on improvement and prevention activities are considered as a form of investment, which should bring reduced failure costs. Time and money may be wasted on prevention activities that do not bring appropriate improvement. Deming (1982) may believe that the proper objective is to have zero defects. However, for some it may be uneconomical to have a high level of quality; they assume that absolute quality must be sacrificed to achieve other objectives, for example, reduced development cycle time . Therefore, a realistic estimate of COQ and improvement benefits, i.e., the correct tradeoff between the level of conformance and nonconformance costs, should be considered an essential element of any quality initiative.

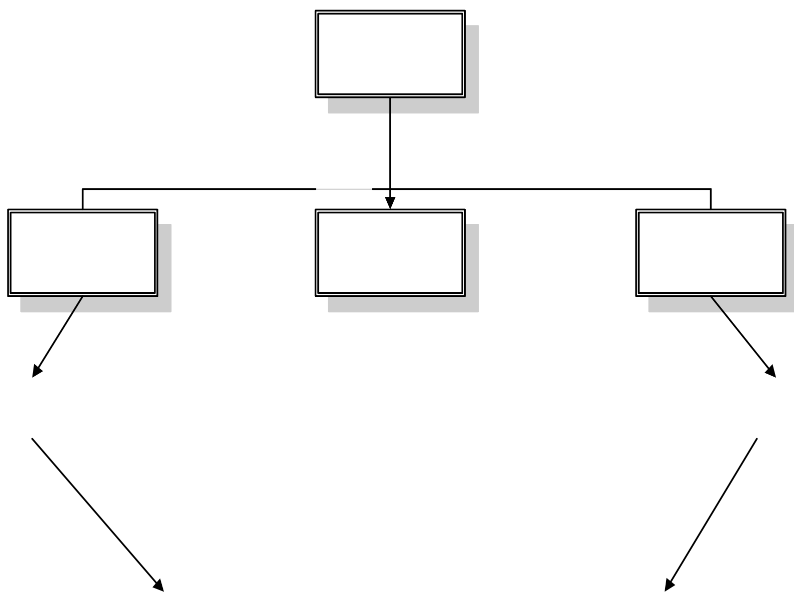
From that point, many organizations promote quality as the central customer value. They consider it a critical success factor for achieving competitiveness. Since the objective of continuous improvement programs is not only to meet customer requirements (expectations or needs) but also to do it at the lowest cost. Therefore, any serious attempt to improve quality must take into consideration the costs associated with achieving that level of quality. This only can happen by reducing the costs needed to achieve a certain level of quality, and the reduction of such costs is only possible if they are recognized and measured. Therefore, measuring and reporting the costs of quality should be considered an important issue for managers.

Regarding what stated above, it becomes clearer that as people become more aware of quality, this “opens” their eyes to the true costs that are involved in getting quality right first time. Furthermore, people will start to understand that quality is not just about checking for defective products within the system, that it is "global". They start to see bad practices, inefficiency and waste, i.e. they become more aware of quality.

One excellent analogy used by John S. Okeland as shown in Figure 4.6 was to describe the tradeoff between quality and cost as a pair of scales. The formula being quite simple as costs rise, quality falls. If quality rises, costs fall, the optimum balance being at the center.

This of course in real life is impossible, as there will always be some defects or associated costs.

Figure 2.6- Balance between quality and cost



(Source: Westgard Jo and Barry Pl, 1986)

Quality costing is an excellent way of highlighting to the workforce, especially senior management the dangers of becoming complacent over quality issues.

2.1.5 The Activity-Based Costing (ABC) model

As pointed out by Merino (1988), existing accounting systems do not provide appropriate quality related data and benefits resulting from improved quality are not measured.

Traditional cost accounting establishes cost accounts by the categories of expenses instead of activities, while most COQ measurement methods are activity/process oriented. Thus, many COQ elements need to be estimated or collected by other methods rather than traditional accounting systems (Tsai, 1998).

To solve this problem an activity-based costing (ABC) model was developed by Cooper and Kaplan (Cooper 1988, Cooper and Kaplan 1988, Kaplan and Atkinson 1998).

Under ABC more accurate-ways of assigning indirect costs and support resources to activities, business processes, products, services and customers are achieved (Kaplan and Atkinson, 1998).

The long-term goal of ABC is not just to allocate common costs to products. The goal is to measure and price out all the resources used for activities that support the production and delivery of products and services to customers, i.e. to eliminate non-value added activities and to continuously improve processes, activities and quality so that no defects are produced (Kaplan and Atkinson, 1998).

Thus, ABC is an accounting methodology and a management tool that helps identify business activities that consume business-valued resources.

In the late 1980's, ABC was mainly implemented in manufacturing organizations, as a replacement for obsolete and inefficient costing systems (Cooper 1988, Johnson 1990, and Roztocki, Valenzuela, Porter, Monk and Needy 1999). During this time period, many managers recognized that the inappropriate allocation of overhead, or "indirect costs", often lead them to make poor decisions . Not knowing actual product costs had caused them to focus on products, markets, or customers which were, in reality, unprofitable. Profitability was often an illusion produced by flaws in their traditional costing systems.

As compared to traditional costing systems, ABC is more reliable in determining profitability because of the use of a two-stage procedure in tracing overhead to cost objects (such as products, processes, services, and/or customers) (Cooper 1987, Cooper 1988, Cooper 1989) . In the first stage, an organization's overhead is traced to activities. In the second stage, costs are traced from activities to cost objects. Because of this two-stage methodology and the use of activities as the medium to trace costs, as well as use of multiple cost drivers, ABC outperforms the traditional volume-based costing systems.

Using the information provided by ABC, organizations are able to cut costs, review pricing, identify opportunities for improvement, and determine a more profitable product mix (Cooper and Kaplan, 1991). In addition, the output of the ABC analysis is a good basis for revising corporate strategies, especially in cases where the daily business environment changes rapidly, or new competitors appear, or customers are highly demanding. These conditions are typical for organizations of the New Economy.

As pointed out by Innes, Mitchell, and Yoshikawa (1994), the development of an activity-based costing (ABC) system involves identifying activities and assessing the basis of relating costs to identified activities, the choice of cost drivers, and the means by which the cost drivers are linked to product lines . This enables managers to obtain product cost information that could be used for developing appropriate COPQ programs to suit the organization specific experience and environment. The activities can be identified as value-added vs. non value-added activities emphasizing the customer-driven approach. They can further be classified in terms of four levels, namely, the unit level, batch level, product sustaining level, and the facility sustaining level activities (Cooper et al., 1992), or they can be classified into two categories, namely, micro and macro activities (Turney and Stratton 1993).

Implementation of COPQ programs within an ABC perspective can be an effective way to drive for continuous improvement in an organization. Traditional costing systems just show how expensive is it. They do not require careful study of how each task is done. An ABC system, on the other hand, reveals the process used to produce goods and services. It measures the total cost of each significant activity performed and identifies the cost driver of the activity. When this information is available to management, it usually provides new insights about the efficiency of the process and reveals opportunities for improvement.

ABC helps management focus on preventive and diversionary activities through quantifying and tracing overhead costs absorbed by them, while a large portion of costs are hidden in the traditional accounting system. Thus, the ABC process provides the foundation for sound business management, and activity-based management is the key for continuous improvement of an organization's profitability (Johnson, 1991).

Concerning these studies and other organizations practices in developing and implementing COPQ programs, Leung and Tummala (1999) formulated a 12-step process of implementing an activity-based COPQ program in any organization. The main purpose of this program is to identify the COPQ by using the activity-based costing model and to enumerate the opportunities and initiate appropriate improvement projects to reduce the costs of poor quality. The program is also useful in evaluating the implemented projects and determining the need for further improvement in reducing the costs of poor quality. The 12-step COPQ program is flexible and can be modified to suit the organization-specific environment and practices. The activity-based COPQ program consists of three phases, namely, determining COPQ (phase 1), initiating improvement projects (phase 2), and evaluating the improvement projects (phase 3).

The purpose of phase 1 is to determine the COPQ in terms of prevention, appraisal, internal failure, and external failure costs. Based on these COPQ categories, one can identify the opportunities and develop the corresponding improvement projects, which is the purpose of phase 2. Similarly, the purpose of phase 3 is to evaluate the selected improvement projects and choose further improvement actions in continuously reducing the COPQ and increasing the quality of processes, products, and services.

2.2 Empirical evidences

There is a reasonable amount of detailed advice available on COPQ, but there are only a few published practical examples that give specifics about the costs that are included or excluded in quality costing, and how the costs are collected. Nevertheless, most examples confirm that quality improvement and costs measurement processes bring about a huge reduction in a company's costs of quality.

For example, Tenneco decreased its failure costs from U.S $ 2.9 billion to U.S $ 1.8 billion, resulting in an increase in operating income of U.S $ 900 million in six years due to improvements made through its costs of quality strategies (Feigenbaum, 1997).

Westinghouse has managed to increase its productivity by 15 percent, reduce scrap by 58 percent, improve cycle by 66 percent, decrease returns by 69 percent and improve service performance by 20 percent (Gupta and Campell, 1995).

Motorola hosted savings of U.S $ 942 million in three years (Butler, 1997). The Federal Communications Commission (FCC) formed quality improvement teams involving internal and external customers in implementing a seven-step-problem-solving process and realized a cost of poor quality reduction by 67 percent (Fontaine and Robinette, 1994). Thus, these organizations have demonstrated that implementing programs based on costs of quality reduces production, design, and development costs because money is no longer spent on waste and rework, and the savings can be reinvested in acquiring new technologies and reducing the cost to customers.

A brief description of some of other documented examples of successful use of COPQ models and methods is given as shown below in Table 2.3 (Andreas, S. and Vince,T., 2004).

Table 2.3- Documented examples of successful use of COPQ models and methods.

Company/Reference	**Model, method**	**Gains**
P-A-F model		
UTC. Essex Group *(Fruin, 1986)*	COPQ = P+A+F COPQ is calculated as a percentage of total manufacturing cost	●COPQ reduced from 23% to 17%.
AT&T Bell Lab. *(Thompson and Nakamura, 1987)*	COPQ = P+A+F(I+E)	----
Hydro Coatings *(Purgslove and Dale, 1995)*	COPQ = P+A+F(I+E) COPQ is calculated as a percentage of annual sales turnovers. COPQ is also expressed as a percentage of raw material usage.	●COPQ reduced from 4.1% to 2.5% in 4 years. ●Investment in quality paid pack in the first year.
Electronic manufacturer *(Denzer, 1978)*	COPQ = P+A+F(I+E)	----
Crosby's model		
Solid State Circuits *(Denton and Kowalski, 1988)*	COPQ = COC+CONC+OC COQ is expressed as a percentage of the revenue.	COPQ reduced from 37% to 17%.
BDM International *(Slaughter et al., 1998)*	COPQ = COC+CONC	
Opportunity and alternative costs models		
Xerox *(Carr, 1992)*	COPQ = COC+CONC+OC	● COPQ reduced by U.S $ 53 million in first year.
Pharmaceutical company *(Malchi and McGurk,2001)*	COPQ = Operating cost + CONC+ Alternative cost	● 11% reduction in COPQ
Process model		
GEC Alsmoth Engineering Systems *(Goulden and Rawlins, 1995)*	COPQ = COC+CONC	----
ABC model		
Hewlett Pckard *(Jorgenson and Enkerlin, 1992)*	ABC(Activity-Based Costing) COPQ = process quality+ board test+ repair+ bench test+ defect analysis .	----

Table 2.3 shows that the companies whose best practices are documented in this study most often implement their COPQ programs in accordance with the

universally accepted Feigenbaum's costing structure (Feigenbaum, 1956). United Technologies Corporation, Essex Telecommunication Products Division, established COPQ measurement based on a P-A-F model and five years of implementation have yielded an improvement of 26% in COPQ measured against cost of goods produced. Specific accomplishments as well as elements of the costs of quality calculation and their relationship to financial performance are examined in detail by Fruin (1986). Thompson and Nakamura (1987) also follow P-A-F quality costing structure and propose a plan, which is currently being used to collect and report COPQ data from several development projects at AT&T Bell Laboratories, Transmission Systems Division. They suggest that managing COPQ in the R&D process is an effective way to improve product development. The work of Purgslove and Dale (1995) discusses the development and operation of a system of quality costing at a manufacturer of coatings for industrial applications. Their COPQ measurement system implementation is based on the P-A-F model as well. They report that the investment made in quality improvement was paid back within the first year. Denzer (1978) presents a description of P-A-F costs of quality costs used in an electronics manufacturing facility and indicates significant quality costs reduction. Moreover, he shows that the collection and use of quality costs are an aid to management and are accompanied by improvement of quality.

As indicated earlier, Crosby's model (Crosby, 1979), in which COPQ is expressed as the sum of cost of conformance and cost of nonconformance, is considered technically the same as Feigenbaum's, and the terminology of both is often used together in one model . Crosby's model has been successfully used for quality improvement programs at several companies.

Solid State Circuits, a manufacturer of printed circuits boards, has designed new methods of measuring conforming and non-conforming costs and the use of such methods has led to the identification of causes of error and the devising of means of correcting them. Denton and Kowalski (1988) describe this quality improvement and measurement process and report a drop from 37% to 17% in the company's cost of quality. Slaughter et al. (1998) have carried out a detailed study in the economics of software quality at BDM International, a major information technology company. They use marginal analysis of non-conformance costs to identify the greatest cost impacts of defect reduction during their quality initiatives and present their successful results.

Use of opportunity or intangible costs for COPQ improvement programs has already provided sound results in industry. Xerox was the first company to use opportunity cost in order to determine the COPQ. Carr (1992) describes a program adopted by Xerox, which consists of a system of quality cost measures and cost of quality concepts adapted to service. The cost of lost opportunities category is defined as profit not earned owing to lost customers and reduction in revenue because of non-conformance. COPQ were reduced by U.S $ 53 million in the first year of the program implemented at Xerox. Malchi and McGruk (2001) discuss the methodology of measuring the COPQ, which includes so-called alternative costs in the total COPQ. Alternative costs are hidden costs, and examples are lost sales, extra inventory, delays and unidentified scrap. They present a case study of implementation of this COPQ program in a pharmaceutical manufacturing facility, where implementing this methodology resulted in an 11% reduction in the cost of quality.

A quality costing system using the process approach has been successfully designed and implemented within the power system division of GEC Alsthom Engineering Systems. Goulden and Rawlins (1995) describe this hybrid process model, which uses flowcharts. These were found to be most effective process molding tools as they facilitated understanding and better interdepartmental communication.

Since activity-based costing (ABC) is considered more compatible with quality costs measurement systems than traditional accounting, its use for a COPQ determination is an appealing alternative. Jorgenson and Enkerlin (1992) describe how a Hewlett-Packard manufacturing operation utilized its ABC system to identify, quantify and allocate quality costs among its products. Having this information allowed product teams to simulate and reduce quality costs earlier in the product design phase.

These documented examples of COPQ improvement programs were successful. They brought about sufficient savings to justify COPQ measurement expenses, and they yielded a good productivity gain and reduction in quality costs. More importantly, they identified target areas for costs reduction and quality improvement.

2.3 The Palestinian context

Regarding what stated above, the real situation at manufacturing organizations in Palestine is different. Thus, this section first takes in-depth look into level of quality awareness existing among the Palestinian manufacturing sectors and the costing systems they use. More specifically, it demonstrates the real situation at food manufacturing sector regarding the above aspects in comparison with other manufacturing sectors.

2.3.1 Level of quality awareness existing among the Palestinian manufacturing organizations

According to the proceedings of the 1st annual national conference on quality infrastructure (Palestinian Standards Institute, 2004), the results reveal that most of the manufacturing organizations in Palestine rarely have a realistic idea of how much profit they are loosing through poor quality. On the other hand, most of those organizations often do not even have any quality budget and do not attempt to monitor quality costs. Even though most managers of those organizations claim that quality is their top priority, only a small number of them are aware of quality. Moreover, even those who are aware of quality, they think of it only as a marketing tool for selling more. They rarely think of it as a cost reduction and a profitability-improving tool.

It might be also agreed upon what stated above when referring to PSI published lists that listing the Palestinian manufacturing organizations and their relevant products that granted either the Palestinian Quality Mark (PS) or the Palestinian Supervision Mark (PSM) (PSI, QM-Con-List and QC-List,2004).

According to PSI list of the Palestinian organizations and their relevant products granted the Palestinian Quality Mark (PS), it includes 16 manufacturing organizations granted the (PS) mark for 18 manufactured products only. While PSI list of the Palestinian organizations and their relevant products granted the Palestinian Supervision Mark (PSM), includes 59 manufacturing organizations granted the (PSM) mark for a total of 77 manufactured products. However, before reading what is behind these numbers, one has to know what each of the above marks means. First of all, each of the above marks is a product-mark, i.e., any products (regardless whether they are goods, services or processes) that conform to all requirements stated in relevant technical standard/s are eligible to be marked with either the (PS) or the (PSM) mark. This means that if a manufacturing organization produces a variety set of products, only the products that conform to all requirements stated in relevant technical standard/s are eligible to be marked with one of the above marks.

This leads the way for asking what is the difference between the Palestinian Quality Mark (PS) and the Palestinian Supervision Mark (PSM)? A product is eligible to be marked with the (PSM) mark if it only conforms to all requirements stated in relevant technical standard/s. While a product is eligible to be marked with the (PS) mark if: **Firstly**, it conforms to all requirements stated in relevant technical standard/s. **Secondly**, the product manufacturer does implement a quality management system (QMS or TQM) conforming to the applicable quality management system standards/s.

Regarding what stated above, it might be agreed upon that manufacturing organizations, which produce products marked with the (PSM) mark rarely have either experience, ability, or desire to implement all or even some major aspects of quality such as quality assurance and quality control. What they do is just limited to testing and inspection activities to be sure that a product conforms to safety requirements stated in relevant technical standard/s. Therefore, the role of the Palestinian Standards Institution (PSI) in this case is summarized in the following:

- raising quality awareness level among those organizations regarding the difference between the (PS) mark and the (PSM) mark.
- demonstrating the benefits that manufacturing organizations can earn throughout the implementation of quality management system conforming to the applicable quality management standard/s.

It becomes clearer that such manufacturing organizations are rarely aware of quality. Furthermore, they rarely have a realistic idea of quality costs. While for manufacturing organizations that produce products marked with the (PS) mark, they are really aware of all or to some extent the major aspects of quality. Even those who are aware of quality, they do not attempt to monitor quality costs, i.e., they do not have any quality budget to measure or even assess (collect) COPQ.

Backwards to the above-mentioned numbers, they show that around (23%) of the manufactured products that granted either the (PS) or the (PSM) mark are marked with the (PS) mark, while around (77%) are marked with the (PSM) mark. Most importantly, while reviewing the application forms list (PSI modified list, 2004) filled by those organizations via the Quality Department at PSI, the list shows that each of those organizations granted either the (PS) or the (PSM) mark produces 5 different products (on average). Concerning the above-mentioned figures, they indicate that 375 different products are produced by those organizations. About (4.8%) of these products are eligible to be marked with the (PS) mark, while about (21%) are eligible to be marked with the (PSM) mark. This leads the way for thinking and asking what the above percentages would be if the total number of the manufactured products in Palestine is to be taken into consideration. Obviously, they would be relatively very low.

2.3.2 Costing systems implemented at the Palestinian manufacturing organizations

Concerning what stated above, it becomes clearer that the percentage of manufacturing organizations in Palestine who are aware of quality (organizations granted the (PS) mark as a measure) is relatively very low compared with all manufacturing organizations in Palestine or even those granted the (PSM) mark. Even those who are aware of quality, they do not attempt to measure and monitor COPQ or even assess these costs. This is implicitly indicated into an earlier study " Requirements of activity-based costing application to Palestinian industry: A theoretical and empirical study" conducted by Naser Abdelkarim and Rasheed Alkukhon (1997).The study advocates that (50%) of the Palestinian manufacturing organizations of the selected sample do implement operation costing system, while others do implement process costing system.

Furthermore, ways of assigning overhead under both systems differ among these organizations. The study advocates that (73%) of these organizations use production unit costs, (18%) use direct labor costs, and (9%) use direct labor hours costs or sometimes use machines hours costs.

Both systems (operation costing system and process costing system) and ways of assessing overhead as stated above are traditional cost accounting systems. Such costing systems establish cost accounts by the categories of expenses instead of activities, while most of COPQ measurement methods are activity/process oriented. This means that traditional cost accounting systems do not provide appropriate quality related data and benefits resulting from improved quality are not measured. Thus, using the information provided by the traditional cost accounting systems may lead managers to make poor decisions (such as focusing on products, markets, or customers which were, in reality, unprofitable) due to inappropriate allocation of overhead or "indirect costs". Even though, as has been advocated by the above mentioned study, most of those organizations' managers do well recognize how important is information provided by traditional cost accounting systems in making strategic decisions. This explains why those managers use such costing systems for the purposes of (in sequence regarding importance as has been advocated by the study):

❖Reviewing pricing; or

❖Monitoring and controlling production costs; or

- ❖Determining a more profitable product mix; or
- ❖Evaluating production lines or the management divisions' performance.

Regarding the above stated sequence that explains what are the mostly important purposes that may help managers make strategic decisions using information provided by traditional cost accounting systems. What noteworthy is that purposes such as reducing costs of poor quality (COPQ) and identifying opportunities for improvement are not classified within the above stated sequence. This insures the incapacity of traditional costing systems to provide appropriate quality-related costs, identify opportunities for improvement, and measure benefits resulting from improved quality. This has been implicitly indicated into the above mentioned study. The study advocates that around (63%) of the organizations' managers of the selected sample are dissatisfied with the traditional costing systems performance those are applicable at their own organizations.

Furthermore, it advocates that all organizations of the selected sample are willing to adapt and develop such costing systems believing that such developed systems may lead the way for improving productivity as well as raising competitiveness capabilities.

Concerning the above-mentioned studies, it becomes clearer that manufacturing organizations in Palestine are rarely aware of quality costs. Furthermore, the level of quality awareness if they have is very low that leads the way for misunderstanding the relationship between costs of poor quality (COPQ) and improving quality. In addition, they lack the experience to measure (COPQ) and even to assess such costs because of traditional cost accounting systems that are still being applicable at their premises. So, a need for developing and implementing COPQ programs within an ABC perspective is a necessity. Because such programs can be an effective drivers for continuous improvement, especially in the case of Palestine where the business environment changes on daily-basis, or new competitors appear. In addition, the conditions outlined below that have been advocated by Naser Abdelkarim and Rasheed Alkukhon (1997), are typical for manufacturing organizations in Palestine to start developing and implementing COPQ programs within an ABC perspective:

❖The increasing complexity, variety of production and management processes.

❖The increased competitiveness.

❖The increasingly use of support activities at manufacturing organizations.

❖The relatively rise of overhead costs to overall costs.

❖The low prices of competitive products those are available in the Palestinian market.

❖Management dissatisfaction with traditional costing systems' performance that are being applicable at their own organizations.

2.3.3 Real situation at food manufacturing sector in Palestine

All aspects discussed above are relevant to all manufacturing sectors in Palestine, in general. Since this study is limited to food manufacturing sector in Palestine, the real situation at this sector has to be considered. The aspects mentioned below discussing the real situation at this sector compared with other manufacturing sectors.

According to surveys conducted by Palestinian Central Bureau of Statistics (Economy survey series-Main results, 2003) as well as those conducted by Palestinian Federation for Food Industries (2005). The surveys results reveal that manufacturing activity in Palestine contributes to about 20.9 percent of the total number of enterprises operating in the covered economic activities in 2003, whereas the food-manufacturing sector contributes to about 12 percent of the total number of manufacturing enterprises.

For gross value added, the manufacturing sector contributes to about 35.5 percent of the total gross value added regarding covered economic activities in 2003, whereas the food-manufacturing sector contributes to about 27.41 percent of the total gross value added regarding the manufacturing sector.

Concerning the figures mentioned above, it becomes clearer that the food-manufacturing sector comprises a considerable portion of the manufacturing sector regarding number and size of operating manufacturing organizations. Therefore, the food sector is considered as one large and relatively developed sector. Moreover, it is considered as a representative sector.

Backwards to the PSI published lists (PSI, QM-Con-List and QC-List, 2004), the number of food manufacturing organizations accounts up to 47 percent of the total manufacturing organizations granted either the (PS) Mark or the (PSM) Mark.

Concerning this figure, the food-manufacturing sector is considered as relatively developed sector among other manufacturing sectors regarding quality standards. This emphasizes the fact the food manufacturing sector has a considerable quality awareness level that can help it identify, categorize and reduce COPQ.

Therefore, the study will highlight COPQ at food manufacturing organizations in Palestine. In other words, the main question to be answered in this study will be:

1. ***Which categories of COPQ at food manufacturing organizations in Palestine are to be identified as opportunities for both quality cost reductions and quality improvement?***

Hoping that the below sub-questions that frequently rise in such or related studies may answer the main question mentioned above:

1.1 What existing COPQ categories could be identified and determined at food manufacturing organizations in Palestine?

1.2 What percentages do identified existing COPQ categories contribute to, regarding total COPQ?

1.3 Will it have an emphasis to strengthen the importance and effectiveness of the implementation of quality costing systems throughout the food manufacturing organizations in Palestine?

1.4 Will it have an emphasis to recommend and advise the food-manufacturing sector in Palestine to implement activity-based COPQ models?

CHAPTER THREE

RESEARCH METHODOLOGY

CHAPTER THREE

METHODOLOGY

Introduction

By identifying, categorizing and determining COPQ, which exist at food manufacturing sector in Palestine throughout the implementation of a built-on activity-based COPQ model suiting the food manufacturing sector's experiences and environment, this will enhance the food-manufacturing sector to open the eyes on existing COPQ at its premises. In addition, to determine the key factors encouraging that sector to recognize and determine COPQ categories. Moreover, to implement COPQ programs within an ABC perspective, because it is an effective technique for reporting accurate costs data that can help this sector identify and prioritize opportunities for cost reductions and quality improvement.

3.1 Type of study

For meeting the study objectives, this study is based on two approaches. ***Firstly***, the ***qualitative*** approach in which available information and experiences are first gathered and compiled. ***Secondly***, the ***quantitative*** approach in which ***an empirical COPQ program (model) within an ABC perspective is built-on and applied to test the questions raised in this study.***

3.2 Study procedures

The study started by setting its importance, defining the objectives and specifying the questions to set a clear picture of it.

The study can be divided into three main stages. ***Firstly***, a preparatory study through an extensive literature review was conducted. It involves relevant issues such as COPQ concepts, existing approaches used for assessing, categorizing and measuring quality costs, and the situation of Palestinian manufacturing sector. ***Secondly***, an activity-based COPQ model, upon which work is based, was built based on existing approaches and models used for assessing, categorizing and measuring COPQ. Then, it was refined to suit the food manufacturing sector's experiences and environment. ***Finally***, the model was applied by means of conducting a case study under actual conditions at one of the top large and well-developed food manufacturing organizations in Palestine. It examined the COPQ existing at the selected case, and prioritized the identified COPQ areas that are considered as opportunities for cost reductions and quality improvement.

3.2.1 Preparatory study

The purpose of the preparatory study was to map the existing models and methods used for assessing and measuring COPQ and experiences of these methods. The work began with extensive studies of secondary sources, such as books, journal articles, research reports and conference articles. The literature searches were made through the available databases and the Internet.

Once the secondary data had been studied, the real situation at manufacturing organizations in Palestine through earlier studies mentioned in chapter two was studied. It concerned the approaches (models) that the Palestinian manufacturing organizations traditionally use to assess and measure quality costs. Moreover, it concerned the experience they have in assessing and measuring such costs. Even though what results clearly indicated that all manufacturing organizations lack awareness and experience of the implementation of activity- based costing (ABC) systems and in consequence quality-related costing systems, they were a number of common problems and strength factors. These were behind the main study purpose of building an activity-based COPQ model that may help those organizations assess and measure quality costs that traditional costing systems cannot do.

3.2.2 Model Building

Based on the information obtained, consisting of secondary data collected and the real situation at manufacturing organizations in Palestine, ***an empirical COPQ model within an ABC perspective was built-on to assess, categorize and measure COPQ existing at food manufacturing organizations in Palestine .*** The model is based on parts of COPQ programs developed by Leung and Tummala (1999). ***The model was built-on throughout conducting the following analysis of the experiences and environment of the case involved in this study as well as those of the food sector:***

First, the general process flow of the selected production line (the scope) was described and analyzed.

Second, by setting the quality-related activities selection rules as outlined in chapter four, the quality-related activities were identified and categorized into regular, irregular activities and activities for ripple effects of failures.

Third, cause-and-effect relationships between identified quality-related activities and cost drivers were established, and then the relevant overhead cost categories were assessed and collected.

Fourth, the collected overhead costs were allocated to activities identified, and consequently to the production line via cost driver volume for each identified activity.

Fifth, direct costs were included and the output COPQ are determined and categorized.

Finally, Pareto analysis was used to identify which COPQ categories are to be prioritized as opportunities for cost reductions and quality improvement, and initiating improvement projects.

The model came to consist of the following two phases:

- **Phase 1: Determine COPQ.**
- **Phase 2: Initiate improvement projects.**

Before coming to the final detailed version of the built-on COPQ model introduced in this study, several quality assurance and production managers, working at different manufacturing organizations, reviewed it for its reliability

and validity. Based on their comments and suggestions, several refinements were conducted.

The final detailed version of this model, consisting of an 11-step process of implementation, is outlined as shown in Figure 4.1 in chapter four.

3.2.3 Model application

For meeting the study objectives as well as examining the questions raised in this study, the built-on two-phase activity-based COPQ model was applied by means of conducting one real case study under actual conditions at one of the top large and well-developed food manufacturing organizations in Palestine.

Besides that the model was built and refined to suit the Palestinian manufacturing sector's experiences and environment, particularly those of the food manufacturing sector, the case was selected from the food manufacturing sector for the following reasons:

- ***According to surveys conducted by Palestinian Central Bureau of Statistics (Economy survey series-Main results, 2003) as well as those conducted by Palestinian Federation for Food Industries (2005). The surveys results reveal that manufacturing activity in Palestine contributes to about 20.9 percent of the total number of enterprises operating in the covered economic activities in 2003. As for gross value added, the surveys results reveal that manufacturing sector contributes to about 35.5 percent of the total gross value added regarding covered economic activities in 2003. Concerning the above-mentioned numbers, the manufacturing sector is considered one of the promising sectors in***

Palestine. Therefore, the case in this study was selected from the manufacturing sector.

- ***Furthermore, the surveys results reveal that the food-manufacturing sector represents a high portion of the manufacturing sector regarding size and number of operating enterprises and the gross value added, which accounts up to 12 percent and 27.41 percent, consequently. In addition, it contributes to about 40 percent of the total share of the processed food market in Palestine where the increased competitiveness is a matter of existence that the manufacturing sector has to consider and fight for. Moreover, as have been advocated by the PSI published lists as outlined in chapter two, the food manufacturing sector is a relatively developed sector among other sectors regarding quality standards. Therefore, the case was selected from the food-manufacturing sector, in particular.***
- ***According to the prior study conducted by Naser Abdelkarim and Rasheed Alkukhun (1997) as outlined in chapter two, the study results reveal that all manufacturing organizations in Palestine within same sector are almost same regarding costs management and working conditions. Therefore, the results of any study conducted by means of one real case study within one sector could be generalized to the whole sector. In addition, regarding the concept of analytical generalization that has been advocated by Yin (Lars Sorqvist, 1997). The concept states that if empirical results of a case study resulted from a model developed in advance support that model, both the model and the results are deemed to be capable of generalization. Therefore, the built-on model was***

applied by means of conducting only one case study at one of the top large and well developed food manufacturing organizations.

- ***Since the study focuses on identifying and reporting COPQ, the main selection criterion for the case in this study based upon that it should have a considerable level of quality costs awareness. Therefore, the selected case is one of the top well-developed food manufacturing organizations regarding quality standards. It has number of certificates regarding compliance with quality standards such as the ISO certificate, QNET certificate and the PS quality mark certificate.***

The case study involved making an investigation of ***only one selected production line (a wafer production line) as outlined in Figure 4.2 in chapter four.*** The selected production line was studied in detail and in several dimensions throughout the implementation of the introduced built-on model coming up with the empirical findings and results outlined in chapter four of this study.

3.3 Methodology discussion

Traditionally, qualitative research has often been criticized for only describing the cases investigated and for being incapable of generalization to other situations. Such methods have therefore mainly been used for the purpose of clarifying and understanding specific problems. Quantitative methods, in which statistically guaranteed results are established, have often been regarded as more exact, objective and thorough, in a nutshell more “scientific”. However, this view has often proved to be incorrect. Quantitative methods of approach usually establish some form of survey population from which a random sample is drawn. The results based on this random sample are then generalized to the entire population by the application of some statistical methods. Experiences often show, however, that this really only applies to the population in question at that specific point in time. The use of statistical methods also often has a negative influence on the design and results of the survey due to the depth and breadth of assumptions, which might be proposed in advance enabling the use of statistical methods.

Today's complex world is characterized by the fact it often provides relatively superficial knowledge of a great number of things. This easily leads to over-simplifications, distortions and omissions. The need for study which provides more in-depth and complete knowledge than traditional quantitative study has thus increased. Yin, as has been advocated by (Lars Sorqvist, 1997), has introduced the concept of analytical generalization, which he distinguishes from traditional statistical generalization. The concept states that if empirical results of a case study resulted from a model developed in advance support that model, both the model and the results are deemed to be capable of generalization. This has become part of the basic methodology concept in this study.

Therefore, this methodology is recommended in particular for developing and testing models, especially for the study of complex problems, which makes it very suitable for this study. Moreover, Yin advocates that when case studies are performed, a large number of different sources of information are used, such as direct observations, interviews and perusal of various documents. This is one of the main strengths of case studies as a survey method, as the methods often complement each other well. On the other hand, the number of case studies is a balance between the breadth and depth of the study. A large number of cases increase the reliability of the study, but the cases should be carefully selected, as each case should have a specific purpose within the survey. The case studies should also be focused on the aspects which are relevant to the purpose and theoretical bases of the survey. Accordingly, this study has focused on actual gathering and reporting of information (data) regarding COPQ existing at the organization (the case) included.

3.4 Data source & collection

The costs of poor quality (COPQ) information necessary to implement the built-on activity-based COPQ model described in Figure 3.1 obtained from two main sources:

◆ ***Normal accounting data***

- Labor hourly payroll.

- Production machines and test equipment hourly depreciation rate.

- Production costs relevant to the selected production line at different stages throughout the production process.

- Cost structure for the selected production line.

◆ ***Data specifically calculated for COPQ***

- Overhead costs of quality-related activities relevant to the selected production line.

- Costs of material scrapped and material rework resulting from the selected production line.

Quality costs worksheets shown in appendix one were designed, and then distributed to quality assurance and production engineers to collect the COPQ information necessary for the effective implementation of the built-on model. In addition, to generate the appropriate analysis, graphs shown in chapter four and tables shown in appendix two were introduced.

The costs were collected and reported per production batches on a monthly basis, as a joint effort with quality assurance and production engineers, and accounting and marketing departments. Unusual events, adverse trends or deviations from the norm were highlighted along with the investigatory action.

It took approximately four months. The first two months spent on analyzing all quality-related activities relevant to the selected production line. In addition, building and refining the introduced COPQ model and the quality costs worksheets, whereas the costs of poor quality were collected throughout all days of the last two months (February and March 2005).

3.5 Study questions

one main question and four sub-questions should be answered in this study to identify, categorize and determine COPQ existing at food manufacturing organizations in Palestine.

To accomplish the purpose of this study, the following questions have been stated:

The main question is:

- ◆ Which categories of COPQ at food manufacturing organizations in Palestine are to be identified as opportunities for both quality cost reductions and quality improvement?

The four sub-questions are:

- ◆ What existing COPQ categories could be identified and determined at food manufacturing organizations in Palestine?
- ◆ What percentages do identified existing COPQ categories contribute to regarding total COPQ?
- ◆ Will it have an emphasis to strengthen the importance and effectiveness of the implementation of quality costing systems throughout the food manufacturing organizations in Palestine?
- ◆ Will it have an emphasis to recommend and advise the food manufacturing organizations in Palestine to implement activity-based COPQ models?

3.6 Data analysis

After and sometimes during the period of collecting necessary costs information, data analysis was conducted using the equations and Pareto analysis as detailed in chapter four; the costs were analyzed and the findings were presented in different tables shown in appendix two and different figures shown in chapter four.

3.7 The Reliability of the Study

Reliability means "the absence of random error", i.e. the precision of the actual survey. In effect, this is to say that another researcher would have arrived at the same results if he/she had used the same method and models or measuring instruments. This is not usually possible in qualitative surveys, as the researcher constitutes the actual measuring instrument. Therefore, the reliability of this study depends on the credibility of the researcher and the methodology used. The methodology has therefore been described to enable the reader to assess the reliability of the work.

Validity means "the absence of systematic measurements faults", i.e. the extent to which one is actually investigating what he/she intends to investigate. Normally, it is very difficult to ascertain definitely whether a study is valid or not. Experience and judgment serve as a basis for whether a study's validity is sufficient. This is easier in a quantitative study than in a qualitative study, as the proximity to and understandings of the area studied are usually greater. Qualitative studies also often involve few simplifications or adaptations which can influence the results.

CHAPTER FOUR

EMPIRICAL FINDINGS

CHAPTER FOUR

EMPIRICAL FINDINGS

Introduction

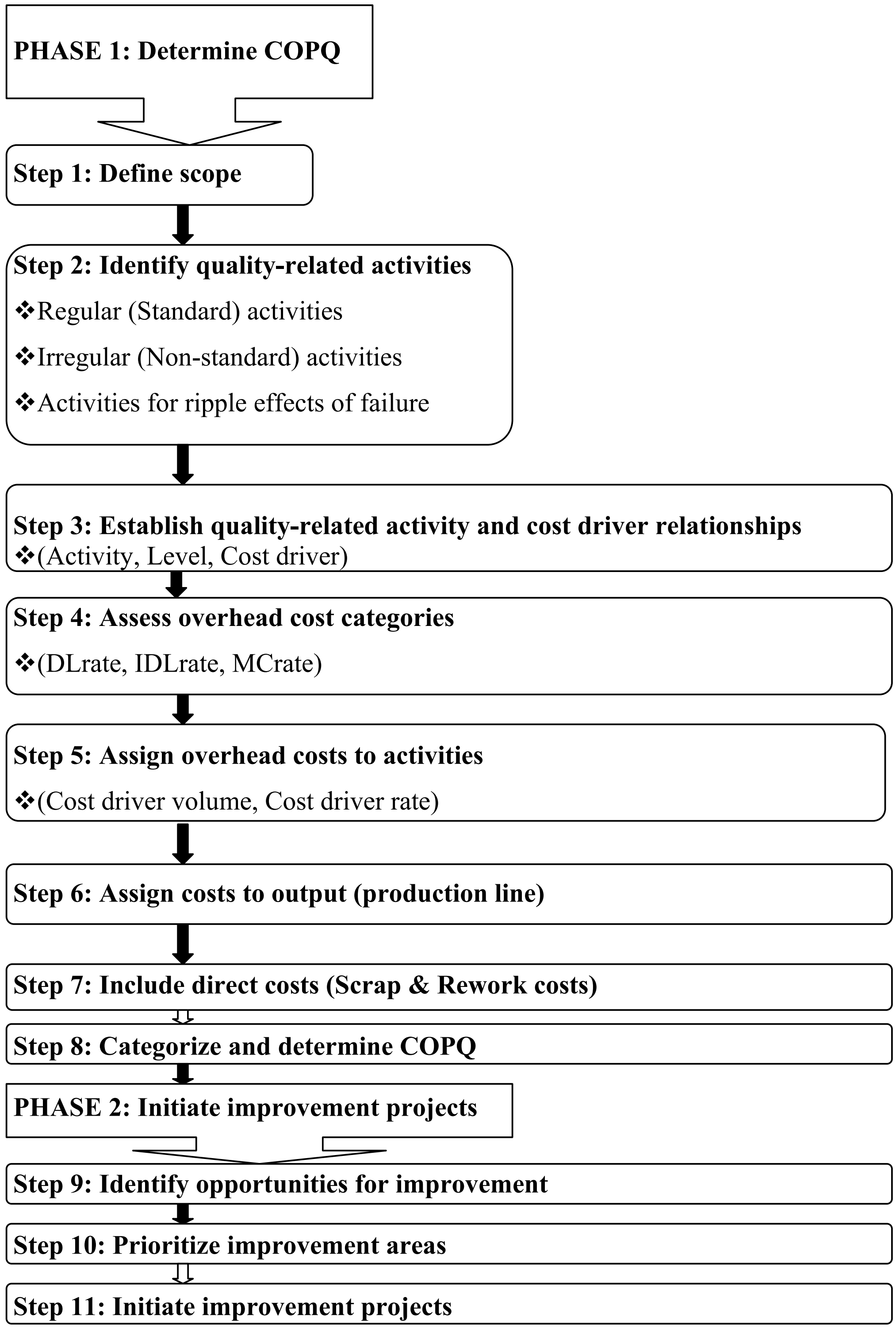
For the reasons outlined in chapter three, the introduced COPQ model was applied at manufacturing sector in Palestine, particularly at the food manufacturing sector. More specifically, it was applied at one of the top large well developed food manufacturing organizations. The model was primarily applied at one selected production line to examine the main question as well as the sub-questions raised in this study.

The findings are analyzed throughout the implementation of the 11-step, two-phase activity-based COPQ model shown in Figure 4.1, which was built-on via the model building procedure outlined in chapter three of this study.

The model application was conducted throughout the implementation process of the steps comprising the built-on two-phase COPQ, which is introduced in this study.

The implementation process as outlined below is divided into two parts. ***Part one*** includes the implementation process of ***the 8-steps*** comprising ***phase 1*** of the introduced model, whereas ***part two*** includes the implementation process of the ***3-steps*** comprising ***phase 2*** of the same model.

Figure 4.1- The built-on activity-based COPQ model



PART ONE

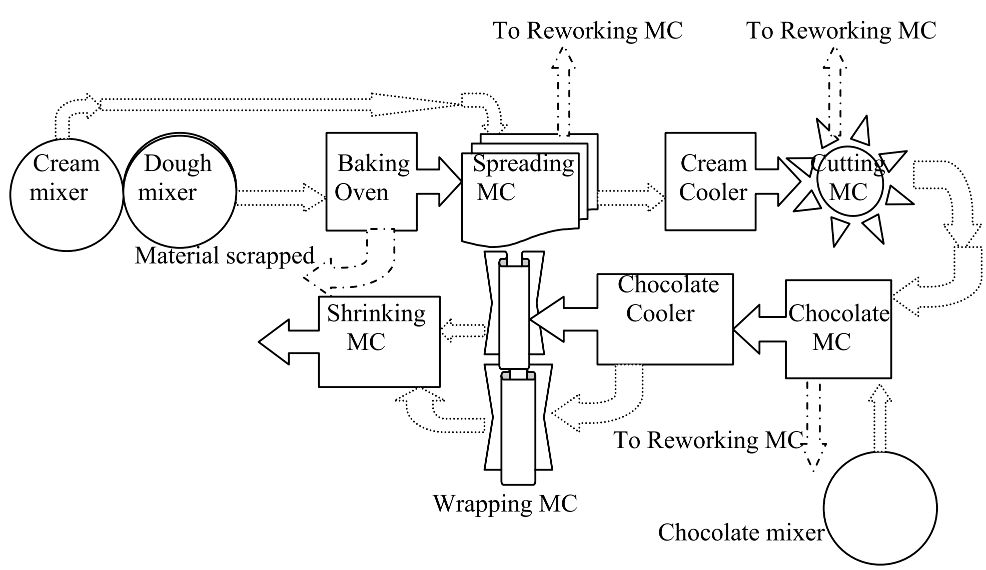
4.1 The implementation of phase 1 of the built-on activity-based COPQ model: Determining COPQ

This phase will primarily include the implementation of the following steps:

4.1.1 Step 1: Define the scope

Following step 1 of the developed activity-based COPQ model illustrated in Figure 4.1, the general process flow of the production line involving the eight major processes of mixing, baking, spreading, cooling, cutting, coating, wrapping and packaging is described as shown in the flow chart of Figure 4.2.

Figure 4.2-The Flow Chart of the General Process Flow of the Selected Production Line



The input to the above illustrated process is mixed dough, cream and chocolate raw materials. The output is the properly and defect-free wafer product which is ready for shipping either to stock-stores or customers. The people involved in the process flow include quality assurance engineer, quality assurance controllers, production and maintenance engineer, production supervisors, equipment engineer, maintenance technicians, and production laborers.

4.1.2 Step 2: Identify quality-related activities

By following step 2, a detailed activity analysis is conducted. Twelve main quality-related activities are identified and classified into three categories, namely, regular (standard) activities, irregular (non-standard) activities, and activities for ripple effects of failures (see Tables 4.1, 4.2, and 4.3 shown in appendix two). Each of these main activities is associated with several micro activities. For example, four micro activities are identified for (R1) (see the first column of Tables 4.1, 4.2, and 4.3). The purpose and value added of each of these activities are analyzed and the responsible people are then identified.

4.1.2.1 Quality-related activities: Selection rules

Regarding the quality-related activities outlined in the above mentioned tables, the selection criteria are based on the following rules (Leung and Tummala, 1999):

Rule 1: An activity is classified as a quality-related activity if it has either direct or indirect effects that may cause or increase the probability of producing defect products.

Rule 2: An activity is classified as a regular quality-related activity if it is planned to be performed periodically on regular (standard) basis.

Rule 3: An activity is classified as irregular quality-related activity if its occurrence cannot be planned or controlled.

Rule 4: An activity is classified as a ripple effect of failure activity if it is to be performed when a defect product is incurred.

4.1.3 Step 3: Establish quality-related activity and cost driver relationships

The quality-related activities identified in step 2 are then classified into batch-level, unit-level, product sustaining-level, or facility-sustaining level based on the characteristics of the resources that are consumed (see the second column of Tables 4.1, 4.2, and 4.3). The cost driver for each activity is identified (see the third column of Tables 4.1, 4.2, and 4.3).

4.1.4 Step 4: Assess overhead cost categories

After establishing the activities and cost driver relationships, the overhead costs sources (categories) for determining COPQ are identified (see Table 4.4 shown in appendix two). Since the overhead costs data for determining COPQ come from various sources, the sources of reports or records that contain the required data are identified and determined as shown in Table 4.4, and then linked with the corresponding quality-related activities (see Table 4.5 shown in appendix two).

4.1.5 Step 5: Collect and allocate overhead costs to activities

To collect overhead cost information (data), a time study using the quality costs sheets shown in appendix one was conducted to determine the time required for each of the activities. The costs of these activities are then determined either by direct charging based on the volume of cost drivers or by estimating the time spent on these activities from the reports of responsible foremen or engineers.

In general, if the activity is not machine related, the cost driver rate is determined by the time consumed and the payroll rate of direct labor or indirect labor. As mentioned earlier, direct laborers are either production operators or quality assurance controllers, production supervisors, and maintenance technicians, while indirect laborers include the quality assurance manager, the production and maintenance manager, and the maintenance engineer. The mode of their salary range shown in Table 4.4 is used for cost driver rate calculations. If the activity is machine related, the depreciation rate of the production machine or the lab. test equipment shown in Table 4.4 is included in cost driver rate calculations.

Based on the overhead cost data collected in February and March, Table 4.6 (see appendix two) shows the activity cost driver volume and the corresponding time spent on or consumed by each activity. ***The activity cost driver volume (CV) is determined using the following equation:***

$$(CV) = \sum_{i=1}^{n} CVi \qquad (1)$$

Where:

CV_i = Cost driver volume for the ith day (i= 1, 2,…., n)

n = Number of month-days

Whereas the time (TC) spent on or consumed by the activity is determined using the following equations:

◆ ***For facility-level or product-level activities:***

$$\mathbf{(TC) = \sum_{i=1}^{n} TCi} \qquad \mathbf{(2)}$$

Where:

TC_i = Time spent on or consumed by the activity for the ith day

(i= 1, 2,…., n)

n = Number of month-days

◆ ***For unit-level or batch-level activities:***

(TC) = time spent on or consumed by the activity cost driver unit (3)

Based on overhead costs data identified and determined as illustrated in the above-mentioned Tables, Table 4.7 (see appendix two) shows how the cost driver rates (CR) are determined for assigning costs to activities, using the following equations:

◆ ***For facility-level or product-level activities:***

(CR) = ∑ overhead cost categories rates allocated to activity (4)

◆ ***For unit-level or batch-level activities:***

(CR) = TC×∑ overhead cost categories rates allocated to activity **(5)**

Where:

(TC) = time spent on or consumed by the activity cost driver unit

Using the aforementioned equations as have been reformulated in Table 4.7, Table 4.8 (see appendix two) shows the cost driver rates determined (calculated) in Feb. and March (see the second column of Table 4.8).

4.1.6 Step 6: Allocate activity costs to production line

Based on the cost driver volume (CV) and the cost driver rate (CR) that are determined as explained in step 5, the activity costs of the selected production line are determined for Feb. and Mar. (see the fourth column of Table 4.8) using the following equation:

Activity cost = Cost driver volume (CV) × cost driver rate (CR) **(6)**

4.1.7 Step 7: Include direct costs (scrap & rework costs)

The calculation of direct material cost for the COPQ of the selected product line includes the costs of material scrapped during baking operation, the costs of material rework during spreading (cream-coating), product-cutting and wrapping operations, the costs of scrapped wrapping paper and the costs of scrapped shrinking nylon. These costs include the costs of quality-related activities accompanied the production process. For example, the cost of material scrapped during baking operation (process) includes the cost of off-line inspection, lab. analysis tests for purchased raw material, start lot document checking, weighing incoming raw material lots, quality assurance gating after weighing incoming raw material lots, and weighing scrapped baked product units.

The costs of material scrapped or material rework is projected from the quantity of material scrapped or material rework and the standard cost per one kilogram of product at the point the cost of material scrapped or material rework incurred. Since the overhead costs (costs of quality-related activities accompanied the production process) have already been considered, therefore, they are not included in the standard cost to avoid double counting.

Table 4.9 (see appendix two) shows material scrapped and material rework costs for Feb. and Mar. that are included in the direct material costs for the COPQ of the selected production line. These costs are calculated using the following equations:

◆ ***For material scrapped during baking operation:***

Material cost = $\mathbf{q \times \text{standard cost}}$[1] **(7)**

◆ ***For material rework during each of cream coating, cutting, and chocolate coating, and wrapping operations:***

Material cost = $\mathbf{(q \times \text{standard cost}) + \text{cost of reworking}}$ **(8)**

Hence:

Cost of reworking = $\mathbf{\text{Reworking hours}^{2} \times (q/Q) \times (3/4PDLrate + MCrate)}$ **(8-1)**

[1] Calculated per one kilogram of processed product at the point the cost of material scrapped or rework is incurred (obtained from normal accounting data)

Where:

q =	Quantity of material scrapped or rework resulting from a specific operation
Q =	Total Quantity of material rework resulting from all operations
MCrate =	Crushing machine depreciation rate obtained from Table 4.4

◆ ***For wrapping material scrapped during wrapping operation:***

Material cost = $$\textbf{(q×cost of material handled}^{3}\textbf{)+worked hours}^{4}\textbf{×(PDLrate+2MCrate}^{5}\textbf{)} \quad (9)$$

◆ For shrinking material scrapped during shrinking operation:

Material cost = $$\textbf{(q×cost of material handled)+worked hours×(PDLrate+MCrate}^{6}\textbf{)} \quad (10)$$

4.1.8 Step 8: Categorize and determine output COPQ

By following step 8, the output COPQ determined for Feb. and Mar. as shown in Tables 4.8 and 4.9 include activity costs, and material scrapped and material rework costs. These costs are then categorized into appraisal, prevention, internal failure, and external failure costs as shown in Table 4.10 (see appendix two).

Based on COPQ categories shown in Table 4.10, ***it is found that the total internal failure costs contributed to more than 96 percent whereas the appraisal and prevention costs are about 2 percent each of the total COPQ***. Table 4.11 (see appendix two) shows the comparative analysis of the determined COPQ categories as well as the percentage that total COPQ contribute to total gross sales for the same period.

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[2] Total crushing machine hours for a month period
[3] Calculated per one kilogram of purchased material handled on production site
[4] Calculated as: worked hours= machine hours for a period of month×q/Q1; Q1= total quantity of material handled and used in production for a month period
[5] Wrapping machines depreciation rate obtained from Table 4.4
[6] Shrinking machine depreciation rate obtained from Table 4.4

4.1.8.1 Effect of total COPQ on break-even point

To further analyze and explore the effect of total COPQ on break-even point for Feb. and Mar. production period. Table 4.12 (see appendix two) shows the cost structure for the selected production line, which then can be used in break-even point analysis. Whereas Table 4.13 (see appendix two) shows the break-even point analysis (calculation) for the same production period, which then can be used to express total COPQ as a percentage of total variable operating costs incurred during the same production period. Moreover, it can be used to explore the effect of total COPQ on such point, and establish a comparative analysis of break-even points determined before and after deducting total COPQ incurred during the same period.

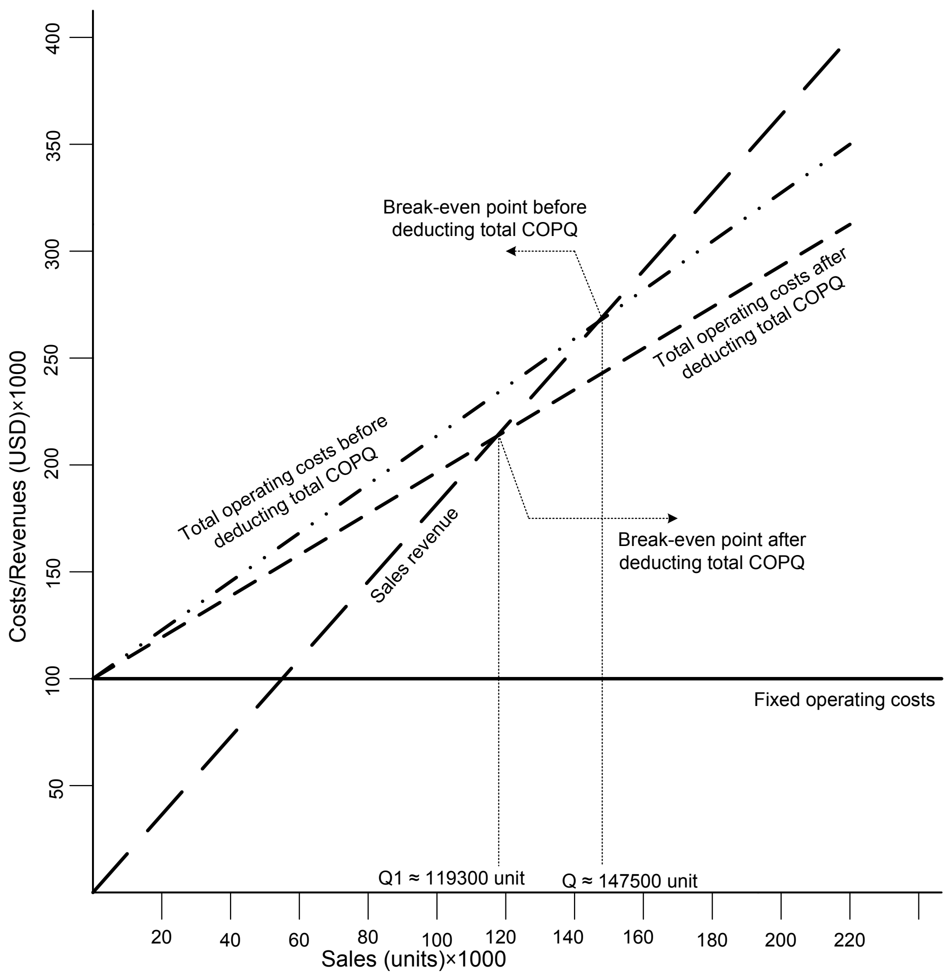
As mentioned earlier the total COPQ contribute to about 9.1 percent of total gross sales for the same period. Such costs are categorized into variable operating costs.

To explore the effect of total COPQ on the calculated break-even point shown in Table 4.13, such costs are expressed as a percentage of the total variable costs incurred during the same production period as shown in Table 4.14 (see appendix two). The contribution of total COPQ is then deducted from the total variable costs, and the new break-even point is then calculated as same as shown in Table 4.13. The new break-even point analysis (calculation) is shown in Table 4.14.

The results shown in Table 4.14 indicate that the ***total COPQ contribute to about 14.11 percent of the total variable operating costs***. Moreover, the results indicate that if ***total COPQ were eliminated through initiating appropriate improvement projects, the break-even point would decrease by 19.11 percent.***

The comparative analysis of the determined break-even points before and after deducting the total COPQ is shown in Figure 4.3.

Figure 4.3- Break-even Points for Feb. and Mar. Before and After Deducting the Total COPQ



PART TWO

4.2 The implementation of phase 2 of the built-on activity-based COPQ model: Initiate improvement projects

This phase will primarily include the following steps illustrated in the built-on model.

4.2.1 Step 9: Identify opportunities for improvement

Regarding the presented results of phase 1 of the COPQ model, including the activity analysis, cost driver relationships, and categorization of COPQ into prevention, appraisal, internal failure and external failure costs, the way the resources are consumed is now clear. From Table 4.11, the high proportion of internal failure costs and low-value added appraisal and prevention costs are identified as opportunities for improvement.

Based on respective costs of COPQ items shown in Table 4.10 and the results of discussions conducted with quality assurance, production and maintenance engineers representing the manufacturing organization in this study, ***the top 10 COPQ items shown in Table 4.15 (see appendix two) are identified as opportunities for improvement.***

4.2.2 Step 10: Prioritize improvement areas

To further analyze costs data. ***Pareto analysis*** as shown in Figure 4.4 is used to prioritize the improvement activities and to allocate resources to reduce the internal failure, appraisal and prevention costs of the chosen product line. More specifically, it is used to prioritize the cost reduction opportunities for improvement. Since the costs of remaining activities are not significant in prioritizing the most impacting COPQ activities, the top 10 COPQ items shown in Table 4.15 are used to conduct Pareto analysis. This could also reduce the complexity and the number of calculations required to conduct Pareto analysis.

4.2.3 Step 11: Initiate improvement projects

As indicated by Pareto analysis shown in Figure 4.4, ***the following six activities are identified, since they represent about 97 percent of the quality costs related to the top 10 activities:***

1. Material rework during product-cutting process

2. Material rework of chocolate-coated product during wrapping process

3. Material scrapped during baking process

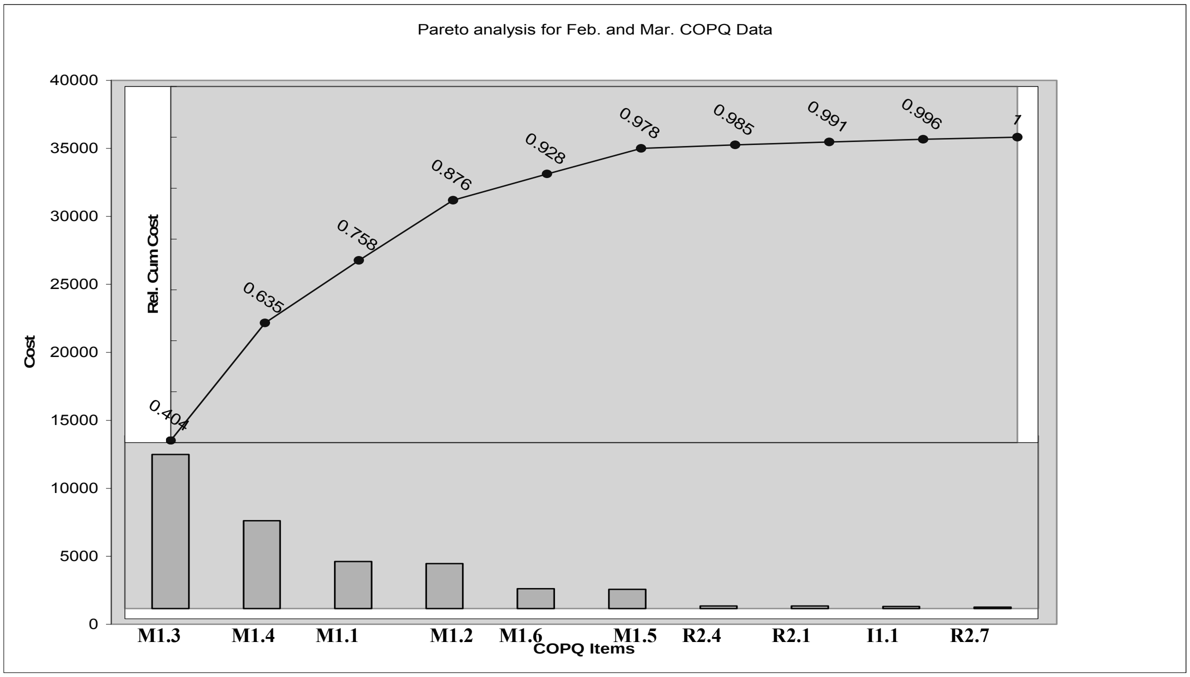
4. Material rework during cream-coating process

5. Shrinking nylon scrapped

6. Wrapping paper scrapped

These six activities should be given the priority to identify appropriate improvement projects.

Figure 4.4- Pareto analysis for Feb. and Mar. COPQ data



4.3 Conclusion

This chapter summarizes the general findings of the implementation of the 2-phases activity-based COPQ model shown in Figure 4.1. In part one of this chapter, the output COPQ are categorized and determined whereas in part two Pareto analysis is conducted to identify opportunities for cost reductions and quality improvement.

CHAPTER FIVE

CONCLUSIONS

CHAPTER FIVE

CONCLUSIONS

Introduction

The study explores and categorizes the COPQ at food manufacturing organizations in Palestine into prevention, appraisal, internal failure and external failure costs. Furthermore, it determines the percentage that each existing category of the COPQ contributes to, regarding the total COPQ. In addition, it determines the effect of total COPQ on break-even point of the selected production line for the same production period.

Moreover, the study explores and assesses the opportunities where to initiate appropriate improvement projects to reduce recognized COPQ and improve quality.

A real case study involving a selected production line (a wafer production line) at one of the top large, well developed an representative food manufacturing organizations in Palestine was considered, Then, the developed 11-step COPQ model within an ABC perspective was used to achieve the above mentioned objectives. The results of the case study are summarized in the conclusions.

5.1 Conclusions

The conclusions would go over the main points illustrated in the previous chapter, by summarizing the foremost-recognized COPQ categories and other aspects relevant to COPQ.

- The COPQ at food manufacturing organizations in Palestine can be determined systematically in terms of ***internal and external failure costs, and appraisal and prevention costs*** by using the level of activity cost drivers and the corresponding activity cost rates related to each micro activity.

- The four categories of the COPQ have been identified as well at food manufacturing organizations in Palestine. ***It is found that the internal failure costs category contributes to the highest portion of the total COPQ. It contributes to more than 96 percent.***

- Furthermore, the total internal failure costs category at food manufacturing organizations in Palestine can be categorized into quality-related activity costs, and material scrapped and material rework costs. ***It is found that material scrapped and material rework costs contribute to the highest portion of the total internal failure costs. They contribute to more than 97 percent.*** On the other hand, ***it is found that material rework costs*** contribute to the highest portion of the material scrapped and material rework costs. ***They contribute to more than 76 percent of the total material scrapped and material rework costs.*** All these indicators show that material rework costs at food manufacturing organizations in Palestine contribute to the highest portion of the total costs of poor quality (COPQ).

- Moreover, since two items of ***material rework costs*** are ranked by Pareto analysis ***as the top 2 and three items as the top 4 of the six prioritized activities*** identified to initiate appropriate improvement projects. Thus, material rework costs are considered as a vital opportunity for COPQ reductions as well as a massive targeted area for continuous improvement.

- For prevention and appraisal costs that are identified and categorized as well at food manufacturing organizations in Palestine, it is found that each category of ***these costs contributes to about 2 percent of the total COPQ.***

These figures indicate that the resources (time and effort) consumed by prevention and appraisal activities are more less than minimum.

Since prevention and appraisal costs are defined as costs of conformance or as costs of control, the figures mentioned above explain why internal failure costs contribute to the highest portion of the total COPQ. This is clearly shown in Table 4.10 where zero-costs incurred by some prevention activities, such as process improvement, quality-related training and equipment improvement. This means that zero resources are consumed by such activities that considered as value-added activities for their cause-and-effect relationships with internal failure costs. ***Empirical practices and prior studies advocate that as more resources consumed within an acceptable limit by prevention and appraisal activities (increasing prevention and appraisal costs' contribution to the total COPQ), more reductions expected to incur in internal failure costs.*** As mentioned earlier in chapter two if considerable COPQ reductions are targeted, the recommended contribution of ***prevention and appraisal costs regarding total COPQ should be about 10 percent and 30 percent, consequently.*** Moreover, any increase within planned –quality perspectives regarding prevention costs is relatively acceptable compared with corresponding expected reductions in internal failure costs as well as in appraisal and external failure costs.

- As for the fourth COPQ category, the external failure costs category. Zero-costs incurred by external failure costs category during the period of the study. This doesn't mean that such costs shouldn't be categorized as an existing COPQ at food manufacturing organizations in Palestine. By reviewing some data recorded by quality assurance engineer regarding returned product lots produced either by other production lines rather than by the selected production line during the period of this study or by the selected production line before conducting this study. It was found that external failure costs really exist at food manufacturing organizations in Palestine due to either customer incident or expiry dates. This explains why this study takes in-depth look into quality- related activities relevant to external failure costs whether such costs expected to incur or not.

- ***When total COPQ are expressed as a percentage of gross sales, it contributes to more than 9 percent.*** This figure represents only the costs incurred by the selected production line in this study while there are other four production lines which is the same case for other food manufacturing organizations. This figure should be really considered as an incentive to emphasize and strengthen the importance and effectiveness of the implementation of quality costing systems within ABC perspectives throughout the food manufacturing organizations in Palestine. Moreover, to be seriously considered as a massive targeted opportunity to initiate improvement projects.

- Furthermore**, *when total COPQ are expressed as a percentage of total variable operating costs, it contributes to about 14.11 percent.*** Moreover, when reflecting this figure into the break-even point analysis, ***the break-even point is reduced by 19.11 percent.*** These considerable figures emphasize what stated above that the implementation of COPQ models within an ABC perspective at food-manufacturing organizations in Palestine should be considered as an effective technique to identify, categorize and reduce COPQ.

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APPENDICES

Appendix One

Quality Costs Worksheets

Quality Cost Worksheet I: Time Consumed and Activity Quantity for Document Checking Activities

Name of Manufacturing Organization	
Manufacturing Sector	
Production Line Name/Code	
Activity Type	**Regular Quality Related Activity: Document Checking (R1)**
Production Period (MM/YY)	
Shift No.	

Date (DD/MM)		/			/			/			/			/		
Item	**Activity**	**TC[7]**		**CV[8]**	**TC**		**CV**	**TC**		**CV**	**TC**		**CV**	**TC**		**CV**
		M[9]	**E[10]**		**M**	**E**		**M**	**E**		**M**	**E**		**M**	**E**	
R1.1	Start batch document checking															
R1.2	Start batch composition document checking															
R1.3	In-process document checking															
R1.4	Packing document checking															

[7] Time consumed in minutes or seconds per cost driver unit
[8] Incurred no. of assigned cost driver (cost driver volume)
[9] Measured
[10] Estimated

Quality Cost Worksheet II: Time Consumed & Activity Quantity for Production Equipment Setup Checking Activities

Name of Manufacturing Organization	
Manufacturing Sector	
Production Line Name/Code	
Activity Type	**Regular Quality Related Activity: Production Equipment Setup Checking (R2)**
Production Period (MM/YY)	
Shift No.	

Date (DD/MM)		/			/			/			/			/		
Item	**Activity**	**TC**		**CV**	**TC**		**CV**	**TC**		**CV**	**TC**		**CV**	**TC**		**CV**
		M	**E**		**M**	**E**		**M**	**E**		**M**	**E**		**M**	**E**	
R2.1	Baking oven setup checking															
R2.2	Spreading MC setup checking															
R2.3	Cream cooling MC setup checking															
R2.4	Product-cutting MC setup checking															
R2.5	Chocolate-coating MC setup checking															
R2.6	Chocolate cooling MC setup checking															
R2.7	Wrapping MC setup checking															
R2.8	Shrinking MC setup checking															

Quality Cost Worksheet III: Regular Quality Related Activity: Lab. Testing Equipment Setup Checking (R3)

Name of Manufacturing Organization	
Manufacturing Sector	
Production Line Name/Code	
Activity Type	**Quality Cost Worksheet III: Time Consumed & Activity Quantity for Lab. Testing Equipment Setup Checking Activities**
Production Period (MM/YY)	
Shift No.	

Date (DD/MM)		/			/			/			/			/		
Item	**Activity**	**TC**		**CV**	**TC**		**CV**	**TC**		**CV**	**TC**		**CV**	**TC**		**CV**
		M	**E**		**M**	**E**		**M**	**E**		**M**	**E**		**M**	**E**	
R3.1	Autoclave setup checking															
R3.2	Incubator setup checking															
R3.3	Moisture analyzer setup checking															
R3.4	Centrifugal separator setup checking															
R3.5	Stomacher setup checking															
R3.6	Lab. testing water bath setup checking															
R3.7	Lab. testing oven setup checking															
R3.8	Lab. testing heater setup checking															
R3.9	Lab. refrigerator setup checking															
R3.10	Lab. weight measuring equipment setup checking															

Quality Cost Worksheet IV: Time Consumed & Activity Quantity for In-process Inspection Activities

Name of Manufacturing Organization	
Manufacturing Sector	
Production Line Name/Code	
Activity Type	**Regular Quality Related Activity: In-process Inspection (R4)**
Production Period (MM/YY)	
Shift No.	

Date (DD/MM)		/			/			/			/			/		
Item	**Activity**	**TC**		**CV**	**TC**		**CV**	**TC**		**CV**	**TC**		**CV**	**TC**		**CV**
		M	**E**		**M**	**E**		**M**	**E**		**M**	**E**		**M**	**E**	
R4.1	Weighing incoming raw material batch															
R4.2	Weighing baked product units															
R4.3	Weighing spread (cream-coated) product units															
R4.4	Weighing wrapped finished product units															
R4.5	Visual inspection of wrapping seal															
R4.6	Visual inspection of shrinking seal															
R4.7	Weighing scrapped baked product units															
R4.8	Weighing spread (cream-coated) product rework															
R4.9	Weighing cooled spread product rework resulting during cutting process															
R4.10	Weighing finished product rework resulting during wrapping process															
R4.11	Weighing scrapped wrapping paper															
R4.12	Weighing scrapped shrinking nylon															
R4.13	Quality assurance gating after weighing incoming raw material batch															
R4.14	Quality assurance gating for packaged product															

Quality Cost Worksheet V: Time Consumed and Activity Quantity for In-process Lab. Analysis Tests & Quality Assurance Gating Activities

Name of Manufacturing Organization	
Manufacturing Sector	
Production Line Name/Code	
Activity Type	**Regular Quality Related Activity: In-process Lab. Analysis Tests & Quality Assurance Gating (R5)**
Production Period (MM/YY)	
Shift No.	

Date (DD/MM)		/			/			/			/			/		
Item	**Activity**	**TC**		**CV**	**TC**		**CV**	**TC**		**CV**	**TC**		**CV**	**TC**		**CV**
		M	**E**		**M**	**E**		**M**	**E**		**M**	**E**		**M**	**E**	
R5.1	Micro-analysis test															
R5.2	Physical-analysis test															
R5.3	Quality assurance gating for in-process lab. analysis tests															

Quality Cost Worksheet VI: Time Consumed and Activity Quantity for Off-line Equipment Maintenance Activities and Off-line Inspection & Lab. Analysis Tests Activities for Purchased Raw Materials

Name of Manufacturing Organization	
Manufacturing Sector	
Production Line Name/Code	
Activity Type	**Regular Quality Related Activity: Off-line Equipment Maintenance and Off-line Inspection & Lab. Analysis Tests (R6)**
Production Period (MM/YY)	
Shift No.	

Date (DD/MM)		/			/			/			/			/		
Item	**Activity**	**TC**		**CV**	**TC**		**CV**	**TC**		**CV**	**TC**		**CV**	**TC**		**CV**
		M	**E**		**M**	**E**		**M**	**E**		**M**	**E**		**M**	**E**	
R6.1	Weighing purchased raw material															
R6.2	Micro-analysis test															
R6.3	Physical-analysis test															
R6.4	Chemical-analysis test															
R6.5	Quality assurance after weighing & testing purchased raw material															
R6.6	Off-line equipment preventive maintenance															

Quality Cost Worksheet VII: Time Consumed and Activity Quantity for Process Audit & Improvement Activities

Name of Manufacturing Organization	
Manufacturing Sector	
Production Line Name/Code	
Activity Type	**Regular Quality Related Activity: Process Audit and Improvement (R7)**
Production Period (MM/YY)	
Shift No.	

Date (DD/MM)		/			/			/			/			/		
Item	**Activity**	**TC**		**CV**	**TC**		**CV**	**TC**		**CV**	**TC**		**CV**	**TC**		**CV**
		M	**E**		**M**	**E**		**M**	**E**		**M**	**E**		**M**	**E**	
R7.1	Specification and working procedures' audits															
R7.2	Quality assurance report															
R7.3	Process improvement															
R7.4	Quality-related training															

Quality Cost Worksheet VIII: Time Consumed & Activity Quantity for Measuring & Lab. Testing Equipment Calibration Activities

Name of Manufacturing Organization	
Manufacturing Sector	
Production Line Name/Code	
Activity Type	**Regular Quality Related Activity: Measuring & Lab. Testing Equipment Calibration (R8)**
Production Period (MM/YY)	
Shift No.	

Date (DD/MM)		/			/			/			/			/		
Item	**Activity**	**TC**		**CV**	**TC**		**CV**	**TC**		**CV**	**TC**		**CV**	**TC**		**CV**
		M	**E**		**M**	**E**		**M**	**E**		**M**	**E**		**M**	**E**	
R8.1	Autoclave calibration															
R8.2	Incubator calibration															
R8.3	Moisture analyzer calibration															
R8.4	Centrifugal separator calibration															
R8.5	Stomacher calibration															
R8.6	Lab. testing water bath calibration															
R8.7	Lab. testing oven calibration															
R8.8	Lab. testing heater calibration															
R8.9	Lab. refrigerator calibration															
R8.10	Lab. balance calibration															

Quality Cost Worksheet IX: Time Consumed and Activity Quantity for Equipment Maintenance Activities

Name of Manufacturing Organization	
Manufacturing Sector	
Production Line Name/Code	
Activity Type	**Irregular Quality Related Activity: Equipment Maintenance (I1)**
Production Period (MM/YY)	
Shift No.	

Date (DD/MM)		/			/			/			/			/		
Item	**Activity**	**TC**		**CV**	**TC**		**CV**	**TC**		**CV**	**TC**		**CV**	**TC**		**CV**
		M	**E**		**M**	**E**		**M**	**E**		**M**	**E**		**M**	**E**	
I1.1	On-line repairing															
I1.2	Equipment improvement															

Quality Cost Worksheet X: Time Consumed and Activity Quantity for Purchased Raw Material Failure Activities

Name of Manufacturing Organization	
Manufacturing Sector	
Production Line Name/Code	
Activity Type	**Quality Related Activity for Ripple Effects of Failure: Purchased Raw Material Failure (F1)**
Production Period (MM/YY)	
Shift No.	

Date (DD/MM)		/			/			/			/			/		
Item	**Activity**	**TC**		**CV**	**TC**		**CV**	**TC**		**CV**	**TC**		**CV**	**TC**		**CV**
		M	**E**		**M**	**E**		**M**	**E**		**M**	**E**		**M**	**E**	
F1.1	Reliability micro-analysis test															
F1.2	Reliability physical-analysis test															
F1.3	Reliability chemical-analysis test															
F1.4	Document work and lot return															
F1.5	Follow-up production line and packaging site for corrective action															

Quality Cost Worksheet XI: Time Consumed and Activity Quantity for In-process Product Failure Activities

Name of Manufacturing Organization	
Manufacturing Sector	
Production Line Name/Code	
Activity Type	**Quality Related Activity for Ripple Effects of Failure: In-process Product Failure (F2)**
Production Period (MM/YY)	
Shift No.	

Date (DD/MM)		/			/			/			/			/		
Item	**Activity**	**TC**		**CV**	**TC**		**CV**	**TC**		**CV**	**TC**		**CV**	**TC**		**CV**
		M	**E**		**M**	**E**		**M**	**E**		**M**	**E**		**M**	**E**	
F2.1	Reliability micro-analysis test															
F2.2	Follow-up production line and packaging site for corrective action															
F2.3	Failure analysis and corrective action															

Quality Cost Worksheet XII: Time Consumed and Activity Quantity for Returned Product & Customer Incident Failure Activities

Name of Manufacturing Organization	
Manufacturing Sector	
Production Line Name/Code	
Activity Type	**Quality Related Activity for Ripple Effects of Failure: Returned Product & Customer Incident Failure (F3)**
Production Period (MM/YY)	
Shift No.	

Date (DD/MM)		/			/			/			/			/		
Item	**Activity**	**TC**		**CV**	**TC**		**CV**	**TC**		**CV**	**TC**		**CV**	**TC**		**CV**
		M	**E**		**M**	**E**		**M**	**E**		**M**	**E**		**M**	**E**	
F3.1	Reliability micro-analysis test															
F3.2	Visual inspection of wrapping seal of returned product units															
F3.3	Visual inspection of shrinking seal of returned filled product packages															
F3.4	Document work and production & packing rework															

Quality Cost Worksheet XIII: Weight of Material Scrapped or Rework

Name of Manufacturing Organization						
Manufacturing Sector						
Production Line Name/Code						
Production Period (MM/YY)						
Shift No.						
Date (DD/MM)		/	/	/	/	/
Item	**Weight** / **Material scrapped or rework category**					
M1.1	Material scrapped during baking process					
M1.2	Material rework during cream-coating process					
M1.3	Material rework during product-cutting process					
M1.4	Material rework of chocolate-coated product during wrapping process					
M1.5	Wrapping paper scrapped					
M1.6	Shrinking nylon scrapped					

Appendix Two
Tables

Table 4.1-Regular Quality-Related Activities (R) and Cost Drivers

Name of Manufacturing Organization : __xxxx______________________________________

Manufacturing Sector : ______Food Sector____

Production Line Name/ Code : __Wafer____

Item	Activity	Level	Cost Driver
R1	**Document checking**		
R1.1	Start batch document checking	batch	No. of batches started
R1.2	Start batch composition document checking	batch	No. of batches started
R1.3	In-process document checking	batch	No. of inspections
R1.4	Packing document checking	batch	No. of product moves
R2	**Production machines setup checking**		
R2.1	Baking oven setup checking	batch	No. of MC setups
R2.2	Spreading MC setup checking	batch	No. of MC setups
R2.3	Cream cooling MC setup checking	batch	No. of MC setups
R2.4	Product-cutting MC setup checking	batch	No. of MC setups
R2.5	Chocolate-coating MC setup checking	batch	No. of MC setups
R2.6	Chocolate cooling MC setup checking	batch	No. of MC setups
R2.7	Wrapping MC setup checking	batch	No. of MC setups
R2.8	Shrinking MC setup checking	batch	No. of MC setups
R3	**Lab. test equipment setup checking**		
R3.1	Autoclave setup checking	batch	No. of tested samples
R3.2	Incubator setup checking	batch	No. of tested samples
R3.3	Moisture analyzer setup checking	batch	No. of tested samples
R3.4	Centrifugal separator setup checking	batch	No. of tested samples
R3.5	Stomacher setup checking	batch	No. of tested samples
R3.6	Lab. testing water bath setup checking	batch	No. of tested samples
R3.7	Lab. testing oven setup checking	batch	No. of tested samples
R3.8	Lab. testing heater setup checking	batch	No. of tested samples
R3.9	Lab. refrigerator setup checking	batch	No. of tested samples
R3.10	Lab. test balance setup checking	batch	No. of tested samples
R4	**In-process inspection**		
R4.1	Weighing incoming raw material lots	batch	No. of orders
R4.2	Weighing baked product units	batch	No. of inspections
R4.3	Weighing spread (cream-coated) product units	batch	No. of inspections
R4.4	Weighing wrapped finished product units	batch	No. of inspections
R4.5	Visual inspection of wrapping seal	batch	No. of inspections

Table 4.1- Regular Quality-Related Activities (R) and Cost Drivers (Continued)

Name of Manufacturing Organization : _xxxx_

Manufacturing Sector : _Food Sector_

Production Line Name/ Code : _Wafer_

Item	Activity	Level	Cost Driver
R4.6	Visual inspection of shrinking seal	batch	No. of inspections
R4.7	Weighing scrapped baked product units	batch	No. of scrap moves
R4.8	Weighing spread (cream-coated) product rework	batch	No. of rework moves
R4.9	Weighing cooled spread (cream-coated) product rework	batch	No. of rework moves
R4.10	Weighing finished product rework resulting during wrapping process	batch	No. of rework moves
R4.11	Weighing scrapped wrapping paper	batch	No. of scrap moves
R4.12	Weighing scrapped shrinking nylon	batch	No. of scrap moves
R4.13	Quality assurance gating after weighing incoming raw material lots	batch	No. of orders
R4.14	Quality assurance gating for packaged product	batch	No. of product moves
R5	**In-process lab. analysis tests**		
R5.1	Micro-analysis test	batch	No. of tests
R5.2	Physical-analysis test	batch	No. of tests
R5.3	Quality assurance gating for in-process lab. analysis tests	batch	No. of reports
R6	**Off-line lab. analysis tests and equipment maintenance**		
R6.1	Weighing purchased raw material	batch	No. of purchase orders
R6.2	Micro-analysis test	batch	No. of tests
R6.3	Physical-analysis test	batch	No. of tests
R6.4	Chemical-analysis test	batch	No. of tests
R6.5	Quality assurance after weighing & testing purchased raw material	batch	No. of reports
R6.6	Off-line equipment preventive maintenance	Facility	Equipment eng. & technicians time
R7	**Process audit and improvement**		
R7.1	Specifications and working procedures' audits	Product	Q.A & production engineers time
R7.2	Quality assurance report	Product	Quality assurance (Q.A) time
R7.3	Process improvement	Product	Q.A & production engineers time
R7.4	Quality-related training	Product	Quality assurance (Q.A) time
R8	**Lab. test equipment calibration**		
R8.1	Autoclave calibration	Facility	Quality assurance (Q.A) time
R8.2	Incubator calibration	Facility	Quality assurance (Q.A) time
R8.3	Moisture analyzer calibration	Facility	Quality assurance (Q.A) time
R8.4	Centrifugal separator calibration	Facility	Quality assurance (Q.A) time
R8.5	Stomacher calibration	Facility	Quality assurance (Q.A) time
R8.6	Lab. test water bath calibration	Facility	Quality assurance (Q.A) time

Table 4.1-Regular Quality-Related Activities (R) and Cost Drivers (Continued)

Name of Manufacturing Organization : ___xxxx ___			
Manufacturing Sector : _________Food Sector___			
Production Line Name/ Code : ____Wafer___			
Item	**Activity**	**Level**	**Cost Driver**
R8.6	Lab. test water bath calibration	Facility	Quality assurance (Q.A) time
R8.7	Lab. test oven calibration	Facility	Quality assurance (Q.A) time
R8.8	Lab. test heater calibration	Facility	Quality assurance (Q.A) time
R8.9	Lab. refrigerator calibration	Facility	Quality assurance (Q.A) time
R8.10	Lab. test balance calibration	Facility	Quality assurance (Q.A) time

Table 4.2-Irregular Quality-Related Activities (I) and Cost Drivers

Name of Manufacturing Organization : _xxxx___			
Manufacturing Sector : _____________Food Sector___			
Production Line Name/ Code : ______Wafer___			
Item	**Activity**	**Level**	**Cost Driver**
I1	**Equipment maintenance**		
I1.1	On-line repairing	Facility	Equipment eng. & technicians time
I1.2	Equipment improvement	Facility	Equipment eng. & technicians time

Table 4.3-Activities for Ripple Effects of Failures (F) and Cost Drivers

Name of Manufacturing Organization : ____xxxx___________________________________

Manufacturing Sector : _______________Food Sector____________________________________

Production Line Name/ Code : ________Wafer____

Item	Activity	Level	Cost Driver
F1	**Purchased raw material failure**		
F1.1	Reliability micro-analysis test	batch	No. of tests
F1.2	Reliability physical-analysis test	batch	No. of tests
F1.3	Reliability chemical-analysis test	batch	No. of tests
F1.4	Document work and lot return	batch	No. of returned lots
F1.5	Follow-up production line and packaging site for corrective action	batch	Q.A & production engineers time
F2	**In-process product failure**		
F2.1	Reliability micro-analysis test	batch	No. of tests
F2.2	Follow-up production line and packaging site for corrective action	batch	Q.A & production engineers time
F2.3	Failure analysis and corrective action	batch	Q.A & production engineers time
F3	**Returned product and customer incident**		
F3.1	Reliability micro-analysis test	batch	No. of tests
F3.2	Visual inspection of wrapping seal of returned product units	batch	No. of returned lots
F3.3	Visual inspection of shrinking seal of returned filled product packages	batch	No. of returned lots
F3.4	Document work and production & packing rework	batch	No. of returned lots

Table 4.4-Overhead Cost Categories Allocated to Identified Quality-Related Activities

Name of Manufacturing Organization : ___xxxx___					
Manufacturing Sector : ___Food Sector___					
Production Line Name/ Code : ___Wafer___					
Item	**Overhead Cost Category**				
1	Direct laborers' salaries				
2	Indirect laborers' salaries				
3	Production machines/lab. test equipment depreciation & labor hourly payroll				
Modes of laborers' salaries[11] (USD)					
Mode of production direct laborers' salaries[12]			xxx		
Mode of other direct laborers' salaries[13]			xxx		
Mode of indirect laborers' salaries[14]			xxx		
Laborers' hourly payroll (USD/hr)					
Production direct laborers' hourly payroll (PDL rate)[15]			xxx		
Other direct laborers' hourly payroll (ODL rate)[16]			xxx		
Indirect laborers' hourly payroll (IDL rate)[17]			xxx		
Production machines & lab. test equipment hourly depreciation rate (MC rate & TE rate)[18]					
Item	**Production machine**	**MC rate (USD/hr)**	**Item**	**Lab. test equipment**	**TE rate (USD/hr)**
1.	Cream-mixer	0.90	1.	Autoclave	0.27
2.	Dough-mixer	0.90	2.	Incubator	0.11
3.	Baking oven	5.40	3.	Moisture analyzer	0.30
4.	Spreading (cream-coating) MC	1.80	4.	Centrifugal separator	0.11
5.	Cream-coated product cooling unit	2.70	5.	Stomacher	0.24
6.	Chocolate-coating MC	0.90	6.	Test water bath	0.08
7.	Wrapping MC (1)	0.72	7.	Test oven	0.24
8.	Wrapping MC (2)	0.72	8.	Test heater	0.11
9.	Shrinking MC	0.36	9.	Lab. refrigerator	0.05
10.	Rework-crushing MC	0.54	10.	Lab. test balance	0.06

[11] Obtained from normal accounting data
[12] Mode of production operators' salary range
[13] Mode of quality assurance controllers, production supervisors and maintenance technicians' salary range
[14] Mode of quality assurance manager, production and maintenance manager and equipment engineer's salary range
[15] Based on mode of production direct laborers' salaries and their labor hours
[16] Based on mode of other direct laborers' salaries and their labor hours
[17] Based on mode of indirect laborers' salaries and their labor hours
[18] Based on estimated machines hours and test equipment hours per year

Table 4.5-Linking Identified Overhead Cost Categories' Rates with Corresponding Quality-Related Activities and Method of Assignment

Name of Manufacturing Organization : _xxxx_

Manufacturing Sector : _Food Sector_

Production Line Name/ Code : _Wafer_

Item	Activity	Assigned Overhead Cost Category rate					Method of assignment
		ODL rate	PDL rate	IDL rate	MC rate	TE rate	
R1	**Document checking**						
R1.1	Start batch document checking			√			D.Charge
R1.2	Start batch composition document checking			√			D.Charge
R1.3	In-process document checking	√					D.Charge
R1.4	Packing document checking	√					D.Charge
R2	**Production machines setup checking**						
R2.1	Baking oven setup checking		√		√		D.Charge
R2.2	Spreading MC setup checking		√		√		D.Charge
R2.3	Cream cooling MC setup checking		√		√		D.Charge
R2.4	Product-cutting MC setup checking		√		√		D.Charge
R2.5	enrobing MC setup checking		√		√		D.Charge
R2.6	Chocolate cooling MC setup checking		√		√		D.Charge
R2.7	Wrapping MC setup checking		√		√		D.Charge
R2.8	Shrinking MC setup checking		√		√		D.Charge
R3	**Lab. test equipment setup checking**						
R3.1	Autoclave setup checking	√				√	D.Charge
R3.2	Incubator setup checking	√				√	D.Charge
R3.3	Moisture analyzer setup checking	√				√	D.Charge
R3.4	Centrifugal separator setup checking	√				√	D.Charge
R3.5	Stomacher setup checking	√				√	D.Charge
R3.6	Lab. testing water bath setup checking	√				√	D.Charge
R3.7	Lab. testing oven setup checking	√				√	D.Charge
R3.8	Lab. testing heater setup checking	√				√	D.Charge
R3.9	Lab. refrigerator setup checking	√				√	D.Charge
R3.10	Lab. test balance setup checking	√				√	D.Charge
R4	**In-process inspection**						
R4.1	Weighing incoming raw material lots	√					D.Charge
R4.2	Weighing baked product units	√					D.Charge
R4.3	Weighing spread (cream-coated) product units	√					D.Charge
R4.4	Weighing wrapped finished product units	√					D.Charge
R4.5	Visual inspection of wrapping seal	√					D.Charge
R4.6	Visual inspection of shrinking seal	√					D.Charge

Table 4.5-Linking Identified Overhead Cost Categories' Rates with Corresponding Quality-Related Activities and Method of Assignment (Continued)

Name of Manufacturing Organization : __xxxx___

Manufacturing Sector : ________Food Sector___

Production Line Name/ Code : ___Wafer___

Item	Activity	Assigned Overhead Cost Category rate					Method of assignment
		ODL rate	PDL rate	IDL rate	MC rate	TE rate	
R4.7	Weighing scrapped baked product units	√					D.Charge
R4.8	Weighing spread (cream-coated) product rework	√					D.Charge
R4.9	Weighing cooled spread (cream-coated) product rework	√					D.Charge
R4.10	Weighing finished product rework resulting during wrapping process	√					D.Charge
R4.11	Weighing scrapped wrapping paper	√					D.Charge
R4.12	Weighing scrapped shrinking nylon	√					D.Charge
R4.13	Quality assurance gating after weighing incoming raw material lots			√			D.Charge
R4.14	Quality assurance gating for packaged product	√					D.Charge
R5	**In-process lab. analysis tests**						
R5.1	Micro-analysis test	√				√	D.Charge
R5.2	Physical-analysis test	√				√	D.Charge
R5.3	Quality assurance gating for in-process lab. analysis tests			√			D.Charge
R6	**Off-line lab. analysis tests and equipment maintenance**						
R6.1	Weighing purchased raw material		√				D.Charge
R6.2	Micro-analysis test	√				√	D.Charge
R6.3	Physical-analysis test	√				√	D.Charge
R6.4	Chemical-analysis test	√					D.Charge
R6.5	Quality assurance after weighing & testing purchased raw material			√			D.Charge
R6.6	Off-line equipment preventive maintenance	√		√			Estimated
R7	**Process audit and improvement**						
R7.1	Specifications and working procedures' audits			√			Estimated
R7.2	Quality assurance report			√			D.Charge
R7.3	Process improvement			√			Estimated
R7.4	Quality-related training			√			Estimated
R8	**Lab. test equipment calibration**						
R8.1	Autoclave calibration			√		√	D.Charge
R8.2	Incubator calibration			√		√	D.Charge
R8.3	Moisture analyzer calibration			√		√	D.Charge
R8.4	Centrifugal separator calibration			√		√	D.Charge

Table 4.5- Linking Identified Overhead Cost Categories' Rates with Corresponding Quality-Related Activities and Method of Assignment (Continued)

Name of Manufacturing Organization : __xxxx__

Manufacturing Sector : __Food Sector__

Production Line Name/ Code : __Wafer__

Item	Activity	Assigned Overhead Cost Category rate					Method of assignment
		ODL rate	PDL rate	IDL rate	MC rate	TE rate	
R8.5	Stomacher calibration			√		√	D.Charge
R8.6	Lab. test water bath calibration			√		√	D.Charge
R8.7	Lab. test oven calibration			√		√	D.Charge
R8.8	Lab. test heater calibration			√		√	D.Charge
R8.9	Lab. refrigerator calibration			√		√	D.Charge
R8.10	Lab. test balance calibration			√		√	D.Charge
I1	**Equipment maintenance**						
I1.1	On-line repairing	√		√			Estimated
I1.2	Equipment improvement			√			Estimated
F1	**Purchased raw material failure**						
F1.1	Reliability micro-analysis test	√				√	D.Charge
F1.2	Reliability physical-analysis test	√				√	D.Charge
F1.3	Reliability chemical-analysis test	√					D.Charge
F1.4	Document work and lot return	√					D.Charge
F1.5	Follow-up production line and packaging site for corrective action			√			Estimated
F2	**In-process product failure**						
F2.1	Reliability micro-analysis test	√				√	D.Charge
F2.2	Follow-up production line and packaging site for corrective action			√			Estimated
F2.3	Failure analysis and corrective action			√			Estimated
F3	**Returned product and customer incident**						
F3.1	Reliability micro-analysis test	√				√	D.Charge
F3.2	Visual inspection of wrapping seal of returned product units	√					D.Charge
F3.3	Visual inspection of shrinking seal of returned filled product packages	√					D.Charge
F3.4	Document work and production & packing rework	√					D.Charge

Table 4.6-Activity Cost Driver Volume and Time Consumed for Feb. & Mar.

Name of Manufacturing Organization : ____________________

Manufacturing Sector : ____________________

Production Line Name/ Code : ____________________

Item	Activity	February		March	
		TC (hrs)	CV[19]	TC (hrs)	CV
R1	**Document checking**				
R1.1	Start batch document checking	20/60	24	20/60	27
R1.2	Start batch composition document checking	30/60	24	30/60	27
R1.3	In-process document checking	25/60	24	25/60	27
R1.4	Packing document checking	20/60	24	20/60	27
R2	**Production machines setup checking**				
R2.1	Baking oven setup checking	40/60	24	40/60	27
R2.2	Spreading MC setup checking	50/60×60	24	50/60×60	27
R2.3	Cream cooling MC setup checking	12/60	24	12/60	27
R2.4	Product-cutting MC setup checking	30/60	40	30/60	32
R2.5	enrobing MC setup checking	20/60×60	32	20/60×60	40
R2.6	Chocolate cooling MC setup checking	05/60	24	05/60	27
R2.7	Wrapping MC setup checking	25/60	38	25/60	48
R2.8	Shrinking MC setup checking	10/60	35	10/60	50
R3	**Lab. test equipment setup checking**				
R3.1	Autoclave setup checking	30/60	06	30/60	06
R3.2	Incubator setup checking	02/60	04	02/60	22
R3.3	Moisture analyzer setup checking	05/60	63	05/60	21
R3.4	Centrifugal separator setup checking	--[20]		--	--
R3.5	Stomacher setup checking	20/60×60	03	20/60×60	24
R3.6	Lab. testing water bath setup checking	05/60	00	05/60	17
R3.7	Lab. testing oven setup checking	20/60	19	20/60	06
R3.8	Lab. testing heater setup checking	02/60	00	02/60	20
R3.9	Lab. refrigerator setup checking	--	--	--	--
R3.10	Lab. test balance setup checking	--	--	--	--
R4	**In-process inspection**				
R4.1	Weighing incoming raw material lots	20/60	48	20/60	54
R4.2	Weighing baked product units	35/60×60	250	35/60×60	295
R4.3	Weighing spread (cream-coated) product units	45/60×60	400	45/60×60	455
R4.4	Weighing wrapped finished product units	05/60	330	05/60	252
R4.5	Visual inspection of wrapping seal	40/60×60	300	40/60×60	321
R4.6	Visual inspection of shrinking seal	45/60×60	250	45/60×60	284

[19] The unit of CV is same as cost driver unit shown in Tables 4.1, 4.2 and 4.3
[20] Setup is rarely done

Table 4.6- Activity Cost Driver Volume and Time Consumed for Feb. & Mar. (Continued)

Name of Manufacturing Organization : _xxxx_

Manufacturing Sector : ___Food Sector___

Production Line Name/ Code : ___Wafer___

Item	Activity	February		March	
		TC (hrs)	CV	TC (hrs)	CV
R4.7	Weighing scrapped baked product units	5/60	264	5/60	289
R4.8	Weighing spread (cream-coated) product rework	5/60	240	5/60	268
R4.9	Weighing cooled spread (cream-coated) product rework	7/60	280	7/60	310
R4.10	Weighing finished product rework resulting during wrapping process	5/60	230	5/60	225
R4.11	Weighing scrapped wrapping paper	2/60	48	2/60	54
R4.12	Weighing scrapped shrinking nylon	2/60	48	2/60	54
R4.13	Quality assurance gating after weighing incoming raw material lots	5/60	48	5/60	54
R4.14	Quality assurance gating for packaged product	5/60	48	5/60	54
R5	**In-process lab. analysis tests**				
R5.1	Micro-analysis test	90/60	24	90/60	27
R5.2	Physical-analysis test	15/60	24	15/60	27
R5.3	Quality assurance gating for in-process lab. analysis tests	10/60	48	10/60	54
R6	**Off-line lab. analysis tests and equipment maintenance**				
R6.1	Weighing purchased raw material	480/60	03	480/60	04
R6.2	Micro-analysis test	90/60	13	90/60	15
R6.3	Physical-analysis test	15/60	14	15/60	16
R6.4	Chemical-analysis test	15/60	10	15/60	15
R6.5	Quality assurance after weighing & testing purchased raw material	10/60	37	10/60	46
R6.6	Off-line equipment preventive maintenance	1240/60	1240/60	765/60	765/60
R7	**Process audit and improvement**				
R7.1	Specifications and working procedures’ audits	00	00	00	00
R7.2	Quality assurance report	00	00	00	00
R7.3	Process improvement	00	00	00	00
R7.4	Quality-related training	00	00	00	00
R8	**Lab. test equipment calibration**				
R8.1	Autoclave calibration	00	00	00	00
R8.2	Incubator calibration	00	00	00	00
R8.3	Moisture analyzer calibration	00	00	00	00
R8.4	Centrifugal separator calibration	00	00	00	00
R8.5	Stomacher calibration	00	00	00	00

Table 4.6-Activity Cost Driver Volume and Time Consumed for Feb. & Mar. (Continued)

Name of Manufacturing Organization : __xxxx__

Manufacturing Sector : ______Food Sector______

Production Line Name/ Code : ______Wafer______

Item	Activity	February		March	
		TC (hrs)	CV	TC (hrs)	CV
R8.6	Lab. test water bath calibration	00	00	00	00
R8.7	Lab. test oven calibration	00	00	00	00
R8.8	Lab. test heater calibration	00	00	00	00
R8.9	Lab. refrigerator calibration	00	00	00	00
R8.10	Lab. test balance calibration	30/60	30/60	00	00
I1	**Equipment maintenance**				
I1.1	On-line repairing	1265/60	1265/60	835/60	835/60
I1.2	Equipment improvement	00	00	00	00
F1	**Purchased raw material failure**				
F1.1	Reliability micro-analysis test	00	00	00	00
F1.2	Reliability physical-analysis test	00	00	00	00
F1.3	Reliability chemical-analysis test	00	00	00	00
F1.4	Document work and lot return	00	00	00	00
F1.5	Follow-up production line and packaging site for corrective action	00	00	00	00
F2	**In-process product failure**				
F2.1	Reliability micro-analysis test	00	00	00	00
F2.2	Follow-up production line and packaging site for corrective action	00	00	00	00
F2.3	Failure analysis and corrective action	00	00	00	00
F3	**Returned product and customer incident**				
F3.1	Reliability micro-analysis test	00	00	00	00
F3.2	Visual inspection of wrapping seal of returned product units	00	00	00	00
F3.3	Visual inspection of shrinking seal of returned filled product packages	00	00	00	00
F3.4	Document work and production & packing rework	00	00	00	00

Table 4.7-Activity Cost Driver Rates Calculation

Name of Manufacturing Organization : __xxxx___		
Manufacturing Sector : ___Food Sector___		
Production Line Name/ Code : ___Wafer___		
Item	**Activity**	**Cost Driver Rate (CR)**
R1	**Document checking**	
R1.1	Start batch document checking	TC×1/2IDLrate
R1.2	Start batch composition document checking	TC×1/2[21]IDLrate
R1.3	In-process document checking	TC×1/3ODLrate
R1.4	Packing document checking	TC×1/3ODLrate
R2	**Production machines setup checking**	
R2.1	Baking oven setup checking	TC×(PDLrate+MCrate)
R2.2	Spreading MC setup checking	TC×(PDLrate+MCrate)
R2.3	Cream cooling MC setup checking	TC×(PDLrate+MCrate)
R2.4	Product-cutting MC setup checking	TC×(PDLrate+MCrate)
R2.5	enrobing MC setup checking	TC×(PDLrate+MCrate)
R2.6	Chocolate cooling MC setup checking	TC×(PDLrate+MCrate)
R2.7	Wrapping MC setup checking	TC×(PDLrate+MCrate)
R2.8	Shrinking MC setup checking	TC×(PDLrate+MCrate)
R3	**Lab. test equipment setup checking**	
R3.1	Autoclave setup checking	TC×(ODLrate+TErate)
R3.2	Incubator setup checking	TC×(ODLrate+TErate)
R3.3	Moisture analyzer setup checking	TC×(ODLrate+TErate)
R3.4	Centrifugal separator setup checking	TC×(ODLrate+TErate)
R3.5	Stomacher setup checking	TC×(ODLrate+TErate)
R3.6	Lab. testing water bath setup checking	TC×(ODLrate+TErate)
R3.7	Lab. testing oven setup checking	TC×(ODLrate+TErate)
R3.8	Lab. testing heater setup checking	TC×(ODLrate+TErate)
R3.9	Lab. refrigerator setup checking	TC×(ODLrate+TErate)
R3.10	Lab. test balance setup checking	TC×(ODLrate+TErate)
R4	**In-process inspection**	
R4.1	Weighing incoming raw material lots	TC×1/3ODLrate
R4.2	Weighing baked product units	TC×1/3ODLrate
R4.3	Weighing spread (cream-coated) product units	TC×1/3ODLrate
R4.4	Weighing wrapped finished product units	TC×1/3ODLrate
R4.5	Visual inspection of wrapping seal	TC×1/3ODLrate
R4.6	Visual inspection of shrinking seal	TC×1/3ODLrate
R4.7	Weighing scrapped baked product units	TC×1/3ODLrate
R4.8	Weighing spread (cream-coated) product rework	TC×1/3ODLrate

[21] Time portion spent on the selected production line obtained from time worksheets recorded by the manufacturer

Table 4.7-Activity Cost Driver Rates Calculation (Continued)

Name of Manufacturing Organization : __xxxx__		
Manufacturing Sector : ____Food Sector____		
Production Line Name/ Code : ____Wafer____		
Item	**Activity**	**Cost Driver Rate (CR)**
R4.9	Weighing cooled spread (cream-coated) product rework	TC×1/3ODLrate
R4.10	Weighing finished product rework resulting during wrapping process	TC×1/3ODLrate
R4.11	Weighing scrapped wrapping paper	TC×1/3ODLrate
R4.12	Weighing scrapped shrinking nylon	TC×1/3ODLrate
R4.13	Quality assurance gating after weighing incoming raw material lots	TC×1/3IDLrate
R4.14	Quality assurance gating for packaged product	TC×1/3ODLrate
R5	**In-process lab. analysis tests**	
R5.1	Micro-analysis test	TC×(1/3ODLrate+TErate)
R5.2	Physical-analysis test	TC×(1/3ODLrate+TErate)
R5.3	Quality assurance gating for in-process lab. analysis tests	TC×1/3IDLrate
R6	**Off-line lab. analysis tests and equipment maintenance**	
R6.1	Weighing purchased raw material	TC×PDLrate
R6.2	Micro-analysis test	TC×(1/3ODLrate+TErate[22])
R6.3	Physical-analysis test	TC×(1/3ODLrate+TErate[23])
R6.4	Chemical-analysis test	TC×1/3ODLrate
R6.5	Quality assurance after weighing & testing purchased raw material	TC×1/3IDLrate
R6.6	Off-line equipment preventive maintenance	1/4×(ODLrate+ IDLrate)
R7	**Process audit and improvement**	
R7.1	Specifications and working procedures' audits	5/6×IDLrate
R7.2	Quality assurance report	1/3×IDLrate
R7.3	Process improvement	5/6×IDLrate
R7.4	Quality-related training	1/3×IDLrate
R8	**Lab. test equipment calibration**	
R8.1	Autoclave calibration	IDLrate+ TErate
R8.2	Incubator calibration	IDLrate+ TErate
R8.3	Moisture analyzer calibration	IDLrate+ TErate
R8.4	Centrifugal separator calibration	IDLrate+ TErate
R8.5	Stomacher calibration	IDLrate+ TErate
R8.6	Lab. test water bath calibration	IDLrate+ TErate

[22] Include autoclave, stomacher, water bath, incubator and heater depreciation rates
[23] Include moisture analyzer, furnace and centrifugal separator depreciation rates

Table 4.7-Activity Cost Driver Rates Calculation (Continued)

Name of Manufacturing Organization : __xxxx_____		
Manufacturing Sector : _____Food Sector_____		
Production Line Name/ Code : __Wafer_____		
Item	**Activity**	**Cost Driver Rate (CR)**
R8.7	Lab. test oven calibration	IDLrate+ TErate
R8.8	Lab. test heater calibration	IDLrate+ TErate
R8.9	Lab. refrigerator calibration	IDLrate+ TErate
R8.10	Lab. test balance calibration	IDLrate+ TErate
I1	**Equipment maintenance**	
I1.1	On-line repairing	1/4×(ODLrate+IDLrate)
I1.2	Equipment improvement	13/12IDLrate
F1	**Purchased raw material failure**	
F1.1	Reliability micro-analysis test	TC×(1/3ODLrate+TErate)
F1.2	Reliability physical-analysis test	TC×(1/3ODLrate+TErate)
F1.3	Reliability chemical-analysis test	TC×1/3ODLrate
F1.4	Document work and lot return	TC×1/3ODLrate
F1.5	Follow-up production line and packaging site for corrective action	5/6IDLrate
F2	**In-process product failure**	
F2.1	Reliability micro-analysis test	TC×(1/3ODLrate+TErate)
F2.2	Follow-up production line and packaging site for corrective action	5/6IDLrate
F2.3	Failure analysis and corrective action	5/6IDLrate
F3	**Returned product and customer incident**	
F3.1	Reliability micro-analysis test	TC×(1/3ODLrate+TErate)
F3.2	Visual inspection of wrapping seal of returned product units	TC×1/3ODLrate
F3.3	Visual inspection of shrinking seal of returned filled product packages	TC×1/3ODLrate
F3.4	Document work and production & packing rework	TC×1/3ODLrate

Table 4.8-Activity Costs for Feb. and Mar. in (USD)

Name of Manufacturing Organization : ___xxxx___							
Manufacturing Sector : ___Food Sector___							
Production Line Name/ Code : ___Wafer___							
Item	**Activity**	**February**			**March**		
		CR	**CV**	**Activity cost**	**CR**	**CV**	**Activity cost**
R1	**Document checking**						
R1.1	Start batch document checking	0.51	24	12.12	0.51	27	13.77
R1.2	Start batch composition document checking	0.78	24	18.18	0.78	27	20.45
R1.3	In-process document checking	0.32	24	7.77	0.32	27	8.74
R1.4	Packing document checking	0.26	24	6.21	0.26	27	6.99
R2	**Production machines setup checking**						
R2.1	Baking oven setup checking	4.37	24	104.96	4.37	27	118.08
R2.2	Spreading MC setup checking	0.04	24	0.97	0.04	27	1.11
R2.3	Cream cooling MC setup checking	0.77	24	18.52	0.77	27	20.84
R2.4	Product-cutting MC setup checking	3.22	40	128.80	3.22	32	103.04
R2.5	enrobing MC setup checking	0.01	32	0.37	0.01	40	0.46
R2.6	Chocolate cooling MC setup checking	0.17	24	4.12	0.17	27	4.63
R2.7	Wrapping MC setup checking	1.57	38	59.53	1.57	48	75.20
R2.8	Shrinking MC setup checking	0.25	35	8.87	0.25	50	12.67
R3	**Lab. test equipment setup checking**						
R3.1	Autoclave setup checking	1.30	06	7.80	1.30	06	7.80
R3.2	Incubator setup checking	0.08	04	0.33	0.08	22	1.79
R3.3	Moisture analyzer setup checking	0.22	63	13.81	0.22	21	4.60
R3.4	Centrifugal separator setup checking	--	--	--	--	--	--
R3.5	Stomacher setup checking	0.01	03	0.04	0.01	24	0.34
R3.6	Lab. testing water bath setup checking	0.02	00	00	0.02	17	0.26
R3.7	Lab. testing oven setup checking	0.86	19	16.28	0.86	06	5.14
R3.8	Lab. testing heater setup checking	0.08	00	00	0.08	20	1.60
R3.9	Lab. refrigerator setup checking	--	--	--	--	--	--
R3.10	Lab. test balance setup checking	--	--	--	--	--	--
R4	**In-process inspection**						
R4.1	Weighing incoming raw material lots	0.26	48	12.48	0.26	54	13.98
R4.2	Weighing baked product units	0.01	250	2.00	0.01	295	2.36
R4.3	Weighing spread (cream-coated) product units	0.01	400	4.00	0.01	455	4.55
R4.4	Weighing wrapped finished product units	0.07	330	16.10	0.07	252	17.64
R4.5	Visual inspection of wrapping seal	0.01	300	2.70	0.01	321	2.89
R4.6	Visual inspection of shrinking seal	0.01	250	2.50	0.01	284	2.84

Table 4.8-Activity Costs for Feb. and Mar. in (USD) (Continued)

Name of Manufacturing Organization : __xxxx__

Manufacturing Sector : __Food Sector__

Production Line Name/ Code : __Wafer__

Item	Activity	February			March		
		CR	CV	Activity cost	CR	CV	Activity cost
R4.7	Weighing scrapped baked product units	0.07	264	18.48	0.07	289	20.33
R4.8	Weighing spread (cream-coated) product rework	0.07	240	16.80	0.07	268	18.76
R4.9	Weighing cooled spread (cream-coated) product rework	0.09	280	25.20	0.09	310	27.90
R4.10	Weighing finished product rework resulting during wrapping process	0.07	230	16.10	0.07	225	17.85
R4.11	Weighing scrapped wrapping paper	0.03	48	1.44	0.03	54	1.62
R4.12	Weighing scrapped shrinking nylon	0.03	48	1.44	0.03	54	1.62
R4.13	Quality assurance gating after weighing incoming raw material lots	0.08	48	3.84	0.08	54	4.32
R4.14	Quality assurance gating for packaged product	0.07	48	3.36	0.07	54	3.78
R5	**In-process lab. analysis tests**						
R5.1	Micro-analysis test	2.38	24	57.12	2.38	27	64.26
R5.2	Physical-analysis test	0.36	24	8.56	0.36	27	9.63
R5.3	Quality assurance gating for in-process lab. analysis tests	0.17	48	8.08	0.17	54	9.09
R6	**Off-line lab. analysis tests and equipment maintenance**						
R6.1	Weighing purchased raw material	9.28	03	27.84	9.28	04	37.12
R6.2	Micro-analysis test	2.38	13	30.94	2.38	15	35.70
R6.3	Physical-analysis test	0.36	14	5.04	0.36	16	5.76
R6.4	Chemical-analysis test	0.19	10	1.90	0.19	15	2.85
R6.5	Quality assurance after weighing & testing purchased raw material	0.17	37	6.23	0.17	46	7.82
R6.6	Off-line equipment preventive maintenance	1.34	20.67	37.11	1.34	12.75	17.09
R7	**Process audit and improvement**						
R7.1	Specifications and working procedures' audits	00	00	00	00	00	00
R7.2	Quality assurance report	00	00	00	00	00	00
R7.3	Process improvement	00	00	00	00	00	00
R7.4	Quality-related training	00	00	00	00	00	00
R8	**Lab. test equipment calibration**						
R8.1	Autoclave calibration	3.30	00	00	3.30	00	00
R8.2	Incubator calibration	3.14	00	00	3.14	00	00
R8.3	Moisture analyzer calibration	3.33	00	00	3.33	00	00
R8.4	Centrifugal separator calibration	3.14	00	00	3.14	00	00
R8.5	Stomacher calibration	3.27	00	00	3.27	00	00

Table 4.8-Activity Costs for Feb. and Mar. in (USD) (Continued)

Name of Manufacturing Organization : __xxxx____________________

Manufacturing Sector : _____________Food Sector____________________

Production Line Name/ Code : _____Wafer____________________

Item	Activity	February			March		
		CR	CV	Activity cost	CR	CV	Activity cost
R8.6	Lab. test water bath calibration	3.11	00	00	3.11	00	00
R8.7	Lab. test oven calibration	3.27	00	00	3.27	00	00
R8.8	Lab. test heater calibration	3.14	00	00	3.14	00	00
R8.9	Lab. refrigerator calibration	3.08	00	00	3.08	00	00
R8.10	Lab. test balance calibration	3.03	30/60	1.55	3.03	00	00
I1	**Equipment maintenance**						
I1.1	On-line repairing	5.36	1265/60	113.00	5.36	835/60	74.59
I1.2	Equipment improvement	3.28	00	00	3.28	00	00
F1	**Purchased raw material failure**						
F1.1	Reliability micro-analysis test	00	00	00	00	00	00
F1.2	Reliability physical-analysis test	00	00	00	00	00	00
F1.3	Reliability chemical-analysis test	00	00	00	00	00	00
F1.4	Document work and lot return	00	00	00	00	00	00
F1.5	Follow-up production line and packaging site for corrective action	2.53	00	00	2.53	00	00
F2	**In-process product failure**						
F2.1	Reliability micro-analysis test	00	00	00	00	00	00
F2.2	Follow-up production line and packaging site for corrective action	2.53	00	00	2.53	00	00
F2.3	Failure analysis and corrective action	2.53	00	00	2.53	00	00
F3	**Returned product and customer incident**						
F3.1	Reliability micro-analysis test	00	00	00	00	00	00
F3.2	Visual inspection of wrapping seal of returned product units	00	00	00	00	00	00
F3.3	Visual inspection of shrinking seal of returned filled product packages	00	00	00	00	00	00
F3.4	Document work and production & packing rework	00	00	00	00	00	00

Table 4.9-Material Scrapped and Material Rework Costs for Feb. and Mar.

Name of Manufacturing Organization : __xxxx_____________________________________

Manufacturing Sector : _______________Food Sector_____________________________________

Production Line Name/ Code : ________Wafer____

Item	Material scrapped/rework category	Material scrapped/rework costs (USD)	
		February	**March**
M1.1	Material scrapped during baking process	1976.45	2377.20
M1.2	Material rework during cream-coating process	1997.46	2163.72
M1.3	Material rework during product-cutting process	6990.08	7290.53
M1.4	Material rework of chocolate-coated product during wrapping process	3984.00	4166.02
M1.5	Wrapping paper scrapped	529.48	1250.83
M1.6	Shrinking nylon scrapped	937.13	895.82
Total		**16414.60**	**18144.12**

Table 4.10- Categorized COPQ for Feb. and Mar.

Name of Manufacturing Organization : ___xxxx___				
Manufacturing Sector : ___Food Sector___				
Production Line Name/ Code : ___Wafer___				
Item	**Activity**	**Output COPQ (USD)**		**COPQ category**
		February	**March**	
R1.1	Start batch document checking	12.12	13.77	Appraisal
R1.2	Start batch composition document checking	18.18	20.45	Appraisal
R1.3	In-process document checking	7.77	8.74	Appraisal
R1.4	Packing document checking	6.21	6.99	Appraisal
R4.1	Weighing incoming raw material lots	12.48	13.98	Appraisal
R4.2	Weighing baked product units	2.00	2.36	Appraisal
R4.3	Weighing spread (cream-coated) product units	4.00	4.55	Appraisal
R4.4	Weighing wrapped finished product units	16.10	17.64	Appraisal
R4.5	Visual inspection of wrapping seal of finished product units	2.70	2.89	Appraisal
R4.6	Visual inspection of shrinking seal of filled product packages	2.5	2.84	Appraisal
R4.7	Weighing scrapped baked product units	18.48	20.23	Appraisal
R4.8	Weighing spread (cream-coated) product rework	16.80	18.76	Appraisal
R4.9	Weighing cooled spread (cream-coated) product rework	25.25	27.90	Appraisal
R4.10	Weighing finished product rework resulting during wrapping process	16.10	17.85	Appraisal
R4.11	Weighing scrapped wrapping paper	1.44	1.62	Appraisal
R4.12	Weighing scrapped shrinking nylon	1.44	1.62	Appraisal
R4.13	Quality assurance gating after weighing incoming raw material lots	3.84	4.32	Appraisal
R4.14	Quality assurance gating for packaged product	3.36	3.78	Appraisal
R5.1	Micro-analysis test	57.12	64.26	Appraisal
R5.2	Physical-analysis test	8.56	9.63	Appraisal
R5.3	Quality assurance gating for in-process lab. analysis tests	8.08	9.09	Appraisal
R6.1	Weighing purchased raw material	27.84	37.12	Appraisal
R6.2	Micro-analysis test	30.94	35.70	Appraisal
R6.3	Physical-analysis test	5.04	5.76	Appraisal
R6.4	Chemical-analysis test	1.90	2.85	Appraisal
R6.5	Quality assurance after weighing & testing purchased raw material	6.23	7.82	Appraisal
Total appraisal		**316.43**	**362.52**	
F3.1	Reliability micro-analysis test	00	00	External failure
F3.2	Visual inspection of wrapping seal of returned product	00	00	External failure

Table 4.10-Categorized COPQ for Feb. and Mar. (Continued)

Name of Manufacturing Organization : __xxxx__________________________________

Manufacturing Sector : ______________Food Sector_____________________________

Production Line Name/ Code : _______Wafer____________________________________

Item	Activity	Output COPQ (USD) February	Output COPQ (USD) March	COPQ category
F3.3	Visual inspection of shrinking seal of returned filled product packages	00	00	External failure
F3.4	Document work and production & packing rework	00	00	External failure
Total external failure		**00**	**00**	
F1.1	Reliability micro-analysis test	00	00	Internal failure
F1.2	Reliability physical-analysis test	00	00	Internal failure
F1.3	Reliability chemical-analysis test	00	00	Internal failure
F1.4	Document work and lot return	00	00	Internal failure
F1.5	Follow-up production line and packaging site for corrective action	00	00	Internal failure
F2.1	Reliability micro-analysis test	00	00	Internal failure
F2.2	Follow-up production line and packaging site for corrective action	00	00	Internal failure
F2.3	Failure analysis and corrective action	00	00	Internal failure
I1.1	On-line repairing	113.00	74.59	Internal failure
Internal failure		**113.00**	**74.59**	
M1.1	Material scrapped during baking process	1976.45	2377.20	Internal failure
M1.2	Material rework during cream-coating process	1997.46	2163.72	Internal failure
M1.3	Material rework during product-cutting process	6990.08	7290.53	Internal failure
M1.4	Material rework of chocolate-coated product during wrapping process	3984.00	4166.02	Internal failure
M1.5	Wrapping paper scrapped	529.48	1250.83	Internal failure
M1.6	Shrinking nylon scrapped	937.13	895.82	Internal failure
Total internal failure		**16527.60**	**18218.71**	
R2.1	Baking oven setup checking	104.96	118.08	Prevention
R2.2	Spreading MC setup checking	0.97	1.11	Prevention
R2.3	Cream cooling MC setup checking	18.52	20.84	Prevention
R2.4	Product-cutting MC setup checking	128.80	103.04	Prevention
R2.5	enrobing MC setup checking	0.37	0.46	Prevention
R2.6	Chocolate cooling MC setup checking	4.12	4.63	Prevention
R2.7	Wrapping MC setup checking	59.53	75.20	Prevention
R2.8	Shrinking MC setup checking	8.87	12.67	Prevention
R3.1	Autoclave setup checking	7.80	7.80	Prevention
R3.2	Incubator setup checking	0.33	1.79	Prevention
R3.3	Moisture analyzer setup checking	13.81	4.60	Prevention

Table 4.10-Categorized COPQ for Feb. and Mar. (Continued)

Item	Activity	Output COPQ (USD)		COPQ category
Name of Manufacturing Organization : __xxxx__				
Manufacturing Sector : Food Sector				
Production Line Name/ Code : Wafer				
		February	March	
R3.4	Centrifugal separator setup checking	--	--	Prevention
R3.5	Stomacher setup checking	0.04	0.34	Prevention
R3.6	Lab. testing water bath setup checking	00	0.26	Prevention
R3.7	Lab. testing oven setup checking	16.28	5.14	Prevention
R3.8	Lab. testing heater setup checking	00	1.60	Prevention
R3.9	Lab. refrigerator setup checking	--	--	Prevention
R3.10	Lab. test balance setup checking	--	--	Prevention
R7.1	Specifications and working procedures' audits	00	00	Prevention
R7.2	Quality assurance report	00	00	Prevention
R7.3	Process improvement	00	00	Prevention
R7.4	Quality-related training	00	00	Prevention
R8.1	Autoclave calibration	00	00	Prevention
R8.2	Incubator calibration	00	00	Prevention
R8.3	Moisture analyzer calibration	00	00	Prevention
R8.4	Centrifugal separator calibration	00	00	Prevention
R8.5	Stomacher calibration	00	00	Prevention
R8.6	Lab. test water bath calibration	00	00	Prevention
R8.7	Lab. test oven calibration	00	00	Prevention
R8.8	Lab. test heater calibration	00	00	Prevention
R8.9	Lab. refrigerator calibration	00	00	Prevention
R8.10	Lab. test balance calibration	1.55	00	Prevention
I1.2	Equipment improvement	00	00	Prevention
R6.6	Off-line equipment preventive maintenance	37.11	17.09	Prevention
Total Prevention		**403.06**	**374.65**	
Total quality-related activity costs		**832.49**	**811.76**	
Total COPQ (including scrap& rework costs)		**17247.09**	**18955.88**	

Table 4.11-Comparative Analysis of COPQ Categories

Name of Manufacturing Organization : _xxxx____			
Manufacturing Sector : ______Food Sector______			
Production Line Name/ Code : ___Wafer______			
Item	**COPQ category**	**Costs for Feb. & Mar. (USD)**	**Relative Costs for Feb. & Mar.**
1.	Internal failure costs	**34746.31**	**0.9597**
2.	External failure costs	**00**	**00**
3.	Appraisal costs	**678.95**	**0.01875**
4.	Prevention costs	**777.71**	**0.02148**
Total		**36202.97**	**1.00**
Total gross sales		**400000**	
%COPQ		**9.1**	

Table 4.12- The Cost Structure of the Selected Production Line

Production line code/name	**Cost Category (%)**				
	DL	**DM1**[24]	**DM2**[25]	**Overhead costs**	**Variable costs as portion of the overhead costs**
Production line # 1[26]	30	22	21	59	20
Production line # 2	15	22	21	20	20
Production line # 3	05	18	20	06	20
Production line # 4	45	18	18	11	20
Production line # 5	05	20	20	04	20
Total	100	100	100	100	100

[24] Production raw material
[25] Packaging material
[26] The selected production line

Table 4.13- Break-even Point Analysis (calculation) for Feb. and Mar.

Item	Category	Calculations	Value
1.	Quantity produced (units)	Obtained from normal accounting data	220000
2.	Overhead costs (USD)	Obtained from normal accounting data	127907
3.	Unit variable operating costs (VC_1) including direct material and direct labor (USD)	Obtained from normal accounting data	1.05
4.	Unit variable operating costs portion (VC_2) of the overhead costs (USD)	Overhead costs×0.2[27]/Quantity produced	0.116
5.	Total unit variable operating costs (VC) (USD)	$VC_1 + VC_2$	1.166
6.	Fixed operating costs portion (FC) of the overhead costs (USD)	Overhead costs×0.8[28]	102326
7.	Unit selling price (P) (USD)	Obtained from normal accounting data	1.86
8.	Break-even point[29] (Q) (units)	FC / (P-VC)	147444

Table 4.14- Break-even Point Analysis (calculation) for Feb. and Mar. after Deducting the Total COPQ

Item	Category	Calculations	Value
1.	Quantity produced (units)	Obtained from normal accounting data	220000
2.	Overhead costs (USD)	Obtained from normal accounting data	127907
3.	Total unit variable operating costs (VC) before deducting total COPQ (USD)	Obtained from Table 4.13	1.166
4.	Total COPQ (USD)	Obtained from Tables 4.10 and 4.11	36202.97
5.	Total variable operating costs before deducting the total COPQ (USD)	VC×Quantity produced	256520
6.	Total COPQ as percentage of total variable costs (%)	Total COPQ / (VC×Quantity produced)	14.11
7.	Total unit variable operating costs (VC_n) after deducting total COPQ contribution to total variable operating costs (USD)	VC ×(1-0.1411)	1.002
8.	Fixed operating costs portion (FC) of the overhead costs (USD)	Obtained from Table 4.13	102326
9.	Unit selling price (P) (USD)	Obtained from normal accounting data	1.86
10.	Break-even point (Q_1) after deducting the total COPQ (units)	FC / (P-VC_n)	119262.1
11.	Break-even point decrease as a percentage of break-even point calculated before deducting the total COPQ	$[(Q_1-Q)/Q] \times 100\%$	19.11

[27] Obtained from Table 4.12
[28] (1-0.2); obtained from Table 4.12
[29] Level of produced units necessary to cover all fixed and variable operating costs

Table 4.15-Top 10 COPQ Items in Feb. and Mar.

Name of Manufacturing Organization : _xxxx							
Manufacturing Sector : Food Sector							
Production Line Name/ Code : Wafer							
Item		**Activity Cost (USD)**					**COPQ category**
		Feb.	**Mar.**	**Total**	**Rel. Cost**	**Rel. Cum. Cost**	
M1.3	Material rework during product-cutting process	6990.08	7290.53	14280.61	**0.404**	**0.404**	Int. failure
M1.4	Material rework of chocolate-coated product during wrapping process	3984.00	4166.02	8150.02	**0.231**	**0.635**	Int. failure
M1.1	Material scrapped during baking process	1976.45	2377.20	4353.65	**0.123**	**0.758**	Int. failure
M1.2	Material rework during cream-coating process	1997.46	2163.72	4161.18	**0.118**	**0.876**	Int. failure
M1.6	Shrinking nylon scrapped	937.13	895.82	1832.95	**0.052**	**0.928**	Int. failure
M1.5	Wrapping paper scrapped	529.48	1250.83	1780.31	**0.051**	**0.978**	Int. failure
R2.4	Product-cutting MC setup checking	128.80	103.04	231.84	**0.007**	**0.985**	Prevention
R2.1	Baking oven setup checking	104.96	118.08	223.04	**0.006**	**0.991**	Prevention
I1.1	On-line repairing	113.00	74.59	187.59	**0.005**	**0.996**	Int. failure
R2.7	Wrapping MC setup checking	59.53	75.20	134.73	**0.003**	**1.00**	Prevention
Total				**35335.92**	**1.00**		