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MASTER THESIS

"COST OF QUALITY IN HELLENIC SUGAR INDUSTRY"

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DEPARTMENT OF BUSINESS ADMINISTRATION

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TOTAL QUALITY MANAGEMENT

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To my parents……..

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Preface

What is the cost of quality? Does it raise the price of goods and services? Are huge savings possible by implementing continual improvement efforts? These questions are not easy ones, but quality is measurable, as are its costs. Philip Crosby, in "Quality is Free", writes that the cost of quality is "the expense of nonconformance - the cost of doing things wrong."

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.

Quality costs can become a driving force in a TQM program? Quality costing is a technique that an organization has to use in combination with other quality management tools in order to develop the Total Quality Management.

In the last few years in Greece, the companies having been influenced by the international competition try to prove the customer satisfaction.

To this aim, they induce development product or service models as Quality Assurance Systems, Improving Performance Models, TQM, Business Excellence.

The Hellenic Sugar Industry (H.S.I.) is the only sugar production company in Greece and the biggest in Europe. Recently it has been certified with ISO 9002.

For the next five year the H.S.I. has set the following targets:

1. The commercial and investment activities in Balkan.
2. The reinforcement of marketplace in local market
3. The improvement performance of Greek raw materials, increasing
    - The land performance
    - The sugar concision of the beets

In this Master Thesis the author has tried to contribute in company's targets, emphasizing on quality development strategy.

Especially, in the present study, the pilot apply of quality cost measurement is attempted, in one of the five plants of the company in a fiscal year and methods for quality improvement are proposed.

This case study contains 5 chapters.

- ❒ The first chapter is reported on the survey's aims and the company's profile.
- ❒ The second chapter is referred to the relative international references that is concerned to the Quality Cost Models.
- ❒ At the third chapter is reported the methods that have been used from the author in this study.
- ❒ At the forth chapter the measurement of quality cost results are performed and analyzed, and some improvement proposals are summarized.
- ❒ The conclusions of this study are performed in the fifth chapter.

The author believes that the elements of this case study will contribute in company's aim obtaining and management strategy and they may be give raise in further survey.

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CHAPTER 1: Introduction

1.1. Study intent

After the freetrade of the sugar price in 1991, in a competitive environment, the Hellenic Sugar Industry (H.S.I.) set up goals in order to improve its situation. These are the investments for technological and functional equipment, the energy savings, the minimization of the staff expenses, recently programs of improving performance of Greek raw material, etc.

Under these circumstances, the author suggested to study the cost of quality in one of the five plants of the HSI, which contains the prevention cost, appraisal cost and failure cost, setting the bases for the establishment of a quality cost system. The measurement, planning and control of quality costs can yield many benefits to an organization interested in improving the quality of its products and services. A quality cost system helps management determine the financial importance of quality and provides clues to the areas in which resources should be spent to improve quality. Improved quality can lead to lower costs, higher productivity, and greater profits. One vital way that they can help is by designing and operating quality cost systems.

The cost of quality composes one of the most important tools for the application of T.Q.M. because it creates the opportunity to be localized important problems that come for poor quality (high cost of internal and external failures) and to be established the appropriate techniques, in order to achieve the highest benefit for the industry and the maximum of customer satisfaction.

The basic intents of the study as the will come of the application of a cost of quality system, are:

- to be established the techniques for the decrease of the total cost of quality with
    1. the decrease of the internal and external failures cost,
    2. the investment in preventiveness activities and
    3. the decrease of the appraisal cost.
- To show the management if its quality is good enough, something that has a lot to do with its capacity for competition.
- To be compared the company's output with the other factories of the company or the other familiar companies.
- To help the management to figure out its priorities and its growth intents.

- To make company's three-level analysis (organization, process and job level).
- To note the qualitative relative processes.
- To put down the bases for the T.Q.M. application.

Generally, the cost of quality improvement does not improve only the products, but also the whole company.

For the study approach the author has planned the following process:

- As Quality Cost measurement model has been chosen the standard BS 6143 Part 2 PAF (Prevention – Appraisal – Failure) model.
- The Quality Cost measurement pilot process has been applied in the raw material production stage (sugarbeets) and contained the accounting period of one year. To this aim is suggested (as it will be referred to the particular chapter) a specific method). This method was intended to detect the production process stage that contains the highest failure costs. The appropriate improvement activities have to be planned and set in order to achieve the best quality result.
- After the planning the adjustment of the above model in the chosen process has been attempted.
- When the above processes were completed, the Quality Cost was calculated and followed its evaluation, processing and data analysis totally and distributively.
- In the following phase the Quality Cost reducing process have been applied. To this aim according to appropriate techniques (Cause and effect diagram and Pareto diagram) has been attempted the "low quality" detection process, such as the main causes that have drawn it on.
- Finally quality improvement suggestions have been made in this process. The suggestion intent is the gradual decrease of the total quality cost. Such a result is tended to contribute to the economical fundamentals of the company and on the other hand to motivate the management setting up for Quality cost System Measurement.

1.2. About the company

1.2.1. Brief History

In ancient Greece and Rome, sugar was unknown. Manufacture of sugar from cane, originated in India. During the Middle Ages and at the beginning of the Renaissance, sugar-cane cultivation spread from India to Arabia, Egypt, and Crete.

Egypt became the main supplier of sugar to Europe (via Alexandria). At the very beginning of the 19th century Europe was compelled to see new sources for sugar other than sugar cane.

The changing economic situation gave rise to numerous suggestions for possible sugar sources, such as grapes, watermelons, maple sap, malt, and finally beets. As reported, as early as 1747 A.S. Markgraf, a German chemist crystallized from an alcoholic extract of dried beets a sugar identical with cane sugar. At the end of the 18th century, Lieutenant Yakov Stepanovich Esipov, near Moscow, and F.C. Achard in Germany, were simultaneously engaged in the selection and cultivation of sugar-rich beet varieties, and in the development of a practical method for their processing into sugar.

1.2.2. The company profile

The company has been established in 1960 in Thessaloniki and firstly took action in district of Thessaly, Macedonian and Thrace. Until 1963, 3 plants had been in order and until 1965 the other two plants.

The company takes action in production and trade of sugar, molasses and pulp. Also it takes action in seed production and in sugarbeet improvement, as much as electomechanological equipment manufacture.

Nowadays, the daily production is the elaboration of about 32.500 ton of sugarbeets. The total annual sugar production of the five plants of the Hellenic Sugar Industry (H.S.I.) is about 320.000 ton and it is enough to cover the sugar needs of the country.

The HSI is the only sugar-producer industry in Greece, sixth among the industrial companies in Greece and one of the biggest sugar industries in Europe.

It occupies 1.500 of abiding and 2950 of provisional staff. The HSI got in the Greek stock exchange in 1993. The work cycle for the financial year 1994/95 was 80 billion Drs. The organization chart of each plant is shown in *Appendix 1*.

1.2.3. The Product Range.

The company's product range can be divided in: a) Sugar (e.g. white sugar), b) Beet Pulp and c) Molasses

The company produces about 10 different products, spanning the above three categories. In some cases, products only differ slightly from one another, for example by virtue of size of granular, or color. Thus, the company supplies a small range of products but many different quantities to the various clients.

1.2.4. The Production Process

The production process can be divided in two directions:

1. The raw material production
2. The Production Line

The basic stages of core processes of the production process are showed in the following Table 1.1:

Raw material production	Production Line
Planning of raw material production	Acceptance and Storage
Field preparation	Diffusion
Growth care	Juice Purification
Seeding	Evaporation
Maturing line checking	Crystallization
Collection	

Table 1.1: Processing stages of production process

The detailed description of the stages is performed in *Appendix 2*.

1.2.5. Current Methods of Assuring Quality.

The Quality Policy of Hellenic Sugar Industry is:

> *"The Management of Hellenic Sugar Industry SA recognize that the Quality of products or services, that the company offer to the Customers should be conform to the highest standards. To achieve these objectives, the personnel is trained continuously in the Quality Concepts, and a Quality Management System is implemented and followed."*

Until quite recently, the company had tended to rely heavily on the use of inspection techniques to achieve product quality. The Quality Control Manager of the Chemical Laboratory and Process Laboratory (same person) was seen as being mainly responsible for this activity. Thus, when a customer complained or an in-house quality problem arose, the Quality Control Manager tended to get most of the blame.

The two chemical analysis laboratories, the first one in the reception of beets, and the second one in the production stage, was being the main area of quality control activities. This philosophy has been replaced by a move towards increased responsibility for product quality on the part of production and agricultural sector. Now, Quality Control Manager, production personnel and agriculturists regularly check product to ensure its conformance to specification.

CHAPTER 2 : Literature Review

2.1. Cost of Quality

2.1.1. A Brief History of Quality Costs

It is difficult to ascertain who coined the term 'quality cost' as this monograph of J. M. Juran's Quality Control Handbook published in 1951 by McGraw-Hill, Inc. In a discussion of the economics of quality, Juran hypothesized that an optimal quality level could be found where the losses due to defects were equal to quality assurance and control costs. The earliest published subdivision of quality costs into prevention, appraisal and failure components is in an article by W. J. Masser, 'The Quality Manager and Quality Costs', in Industrial Quality Control, October 1957. In the 1960s, the U. S. Department of defense also issued guidelines requiring quality cost measurement on many government contracts and subcontracts.

The most significant event to date in the development of quality cost concepts and measurement techniques was the formation of a Quality Cost technical Committee by the American Society for Quality Control (ASQC). This Committee has developed three important quality cost publications: Quality Costs – What and How, published in 1967 and revised in 1971; a Guide for Reducing Quality Costs, 1977; and a Guide for Managing Vendor Quality Costs, 1980.

Quality Progress, a monthly publication of the ASQC, contains many articles on quality costs [2].

2.1.2. Definitions

Quality costs can be defined as follows:

B.G. Dale & J.J. Plunkett (1995) stress the need for vigorous definitions in quality costing exercises, since in any cost-collection exercise the costs must be relevant to the topic. Without clear definitions there will be considerable confusion and misunderstanding of what is considered to be a quality cost and what is normal business practice. The definition of what constitutes quality costs is not straightforward and there is no general agreement on a single broad definition [5].

Quality costs may be regarded as one criterion of an organization's quality performance - but only if valid comparisons can be made between different sets of cost data.

Many writers on the subject of quality costing state or imply their definitions of quality costs.

A variety of definitions associated with quality costing are given:

According to W.J. Morse, H.P.R. Roth, & K.M. Poston "Quality costs are costs incurred poor quality may exist or does exist [2].

J.M. Groocock said that: "Quality costs are costs associated with making defective product." For service industries "making defective product" can be replaced by "providing defective service" [4].

Further Dahlgard *et al.* (1992) classified the quality cost into one more classification as visible and invisible costs. The invisible costs are the cots due mainly to the loss of goodwill (or loss of future sales) and additional costs incurred due to internal inefficiencies. As the term 'invisible cost' indicates, these costs are not readily available and are not easy to estimate; but efforts should be taken to understand these concepts in evaluating the quality cost and to try to reduce the occurrence of these activities to minimize the costs [31].

A quality cost is defined in BS 4778: Part 2 as:

The expenditure incurred by the producer, by the user and by the community, associated with product or service quality [45].

and a quality-related cost as:

The expenditure incurred in defect prevention and appraisal activities plus the losses due to the internal and external failure'.

'Cost in such categories as prevention cost; appraisal cost; internal failure cost;' [35].

'Cost in ensuring and assuring quality as well as loss incurred when quality is not achieved' [36].

Whilst the meaning of these four different definitions of quality related costs are the same the lack of standardization may be seen as a major drawback for the cost collector. Almost the same holds true for the definitions of prevention, appraisal, internal and external failure costs.

The fact that there are not yet agreed definitions of some of the fundamental terms of quality costing should warn cost collectors of the uncertainties and difficulties which may be met when attempting to measure and report quality costs.

2.1.3. Why measure quality costs

For service and manufacturing organizations to become leaders in the changing marketplace, they must commit to implementing tools, systems, and quality management techniques. Continual success depends on individual and team efforts to turn the organizations' strategic quality plans into reality [28].

To achieve international success, companies must introduce the principles and practices of total quality management (TQM). A successfully implemented TQM program will eventually affect the quality cost of product or service (Sohal & Shah, 1992). The first step along the TQM journey is quality costing. The analysis of quality costs reveals potential for saving while improving quality over a period of time (Dale & Plunkett, 1990).

The most viable predictors of productivity growth through quality improvement are the cost of quality and the number of implemented TQM elements (Radovilsky et al., 1996).

Quality cost theory states that investing in prevention and appraisal reduces the internal and external failure costs over a period. In order to prevent and appraise costs it is essential to measure costs, and the measurement of quality cost is the first step in implementation of TQM (Dale & Plunkett, 1991; Elshennawy et al., 1991; Morse, 1993).

Dahlgaard et al. (1995) suggest that the total quality should be achieved at the lowest cost, and without cost consideration it is difficult to achieve continuous improvement.

Plunkett and Dale (1987) noted that though the need for collecting and measuring quality cost is a central theme of quality cost programs, most of the authors ignore this subject and start discussing the uses of quality cost data [34].

Measurements of costs allow quality-related activities to be expressed in the language of management, i.e. money. This, in turn, allows quality to be treated as a business parameter as in marketing, R&S, etc. Drawing quality costs into the business arena helps emphasize the importance of product and service quality to corporate health and will influence behavior and attitudes towards TQM at all levels in the organization. Quality cost measurement focuses attention on areas of high expenditure and potential cost-reduction opportunities. It allows measurement of performance and provides a basis for comparison between products, services, processes, departments and divisions.

The size of quality costs can be used to attract management attention and stock them into making a commitment to a TQM program. The reporting of quality-relating activities in financial terms generally raises the importance of quality within the management team and ensures it is given the same attention as any other activity with such a large potential impact on the company's performance [5].

Robertson draws on data from the National Council for Quality and Reliability saying that for the average UK organization quality-related costs are divided in the proportions: 5% prevention costs, 30% appraisal costs and 65% failure costs. He goes on to say that they may be 4-20% of sales turnover, and that concentrating on prevention may alter the failure-appraisal-prevention ratio to 35:20:10 whilst achieving of 1.5 to 6.5% of turnover.

Abed and Dale from an analysis of the quantitative data contained in the quality costing literature found that the quality cost categories expressed as a percentage of total quality costs are: prevention (5%), appraisal (28%) and failure (67%). Total quality costs as a percentage of annual sales turnovers averaged 9.2% with a range from 2 to 25% [5].

2.1.4. Quality cost categories

2.1.4.1. Process cost model

The concept of the process cost model was originally developed by Grosby (1979, 1983, 1984). The cost of quality (COQ) is determined as the sum of the price of conformance (POC) and the price of non-conformance (PONC); therefore,

COQ=POC+PONC

Grosby's concept was introduced into BS 6143 Part 1 (1992), but the standard uses cost instead of price [11].

Like all things there is a price to pay for quality. This total cost can be split into two fundamental areas:

a. Price of Non Conformance (PONC). This area covers the price paid by not having quality systems or a quality product. Examples of this are:

(1) Rework. Doing the job over again because it wasn't right the first time.

(2) Scrap. Throwing away the results of your work because it is not up to the required standard.

(3) Waiting. Time wasted whilst waiting for other people.

(4) Down Time. Not being able to do your job because a machine is broken.

b. Price of Conformance (POC). Conformance is an aim of quality assurance. This aim is achieved at a price. Examples of this are:

(1) Documentation. Writing work instructions, technical instructions and producing paperwork.

(2) Training. On the job training, quality training, etc.

(3) Auditing. Internal, external and extrinsic.

(4) Planning. Prevention, do the right thing first time and poka yoke.

(5) Inspection. Vehicles, equipment, buildings and people [19].

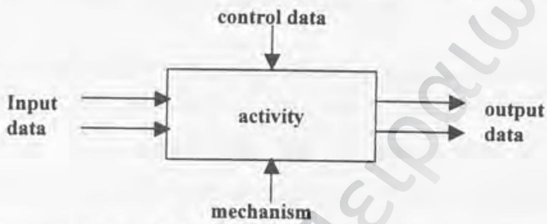


Figure 2.1 : Process cost model structure
(BSI Quality Management Handbook : Part 1 : 1995 BS 6143 : Part 1 : 1995)

Each of the cost elements, such as people, equipment, material and the environment, is identified as either a POC or a PONC for each process, on the pretext that any process can be structured as depicted in Figure 2.1 [16].

Finally, the only valid measure of quality is the Price of Non-Conformance (PONC). In other words, how much the company spends on discovering, scrapping, and correcting errors. To calculate the PONC the company could enter "Activity Based Costing" (ABC). ABC allocates its costs to specific activities rather than departments or functions [17].

It is a systems approach where the whole system is viewed and then broken down into steps and sub-steps and it can be used in many situations. The first thing to do is to determine the steps within the organization being investigated. Next, relationships are determined.

The standard advocates that a number of teams be set up. These teams should include multi-functional, highly qualified people. Their brief is to identify processes; to break this process down; to identify the costs in this process; to determine the categories of costs; and to prepare cost reports. Cost reports would be used to advise the senior managers about the problem associated with the process [16].

TQM focuses on the management of processes not only on their outputs. In *Appendix 3* is illustrated a typical process model inputs and outputs for personnel department process.

The process cost model pursues a continuous improvement policy on key processes within the organization and innovates where appropriate, which in itself reflects both the Kaizen approach and Deming's plan-do-check-act (PDCA) cycle. It can be applied to both service and manufacturing industries, and can be used to improve a process stage with either a high non-conformance cost by increasing preventative costs or with excessive conformance costs [11].

2.1.4.2. Prevention, appraisal and failure model (PAF Model)

The PAF model, the oldest of the quality cost models, was developed by Feigenbaum (1956) and Masser (1957). It is one of the better known models among quality practitioners and has seen application in both manufacturing and service industries. The British Standards Institution (BSI) and the US have adopted it for their standards BS 6143 Part 2 (1990) and ASQC (1971) respectively. Many writers, such as Harrigton (1978), Juran and Gryna (1988) and Gibson *et al.* (1991), have used it as a basis for studies [11].

2.1.4.2.1. Definition PAF Model

Prevention cost. The cost of all activities specifically designed to prevent poor quality in products or services. Examples are the costs of new product review, quality planning, supplier capability surveys, process capability evaluations, quality improvement team meetings, quality improvement projects, quality education and training [1]. This area covers avoiding defects, planning, preparation, training, preventative maintenance and evaluation [19]. The cost of any action taken to investigate, prevent or reduce the risk of nonconformity or defect [36].

Appraisal cost. The costs associated with measuring, evaluating or auditing products or services to assure conformance to quality standards and performance requirements. These include the costs of incoming and source inspection/test of purchased material, in process and final inspection/test, product, process, or service audits, calibration of measuring and test equipment, and the costs of associated supplies and materials [1]. This area covers finding defects by inspection (poka yoke), audit, calibration, test and measurement [19].

The cost of evaluating the achievement of quality requirements including e.g. cost of verification and control performed at any stage of the quality loop [36].

Failure costs. The costs resulting from products or services not conforming to requirements or customer/user needs. Failure costs are divided into internal and external failure cost category [1].

Internal failure costs. Failure costs occupying prior to delivery or shipment of the product, or the furnishing of a service, to the customer. Examples are the costs of scrap, rework reinspection, retesting, material review, and down grading [1]. This area covers the costs that are born by the organization itself such as scrap, rework, redesign, modifications, corrective action, down time, concessions and overtime [19]. The costs arising within an organization due to non-conformities or defects at any stage of the quality loop such as costs of scrap, rework, retest, reinspection and redesign [36].

External failure costs. Failure costs occurring after delivery or shipment of the product, and during or after furnishing of a service, to the customer. Examples are the costs of processing customer complaints, customer returns, warranty claims, and product recalls [1]. This area covers the costs that are borne by the customer such as equipment failure, down time, warranty, administrative cost in dealing with failure and the loss of goodwill [19]. The costs arising after delivery to a customer/user due to non-conformities or defects, which may include the cost of claims against warranty, replacement and consequential losses and evaluation of penalties incurred [36].

Total quality costs. The sum of the above costs. It represents the difference between the actual cost would be if there was no possibility of sub-standard service, failure of products, or defects in their manufacture [1].

Reductions in failure costs are driven by the correct application of appraisal and prevention investments. While most people are aware of the four COQ elements, the how-to side of implementing them continues to mystify many potential users. But by integrating COQ elements in the team problem-solving process, the ability to analyze business processes and eliminate non value-added activities is made easier. The results can be an eye-opener: a streamlined, efficient organization that is realizing maximum output using minimal resources [28].

There are some general and specific advantages and limitations from this type of categorization.

Among the specific advantages are, first, its universal acceptance, second, its conference of relative desirability of different kinds of expenditure, and third, and most important, it provides keyword criteria to help to decide whether cost are, in fact, quality related. It is also easy to understand and may prompt a rational approach to collecting costs, and it can add orderliness and uniformity to the ensuring reports.

Among its limitations are:

The quality activity elements as defined do not match well with the cost information most commonly available from accounting systems.

To the unwary, because of the distribution of cost elements, it can lead to more focus on the prevention and appraisal components than on failure costs.

It is not broad enough to account for many of the activities of non-manufacturing areas.

There are many quality-related activities in gray areas where it is unclear to which category they belong.

In practice, the categorization is often a post-collection exercise done in deference to the received wisdom on the topic.

The categorization seems to be of interest only to quality assurance personnel.

It is not an appropriate categorization for the most common uses of quality related cost information [5].

The lack of the collection mechanism in place.

The cultural or organizational barriers [16].

2.1.4.2.2. Graphical presentations of PAF Model

To date many diagrams have been issued that illustrate the relation between the major categories of quality costs [12].

The most famous of these have been developed from Juran and they illustrate the long-term trend of Total Quality Cost.

This diagram, in Figure 2.2, shows a concave cost function that is minimized at a level of conformance where the marginal cost of prevention plus appraisal equals the marginal cost of failure. As shown by the "U" shaped total quality cost curve, this model implies that the optimal level of quality is less than 100 percent conformance (the "optimal" point being at the "valley" of the "U" shaped cost curve) [8].

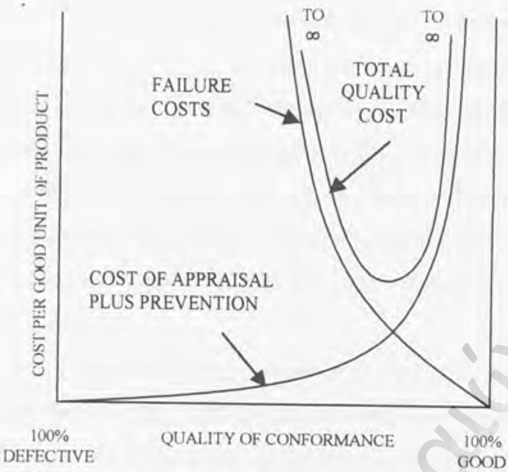


Figure 2.2: Classic Model of Optimum Quality costs
(figure reproduced from Juran's Quality Control Handbook, 4th ed. By J.M.Juran anf Frank M. Gryna. New York: McGraw-Hill Book Co., 1988)

Confusion exists over the use of quality cost information. The zero-defects followers maintain that there is little value in knowing and using traditional COQ trade-off information. Instead, they employ operational measures, such as yield and defect rates, to measure quality programs. The other group, optimum-quality cost followers, use the traditional COQ of quality trade-off model.

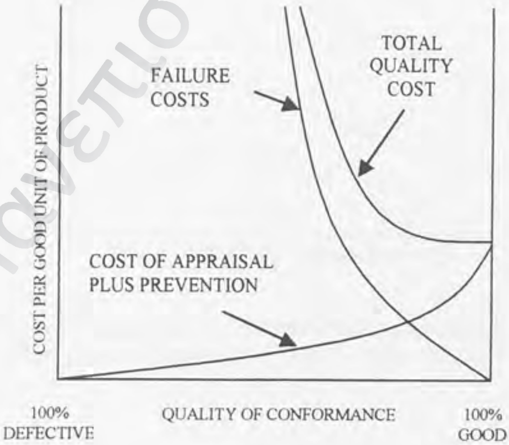


Figure 2.3. : New Model of Optimum Quality Costs
(figure reproduced from Juran's Quality Control Handbook, 4th ed. By J.M.Juran anf Frank M. Gryna. New York: McGraw-Hill Book Co., 1988)

These advocates contend that managing conformance and nonconformance cost trade-off leads to the lowest COQ or the optimal level of quality cost. Each group encourages quality programs, but make resource-spending decisions differently [10].

New technology has reduced inherent failure rates of materials and products, while robotics and other forms of automation have reduced human error during production, and automated inspection and testing have reduced the human error of appraisal. These developments, in Figure 2.3., have resulted in an ability to achieve perfection at finite cost [1].

Figure 2.4. illustrates the new model that has been suggested in BS 6143: Part2: 1990. This model implies that total quality costs can be reduced over time. It:

> *"illustrates how an increased awareness of the cost to the organization of quality failure leads first to an increase in appraisal of product quality. Then, as appraisal together with investigation points to features/elements where improvement can be made to product design/process/systems, more is spent on prevention appraisal and failure proportions of the costs realign and all costs reduce* " [36].

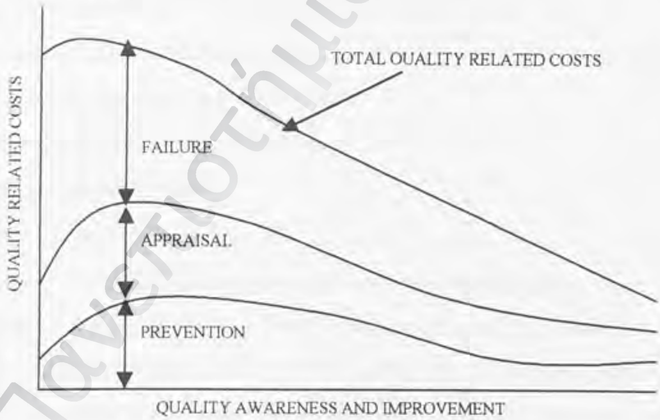


Figure 2.4: Increasing quality awareness and improvement activities
(BSI Quality Management Handbook : Part 1 : 1995 BS 6143 : Part 2 : 1990)

2.1.4.3. Discrimination in Macro and Micro PAF Model

The PAF models just explained, generally known as macro-PAF models, have been developed around the external customer and supplier relationship of an organization.

Winchell and Bolton (1987) suggested a micro-model, which focused on the internal customer and supplier within a department or process. Their model is similar to the macro-model, expert that the whole organization is broken down into departments and sections prior to its application [11].

2.1.5. Quality Cost System Set up

Some specific steps in installing a quality cost system are following. There are an almost unlimited number of ways to organize the installation process. An organization need not follow the exact procedures outlined below. They can be modified and fit according to the needs and individuality of each organization.

2.1.5.1. Goal of a quality cost system

The goal of any quality cost system is to facilitate quality improvement efforts that will lead to operating cost reduction opportunities. The strategy for using quality costs is:

- Take direct attack on failure costs in an attempt to drive them to zero.
- Invest in the "right" prevention activities to bring about improvement.
- Reduce appraisal costs according to results achieved.

Continuously evaluate and redirect prevention efforts to gain further improvement. This strategy is based on the premise that:

- For each failure there is a root cause.
- Causes are preventable.
- Prevention is always cheaper.

2.1.5.2. Management commitment and support.

Before undertaking any large-scale attempt to implement a quality cost program, management must be convinced of the value of the program and the use for which the system is intended. Any proposed need for additional efforts in the important business of cost accumulations and use is likely to be challenged.

Thus, there is a need for a comprehensive presentation to management so as to elicit its understanding and interest, and to justify the proposed effort.

2.1.5.3. Quality Cost team

The quality cost team should include individuals from every part of the organization – product managers, engineers, line workers and others who can identify specific elements of quality costs.

The quality cost team has the responsibility of studying all relevant issues; estimating the organization's quality costs and making some specific recommendations as to whether a quality cost system should be installed.

It must also identify the specific individuals who will be responsible for performing various system tasks and ensure that employees involved in the system are properly trained and accept their responsibility. Finally, the team must verify that all goes as planned and that any necessary modifications are made.

2.1.5.4. Define Quality Costs and Quality Cost Categories

The concept of quality costs is new to most individuals. The quality cost team has the responsibility to make certain that everyone in the organization understands what quality costs are what they are not. While the categorization of quality costs into prevention, appraisal, internal and external failure should prove satisfactory for most organizational needs, the team should be willing to accept suggestions for alternative classifications.

2.1.5.5. Identify Quality Costs within Each Category

After defining quality costs operationally, the next step is to determine what types of costs are likely to appear in each category. The quality cost team should ask individuals throughout the organization to identify specific costs the company incurs because poor quality may or does exist. This list may have to be revised numerous times before everyone agrees on its validity.

2.1.5.6. Determine Sources of Information

Once the specific quality cost elements to be included in the reports are identified, the quality cost team must determine the available sources of data for each element. Many of the data used in quality cost reporting exist in the accounting system. Other quality cost elements, while not directly available in the accounting system can be calculated with minor modifications to the existing system. Unfortunately, cost data may not be available for some quality costs [2].

The ease of collection of quality cost data is dependent upon identifying cost data sources. BS6143: Part2 recommends the following as source documents:

- Payroll analysis
- Manufacturing expense reports
- Scrap reports

- Rework or rectification authorizations/reports
- Travel expense claims
- Production cost information
- Field repair, replacement and warranty cost reports
- Inspection and test records
- Non-conformance reports

In general, quality-costing data is obtained from three main sources:

- Normal accounting data (i.e. labor and overhead cost reports) from accounts ledgers,
- Company operating systems, procedures, standards and specifications, and
- Data specifically calculated or estimated for the quality costing exercise [5].

The quality team must decide whether additional data are to be collected in such cases, and, from what sources [1].

2.1.5.7. Report and Analyze Quality costs

Quality cost reports must be designed to meet the needs of the users of the quality cost information. The system must be able to help identify products and segments where management should focus its quality improvement efforts in an attempt to minimize quality cost [1].

The purposes of quality cost reporting can be listed as follows:

1. to enable the unit's managers to know the size of their quality cost problem so that they can apply appropriate resources to its solution;
2. to show broadly where the problem so is, e.g. in inspection or in warranty, so that unit management can concentrate effort effectively;
3. to enable unit management can to set targets for quality-cost reduction and to plan actions to meet the targets;
4. to enable progress towards meeting the targets to be measurement;
5. to enable company management to motivate unit management to set ambitious targets and to provide help to unit management for their achievement [4].

According to Morse:

"The potential uses of the information contained in such a (quality cost) report are limited only by imagination of management."

Many of the uses can however be grouped into four broad categories.

1. Quality costs may be used to promote quality as a business parameter.
2. They give rise to performance measures.
3. They provide the means for planning and controlling quality costs.
4. They act as motivators [5].

Presentation of costs under prevention, appraisal and internal and external failure is the most popular approach.

Shah and Fitzroy's survey is referred to the concept of reporting quality cost data is not widely accepted by firms, though a number of researches tried to collect quality cost data from the TQM superior firms. This finding might suggest further research into how firms are taking decisions for improving product quality and hence reducing Total Quality Cost.

In the quality cost literature, from the accounting fraternity, a number of articles suggested the use of ABC systems for collecting quality costs.

Plunkett and Dale (1983) stated that the use of a matrix type accounting system helps in controlling quality cost topic wise (e.g. quality) across the traditional functional groups (such as sales and production) and all quality-related costs under a single cost center [32].

An importance consideration in the presentation of quality costs is the needs of the recipients and it may be worth presenting information in several different formats. In *Appendix 4* is presented a quality cost summary report approach.

2.1.5.8. Establish Procedures to Accumulate Quality Costs

This step involves the creation of a systematic method for collecting quality cost information. Specific tasks must be assigned to specific individuals, and the individuals involved in accumulating quality cost data must understand what they are to do and how they are to do it [2].

2.1.5.9. Avoid the obstacles and gain the benefits

Implementing Cost of Quality (COQ) systems is not an easy task. Obstacles frequently encountered include:

- Management does not allocate sufficient time and resources.
- Since the COQ system is usually not entirely compatible with existing product costing systems, it often requires the administration of a separate system.
- The "softness" of indirect quality cost data makes using those data controversial.

- Using only out-of-pocket, or direct, quality costs can result in management investing too little in prevention activities. This generally results in lower reductions in quality costs than was expected, causing management to lessen its financial support for the COQ and quality improvement systems.
- Lack of training in quality concepts and group facilitation methods makes it difficult to lead or participate in cross-functional teams.
- Quality concepts are often inhibited by financial concepts. When subjected to the pressures of the budgeting process, harmful quality cost trade-offs are hard to resist without a strong commitment from upper management.
- If a controller lacks the training or commitment to quality management concepts, he might allocate fewer resources to the COQ system, eroding the accounting department's critical role in COQ.

If companies can avoid such obstacles and implement successful COQ systems, the benefits are numerous. The advantages of having a COQ system include:

- Quality data are more readily accepted because they are gathered and analyzed with the accounting department in a team environment.
- The COQ system aids in the evaluation of capital investment alternatives.
- The COQ system helps justify and steer investments in prevention activities, which lowers quality costs. It also helps justify and steer other quality improvement efforts and investments.
- The COQ system leads to the development of more advanced performance measures in the areas of customer satisfaction, production, and design to better target indirect quality costs.
- Return on investment and sales are improved while reducing costs [30].

In summary, an effective quality cost program consists of the following steps:

- Establish a quality cost measurement system
- Develop a suitable long-range trend analysis
- Establish annual improvement goals for total quality costs
- Develop short-range trend analyses with individual targets, which collectively add up to the incremental demands of the annual improvement goal
- Monitor progress against each short-range target and taking appropriate corrective action when targets are not being achieved

2.1.6. Reducing Quality cost

2.1.6.1. Philosophy

The quality cost improvement philosophy is:

Quality improvement results in cost improvement. Designing and building a product right the first time always cost less.

Solving problems by finding their causes and eliminating them results in measurable savings. To cash in on these savings the quality performance must be improved.

The first step in the process is the identification of problems; a problem in this context is defended as an area of high quality costs. Every problem identified by quality costs is an opportunity for profit improvement [1].

2.1.6.2. Improvement Program

The strategic quality plan describes a management commitment to quality and quality cost improvement.

When the highest cost areas are analyzed in greater detail, many improvement projects become apparent.

In summary, to effectively establish quality improvement efforts, it is necessary to:

- Recognize and organize quality-related costs to gain Knowledge of magnitude, contributing elements, and trends.
- Analyze quality performance, identify major problem areas, and measure product line and/or manufacturing section performance.
- Implement effective corrective action and cost improvement programs.
- Evaluate effect of action to assure intended results.
- Program activities for maximum dollar payoff and maximum effective manpower utilization.
- Budget quality work to meet objectives [1].

2.1.6.3. Analysis techniques for quality costs

Analysis techniques for quality costs are as varied as those used for any other quality problems in industry. They range from simple charting techniques to complicated mathematical models of the program.

The most common techniques are trend analysis and Pareto analysis by quality cost category, element, department, product, or other groupings.

2.1.7. The role of accounting in Quality Costing

Some companies believe that a quality cost program will require extensive accounting system changes and additional staff. Others believe that their present cost accounting system is sufficient to identify all areas requiring management attention. Unfortunately, accounting systems were never designed to demonstrate the impact of the quality of performance on overall operating costs. That is why many of these costs have remained hidden for so long.

The responsibility for collecting and analyzing quality costs comes, in general from the quality assurance department; sometimes it is driven by the board of directors and senior management team but rarely does the initiative come from the accounting and financial department.

The initiatives taken by accountants seem to be restricted only to high costs of inspection and checking activities or scrap appearing in labor or material cost analyses, respectively.

The collection of quality costs should be a joint exercise between quality assurance, technical specialists and accountants. Accountants should be involved from the outset of the exercise.

2.2. Other Quality Cost Models

2.2.1. A new method to estimate the total quality costs

The traditional method is to record costs as they arise (e.g. wage costs, material etc.) or are thought to arise (e.g. deprecations). This method is only applicable in calculating visible costs however.

J. J. DAHLGAARD (1996) proposed a new method for the indirect measurement of total quality costs – a method that might be invaluable in connection with the strategic quality management process.

The methods is as follows:

Let P_{jt} stand for the ordinary trading result of company j at time t, and let P_{jt}/Nj stand for the ordinary trading result per employee. N denotes the numbers of employees, converted to full-time employees, in company j. Assume also that there are m comparable firms competing in the same industry/market.

Now let the m competing firms be ranked as follows:

$$P_{1t}/N_1 < P_{2t}/N_2 < \ldots\ldots < P_{mt}/N_m \qquad (1)$$

Based on this ranking, the lower limit of company j's total quality costs at time t can now be calculated:

$$C_{jt} = (P_{mt}/N_m - P_{jt}/N_j) * N_j$$
$$= (N_j/N_m) * P_{mt} - P_{jt} \qquad (2)$$

The limit in (1) is a lower limit in the short term.

It can be seen from (2) that this lower limit is calculated as the difference between the ordinary trading result per employee of the most profitable firm (per employee) and company j, multiplied by the number of employees in company j.

J. J. DAHLGAARD called this limit a lower limit because the method builds on a comparison with the best company, i.e. the company that has achieved the highest profits per employee. This company is used as a benchmark for the other firms being compared; a consequence of this approach being that its lower limit of quality costs is zero. It doesn't have zero quality costs, of course, which is why, with the help of equation (2), he called it a lower limit.

The advantage of the method, apart from its being simple to use, is a "benchmarking method" that a firm is forced to compare itself with its competitors and rely on the Total Quality implementation [37].

2.2.2. Cost-benefit model

Most of cost models have been developed in the basis of estimating the return on investment, by equalizing the relation between the prevention and appraisal cost and the failure cost. On the other hand, they don't estimate the long-term benefits that an organization can achieve investing in TQM.

The ultimate purpose of quality improvement is to increase the benefit attained from the increased market share as well as to reduce quality costs.

Deming (1986) explains the chain effect attained from the improvement of quality by saying that if you improve quality, its related cost decrease, resulting in improved productivity, market share growth, stability, etc. However, an investment in TQM does not result in quality improvement for a product or service in the short term, because improvement is a gradual process, which starts slowly but after a certain period progresses steadily, as the Japanese proved (Kanji, 1990).

Many writers say that it takes more than 5 years to see the visible effect of quality improvement in TQM (Berry, 1990).

On this basis, Porter and Rayner (1992) suggested a simple cost-benefit model to monitor the effect of a TQM program without reflection the dynamics of the quality activities. Bajpai (1989) developed a simulation model over time with system dynamics techniques, which enumerated different elements of costs and benefits relating to preventive activities in a manufacturing company. Similarly, Baston (1988) structured a dynamic flow system for a quality cost system that included complaints and managerial pressure, together with a quality cost and a management accounting element. Coulson (1993) considered the economic ratio of income and cost that is incurred as a result of marketing, innovation and improvement activities. Merino (1989) also developed a detailed cost-benefit model related to technology, which considered the types of quality problems encountered and their possible solution using engineering economics.

The cost benefit-modes help companies to decide how, when and where to invest in preventive activities or equipment (Plunkett & Dale, 1988), and enables quality-related departments to participate in strategic planning [11].

2.2.3. ISO 10014

This model explains how the application of quality management can obtain financial results. The philosophy of ISO 10014 model counts on the principle that the management of organization has to set the basic aim, the quality policy and the quantitative goals.

The model faces the organization as a whole that doesn't include the customers. These should be externals. In this way, it studies the performance development activities as a request of the managing economics of quality from organization's view and customer's view. For the application of this model some basic steps are treaded which are illustrated in *Appendix 5*.

At first the management determines all the process in the organization.

From the organization's view it defines the activities of the processes, such as the inputs and outputs. Continuously, applying the known models of cost of quality measurement produce the process cost report.

From the customer's view the management, with the support of quantitative or qualitative surveys, monitors and reports the level of customer satisfaction.

Both the reports of cost and customer satisfaction the organization should determine if there are opportunity areas to improve process and customer satisfaction.

The management should manage cost benefit analysis to determine if action is required and if the proposed improvement action is justified, taking into account the short and long-term benefits. If the action is approved, the organization should plan and implement the improvement and monitor the results to give feedback to the process. The organization should repeat this methodology for continuous improvement [38].

2.2.4. The comparison of each cost model

From the above presentation and analysis of the different cost models, has been obvious that these models consist a very important tool in quality development systems application and in other words TQM.

To date and according to published surveys, several disadvantages of cost models have been noted as the try to give the best result in management to design the quality strategy based on the principle that:

Quality – is to continuously satisfy customers' expectations

Total Quality – is to achieve at low cost [37].

In their survey, G.H.HWANG and E.M.ASPINWALL tried to set a comparison among the cost models that is based on their ability to contribute in problems resolution in the quality costing area, as:

- **Retroaction** as the time lag between action and effect.
- **Construction of a quality management system.** This is the cost model ability to allow the construction of a small quality management system and a series of appropriate preventive.
- **Strategic management.** The most important advantage of quality cost is that modulates and reinforces the interest of the top management for the quality. This is impressed by including in strategic business plan.
- **Intangible quality costs.** The inability of the cost models to estimate costs that includes loss of customer goodwill, delays caused by stoppage and rework, loss of staff morale (absenteeism, rapid turnover, extra training) and lost revenues caused by repetition.
- **External supplier.** Mechanisms for the quality problems release from purchased raw materials, intermediate and end product.

- **White-collar quality costs** relating to concession or engineering changes, purchasing, accounting, need to be explained in detail in in-house quality costs for effective quality improvement.
- **Quality improvement techniques.** Techniques as SPC, JIT, value-added analysis, QFD, ABC, benchrmaking, market share surveys which used to improve the quality of a product, service or process in an organization.

The writer has been expanded this survey including the cost models "New method to estimate the total quality cost" by J. J. DAHLGAARD and "ISO 10014" [11].

The abilities of the cost according to the strengths and weakness are imprinted in *Appendix 6* with the highest approach in the quality costing area problems resolution.

2.3. The role of Quality Cost in TQM

Management should give support to leadership so that to align the daily priorities and activities in the entire organization with the business goals, to improve the productivity and reduce overheads, by improving the current quality and customer service level. As we all know, the common denominator in business is money. Therefore, the easiest way to measure the contribution of the activities to goals is to express their value in money.

The quality cost is the money expression of all the activities related to quality. In addition, the meaning cost of quality strengthens the management in order to use quality as a business tool, which is the subject of economic analysis. In the environment of TQM the approach of quality cost is one of the keys to success.

So far many researches about failure of TQM have been published. Some of them are focused in first place on the view of the management that TQM is the panacea of all the problems and in the second place that the management loses quickly its original enthusiasm because it ascertains insufficient material gains as it expects the results of the investment immediately.

In addition, the costs from the application of TQM, although they are continuously cumulated, do not present accounting gains as it happens with the profits of the several projects [27].

However, some time, management understands the non-correct distribution of the resources and goes into action. Quality cost is an effective tool, which may express the matters of operations quality in the business language, namely in money.

Another questioning for TQM is created due to the erroneous idea that there cannot be cooperation between business oriented and people-oriented approaches.

The effective TQM programs are based on participation and cooperation of employees, customers and suppliers in an organization. The strong relationship of these categories together with the commitment of leadership to the philosophy of TQM constitutes the touchstone for the success of TQM. In addition, management should have under observation the development of resources and confirm the efficiency of investment yields. Further, the existence of a strong relationship between business plans and quality improvement plans is considered to be important for an organization, because it intensifies the focusing on the strategic direction and gives the possibility to the employees to adopt the added value approach and to work for the increase of customer satisfaction and shareholder value.

Management should support quality not as a «charity» but as a business investment expecting profits.

In addition, when quality is used as business tool, the support as well as the maintenance of the employees' enthusiasm for its improvement should be continuous. The employees should be encouraged not only to correct mistakes and predict problems but also to seek actively opportunities for improvement. This is the meaning of existence of TQM, i.e. each one to seek continuous improvement.

CHAPTER 3: METHODOLOGY

3.1. Quality Cost Model selection

As mentioned in the theoretical part, the most widespread and manageable cost model is BS 6143 with its two distinct expressions, PART 1 (Process Model) and Part 2 (Prevention, Appraisal, Failure Model).

An efficient quality cost program is designed to reduce the total cost of quality with the respective equalization of its components: the prevention, appraisal, internal and external quality cost. Examining the dissimilarities of categories, we may classify them in two categories.

The first one includes the costs in relation to prevention and appraisal and constitutes the corporation's investment in quality improvement, which consists in the management decisions.

The second one includes internal and external failure cost and consists of the expenses incurred due to errors and problems in the operations, products and services offered to the customers.

From the point of view that cost reduction through quality cost control is based on the investment planning for quality improvement projects, the consideration of management should be focused on investments and not on costs.

Focusing on cost of reduction is cost avoidance and curtails the additional gains arising from the result of improvements and is the increased operational efficiencies, higher customer satisfaction, greater capacity due to the reduction of waste associated with errors, etc.

However, management should focus its attention on value added approach on the level of the corporation's operations as opposed to cutting cost approach. Whereas a cutting cost program is most likely to create temporary profits, however, if it is not in harmony with customer satisfaction, in the future, during the product's lifetime, the market share may be reduced and even negative business gains may be caused. The value-added approach to quality cost and quality improvement maintains the focusing on the customers and confirms that final user determines quality.

The use of cost based approach for the selection of quality improvement projects that are suitable for the corporation from the value added approach point of view is the key to success.

The foregoing analysis is of help to a better approach to the procedure of selection of the total cost of quality measurement model in the company under investigation.

After the parameters' evaluation on company's level, there were ascertained as follows:

- A total quality cost system has never been applied to the company in the past.
- The company uses the traditional accounting system and not the Activity Based Costing. This results to the non-application to the company of the management of process. Therefore, no data are recorded for each procedure related to input, outputs, controls and resources.
- Whilst the requirement of Process model is the calculation of cost of conformance and the cost of non conformance, traditional accounting system does not give the possibility of calculation of cost data related to procedures, which may be determined and recorded in categories, such as: people, equipment, materials and environment.
- The cost data, according to the author, of each category of PAF model, notionally, are considered more accessible, understandable and acceptable by personnel. There are, obviously, the objective difficulties of their detection, especially for those which are not clearly codified by the accounting system, but upon the completion of the pilot application of quality cost measurement and by means of comparisons of the partial categories (Prevention, Appraisal & Failure) the low quality areas may be detected more clearly, the real causes be localized, the improvement techniques be planned so that not only the results are more obvious but also constitute the corner stone of establishment and application of a quality cost system to the company.
- PAF model is deemed more useful to industries, in opposition to Process Model, which is more flexible at services.

For the above-mentioned reasons, mainly, and despite the difficulties in comparison with Part 1, the application of BS 6143 Part 2 Model PAF (Prevention, Appraisal & Failure) was selected as the total quality cost measurement model for the company under investigation.

3.2. Company's meanings presentation of Quality Cost

The first step consisted in making the most possible detailed presentation of Quality Cost to the management but also to the other executives of the factory, so that philosophy, purpose, meanings, utility and width of application, effectiveness, efficiency, potential relationship with improvement of products and service quality may become understandable, the most significant questions may be solved and what's more, the target, which is the adoption and application of Quality Cost measurement may be achieved.

To this end, an informative leaflet (*Appendix 7*) was prepared with the following unities:

- Definition of Quality Cost
- Categories of Quality Cost - Brief analysis of categories
- Importance of Quality Cost - Schematic analysis
- Purpose of quality cost measurement

In consultation of the author with the factory's Management, a meeting was appointed for the presentation of quality cost to the factory's personnel.

The results of the presentation may be described as follows:

The factory, as already mentioned, has been accredited with ISO 9002 and, therefore, personnel appeared to understand rather easily the meanings related to quality and by extension of Quality Cost.

There was a questioning rather as concerns the practical part, such as, e.g. the strategic planning of application to the current statistical estimation of the level of Quality Cost in relation to important economic magnitudes of the company, the adjustment of accounting techniques to the new data and the localization of the cost sources.

3.3. Pilot program implementation

3.3.1. Object

For the needs of research the procedure of pilot application of Quality Cost measurement was chosen, because:

- ➢ It shall prove the ability of the system to produce cost reduction results
- ➢ It shall restrict the original range of application
- ➢ It shall allow the system to localize errors before the final application.

3.3.2. Methodology of application of pilot program

3.3.2.1. The method

One of the most important matters which is not adequately dealt with so far by bibliography is the way of selection of the field of application of the pilot program.

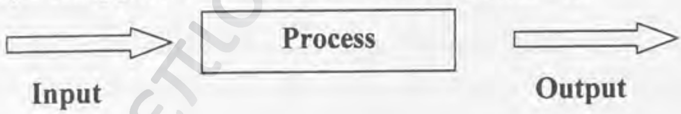
The selection procedure is mainly carried out without the use of certain techniques having the capability to determine to a satisfactory degree of approach that field of the company which could present significant benefits from the reduction of quality cost, so that the establishment of the total quality cost measurement system shall be considered necessary.

An intermediate target of the author was to find a way of the field's approach to the spectrum of the factory under investigation.

The idea of formation of the application field determination technique was based on the published research of dott. Ing. Roberto De Falco, prof. Ing. Ello Masturzi & dott. Ing. Vittorio Cesarotti under the title Modello Activity Based Value Added Breakdown nelle aziende ad alta technologia [26].

The authors develop a model by which the improvement of ABCosting method to ABManagement method is attempted.

They consider ABM within the frameworks of enterprise to operate as a system acquiring productive Raw Materials and by the necessary work, processing them and finally creating products according to the following procedure:



The introduction of an intermediate phase between the transformation of inputs to products leads to a reconsideration of the whole production procedure and more especially to a reapproach of calculation of accounting cost in opposition to the traditional form, which simply absorbs productive materials and transforms them to products.

In principle, the factors having a strategic importance for the enterprise are analyzed and grouped in four categories, as follows:

- Technical factors: R&D, automation and flexibility of systems, total quality
- Administrative factors: organization flexibility, J.I.T., automated information system

- Commercial factors: cycles of product's life, marketing, products standardization
- Economic factors: product's dynamics, equipment installation dynamics

The authors focus the analysis of the model proposed on two levels from the commercial and the technical point of view by making a matrix.

Commercial analysis, which substantially reflects the viewpoint of the customers, is analyzed into 5 elements:

- Efficiency : the product's characteristics without which the customer would not buy the product
- Quality : characteristics giving a different presence to the product in the purchaser's eyes
- Time of delivery : the time required according to the purchaser for the product's delivery
- Time to market : the interim time lapsing from the product's design up to the necessity of market for such product
- Services: the whole activities following the product before and after sale.

After a market research, the gravity coefficient for each of the above mentioned elements is determined, as well as a range of marking from 1 to 10 so that the aforementioned strategic factors may be classified, according to the greater value they present for the price added from the consumers' point of view for the enterprise under investigation.

In the technical analysis, the activities giving value to the product are determined. Each element is made of a fundamental factor, which measures the strength of the simple constituent of value added for each product. In that way a price is made up as the ratio of strategic factors/activities, which represents the original point for the value, added of simple elements of production.

In this way, an analysis is described which replaces the simple method of value added (ABCosting) with the activities giving significance to the meaning of the product's value added.

The author, based on the development of the above-mentioned model, formed an ancillary tool of determination of the field of application of the pilot program to the factory.

3.3.2.2. Development of factory's process plan

After the selection of the Quality Cost measurement model (BS 6143 PAF model), the preparation of its pilot application to the factory started.

So, in cooperation with the management of the factory, the basic flow chart was developed, which reflects the total production process from the production of raw material, up to the process of production, packing and disposal of the products i.e. sugar, molasses and pulp (*Appendix 8*).

Then, the core process was mapped per sector in the whole factory (*Appendix 9*).

After the completion of the procedure of updating of the factory's executives about the meanings of Quality Cost, the author proceeded to the formation of a model in order to determine with a certain degree of significance the sector of the productive procedure which could, if investigated, give the most positive results for the needs, firstly, of the research and by extension, of the company.

For the development of the model proposed, the below steps were followed:

3.3.2.3. Structure of Quality Cost Questionnaire

3.3.2.3.1. Purpose

The purpose of the questionnaire is the following:

- To select the stage of productive procedure in which the higher cost of failure is estimated to exist
- To select such stage as a pilot application of calculation of quality cost (prevention, appraisal of internal and external failures).
- To constitute a tool for the establishment of a system of continuous measurement and observation of the total quality cost in the whole range of the factory.

3.3.2.3.2. Basic component's selection of quality cost

By this procedure, the most basic components were selected, which, according to their intensity, have the greatest gravity in the creation of the total Quality Cost.

1) Costs from rework of defective products
2) Costs from production of faulty products
3) Costs from corrective actions during operation
4) Costs from insufficient design of the product
5) Costs from faulty analyses by chemical laboratories
6) Costs from evaluation, repair or replacement of products.

3.3.2.3.3. Structure of questionnaire

The structure of questionnaire was based on three basic particulars:

- on the flow chart of the enterprise showing all the **basic stages** of the sugar production procedure.
- **on the six (6) main categories of quality cost failures,** as mentioned above.
- For each of the above categories an **intensity mark** is determined ranging from 1 to 10 with the purpose of estimating the existence and the intensity of each category in the creation of failure cost at every stage of the production procedure.
- Further, for each category a by estimate **gravity coefficient** is appointed **from 0 to 100** for the contribution of each cost component to the failure cost with the following (Table 3.1) proportion :

Categories	gravity coefficient
Rework	**24**
Defective products	**12**
Corrective actions	**16**
Product's design	**33**
Faulty chemical analyses	**7**
Replacement of products by customers	**8**

Table 3.1: Gravity coefficient in quality cost failures.

The scale was formed after brainstorming with the company's executives.

On this basis six (6) questions were formed, one for each component of quality cost in connection with the stages of sugar production procedure and in the following form:

Question (e.g.)

"At which stage of production procedure and to which degree of significance do you consider that there is a cost (work, materials, general expenses) from the ***rework and repair*** *of defective products arising through operational procedure?"*

The questionnaire was distributed to the heads of the factory's sectors. The marking was made after consultations carried out per Department and according to the degree of significance 1-10 as set out above. The questionnaire is shown in *Appendix 10*.

3.6.3. Collection - analysis - evaluation of results

Within a period of 10 days, the questionnaires from 5 departments were collected, which were finally answered: the Agricultural Department, the Production Department, the Administration - Finance Department, the Electromechanical Department and the Chemical Laboratories Department.

The Pareto diagram (Figure 3.1) which was made from the integrated results (*Appendix 11*) shows the marking of the stages of sugar production procedure in connection with the Quality Cost components which have been selected.

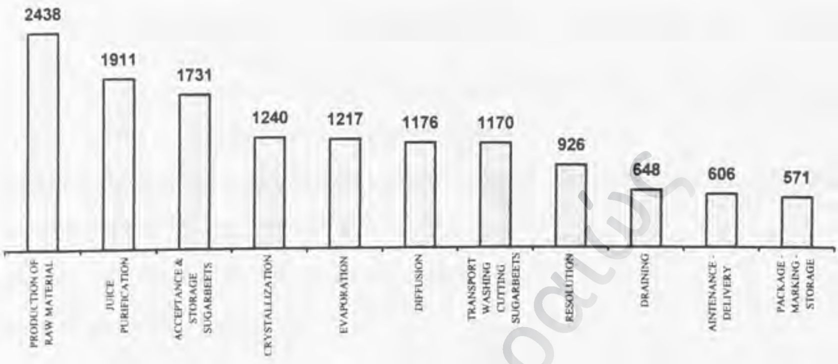


Figure 3.1: Pareto diagram

From the analysis of the result table and the Pareto Diagram, the following conclusions were drawn:

1. At the stage of the productive procedure of production of Raw Material (sugarbeets) the greatest intensity of creation of failure cost was noticed.
2. Failure cost is created in lower but equally important intensity at the stages of juice purification processing and storage of sugarbeets in silos.
3. As regards the partial categories constituting failure cost, the following were noticed :
   * The insufficient planning of a) production of sugarbeets resulting in the production of products with lower than the expected content in sugar and b) the intermediate and end products in the production line of the factory affects to a high degree the creation of failure cost.
   * Significant failure costs are created from corrective actions and rework.
   * The category of defective products which usually affects to a high degree statistically the creation of quality cost in the particular research due to the peculiarity of the sugar production procedure (absorption and process of the entirety of the Raw Material produced as well as non production of scrap) is the third, in order of contribution, factor of creation of failure cost.
   * Faulty analyses and replacement of products to the customer contribute to a much smaller degree to the creation of quality cost at the stages of production procedure.

The above conclusions led the author to choose as a field of application of the quality cost measurement the procedure of production of Raw Material and its storage in the factory's silos before the entry into the production line for process.

3.3.4. Recording - Documentation - Mapping of crucial procedures

After the selection of the stage for the application of the pilot program, the next step was the mapping of the crucial procedures.

To this end, the author, in cooperation with the company's management, recorded and documented the following procedures:

- Production of Raw Material (Sugarbeets) - Storage
- Raw Material Quality Control
- Control of inspections, measurements and chemical laboratory tests equipment
- Control of measurement and tests instruments
- Electromechanical support in the production procedure
- Control of automation devices and systems - technical control of devices

The documentation of the above-mentioned crucial procedures was made according to the purpose, the application field and the competencies (*Appendix 12*).

Then, the flowchart of core steps of the crucial procedure of sugarbeets Production and Storage was developed (*Appendix 13*).

Further, for the existence of a more effective approach to the stage under research the process map was developed (*Appendix 14*).

The process map reflects the flow of procedure of sugarbeets production and storage on the level of operations and the persons responsible for each action.

CHAPTER 4: QUALITY COST MEASUREMENT

4.1. Settlement of a researcher at the factory

After the completion of the first stage of the research, the author settled at the company's headquarters in order for the procedure of Quality Cost measurement to start at the department of production procedure which has been selected.
Measurement was scheduled to cover the accounting period of one year.

4.2. Finding and recording of cost sources

The company uses the traditional costing method and has not applied in the past any quality cost measurement system. As a result of that, the author faced significant difficulties in the localization of cost categories related to quality.
In the first phase, the cost sources were classified in three categories:

* Normal accounting data (i.e. labor and overhead cost reports) from accounts ledgers,
* Company operating systems, procedures, standards and specifications, and
* Data specifically calculated or estimated for the quality costing exercise.

The relevant documents, which were used, were the following:

a) Payroll analysis
b) Manufacturing expense reports
c) Scrap reports
d) Rework reports
e) Production cost information
f) Sales report

One of the most crucial stages in the calculation of the cost of quality was the localization and recording of cost components (labor and overhead cost) of the staff of the several sectors of the factory involved in the procedures relevant to the requirements of BS 6143 Part 2. These costs, for the above-mentioned reasons, are not obvious and classified. The crucial factor of these procedures is the calculation of the time of employment.

For this reason the below special form (Table 4.1) was made with whose assistance the time of employment of the staff involved was calculated per sector and per activity in the accounting period of one year under investigation.

Employment time estimation															
Sector:															
Activity	**Staff**	**Months**													**Time**
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**		

Table 4.1: Employment time estimation

The calculation of the time of employment was made by estimate and in cooperation of the author with the Heads of the Sectors.

4.3 Creation of tables recording Quality Cost components

After successive brainstorming with the company's executives for the understanding of the partial categories and subcategories of the quality cost according to BS 6143 Part 2 (PAF model), the procedure of making tables per category (Prevention, Appraisal & Failure) of quality cost was selected as Table 4.2.

COST CATEGORY
(e.g. Prevention Cost)

MAIN SUBCATEGORY OF QUALITY COST (e.g. Product design development)					
CODE COST	**ACTIVITIES**	**RESPONSIBLE SECTOR**	**NUMBER OF EMPLOYEES**	**TIME OF EMPLOYMENT**	**HOURLY PAY**
e.g. (design quality progress reviews)					

Table 4.2: Quality cost measurement form

The above table has been made in such a way that:

- ➢ The category «prevention or appraisal or failure cost of quality» is defined as caption.
- ➢ At the place **main subcategory of quality cost,** there appears the general activity per category of cost, which besides, is the main requirement of the model, e.g. Product Design Development.
- ➢ In the column **Cost Code** there are entered in details all the activities constituting the main subcategory of the cost, e.g. for the Product Design Development, activities such as :

***design quality progress reviews**

***design support activities**

***product design qualification test**

***service design - qualification**

***field trials**

- In the column **activities,** there appear the respective activities on company's level, meeting the model's requirements.
- In the column **responsible sector**, the responsibilities are entered. Namely which sectors of the company have the responsibility of the activities and who is responsible for each sector.
- In the column **number of employees** there are listed in details all the employees involved in the procedure per post and specialty.
- In the column **time of employment,** the time for which each employee is engaged in the procedure under investigation for the determination of the quality cost is approximately estimated.
- And finally in the column **hourly pay** the hourly remuneration paid to each employee involved in the respective procedure is entered.

At this point it is worthwhile mentioning that in the case in which we investigate costs related to materials (scrap, downgraded materials etc.) as we shall see below in the measurement procedure the tables are differentiated in such a way as to enable the calculation of the respective categories of the quality cost.

Next step was the adjustment of the model's requirements to the activities, which are related to the stage of procedure of production of Raw Material. The strategy applied was the following:

In the first place, prevention cost was investigated. All the categories and subcategories as mentioned as requirement of PAF model were developed and studied. Then, it was investigated on company's level, which respective activities, with the most possible approximation, are realized.

For each activity, the competent Department, the Sectors, the responsible Manager, the Heads and the employees were determined.

The very same procedure was followed for the other two categories of quality cost, i.e. appraisal and failure cost.

4.4. Quality Cost Measurement Procedure

4.4.1. Prevention Cost measurement

The procedure of Quality Cost Measurement started from the analysis, recording and calculation of Prevention Cost.

According to the above analysis, for the development of the tables, the measurement of Prevention Cost was performed per subcategory.

4.4.1.1. Product Design Development

The required actions, design quality progress reviews, design support activities, product design qualification test, service design, qualification and field trials, as determined by BS 6143 PAF Model in the procedure under study of the production of Raw Material, are carried out by a small experimental laboratory with limited possibilities which comes under Agricultural Department. The Manager of the Agricultural Department and 4 Agriculturists are employed.

The quality cost for the respective actions is calculated on the basis of the, by estimate, time of employment in the fiscal year under investigation in connection with the labor cost, as follows:

No. of employees	Time of Employment	Hourly Pay
Manager of Agricultural Department 1	Mar-Aug 160h	3175*160= 508000
	Sept 32h	**4175*32= 132384**
Agronomists 4	Mar-Aug 4*64 h= 256h	3175*256= 808192
	Sept 4*16h= 64h	**4137*64= 264768**
TOTAL		**1.713.344**

At this point it should be pointed out that the differentiation in the labor cost is due to the different levels of salaries during the period of the factory's maintenance and the period of the «campaign».

4.4.1.2. Marketing/Customer/User

Procedures relevant to Marketing Research, Customer Perception Surveys and Contract/Document Review are not involved in the procedure of Raw Material's production.

4.4.1.3. Operations Prevention Costs

4.4.1.3.1. operations process validation/operations quality planning

The works are executed by the Agricultural Department for the period Jan - Aug and the Chemical Laboratory Department 10 days before the start of the campaign.

4.4.1.3.2. data analysis and preventive actions

These actions take place from the beginning of the next process stage by the Agricultural Department.

4.4.1.3.3. calibration and maintenance of quality measurement and test equipment

The Chemical Laboratories Department is entrusted with the responsibility of all the required actions. All the actions are performed during the campaign. In the activity in question, the Manager of the Chemical Laboratories Department, the Assistant Manager (2 shifts), and 3 Analysts of the Sugarbeets Chemical Laboratory (2 shifts) are employed. The existing cost is labor intension cost, as the cost of consumable materials is not remarkable.

4.4.1.3.4. calibration and maintenance of production equipment used to evaluate quality

In the case in question the cost of activities at the factory's storage facilities is measured. The responsibility of these activities is assigned to Electromechanical Department and the 3 sectors constituting it (Automations Sector, Mechanics Sector, Electrology Sector). The staff employed consists of the Manager and the Deputy Manager of the Electromechanical Department as well as 3 foremen in each sector, one for each shift. This happens due to the fact that the above mentioned activities take place during the campaign and the factory is operating in 3 shifts.

4.4.1.3.5. design and development of quality measurement and test equipment

The Chemical Laboratories Department carries out the work 2 days before the start of the campaign.

4.4.1.3.6. operations support quality planning

The responsibility of planning of the quality control procedures supporting the production of Raw Material is assigned to the Phytopathology Sector and the Nourishment Observation Laboratory. The Manager of the Agricultural Department and one Agriculturist are employed.

4.4.1.4. Quality administration

The Quality Assurance Sector is responsible for the above operation and the competence has been assigned to the Manager of the Chemical Laboratories Department.

4.4.1.5. Purchasing Prevention Costs

Actions related to supplier review, supplier rating, purchase order tech data reviews and supplier quality planning are not performed by the company.
This is so, because the basic supplies for the production of Raw Material are seeds and pesticides. The Central Department of the Hellenic Sugar Industry carries out all the works. There are not procedures for the inspection and tests of the materials purchased at the facilities of the factory of the Hellenic Sugar Industry, or at the facilities of the suppliers.
Note: the records and analytical results of prevention cost categories are shown in *Appendix 15*.

4.4.2. Appraisal Cost Measurement

4.4.2.1. Operations Appraisal Costs

4.4.2.1.1. set up inspections and tests

The responsibility of the inspections has been assigned to the Agricultural Department and is carried out by the Manager, the 4 Agriculturists/Heads of the Sectors and 6 Assistant Agriculturists.

4.4.2.1.2. planned operations, inspections, tests, audits

In the case in question two kinds of inspections are performed.

1) inspections from January to November by the staff of the Agricultural Department related to the progress of development of the Raw Material, but also the end-product (sugarbeets). During the factory's operation, 2 seasonal agriculturists were employed.
2) inspections by the Chemical Laboratories Department: a) for the determination of the quality of the sugarbeets during cultivation and b) for the determination of the sugar's title (POL) at the entry of the Raw Material to the factory. Works are performed during the campaign by the Manager of the Chemical Laboratories Department, the Assistants and the 3 Analysts and 4 workers-technicians of the Sugarbeets Chemical Laboratory (2 shifts).

4.4.2.1.3. process control measurement

All the planned measurements of the production line equipment for the confirmation of compliance with the pre-established standards.

Work is performed by the Manager and the Deputy Manager of the Electromechanical Department as well as by 3 foremen for each sector of the Electromechanical Department (Automations, Mechanics, Electrology Dept.) in 3 daily shifts during the campaign.

4.4.2.1.4. laboratory support

It is about labor cost incurring from tests performed by the Phytopathology Sector and the Nourishment Observation Sector for the plant growth progress. The responsibility of the procedure has been assigned to the Agricultural Department and the Manager of the Agricultural Department and one agriculturist are employed.

4.4.2.1.5. inspection and test material

The costs of consumable materials during the inspection of intermediate and end products at the sugarbeets chemical laboratory are considered negligible by the factory's management.

4.4.2.1.6. outside endorsements and certifications

The Central Department of the Hellenic Sugar Industry realizes outside endorsements and certifications, so that they are not taken into consideration in the research.

4.4.2.1.7. evaluation of field stock and spare parts

No controls of the stock of sugarbeets are carried out till their entry to the factory for process. The losses are calculated from the difference of sugarbeets POL and sugarbeets processing POL.

4.4.2.2. Purchasing Appraisal Costs

4.4.2.2.1. receiving or incoming inspections and tests

In the case in question, only quantitative and not qualitative inspection is carried out at receiving and delivery of seeds and pesticides to the farmers.

4.4.2.2.2. measurement equipment

There is no supplies evaluation equipment.

4.4.2.2.3. qualification of supplier product

Inspections and tests for the certification of the use of the quantities gradually produced from the goods supplied.

The Manager of the Agricultural Department in order for the yield of seeds in production to be ascertained performs equivalence experiments.

4.4.2.2.4. source inspection and control programs

For the specific requirement, no controls of the seeds and pesticides are carried out at the suppliers' facilities and at outside laboratories on responsibility of the factory of the Hellenic Sugar Industry. Such controls are responsibility of the Central Departments.

Note: the records and analytical results are shown in *Appendix 16*.

4.4.3. Internal Failure Cost Measurement

4.4.3.1. Product Design failure Costs

As already mentioned, the product design is realized by a small experimental laboratory and under the supervision of the Manager of the Agricultural Department. Therefore, the costs resulting from the design of the corrective actions, the rework and the scrap are considered to be negligible.

4.4.3.2. Operations Failure Costs

4.4.3.2.1. operations corrective action

Corrective actions by the Agricultural Department during the period Feb - Nov at all the stages of the procedure.

4.4.3.2.2. rework

Rework is carried out at its greatest part during the seeding and more especially when reseeding of the farms is required due to several problems, under the supervision and the control of the Agricultural Department.

4.4.3.2.3. reinspection / retest costs

The reinspections, retests and trials performed by the agriculturists in order to ascertain the acceptability of the product after rework or corrective actions.

4.4.3.2.4. operations scrap costs

At the stage of Raw Material production procedure, the completely spoiled products (waste sugarbeets) are in very small quantities and cause a negligible cost. The main problem is the downgraded product in relation to the goals of the Greek Sugar Industry.

4.4.3.2.5. downgraded end-product

It is the difference resulting between the sale value of the end-products produced during the current «campaign» and the value, which would result, if quantities of end-products had been produced from the transformation of Raw Material in accordance with the qualitative goals. For the purposes of this research, downgraded product means the quantities of Raw Material (subarbeets) produced up to the stage of start of process at the factory. As regards the failures caused during the transformation of the Raw Material into end product, they shall constitute the motive for the extension of the research.

For the calculation of the failure cost, the deviation from the goals set by the company during the fiscal year 1997-98 should be estimated.

The author, as shown in the below Table 4.3 «Goals - Results 1997-1998» attempts another approach too, mentioning also the means of the factory's productive activity from the year 1965 to the year 1997, in order for the best possible picture of the company's progress to be achieved.

DATA	MEAN 1965-1996	GOALS 1998	RESULTS 1998
Arable lands (in square meters)	**91.144**	**90.800**	**91.347**
Yield per 1.000 sq. m. – tons/1.000 sq. m.	**5,827**	**6**	**5,502**
Sugarbeets produced (tons)	**535.913**	**545.000**	**502.631**
Sugarbeets POL (%)	***14,79%***	***14,50%***	***13,87%***
Sugar imported (tons)	**79.262**	**79.025**	**68.657,6**
Yield in Sugar (%)	**61.947** ***11,26%***	**59.458,4** ***10,91%***	**51.396,6** ***10,22%***
Losses up to entry to the production line (%)			**1.057,3** ***0,21%***
Molasses (%)	**12.647** ***2,36%***	**14.170** ***2,6%***	**12.503** ***2,49%***
Technical Difference (%)	***3,3%***	***3,59%***	***3,65%***

Table 4.3: Goals - Results 1997-98

In the above table the following are set out:

1. During the period of the fiscal year 1997-98 91.347.000 square meters of sugarbeets were cultivated.
2. The yield per 1.000 sq. m. was 5.502 tons.
3. Sugarbeets produced were amounted to 502.631 tons.
4. POL, for the specific campaign, of sugarbeets entered to the factory for process was 13.87%.

5. The quantity of sugar according to POL entered to the factory for process amounted to 68.657,6 tons.
6. The quantity of sugar produced amounted to 51.396,6 tons or the 10,225% of the quantity of the sugarbeets produced.
7. The loss in sugar from the storage of the sugarbeets in the factory's silos till their entry for process was measured to 0,21% and to 1.057,3 tons.
8. Total technical difference amounted to 3,65% and is distributed as follows :

a) 2,4875% in molasses
b) 0,21% losses in sugar during the period of storage in silos
c) 0,96% in other losses during the process of sugarbeets at the factory.

From the above it ensues that the percentage of Sugarbeets POL in the specific campaign is analyzed as follows:

- 10,22% in pure sugar produced
- 1,52% in storage losses
- 2,48% in production of molasses
- 0,96% in other losses during process

From the analysis of the Table 4.3, the following conclusions are gathered:

1. An area larger by 547.000 square meters was cultivated in the fiscal year under investigation.
2. Yield was less by 0,498 tons of sugarbeets per 1.000 sq. m. than that of the goal and as a result 42.369 less tons of sugarbeets were produced.
3. Sugarbeets POL of crop had a deviation of 0,63 percentage units from the goal of 14,5%, namely was decreased by 4,344% with the result that the sugar imported was decreased by 10.367.4 tons.
4. Whereas in our analysis, only the quality cost in the field of production of Raw Material is measured and for the purposes of the research, the author made the following acceptance :

   That the losses (technical difference) occurring during the process of the Raw Material till the production and sale of the end-product and the by-products (namely from the entry of the sugarbeets to the factory for cutting off till the formation of the end-product) shall be considered to be granted and not as a deviation from the goal. These failures shall constitute a subject of research when the Quality Cost measurement system applies to the whole operation.

5. As a result of the above and taking the losses during process for granted, the sugar produced was 8.061,8 tons less than the goal, taking into account that the losses in sugar during the storage of sugarbeets in silos are due to clearly qualitative reasons and should not exist.
6. 1.667 tons of molasses less than the goal were produced.
7. Finally, technical difference was greater than that of the goal by 0,07 percentage units.
8. It is also noticeable, as shown in the above Table, that the company determined as its master goal for the POL the percentage of 14,5%, which is smaller than the Mean of the last fifteen-year-period.

   For the calculation of failure, reflecting the differentiation from the goal in the below Table 4.4, the current prices of the Raw Material and the end-products are set out during the period of the research.

PRODUCTS		Measurement Unit	Market Price	Sale Price
Sugarbeets	POL 14.50	Ton	15.866,5 Dr	
	POL 13,87	Ton	14.617,5 Dr	
Sugar		Kgr		245 Dr
Molasses		Kgr		28 Dr

Table 4.4: Product prices

Below the Tables (Goals-Results) are set out showing the productive activity failure cost measurement, as deviation from the goal determined by the company for the period 1997-98.

PRODUCTS	QUANTITY	PRICE	PURCHASES	SALES
Sugarbeets produced	545.000	15.866,5	8.647.242.500	
Sugar produced	59.458.400	245		14.567.308.000
Molasses produced	14.170.000	28		396.760.000
RESULTS			8.647.242.500	14.964.068.000
FISCAL YEAR				**6.316.825.500**

Table 4.5: Goals 1998

PRODUCTS	QUANTITY	PRICE	PURCHASES	SALES
Sugarbeets produced	502.631	14.617.5	7.347.208.643	
Sugar produced	51.396.600	245		12.592.167.000
Molasses produced	12.503.000	28		350.084.000
RESULTS			7.347.208.643	12.942.251.000
FISCAL YEAR				**5.595.042.358**

Table 4.6: Results 1998

Product failure cost is in the case in question the difference of the results of the fiscal year 1998 from the results expected by the company.

Product Failure Cost

	Goals	**1998**	**6.316.825.500 drachmas**
Minus	**Results**	**1998**	**5.595.042.358 drachmas**
	TOTAL		**721.783.142 drachmas**

4.4.3.2.6. downtime

Failure cost existing due to the stoppage of the factory's operation (downtime) during campaign, which is due to qualitative reasons and more especially to the planning of mainly the procedure of the sugarbeets harvesting.

1. During downtime, the works of the seasonal staff are suspended and therefore there is no labor cost. On the other hand the expenses of the permanent staff are inelastic.
2. Main works carried out are the following: a) maintenance (operation) of limekiln and b) operation of certain machines of sugar industry. In these procedures, the Electromechanical and the Production Departments are involved with 6 employees in three shifts daily as follows :

29 days x 24h x 6 = 417h x 4176 = 19.986.336 drachmas

In addition, the values of the consumable materials used for the maintenance of the above mentioned sectors for the period of stoppage of the factory's operation (downtime) should be calculated.

CONSUMABLE MATERIALS	MATERIAL UNITS	UNIT VALUE	TOTAL VALUE
Public Electricity Corporation	Downtime 29days		10.000.000 dr
Limestone	5240 ton	1300 dr/ton	6.812.000 dr
Coal (coke)	422 ton	38000 dr/ton	16.036.000 dr
TOTAL			**32.848.000**

4.4.3.3. Purchasing Failure Costs

4.4.3.3.1. purchased material reject disposition costs

The cost from classification of the materials supplied, which have been characterized through control as unfit (documentation of inspections and appraisal, disposition, storage and transport).

In the case in question, no control is carried out and for this reason no cost is created according to the respective code.

4.4.3.3.2. purchased material replacement disposition costs

The replacement cost added of all the materials, which were rejected and returned to the supplier. During the fiscal year in which the research was realized, there were no unfit quantities of purchased seeds and pesticides.

4.4.3.3.3. supplier corrective action

It is the cost resulting from analyses and research of the company for the finding of the reasons of provision of unfit materials by the supplier so that the necessary action may be determined. It includes visits to the supplier's facilities. This activity is not realized.

4.4.3.3.4. rework of supplier rejects

The total cost of necessary repairs in the purchased units of material chargeable to the company. This activity is not realized.

4.4.3.3.5. uncontrolled material losses

The costs of materials or defective products which are due to destruction, theft or other unknown reasons. Such costs are caused at other stages of the sugar production procedure.

Note: the records and analytical results of internal failure cost categories are shown in *Appendix 17.*

4.4.4. External Failure Cost Measurement

The External Failure Cost is not incurred in raw material production stage of production process. These costs occur after delivery or shipment of the total product, and during of after furnishing of a service, to the customer.

In conclusion, consummating the Quality Cost measurement procedure, Table 4.7 and Figures 4.1, 4.2, 4.3, are set out below reflecting the Total Quality Cost at the stage of Raw Material Production procedure under investigation.

Table 4.7: Total Quality Cost report

	PREVENTION COSTS	
1	**Product Design Development**	1.713.334
2	**Marketing/Customer/User**	--------
3	**Operations Prevention Costs**	
	I. Operations process validation / operations quality planning	6.980.058
	II. Data analysis and preventive actions	7.413.632
	III. Calibration and maintenance of quality measurement and test equipment	2.508.421
	IV. Calibration and maintenance of production equipment used to evaluate quality	336.934
	V. Design and development of quality measurement and test equipment	90.864
	VI. Operations support quality planning	406.400
4	**Quality planning**	50.800
5	**Purchasing Prevention Costs**	--------
TOTAL PREVENTION COSTS		**19.500.443**
	APPRAISAL COSTS	
1	**Operations Appraisal Costs**	
	I. set up inspections and tests	2.404.512
	II. planned operations, inspections, tests, audits	60.741.330
	III. process control measurement	3.032.408
	IV. laboratory support	2.514.600
	V. inspection and test material	----
	VI. outside endorsements and certifications	----
	VII. evaluation of field stock and spare parts	----
2	**Purchasing Appraisal Costs**	
	I. receiving or incoming inspections and tests	2.074.400
	II. measurement equipment	----
	III. qualification of supplier product	673.480
	IV. source inspection and control programs	----
TOTAL APPRAISAL COSTS		**71.440.730**
	FAILURE COSTS (Internal)	
1	**Product Design failure Costs**	-----
2	**Operations Failure Costs**	
	I. operations corrective action	8.897.568
	II. rework	2.362.200
	III. reinspection / retest costs	7.270.068
	IV. operations scrap costs	-----
	V. Downgraded end-product	721.783.142
	VI. Downtime	52.834.336
TOTAL FAILURE COSTS		**793.147.314**
	TOTAL QUALITY COST	**884.088.487**

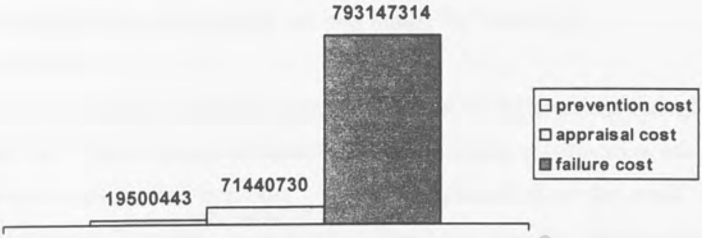


Figure 4.1: Quality Cost Categories

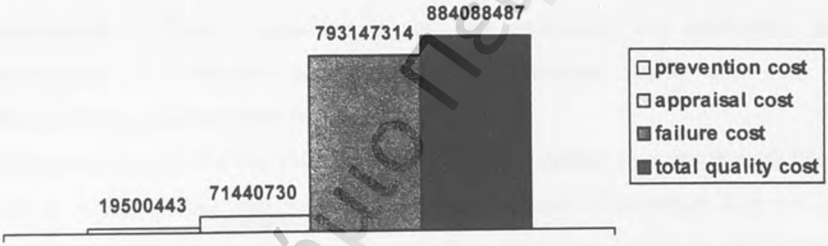


Figure 4.2: Total Quality Cost

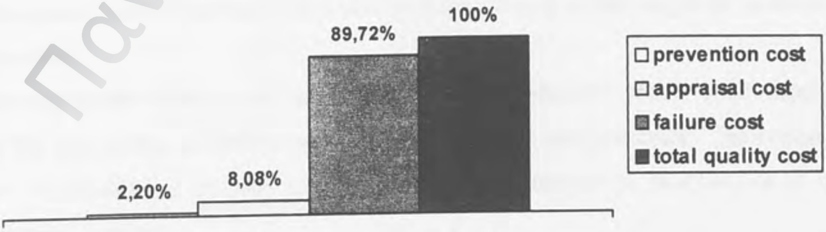


Figure 4.3: Total Quality Cost

4.4.6. Processing – Analysis of Quality Cost

After the completion of the quality cost measurement procedure and from the processing-analysis of the data resulted, we may notice the following:

Prevention Cost

Prevention cost is disproportionately small in relation to failure cost but also to appraisal cost too. This happens because the company under investigation does not lay the required weight on prevention. This is ascertained from the small costs existing in the product's design, the qualitative design but also the quality policy as well. As already mentioned, the procedure of development of the product's design, which constitutes one of the most important prevention procedures and concerns the planning of the Raw Material production (sugarbeets), according to the required procedures, is executed by a small experimental laboratory with limited possibilities.

An important part of prevention cost consists in actions related to calibration and maintenance of quality measurement and test equipment and calibration and maintenance of production equipment used to evaluate quality and may be characterized as appraisal cost too.

It is also noticed that the cost relevant to the operations quality planning is particularly small in relation to the total cost. This happens because the company does not lay significant weight on the planning of productive procedures so that it may succeed production of products adjusted to the goals it has determined.

The cost concerning quality policy may be characterized as insignificant and reflects the emphasis put by the company on quality matters.

Appraisal Cost

As concerns appraisal cost, we may notice as follows:

The greatest cost is caused from controls taking place at all the stages of production procedure.

The cost created from the evaluation of supplies is particularly small. Main supplies for the companies, as already mentioned, are the seeds and pesticides. The company has not established supplies control mechanisms, either at its facilities, or at the suppliers' facilities.

Failure Cost

A remarkable notice in the categories constituting failure cost is the insignificant cost presenting operations scrap.

This happens because, apart from the business activity exercised by the company, it exercises in parallel a social character activity, so that to take delivery of all the production of sugarbeets irrespective of their percentage in sugar (POL) having formed the analogous billed policy. The percentage of scraps created in the procedure of production of intermediate but also end products is considered minimal and without any importance.

4.5. Reducing of Quality Costs

4.5.1. Analysis

4.5.1.1. Finding the problem areas

The technique used in the case in question is Pareto analysis.

The Pareto analysis technique involves listing the factors that contribute to the problem and ranking them according to the magnitude of the contributions.

In the below Figure 4.4 we may see Pareto analysis and failure cost.

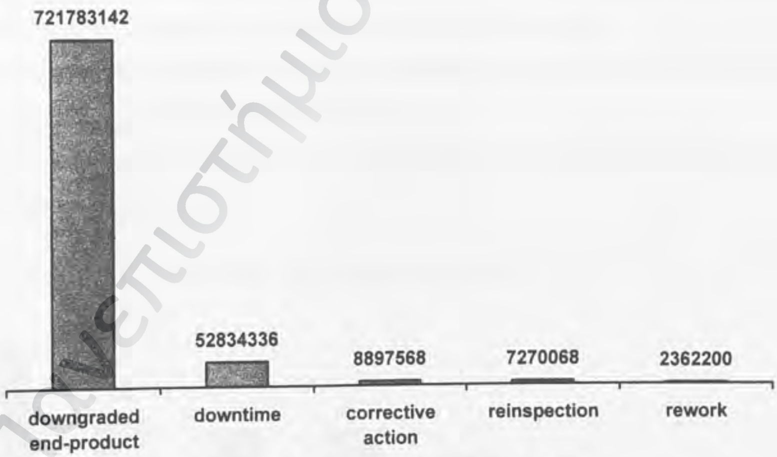


Figure 4.4: Pareto diagram for Failure cost

From the above diagram, we may notice that the category of downgraded end product possesses the most significant percentage in failure cost. This is explained as already mentioned from the differentiation of the value from the sales if the goal of sugarbeets production with POL 14,50% had been achieved.

The cost which is due to the stoppage of the factory's operation (downtime) contributes to failure cost with a smaller percentage, because of the harvesting planning creating a problem in the transport and storage of sugarbeets at the factory.

High concentration in the category of downgraded end-product gives us the possibility to determine as main cause of creation of such a high failure cost the production of sugarbeets with a low POL. This cause shall be hereinafter analyzed by the use of a cause and effect diagram so that the improvement proposals may be formed.

After determining the low content in sugar (POL) as the main reason of production of downgraded Raw Material, a consultation with the company's executives was planned in order for the areas presenting the greatest problem to be localized.

The procedure of brainstorming and the technicque of cause and effect diagram were chosen. The results of the research are presented in the Cause and Effect diagram in *Appendix 18*.

The cause and effect diagram was made as follows:

The basic areas and their percentage contribution to the formation of the basic production problem, namely downgraded product, were localized.

In the same manner, the partial areas and their percentage contribution to the creation of the problem in the basic areas were localized.

The proper tool for presenting the areas where the greatest problems are noticed is Pareto diagram (Figure 4.5).

4.5.1.2. Cause and Effect diagram analysis

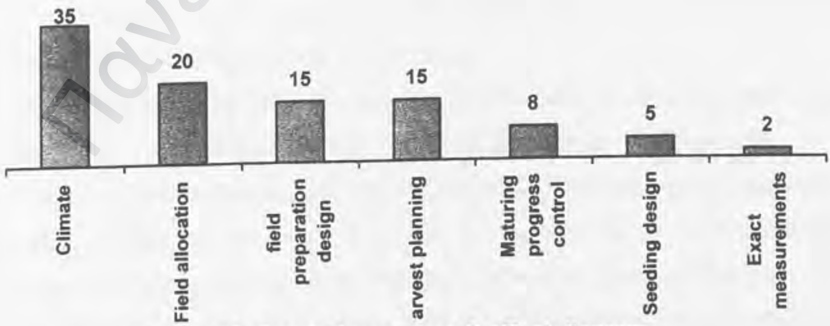


Figure 4.5: Pareto from cause & effect diagram

From the analysis of the above diagrams we may notice the following:

- Climatological conditions constitute the greatest cause of creation of the problem in the sugarbeets production. It is considered to be a factor of «force majeure» and the possibility of intervention is practically difficult. However, it could be pointed out that the contemporary technology and science gives the possibility of short-term, medium-term and long-term predictions so that data may exist, which could be of great help to the planning of the sugarbeets production procedure.
- The second area, according to Pareto diagram, in which the greatest problem is presented, is the procedure of allocation of the fields to the farmers for cultivation. The level of cooperation with the farmers, the procedure of evaluation of the farmers' applications for cultivation (rotation of crops), the qualitative control about the chemical composition of the soil, the calculation of the arable lands etc. are recorded as main causes.
- The design of field preparation for cultivation is the area presenting significant possibilities of improvement due to the problems localized. The most important are the procedure of the farmers' updating, the planning of the chemical support of the soil (fertilizers), timetable, machinery control, etc.
- With the same intensity problems are also recorded in the planning of the sugarbeets harvesting, as well as in the planning of the harvesting time, the maturing control by the agriculturists, the storage of sugarbeets in silos, etc.
- With a lower intensity possibilities of improvement of maturing progress control procedure are recorded. The procedure of the soil chemical support during maturing, the correct and timely information of the farmers, the planning of samplings are important areas for improvement interventions.
- The planning of seeding procedure and the procedure of POL measurement are lower intensity areas for creation of failure cost but are susceptible of improvement.

The above techniques help significantly to find important areas presenting the greatest problems in the creation of failure cost but also to form the strategy, determine the goals, make programming, apply corrective actions, evaluate the results and determine the budget of all the works for the achievement of the qualitative goals. Of course, at this point it is necessary to mention the results of the measurement of Quality Cost and more especially the magnitude of prevention cost.

The low cost incurred by the company on annual basis characterizes also the high magnitude of failure cost and by extension, the total Quality Cost.

To make more conceivable the disproportional behavior of the magnitudes, it is advisable to make a comparison of Quality Cost and its categories with certain economic magnitudes of the company and more especially the cost of production and the sale value of the end-product (sugar) and the by-products (molasses, fresh and dry pulp) during the fiscal year 1997-1998.

Although Quality Cost was measured at the stage of the procedure of Raw Material production, it is noticed that it constitutes a significant part of production cost 7,41% (Figure 4.6 & 4.7) but also of the company's sales 6,94% (Figure 4.8 & 4.9) in the fiscal year 1997-1998.

The quality cost measured is considered to be particularly high because in the research in question, the main production activity of the factory corresponding to the process of the Raw Material, the production of end-products as well as the procedures of their storage and delivery has not been taken into account, as first mentioned. This is mentioned because in the event of expansion of the research on the line of production, very significant failure costs shall be detected.

Suggestively, significant failure costs may be mentioned which are created during diffusion, juice purification, evaporation, crystallization, resolution of sugar mass, draining as well as maintenance and delivery of sugar to the customers. At these stages, significant external failure costs shall be calculated.

This may become conceivable even from the data already mentioned and concerning the technical difference, which amounted, for the fiscal year under investigation, to 3,65%.

The above were mentioned in order to reveal that Total Quality Cost may reach a very high percentage in relation to the economic magnitudes of the company.

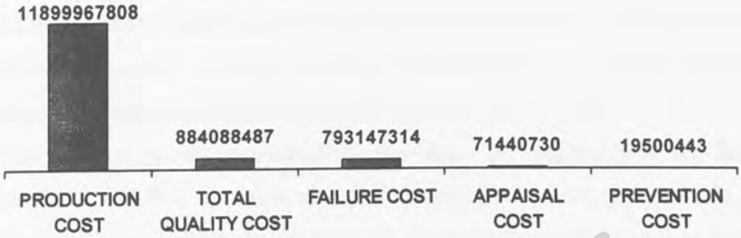


Figure 4.6: Production Cost and Quality Cost

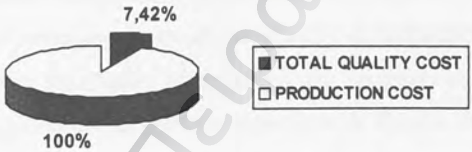


Figure 4.7 : Total Quality Cost in Production Cost

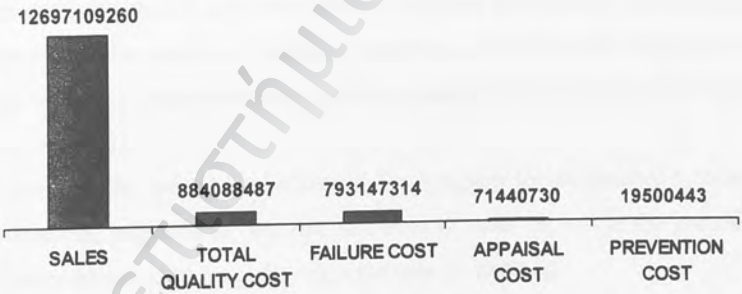


Figure 4.8: Sales and Quality Cost

Figure 4.9 : Total Quality Cost in Sales

4.6. Proposals

1. Therefore, the company's goal should be its gradual decrease. The very low prevention cost creates great opportunities for its improvement. The company should lay particular weight on design product development. A small experimental laboratory with limited possibilities presently carries out the works.

At this point, it is necessary to mention that from the beginning of the factory's operation the annual POL curve presents a diminishing behavior (*Appendix 19*).

2. This significant element should give the spark to the management to invest in quality improvement projects based on the measurement of total quality cost. The increased investments in research, training, product design, procedures and the well-planned quality controls should constitute the keystone of the company's strategy.

3. The company should lay particular emphasis on Quality Administration. The structure of the Department with the Quality Manager and the necessary staff should comply with the standards imposed by the modern conception of Quality Assurance. When the company lays the required emphasis on prevention, prevention cost, in the beginning, shall increase abruptly.

4. The company should apply the Human Resource Management. Involving human resources in quality costs is of strategic importance. Training and education are vital in order to impart understanding or problem areas in which the workforce can effect improvement [33].

5. As concerns the controls and appraisal, the company should proceed to redesign of the procedures, inspections, controls, and tests in order to reduce the production of downgraded end-product (sugarbeets) in the case in question.

Certainly, in a medium-term horizon, it is possible to exist an increase of appraisal cost, but in the long run this cost shall have a diminishing tendency, reducing failure cost but also Total Quality Cost as well, which, besides, is the main goal.

An important tool, which may be used by the company for the improvement of procedures, is the improving performance theory with the three level analyses (organization, process and job level).

6. From the above analysis for the detection of areas with problems, the analysis of the causes, as recorded, give the company's management the possibility to determine goals, to plan the operations, to form the framework of inspections and controls, to evaluate the results and to proceed to the necessary corrective actions in order to succeed the final goal.

When the results and their positive influence on the economic magnitudes of the company become understandable and conceivable, the management should proceed to the establishment of a Quality Cost System Measurement.

7. The company, in the future, should change the traditional accounting system currently used, applying the Activity Based Costing. ABC shall help the company to apply as a system of quality cost measurement the Process Map Model of BS 6143 with the purpose of the quality being based on customer based measurements.

8. Further, the company, due to the free competition currently effective, should adopt benchmarking procedures, developing the Quality Function Deployment tool.

Effective benchmarking gives a sense of urgency, and accelerates the rate of change. Differences are rapidly quantified, and with the right partner, there can be a quick transfer of technology or improvement methodology. The results are in improved productivity [15].

9. The next and most basic stage of expansion and investment in quality matters of the company should be the adoption of the philosophy of Total Quality Management.

CHAPTER 5: CONCLUSIONS

1. Total Quality Cost measured in the Raw Material production procedure is characterized as quite high in relation to the total production cost in the fiscal year under investigation. More particularly:

1.1 The failure cost is considered to be particularly high. At this point we should especially stress the social character of the sugar industry, which takes delivery of all the quantities of the sugarbeets produced regardless of their quality (POL). Certainly, the most important factor of this deviation is climatological conditions. However, that does not refute the view, as we saw in the foregoing cause and effect analysis too, that there are many areas with great opportunities of improvement.

1.2 The prevention cost and appraisal cost are considered to be very low and reflect the policy of the industry on prevention. However, whereas the responsibility of the procedure of production and control of the Raw Material belongs to the industry, investing in quality improvement projects should increase the efforts for the improvement of quality.

2. One of the most important stages of the research was the study, explanation and adjustment of the categories and sub-categories of BS 6143 Part 2 Model PAF to the company's data.

That stage lasted for a quite a few time period, because it took both the author and the staff of the factory several days to study, form and structure the framework on which the quality cost measurement procedures were based.

Because one of the most important problems of the model, from the notional point of view, is that it includes quite general elements even it proceeds to the greatest possible categorization of the partial categories of Quality Cost.

3. It was noticed that the role of management and, by extension, the Assurance Quality Department on matters relevant to quality was limited, although it has been recently accredited with ISO 9002.

4. Due to the great competition in the world sugar production, the industry does not seem to be dynamically oriented to benchmarking procedures.

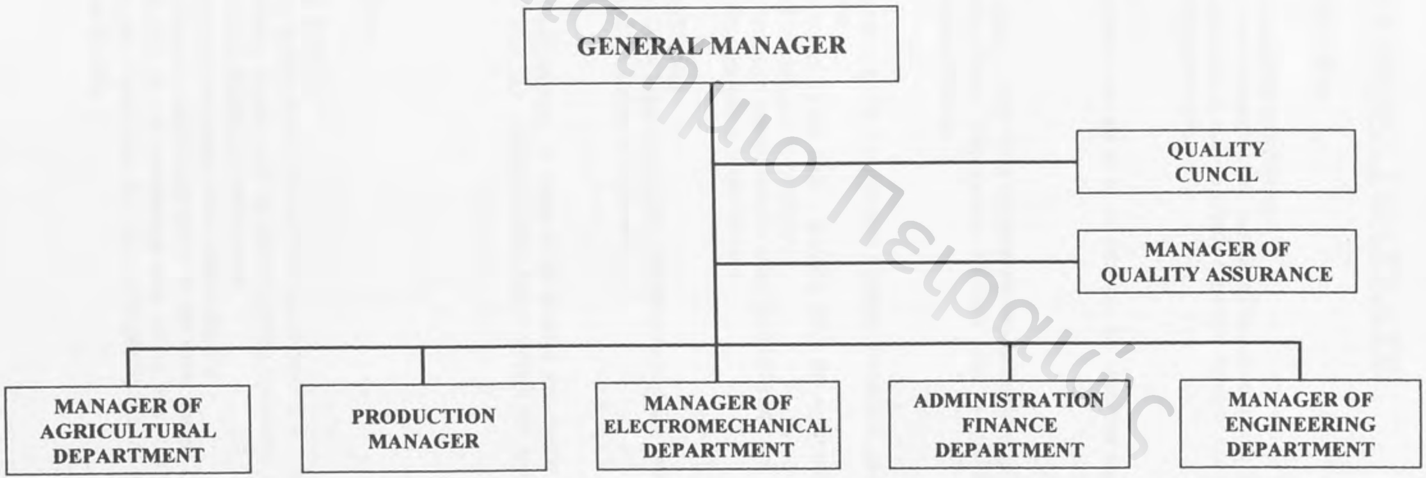
5. The meaning of TQM is deemed to be on an infantile level in the company.

6. In addition, there are noticed activities of limited width, which are related to the training and the human resources management.

APPENDICES

APPENDIX 1

PLANT'S ORGANIZATION CHART



APPENDIX 2

THE PRODUCTION PROCESS

1. Raw Material Production

1.1. Planning of raw material production

The aim of this process is to be ensured the benefit of the quantitative and qualitative appropriate raw material, which will be able to supply the sugar industry and will set up the basis for the certain sugar quota production.

1.2. Field preparation

The aim of the field preparation process is to be ensured the condition rightness for the seeding.

1.3. Growth care

These are the appropriate cares, in order to be achieved the maximum level of the qualitative and quantitative output of the fields. They include activities such as rarefaction, digging, weed killing, irrigation and plant protection.

1.4. Seeding

Seeding is the most important activity for the raw material production and concerns the responsible granger – producer.

Seeds and pesticides are provided to the beet – growers from the sugar industry, as buy instructions from the fertilizer market in it is necessary.

After seeding, the sector agriculturist appreciates the grow conditions and if it is necessary is decided the re-seeding need after the grower's application.

1.5. Maturing line checking

After the 1st of July of each year, begin the process of beet maturing line checking and they are continued per 10 days until the middle of September.

1.6. Harvest

The harvest taken place in certain way, in order to be ensured the regular supply of the industry and to be avoided high raw material stocks, which worsen the quality of storage beets.

2. The Production line

2.1. Acceptance & Storage

Since a modern sugar factory handles from 1500 to 2000 tons of beets in a 24-hour period, the problems of loading, unloading, supply, and all other handling operations acquire special importance. All operations of beet handling are mechanised.

2.1.1. Pattern of beet supply from field to factory

Harvested beet, gathered in heaps is loaded onto trucks by the truck loader. The trucks bring the beets directly to the factory, in the beet-storage area, where they first enter a special receiving hopper, the beet bin, wherefore they are hydraulically hauled through flumes carrying flowing water inside the mill.

2.1.2. Beet bins and flumes

Bins receiving beets required for immediate processing are installed near the factory. To ensure uninterrupted work of the factory, they should carry approximately a two-day supply of beets. A channel of 400mm wide and 750mm deep is built on the bottom of the beet bins. This channel, into which water is pumped, serves as a flume for the delivery of beets to the factory. Fluming requires from 400 to 700% water per weight of beets. After settling in settling tanks, the water is reused.
In this stage of the process, samples of beets, goes for chemical analysis, to the Tarehouse Laboratory. The results of this analysis define the level of sugar in the beets (POL or DM).

2.1.3. Feeding beets into the washing unit

The flume line ends in the washing section of the factory. Once inside the factory building, the beets are lifted into the beet washer, located several meters higher than the flume.
Equipment for separating coarse impurities, such as stones, straw, and sand from the beets, is usually an integral part of the flume system.
The final cleaning stage of beets, takes place in special washing units.

2.1.4. Separation of water from washed beets.

A one-meter long inclined screen installed at the end of the washing unit will free the beets from the most amount of water which will otherwise get into the beet elevator and the slicer, and will be delivered to the evaporator together with the cossetes.

2.1.5. Beet elevator

The beet washer is accommodated on the first floor. In order to ensure the movement of washed beets by gravity to the automatic scales, the slicer, and to the conveyor delivering the cossetes to the diffusion cells, a vertical bucket elevator elevates the betts to a height of 18 meters.

2.1.6. Automatic scales

From the elevator the beets move by gravity through a chute to automatic scales which record their weight. The weight of the beets delivered to the factory is registered, and knowing their sugar content from laboratory analyses, the quantity of sugar brought in with the beets during a given period may be calculated. Thus, automatic scales are a most important piece of equipment, whose data provide a basis for all technical and chemical records of the sugar factory.

2.1.7. Beets slicing

Proper slicing of beets into long and thin cossettes is very important for quick and complete extraction of sugar by the diffusion method.

2.2. Diffusion

The diffusion method of beet juice extraction was first proposed in Russia by D.A. Davydov in 1833, and applied in various modifications.
Extraction of sugar is effected by treatment of thinly cut beets with hot water. Since sugar and soluble non-sugars pass from the beet into water by diffusion, this method of extraction is called the diffusion method.
When a beet slice with coagulated protoplasm is placed in water, sugar and other soluble will gradually pas from the slice into the water. Inside the slice their concentration will decrease, while in the surrounding water it will increase. The movement of soluble will continue until concentrations in beet and water equalise.
The spontaneous movement of dissolved substances in the direction of lower concentration is called diffusion.

- **Mechanism of Diffusion**
- **Equipment**

2.3. Juice Purification

Diffusion juice has a number of properties, which impede extraction of sugar by direct evaporation and crystallisation without preliminary purification:

1.It contains fine suspended matter; moreover, when heated, it forms flakes of coagulated proteins; all these particles have to be removed, so that they are not admixed with the sugar crystals.

2.The suspended matter is very difficult to filter out because it clogs the filters; it is impossible to obtain a clear filtrate, which is not opalescent.

3.Because the reaction of diffusion juice is acid, direct evaporation would cause significant sucrose inversion. Neutralisation is necessary, and it should be done by using a cheap base, namely, lime.

4.If the processing were direct, the dark color of the juice would pass over to the sugar crystals.

5.Owing to its strong foaming properties, direct evaporation of the juice is troublesome.

6.The large quantity of non-sugars in solution contained in the juice increase the yield of molasses and sugar losses.

Thus the purpose of purification is:

a) to free diffusion juice from suspended mater
b) to neutralise diffusion juice
c) to remove as many non-sugars as possible from the solution, particularly the surface-active non-sugars and colloids.

The method

Schematically, the process of juice purification consists of the following stages:

1. Defecation
2. First Carbonation
3. Second Carbonation

Defecation

Defecation aims at purifying the diffusion juice by treatment with 2% of lime per weight of beets in the form of milk of lime, which coagulates proteins and coloring substances, and precipitates a number of anions forming insoluble salts with the calcium action of lime (anions of oxalic, phosphoric, and other acids); in addition, defecation decomposescertain non-sugars such as amides, invert sugar, and peptic substances.

First Carbonation

In the first carbonation which supplements purification, soluble non-sugars and particularly coloring substances are absorbed on the surface of particles of the fine $CaCO3$ precipitate that is obtained by passing carbone bioxide through the defecated juice which contains excess lime; a quantity of lime almost ten times as much as necessary for the coagulation and decomposition reactions with non-sugars is added during the defecation process in order to produce a large quantity of the $CaCO3$ precipitate during carbonation; from 0.08 to 0.10% of CaO in the form of free lime is left in the juice.

This is done because the first-carbonation juice still contains all the non-sugars precipitated with lime in defecation; if lime is fully removed from solution, these precipitates, in the absence of an excess of the precipitating agent (lime), will partly redissolve and will decontaminate the juice.

Second Carbonation

Second Carbonation aims at maximum removal of lime and calcium ions in the form of $CaCO3$; this is possible (obtain a low - optimum- alkalinity), since the precipitates were filtered off after the first carbonation and, in the absence of free lime, there is no more danger of their redissolving.

2.4. Evaporation

Around 125Kg of purified juice, with a DM content of beets 15.0% and PI (level of sugar in the juice) of 91.0% i.e. with a sugar content of 15.0 x 91.0 / 100 = 13.65%, are usually obtained from 100Kg of processed beets in the sugar plant. The sugar is separated by crystallisation. The solvent, water, is removed, allowing the sugar to crystallise.
The water is removed from the purified juice in two operations:

- **From a thin to a thick juice**
- **From a thick juice to the 7-8% liquor**

2.5. Crystallisation

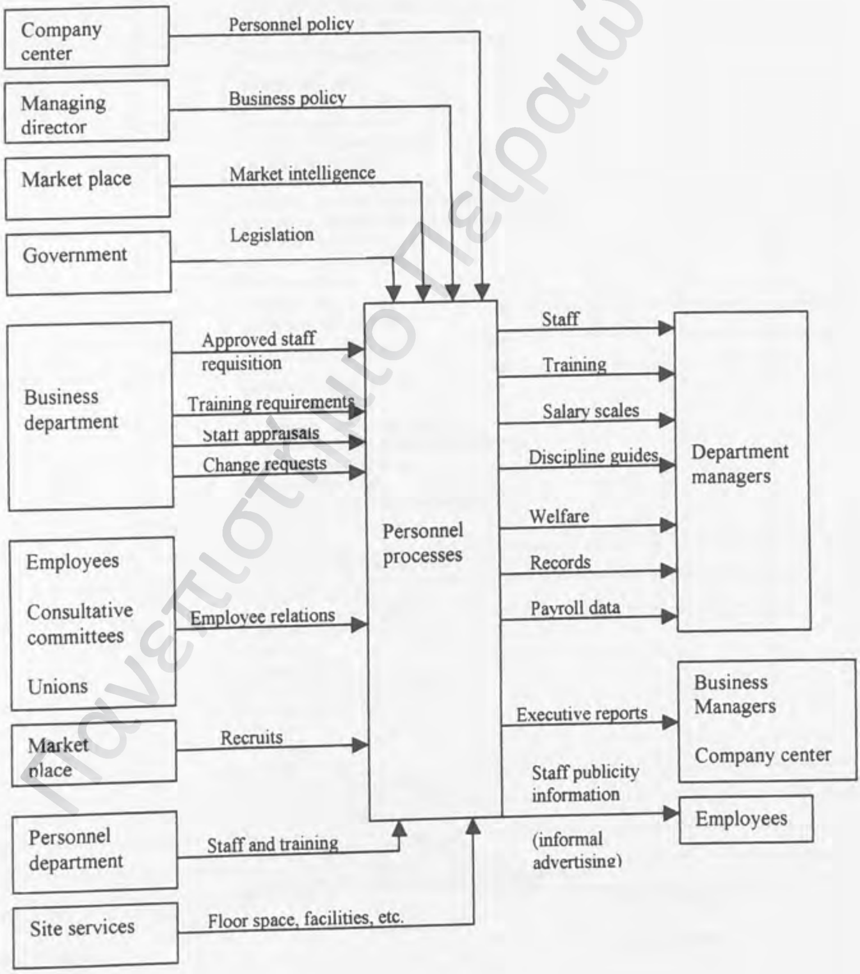
The heated and filtered standard liquore is carried to the boiling operation for further evaporation of water and turns into a supersaturated solution from which sugar separates as crystals. The objective of boiling is the crystallisation of sugar by evaporation of water.
Thus the following products are obtained after centrifuging and washing first massecuite:

1. Green syrup
2. Wash syrup
3. White granulated sugar

The white sugar is passed into a dryer for moisture removal, and then for packing.
All the wash syrup is returned to the vacuum pan at the end of first boiling. Part of the green syrup is returned there too. The green syrup is added to the first massecuite-boiling to reduce the crystal-sugar content of the massecuite, and to separate the crystals from each other by diluting the mixture with green syrup. This dilution liquefies the massecuite and permits more water to be evaporated from it, yielding more sugar.
The main portion of green syrup is boiled in second-boiling vacuum pans, where second massecuite containing approximately 40% crystalline sugar is obtained.
This massecuite is gradually cooled to 40 Celsius grades while being mixed in appliances known as crystallises, which help to crystallise more sugar. Finally, the second massecuite is sent to centrifugal, which separate the second-grade syrup, molasses, from the sugar crystals.
Molasses is a waste product of the sugar plant, since further concentration and crystallisation cannot economically obtain sugar from it.
The second-crystallisation sugar, or yellow sugar, is of considerably lower quality than white sugar. Therefore, it is not marketed as such, but redissolved in thin purified juice, and the resulting liquor is added to the thick juice from evaporation and pumped together to sulfitation. The yellow sugar is sometimes given a short wash with a small amount of water in the centrifugal to improve its quality. A "brown" or low wash syrup (the one from the first massecuite is then called "white" or high wash syrup), with a PI higher than that of molasses, is obtained. The low wash syrup is returned to the second boiling when the boiling is nearly completed.

APPENDIX 3

Typical process model inputs and outputs for personnel department processes *(source: BSI Quality Management Handbook : Part 1 : 1995 BS 6143 : Part 1 : 1995)*



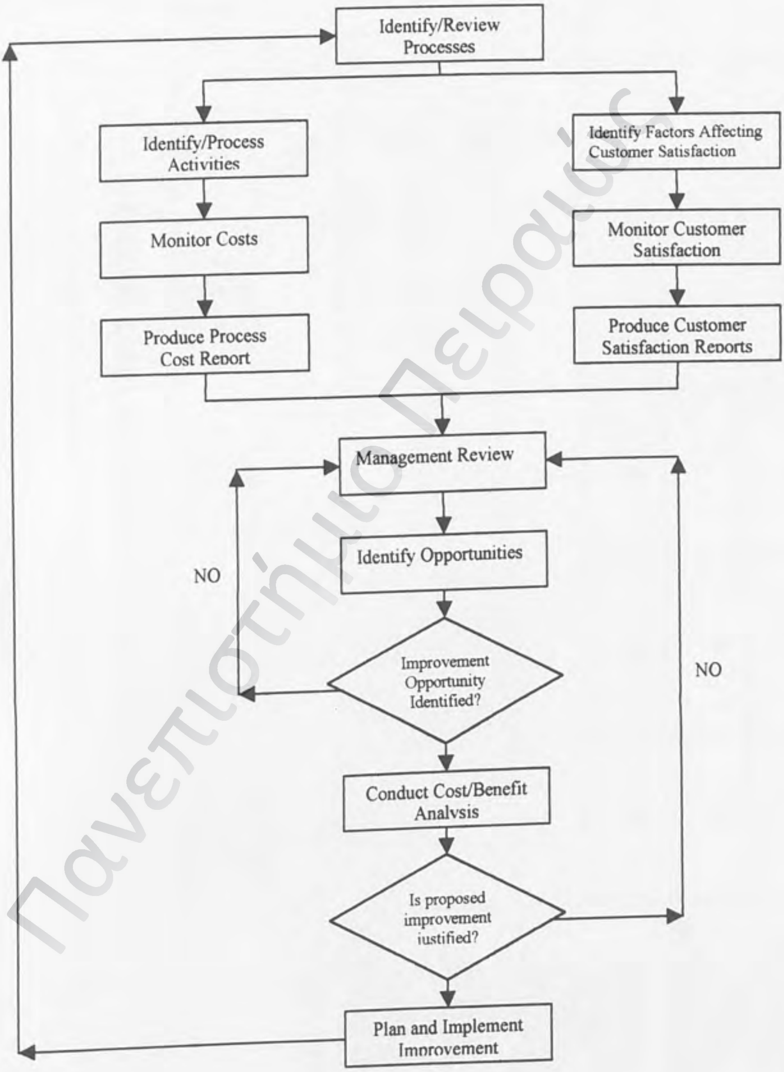
APPENDIX 4

Group:				**Division:**		
Unit:				**Period:**	**Year:**	
Current period				**Year to date**		
Budget	**Actual costs**	**Difference**		**Budget**	**Actual costs**	**Difference**
			Prevention costs Quality Planning Design and development of quality measurement, test and control equipment Quality review and verification of design Calibration and maintenance of quality measurement, test and control equipment Calibration and maintenance of production equipment used to evaluate quality Supplier assurance Quality training Quality auditing Acquisition, analysis and reporting of quality data Quality improvement programme			
			Total prevention cost			
			% of total quality cost			
			Appraisal costs Pre-production verification Receiving inspection Laboratory acceptance testing Inspection and testing Inspection and test equipment Materials consumed during inspection and testing Analysis and reporting of test and inspection results Field performance testing Approvals and endorsements Stock evaluation Record storage			
			Total appraisal cost			
			% of total quality cost			
			Internal failure costs Scrap Replacement, rework and repair Troubleshooting or defect/failure analysis Reinspection and retesting Fault of subcontractor Modification permits and concessions Downgrading Downtime			
			Total internal failure cost			
			& of total quality cost			
			External failure cost Complaints Warranty claims Products repeated and returned Concessions (deviations) Loss of sales Recall costs Product liability			
			Total external failure cost			
			& of total quality cost			
			Total quality cost (TQC)			
			Typical ratios TQC as a percentage of:			
TQC X 100 / **Sales revenue** %			**Sales revenue**	**TQC X 100** / **Sales revenue** %		
TQC X 100 / **Value added** %			**Value added**	**TQC X 100** / **Value added** %		
TQC X 100 / **Direct labor costs** %			**Direct labor costs**	**TQC X 100** / **Direct labor costs** %		

APPENDIX 5

"Methodology for Managing the Economics of Quality".

(source: ISO 10014)



APPENDIX 6

COMPATIBLE TABLE QUALITY COST MODELS

	PROCESS COST MODEL	MICRO PAF MODEL	MACRO PAF MODEL	COST BENEFIT MODEL	ISO 10014	NEW METHOD
RETROACTION	X	X			X	X
CONSTRUCTION OF Q.M.S.	X	X			X	
STRATEGIC MANAGEMENT			X	X	X	
INTANGIBLE QUALITY COSTS			X ;		X	
EXTERNAL SUPPLIER	X	X	X			
WHITE-COLLAR QUALITY COSTS	X	X			X	
QUALITY TECHNIQUES		X	X		X	X

APPENDIX 7

ΠΑΡΟΥΣΙΑΣΗ
ΚΟΣΤΟΥΣ ΠΟΙΟΤΗΤΑΣ

ΓΙΑΝΝΑΡΗΣ ΧΡΗΣΤΟΣ

ΚΟΣΤΟΣ ΠΟΙΟΤΗΤΑΣ

ΟΡΙΣΜΟΣ

Τα κόστη που σχετίζονται με την ποιότητα είναι εκείνα που αναφέρονται στον σχεδιασμό, στην εφαρμοφή, στη λειτουργία και στη συντήρηση του συστήματος ποιότητας μιας επιχείρησης, το κόστος των επιχειρησιακών πόρων που αναφέρεται στην διαδικασία διαρκούς βελτίωσης της ποιότητας και επιπλέον τα κόστη εκείνα που αναφέρονται στις αστοχίες των συστημάτων, των προϊόντων και των υπηρεσιών.

Το κόστος ποιότητας είναι ένα εργαλείο/τεχνική που βοηθάει στην βελτίωση της ποιότητας όχι μόνο του παραγόμενου προϊόντος αλλά και ολόκληρης της επιχείρησης.

ΚΑΤΗΓΟΡΙΕΣ ΚΟΣΤΟΥΣ ΠΟΙΟΤΗΤΑΣ

Σήμερα διακρίνουμε τις ακόλουθες κατηγορίες κόστους ποιότητας:

- **Κόστος πρόληψης** που περιλαμβάνει το κόστος κάθε ενέργειας για την βελτίωση του συστήματος ποιότητας της επιχείρησης.
- **Κόστος αξιολόγησης** για την εκτίμηση του επιπέδου ποιότητας του προϊόντος.
- **Κόστος αστοχιών** το οποίο διακρίνεται σε:
  - **Κόστη εσωτερικών αστοχιών** είναι αυτά που δημιουργούνται στην επιχείρηση εξαιτίας των μη αποδεκτών ή ελαττωματικών προϊόντων σε κάθε στάδιο της διαδικασίας.
  - **Κόστη εξωτερικών αστοχιών** είναι αυτά που προκύπτουν εξαιτίας των μη αποδεκτών ή ελαττωματικών προϊόντων μετά την παράδοση στον πελάτη.

Σύντομη ανάλυση των 4 κατηγοριών κόστους ποιότητας.

Το Κόστος Πρόληψης περιλαμβάνει:

- σχεδιασμό, οργάνωση, λειτουργία του συστήματος ποιότητας
- διακρίβωση, συντήρηση μηχανών παραγωγής
- διακρίβωση, συντήρηση συσκευών ελέγχου και δοκιμών
- εκπαίδευση προσωπικού
- επιθεωρήσεις ποιότητας διαδικασιών
- έρευνες βελτίωσης αξιοπιστίας
- καθορισμό προδιαγραφών και ανοχών
- αρχεία πελατών

Το Κόστος Εκτίμησης περιλαμβάνει:

- δοκιμές αποδοχής υλικών
- ελέγχους και δοκιμές πρώτων υλών και εισερχόμενων υλικών
- ελέγχους και δοκιμές ενδιαμέσων προϊόντων
- ελέγχους και δοκιμές τελικών προϊόντων
- ελέγχους διεργασιών
- επιθεωρήσεις ποιότητας προϊόντων
- ελέγχους παραγγελιών, δαπανών, τιμολογίων
- εξοπλισμό επιθεωρήσεων – ελέγχων – δοκιμών

Το Κόστος Αστοχιών περιλαμβάνει:

Κόστη Εσωτερικών Αστοχιών

- αχρηστρα υλικά
- επιδιορθώσεις υλικών
- ανάλυση αστοχιών
- επανελέγχους και διαλογή σκάρτων
- επαναλαμβανόμενες εργασίες ή και ελλειπείς εργασίες
- εσφαλμένο σχεδιασμό
- λανθασμένο προγραμματισμό
- σφάλματα παραγωγικής διαδικασίας
- υπερκατανάλωση πρώτων υλών
- σφάλματα παραγωγικής διαδικασίας
- λανθασμένες προμήθειες
- τεχνικές αλλαγές
- μη αποτελεσματική διάγνωση

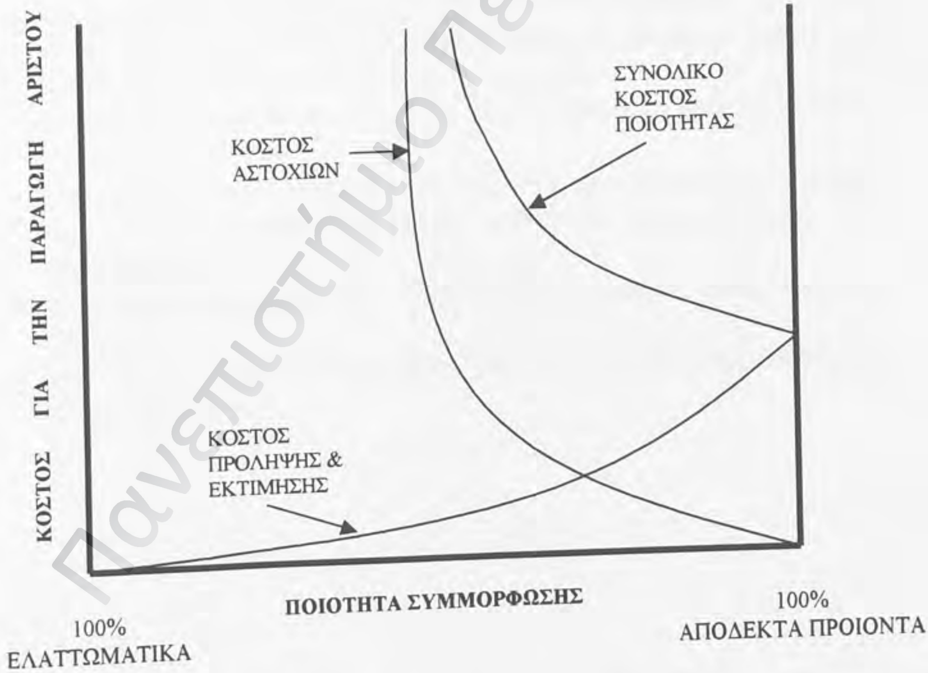
Κόστη Εξωτερικών Αστοχιών

- ανάκληση προϊόντων
- παράπονα πελατών
- αστικές ευθύνες
- αντικατάσταση προϊόντων
- επισκευή επιστρεφόμενων και ανακαλούμενων προϊόντων
- δαπάνες από επιβαλλόμενη χρήση νέας τεχνολογίας
- αδιάθετα εμπορεύματα και ακινησία εμπορευμάτων στην αγορά

Η ΣΗΜΑΝΤΙΚΟΤΗΤΑ ΤΟΥ ΚΟΣΤΟΥΣ ΠΟΙΟΤΗΤΑΣ

Οταν δεν υπάρχει οργανωμένος έλεγχος ποιότητας, έρευνες έχουν δείξει ότι το κόστος ποιότητας μπορεί να φθάνει στο 10% - 20% του τζίρου και ότι το 60% - 70% αυτού του κόστους προέρχεται από κόστη αποτυχίας, το 25% περίπου από κόστος εκτίμησης και το 5% περίπου από κόστος πρόληψης.

Επίσης από έρευνες διαπιστώθηκε ότι το κόστος ποιότητας μπορεί να μειωθεί κατά το 1/3 σε χρονική περίοδο 3 ετών, αν η επιχείρηση υιοθετήσει μία διαδικασία συνεχούς βελτίωσης της ποιότητας.



ΠΙΝΑΚΑΣ 1: ΜΟΝΤΕΛΟ ΓΙΑ ΤΟ ΒΕΛΤΙΣΤΟ ΚΟΣΤΟΣ ΠΟΙΟΤΗΤΑΣ

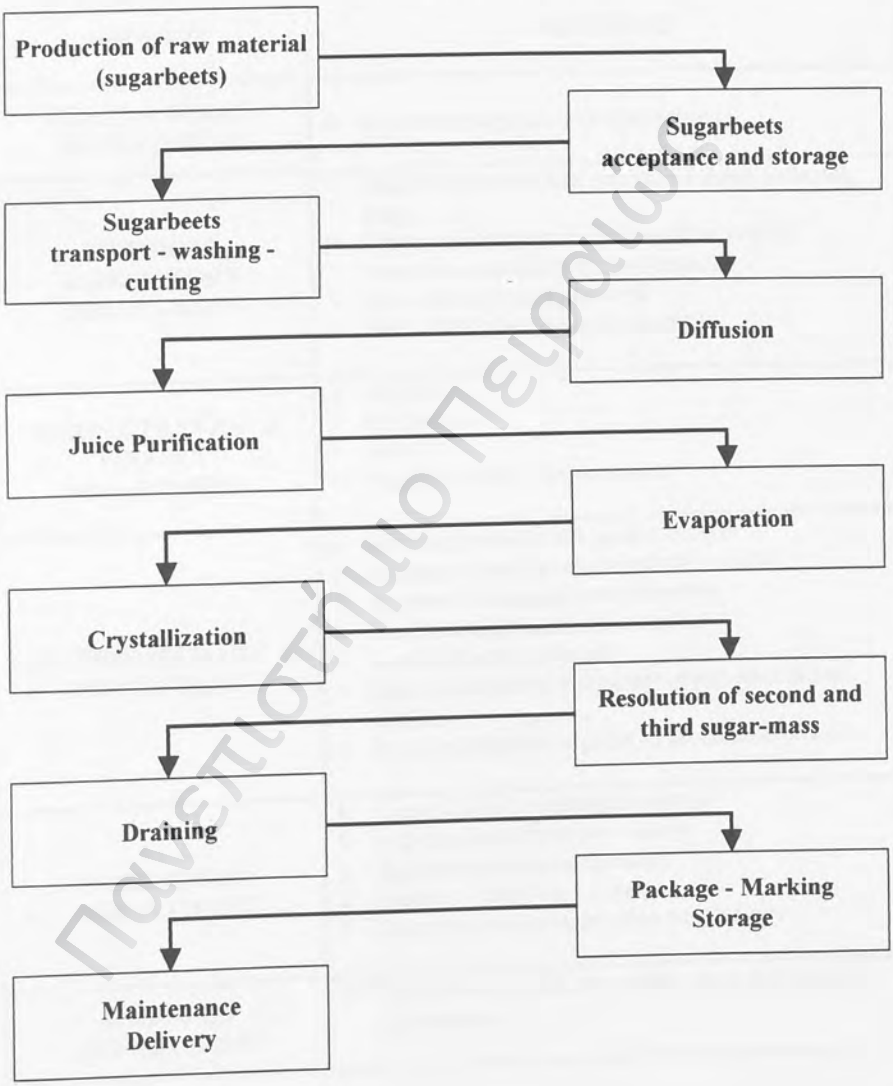
ΣΚΟΠΟΣ ΤΟΥ ΥΠΟΛΟΓΙΣΜΟΥ ΤΟΥ ΚΟΣΤΟΥ ΠΟΙΟΤΗΤΑΣ

Ο υπολογισμός του κόστους ποιότητας στην εταιρεία παρέχει τα εξής οφέλη όπως :

- δείχνει στη Διοίκηση κατά πόσο βρίσκεται ή όχι σε καλό δρόμο η ποιότητά της, γεγονός που έχει άμεση σχέση με την ανταγωνιστικότητά της.
- παρέχει μέτρο σύγκρισης ανάμεσα στα προϊόντα, τις υπηρεσίες, τις διαδικασίες και τα τμήματά της.
- δείχνει τις «φτωχές από ποιότητα περιοχές», όπου πρέπει να γίνει προσπάθεια βελτίωσης.
- βοηθά την Διοίκηση να καθορίσει τις προτεραιότητες και τους στόχους ανάπτυξης.
- επηρεάζει θετικά όλα τα τμήματα της επιχείρησης όσον αφορά στην εφαρμογή του συστήματος ποιότητας.
- την καταγραφή των διαδικασιών σχετικών με την ποιότητα
- να συγκρίνει η Διοίκηση το κόστος ποιότητας με άλλα κόστη (π.χ κόστος παραγωγής κ.λ.π.), πωλήσεις και κέρδη.
- σύγκριση της απόδοσης με τα άλλα εργοστάσια της εταιρείας, ή άλλες εταιρείες του κλάδου.
- πληροφόρηση για την οικονομική αξία των προγραμμάτων βελτίωσης της ποιότητας, καθώς και στην κατάρτιση προϋπολογισμού του προγράμματος.
- αξιολόγηση της επιτυχίας / προόδου της εταιρείας στους στόχους ποιότητας.
- αποτελεί ένα σημαντικό εργαλείο για την εφαρμογή της Διοίκησης Ολικής Ποιότητας.

APPENDIX 8

SUGAR PRODUCTION PROCESS FLOWCHART



APPENDIX 9

SECTOR'S RESPONSIBILITIES

SECTORS	PROCESSES
AGRICULTURAL DEPARTMENT	➢ Raw material production (sugarbeets)
CHEMICAL LABORATORY DEPARTMENT	➢ Quality control of final products (sugar, molasses, pulp). ➢ Chemical laboratory's equipment control of inspection, measurement and tests. ➢ Raw material quality control ➢ Production process quality control
ADMINISTRATION & FINANCE DEPARTMENT	➢ Supplies ➢ Purchases ➢ Sales ➢ Suppliers index administration
ELECTROMECHANICAL DEPARTMENT	➢ Measurement and test gauges control ➢ Automatic equipment and system control ➢ Mechanical equipment maintenance ➢ Electrical equipment maintenance ➢ Automation maintenance ➢ Electromechanical equipment order, control and receipt ➢ Electromechanical support in production process
PRODUCTION DEPARTMENT	➢ Sugar production process control ➢ Pulp production process control ➢ Assistant circuit management ➢ Package – Marking - Storage ➢ Sugar and pulp conservation and delivery
ENGINEER DEPARTMENT	➢ Production support settlement construction and maintenance

APPENDIX 10

ΕΡΩΤΗΜΑΤΟΛΟΓΙΟ
ΚΟΣΤΟΥΣ ΠΟΙΟΤΗΤΑΣ

ΓΙΑΝΝΑΡΗΣ ΧΡΗΣΤΟΣ

ΕΡΩΤΗΜΑΤΟΛΟΓΙΟ ΚΟΣΤΟΥΣ ΠΟΙΟΤΗΤΑΣ

ΤΜΗΜΑ: ....
ΕΠΑΓΓΕΛΜΑΤΙΚΟΣ ΤΙΤΛΟΣ: ....
ΗΜΕΡΟΜΗΝΙΑ: ....

ΕΙΣΑΓΩΓΗ

ΔΟΜΗ ΕΡΩΤΗΜΑΤΟΛΟΓΙΟΥ

Το ερωτηματολόγιο των **έξι (6) ερωτήσεων** που ακολουθεί έχει δομηθεί ως εξής:

- Στηρίζεται στο διάγραμμα ροής της που εμφανίζει όλα τα **βασικά στάδια** της διαδικασίας παραγωγής της ζάχαρης.
- Εχουν επιλεγεί οι παρακάτω **έξι (6) κύριες υποκατηγορίες κόστους** ποιότητας αστοχιών που προσδίδουν την μεγαλύτερη βαρύτητα :
    1. Κόστη από επανεργασία ελαττωματικών προϊόντων
    2. Κόστη από παραγωγή σκάρτων προϊόντων
    3. Κόστη από διορθωτικές δράσεις κατά την διάρκεια της λειτουργίας
    4. Κόστη από προμήθεια ακατάλληλης πρώτης ύλης
    5. Κόστη από αποτυχημένες αναλύσεις χημικών εργαστηρίων
    6. Κόστη από αξιολόγηση, επισκευή ή αντικατάσταση προϊόντων
- Για κάθε μία από τα ανωτέρω υποκατηγορίες τίθεται **βαθμός σημαντικότητας** με εύρος από 1 έως 10 με σκοπό να εκτιμηθεί η ύπαρξη και η ένταση εκάστης στη δημιουργία κόστους αστοχιών σε κάθε στάδιο της παραγωγικής διαδικασίας.

ΣΚΟΠΟΣ

Σκοπός του ερωτηματολογίου είναι :

- Να επιλεγεί το στάδιο εκείνο της παραγωγικής διαδικασίας που υφίσταται κατ' εκτίμηση το υψηλότερο κόστος αστοχίας.
- Το στάδιο αυτό να επιλεγεί σαν **πιλοτική εφαρμογή** υπολογισμού του κόστους ποιότητας (πρόληψης ,αξιολόγησης εσωτερικών και εξωτερικών αστοχιών).
- Να αποτελέσει ένα εργαλείο για την εγκατάσταση συστήματος συνεχούς μέτρησης και παρακολούθησης του συνολικού κόστους ποιότητας σ' όλο το εύρος του εργοστασίου.

Συνημμένα : Διάγραμμα ροής παραγωγικής διαδικασίας ζάχαρης.

1η ΕΡΩΤΗΣΗ

Σε ποιά στάδια της παραγωγικής διαδικασίας και σε ποιό βαθμό σημαντικότητας θεωρείτε ότι υφίσταται κόστος (εργασία, υλικά, γενικά έξοδα) από την **επανεργασία και επισκευή** ελαττωματικών προϊόντων που ενέκυψαν μέσα από την λειτουργική διαδικασία;

ΚΟΣΤΟΣ ΠΟΙΟΤΗΤΑΣ ΑΣΤΟΧΙΩΝ ΑΠΟ ΕΠΑΝΕΡΓΑΣΙΑ

ΣΤΑΔΙΑ ΠΑΡΑΓΩΓΙΚΗΣ ΔΙΑΔΙΚΑΣΙΑΣ	ΒΑΘΜΟΣ ΣΗΜΑΝΤΙΚΟΤΗΤΑΣ
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ΑΠΟΘΗΚΕΥΣΗ	
ΜΕΤΑΦΟΡΑ - ΠΛΥΣΗ - ΚΟΠΗ	
ΕΚΧΥΛΙΣΗ	
ΚΑΘΑΡΙΣΜΟΣ ΑΚΑΤΕΡΓΑΣΤΟΥ ΧΥΜΟΥ	
ΣΥΜΠΥΚΝΩΣΗ	
ΚΡΥΣΤΑΛΛΩΣΗ & ΦΥΓΟΚΕΝΤΡΗΣΗ ΚΑΤΑ ΣΕΙΡΑ Α΄, Β΄ & Γ΄ ΠΡΟΙΟΝΤΟΣ	
ΑΝΑΔΙΑΛΥΣΗ Β΄& Γ΄ ΖΑΧΑΡΟΜΑΖΑΣ ΚΑΙ ΜΗ ΣΥΜΜΟΡΦΟΥΜΕΝΟ Α΄ ΠΡΟΙΟΝ	
ΞΗΡΑΝΣΗ - ΚΟΣΚΙΝΙΣΜΑ	
ΣΥΣΚΕΥΑΣΙΑ - ΣΗΜΑΝΣΗ - ΑΠΟΘΗΚΕΥΣΗ	
ΔΙΑΤΗΡΗΣΗ & ΠΑΡΑΔΟΣΗ ΖΑΧΑΡΗΣ	

Σημείωση : Επιλέξτε βαθμό σημαντικότητας στην περίπτωση που υφίσταται κόστος αστοχίας για κάθε στάδιο της διαδικασίας από 1 έως 10. **(1: ελάχιστο - 10: *πάρα πολύ υψηλό*).**

2η ΕΡΩΤΗΣΗ

Σε ποιά στάδια της παραγωγικής διαδικασίας και σε ποιό βαθμό σημαντικότητας θεωρείτε ότι υφίσταται κόστος (εργασία, υλικά, γενικά έξοδα) από τη παραγωγή **ελαττωματικών προϊόντων (αχρήστων)** που δεν είναι σε θέση να επισκευαστούν;

ΚΟΣΤΟΣ ΠΟΙΟΤΗΤΑΣ ΑΣΤΟΧΙΩΝ ΑΠΟ ΠΑΡΑΓΩΓΗ ΑΧΡΗΣΤΩΝ

ΣΤΑΔΙΑ ΠΑΡΑΓΩΓΙΚΗΣ ΔΙΑΔΙΚΑΣΙΑΣ	ΒΑΘΜΟΣ ΣΗΜΑΝΤΙΚΟΤΗΤΑΣ
ΠΑΡΑΓΩΓΗ ΠΡΩΤΗΣ ΥΛΗΣ (ΖΑΧΑΡΟΤΕΥΤΛΑ)	
ΑΠΟΘΗΚΕΥΣΗ	
ΜΕΤΑΦΟΡΑ - ΠΛΥΣΗ - ΚΟΠΗ	
ΕΚΧΥΛΙΣΗ	
ΚΑΘΑΡΙΣΜΟΣ ΑΚΑΤΕΡΓΑΣΤΟΥ ΧΥΜΟΥ	
ΣΥΜΠΥΚΝΩΣΗ	
ΚΡΥΣΤΑΛΛΩΣΗ & ΦΥΓΟΚΕΝΤΡΗΣΗ ΚΑΤΑ ΣΕΙΡΑ Α΄, Β΄ & Γ΄ ΠΡΟΙΟΝΤΟΣ	
ΑΝΑΔΙΑΛΥΣΗ Β΄& Γ΄ ΖΑΧΑΡΟΜΑΖΑΣ ΚΑΙ ΜΗ ΣΥΜΜΟΡΦΟΥΜΕΝΟ Α΄ ΠΡΟΙΟΝ	
ΞΗΡΑΝΣΗ - ΚΟΣΚΙΝΙΣΜΑ	
ΣΥΣΚΕΥΑΣΙΑ - ΣΗΜΑΝΣΗ - ΑΠΟΘΗΚΕΥΣΗ	
ΔΙΑΤΗΡΗΣΗ & ΠΑΡΑΔΟΣΗ ΖΑΧΑΡΗΣ	

Σημείωση : Επιλέξτε βαθμό σημαντικότητας στην περίπτωση που υφίσταται κόστος αστοχίας για κάθε στάδιο της διαδικασίας από 1 έως 10. **(1: ελάχιστο - 10: *πάρα πολύ υψηλό*).**

3η ΕΡΩΤΗΣΗ

Σε ποιά στάδια της παραγωγικής διαδικασίας και σε ποιό βαθμό σημαντικότητας θεωρείτε ότι υφίσταται κόστος (εγασία, υλικά, γενικά έξοδα) από **διορθωτικές δράσεις** που απαιτούνται κατά την διάρκεια της λειτουργίας με σκοπό να εξαλειφθούν ή να περιοριστούν βασικές αιτίες παραγωγής μη αποδεκτών προϊόντων;

ΚΟΣΤΟΣ ΠΟΙΟΤΗΤΑΣ ΑΣΤΟΧΙΩΝ ΑΠΟ ΔΙΟΡΘΩΤΙΚΕΣ ΔΡΑΣΕΙΣ

ΣΤΑΔΙΑ ΠΑΡΑΓΩΓΙΚΗΣ ΔΙΑΔΙΚΑΣΙΑΣ	ΒΑΘΜΟΣ ΣΗΜΑΝΤΙΚΟΤΗΤΑΣ
ΠΑΡΑΓΩΓΗ ΠΡΩΤΗΣ ΥΛΗΣ (ΖΑΧΑΡΟΤΕΥΤΛΑ)	
ΑΠΟΘΗΚΕΥΣΗ	
ΜΕΤΑΦΟΡΑ - ΠΛΥΣΗ - ΚΟΠΗ	
ΕΚΧΥΛΙΣΗ	
ΚΑΘΑΡΙΣΜΟΣ ΑΚΑΤΕΡΓΑΣΤΟΥ ΧΥΜΟΥ	
ΣΥΜΠΥΚΝΩΣΗ	
ΚΡΥΣΤΑΛΛΩΣΗ & ΦΥΓΟΚΕΝΤΡΗΣΗ ΚΑΤΑ ΣΕΙΡΑ Α΄, Β΄ & Γ΄ ΠΡΟΙΟΝΤΟΣ	
ΑΝΑΔΙΑΛΥΣΗ Β΄& Γ΄ ΖΑΧΑΡΟΜΑΖΑΣ ΚΑΙ ΜΗ ΣΥΜΜΟΡΦΟΥΜΕΝΟ Α΄ ΠΡΟΙΟΝ	
ΞΗΡΑΝΣΗ - ΚΟΣΚΙΝΙΣΜΑ	
ΣΥΣΚΕΥΑΣΙΑ - ΣΗΜΑΝΣΗ - ΑΠΟΘΗΚΕΥΣΗ	
ΔΙΑΤΗΡΗΣΗ & ΠΑΡΑΔΟΣΗ ΖΑΧΑΡΗΣ	

Σημείωση : Επιλέξτε βαθμό σημαντικότητας στην περίπτωση που υφίσταται κόστος αστοχίας για κάθε στάδιο της διαδικασίας από 1 έως 10. **(1: ελάχιστο - 10: πάρα πολύ υψηλό).**

4η ΕΡΩΤΗΣΗ

Σε ποιά στάδια της παραγωγικής διαδικασίας και σε ποιό βαθμό σημαντικότητας θεωρείτε ότι υφίσταται κόστος (εργασία, υλικά, γενικά έξοδα) **από ανεπαρκή σχεδιασμό** του προϊόντος;

ΚΟΣΤΟΣ ΠΟΙΟΤΗΤΑΣ ΑΣΤΟΧΙΩΝ ΑΠΟ ΑΚΑΤΑΛΛΗΛΕΣ ΠΡΟΜΗΘΕΙΕΣ

ΣΤΑΔΙΑ ΠΑΡΑΓΩΓΙΚΗΣ ΔΙΑΔΙΚΑΣΙΑΣ	ΒΑΘΜΟΣ ΣΗΜΑΝΤΙΚΟΤΗΤΑΣ
ΠΑΡΑΓΩΓΗ ΠΡΩΤΗΣ ΥΛΗΣ (ΖΑΧΑΡΟΤΕΥΤΛΑ)	
ΑΠΟΘΗΚΕΥΣΗ	
ΜΕΤΑΦΟΡΑ - ΠΛΥΣΗ - ΚΟΠΗ	
ΕΚΧΥΛΙΣΗ	
ΚΑΘΑΡΙΣΜΟΣ ΑΚΑΤΕΡΓΑΣΤΟΥ ΧΥΜΟΥ	
ΣΥΜΠΥΚΝΩΣΗ	
ΚΡΥΣΤΑΛΛΩΣΗ & ΦΥΓΟΚΕΝΤΡΗΣΗ ΚΑΤΑ ΣΕΙΡΑ Α΄, Β΄ & Γ΄ ΠΡΟΙΟΝΤΟΣ	
ΑΝΑΔΙΑΛΥΣΗ Β΄& Γ΄ ΖΑΧΑΡΟΜΑΖΑΣ ΚΑΙ ΜΗ ΣΥΜΜΟΡΦΟΥΜΕΝΟ Α΄ ΠΡΟΙΟΝ	
ΞΗΡΑΝΣΗ - ΚΟΣΚΙΝΙΣΜΑ	
ΣΥΣΚΕΥΑΣΙΑ - ΣΗΜΑΝΣΗ - ΑΠΟΘΗΚΕΥΣΗ	
ΔΙΑΤΗΡΗΣΗ & ΠΑΡΑΔΟΣΗ ΖΑΧΑΡΗΣ	

Σημείωση : Επιλέξτε βαθμό σημαντικότητας στην περίπτωση που υφίσταται κόστος αστοχίας για κάθε στάδιο της διαδικασίας από 1 έως 10. **(1: ελάχιστο - 10: *πάρα πολύ υψηλό*).**

5η ΕΡΩΤΗΣΗ

Σε ποιά στάδια της παραγωγικής διαδικασίας και σε ποιό βαθμό σημαντικότητας θεωρείτε ότι υφίσταται κόστος (ερασία, υλικά, γενικά έξοδα) από **αποτυχημένες αναλύσεις χημικών εργαστηρίων;**

ΚΟΣΤΟΣ ΠΟΙΟΤΗΤΑΣ ΑΣΤΟΧΙΩΝ ΑΠΟ ΛΑΘΗ ΧΗΜΙΚΩΝ ΑΝΑΛΥΣΕΩΝ

ΣΤΑΔΙΑ ΠΑΡΑΓΩΓΙΚΗΣ ΔΙΑΔΙΚΑΣΙΑΣ	ΒΑΘΜΟΣ ΣΗΜΑΝΤΙΚΟΤΗΤΑΣ
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ΑΠΟΘΗΚΕΥΣΗ	
ΜΕΤΑΦΟΡΑ - ΠΛΥΣΗ - ΚΟΠΗ	
ΕΚΧΥΛΙΣΗ	
ΚΑΘΑΡΙΣΜΟΣ ΑΚΑΤΕΡΓΑΣΤΟΥ ΧΥΜΟΥ	
ΣΥΜΠΥΚΝΩΣΗ	
ΚΡΥΣΤΑΛΛΩΣΗ & ΦΥΓΟΚΕΝΤΡΗΣΗ ΚΑΤΑ ΣΕΙΡΑ Α΄, Β΄ & Γ΄ ΠΡΟΙΟΝΤΟΣ	
ΑΝΑΔΙΑΛΥΣΗ Β΄& Γ΄ ΖΑΧΑΡΟΜΑΖΑΣ ΚΑΙ ΜΗ ΣΥΜΜΟΡΦΟΥΜΕΝΟ Α΄ ΠΡΟΙΟΝ	
ΞΗΡΑΝΣΗ - ΚΟΣΚΙΝΙΣΜΑ	
ΣΥΣΚΕΥΑΣΙΑ - ΣΗΜΑΝΣΗ - ΑΠΟΘΗΚΕΥΣΗ	
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Σημείωση : Επιλέξτε βαθμό σημαντικότητας στην περίπτωση που υφίσταται κόστος αστοχίας για κάθε στάδιο της διαδικασίας από 1 έως 10. **(1: ελάχιστο - 10: πάρα πολύ υψηλό).**

6η ΕΡΩΤΗΣΗ

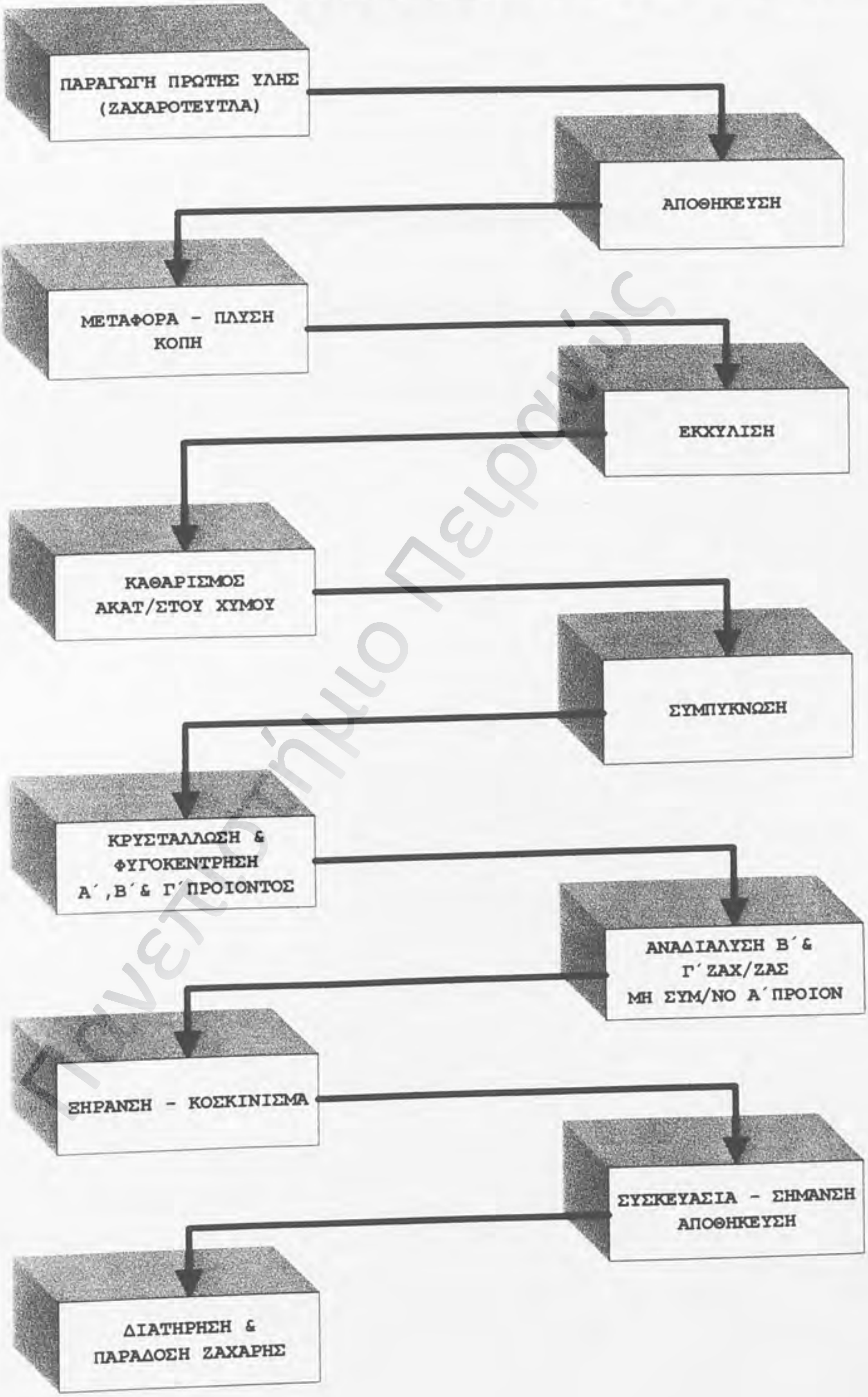
Σε ποιά στάδια της παραγωγικής διαδικασίας και σε ποιό βαθμό σημαντικότητας θεωρείτε ότι υφίσταται κόστος (εργασία, υλικά, γενικά έξοδα) από **αξιολόγηση, επισκευή ή αντικατάσταση προϊόντων** που δεν είναι αποδεκτά από τον πελάτη;

ΚΟΣΤΟΣ ΠΟΙΟΤΗΤΑΣ ΑΣΤΟΧΙΩΝ ΑΠΟ ΑΞΙΟΛΟΓΗΣΗ, ΕΠΙΣΚΕΥΗ & ΑΝΤΙΚΑΤΑΣΤΑΣΗ ΠΡΟΙΟΝΤΩΝ

ΣΤΑΔΙΑ ΠΑΡΑΓΩΓΙΚΗΣ ΔΙΑΔΙΚΑΣΙΑΣ	ΒΑΘΜΟΣ ΣΗΜΑΝΤΙΚΟΤΗΤΑΣ
ΠΑΡΑΓΩΓΗ ΠΡΩΤΗΣ ΥΛΗΣ (ΖΑΧΑΡΟΤΕΥΤΛΑ)	
ΑΠΟΘΗΚΕΥΣΗ	
ΜΕΤΑΦΟΡΑ - ΠΛΥΣΗ - ΚΟΠΗ	
ΕΚΧΥΛΙΣΗ	
ΚΑΘΑΡΙΣΜΟΣ ΑΚΑΤΕΡΓΑΣΤΟΥ ΧΥΜΟΥ	
ΣΥΜΠΥΚΝΩΣΗ	
ΚΡΥΣΤΑΛΛΩΣΗ & ΦΥΓΟΚΕΝΤΡΗΣΗ ΚΑΤΑ ΣΕΙΡΑ Α΄, Β΄ & Γ΄ ΠΡΟΙΟΝΤΟΣ	
ΑΝΑΔΙΑΛΥΣΗ Β΄& Γ΄ ΖΑΧΑΡΟΜΑΖΑΣ ΚΑΙ ΜΗ ΣΥΜΜΟΡΦΟΥΜΕΝΟ Α΄ ΠΡΟΙΟΝ	
ΞΗΡΑΝΣΗ - ΚΟΣΚΙΝΙΣΜΑ	
ΣΥΣΚΕΥΑΣΙΑ - ΣΗΜΑΝΣΗ - ΑΠΟΘΗΚΕΥΣΗ	
ΔΙΑΤΗΡΗΣΗ & ΠΑΡΑΔΟΣΗ ΖΑΧΑΡΗΣ	

Σημείωση : Επιλέξτε βαθμό σημαντικότητας στην περίπτωση που υφίσταται κόστος αστοχίας για κάθε στάδιο της διαδικασίας από 1 έως 10. **(1: ελάχιστο - 10: πάρα πολύ υψηλό).**

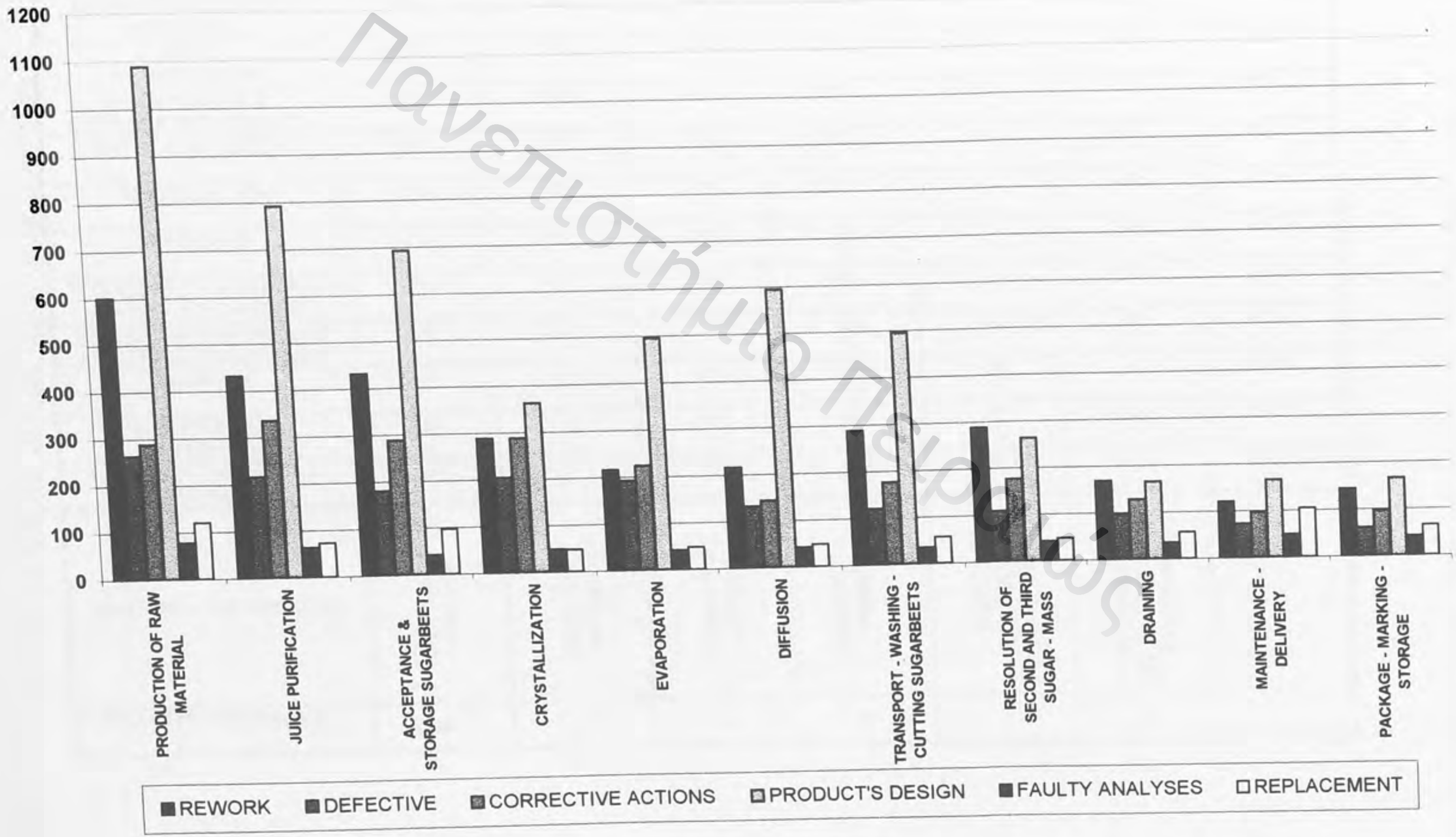
ΔΙΑΓΡΑΜΜΑ ΡΟΗΣ ΠΑΡΑΓΩΓΙΚΗΣ ΔΙΑΔΙΚΑΣΙΑΣ ΖΑΧΑΡΗΣ



APPENDIX 11

Results from Pilot Program implemettation

(see next two pages)


1200
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PRODUCTION OF RAW MATERIAL
JUICE PURIFICATION
ACCEPTANCE & STORAGE SUGARBEETS
CRYSTALLIZATION
EVAPORATION
DIFFUSION
TRANSPORT - WASHING - CUTTING SUGARBEETS
RESOLUTION OF SECOND AND THIRD SUGAR - MASS
DRAINING
MAINTENANCE - DELIVERY
PACKAGE - MARKING - STORAGE
REWORK
DEFECTIVE
CORRECTIVE ACTIONS
PRODUCT'S DESIGN
FAULTY ANALYSES
REPLACEMENT

STAGES OF PRODUCTION PROCEDURE							TOTAL
PRODUCTION OF RAW MATERIAL	600	264	288	1089	77	120	2438
JUICE PURIFICATION	432	216	336	792	63	72	1911
ACCEPTANCE & STORAGE SUGARBEETS	432	180	288	693	42	96	1731
CRYSTALLIZATION	288	204	288	363	49	48	1240
EVAPORATION	216	192	224	495	42	48	1217
DIFFUSION	216	132	144	594	42	48	1176
TRANSPORT – WASHING – CUTTING SUGARBEETS	288	120	176	495	35	56	1170
RESOLUTION OF SECOND AND THIRD SUGAR-MASS	288	108	176	264	42	48	926
DRAINING	168	96	128	165	35	56	648
MAINTENANCE DELIVERY	120	72	96	165	49	104	606
PACKAGE – MARKING – STORAGE	144	60	96	165	42	64	571
FAILURE COST FACTORS	REWORK & REPAIR	DEFECTIVE PRODUCTS	CORRECTIVE ACTIONS	PRODUCT'S DESIGN	FAULTY CHEMICAL ANALYSES	REPLACEMENT OF PRODUCTS BY CUSTOMERS	
GRAVITY COEFFICIENT	24	12	16	33	7	8	

APPENDIX 12

PROCESS DOCUMENTATION

RAW MATERIAL PRODUCTION PROCESS	
Aim	The aim of the raw material production process is to be ensured the supply of the qualitative and quantitative appropriate raw material, which can be able to feed the sugar industry and can determine the basis of the prescribed sugar quota production.
Application area	The present process is applied in beets production and contains the Agricultural Department from the side of Sugar Industry and the beet-growers, as raw material suppliers
Responsibilities	Responsible is the manager of the Agricultural Department, who can assign part of his responsibilities to the agriculturists using geographic criteria.

RAW MATERIAL QUALITY CONTROL	
Aim	The aim of the raw material process control is: 1. The beet quality determination which is characterised of the concision of POL, Calcium, Sodium, toxic air, consists the measurement of these elements, either in produced or in adduced experimental beet samples. 2. The determination of beet POL which will underlie the «induced sugar» and the producer's payment
Application area	The present process is applied in raw material quality control and contains the Chemical Laboratories Department (C.L.D.) and the Agricultural Department of the Industry.
Responsibilities	Responsible for the raw material analysis is the Manager of C.L.D. and apposite is the shift-head of C.L.D. If there is no C.L.D. shift-head the responsibility goes to the Manager of C.L.D.

INSPECTION, MEASUREMENT AND TEST CHEMICAL EQUIPMENT CONTROL	
Aim	The aim of this process is the appropriate function of the measurement and test equipment, such as the production of the standard solutions that are used in quality control of industry products and subproducts. The calibration and maintenance of the gauges are neccesary.
Application area	This process is applied in all the gauges that can inspect, measure, test such as the standard solutions. This is a job of the C.L.D
Responsibilities	Responsible for this process is the Manager of the C.L.D. and apposite is the shift-head of the Chemical Laboratory.

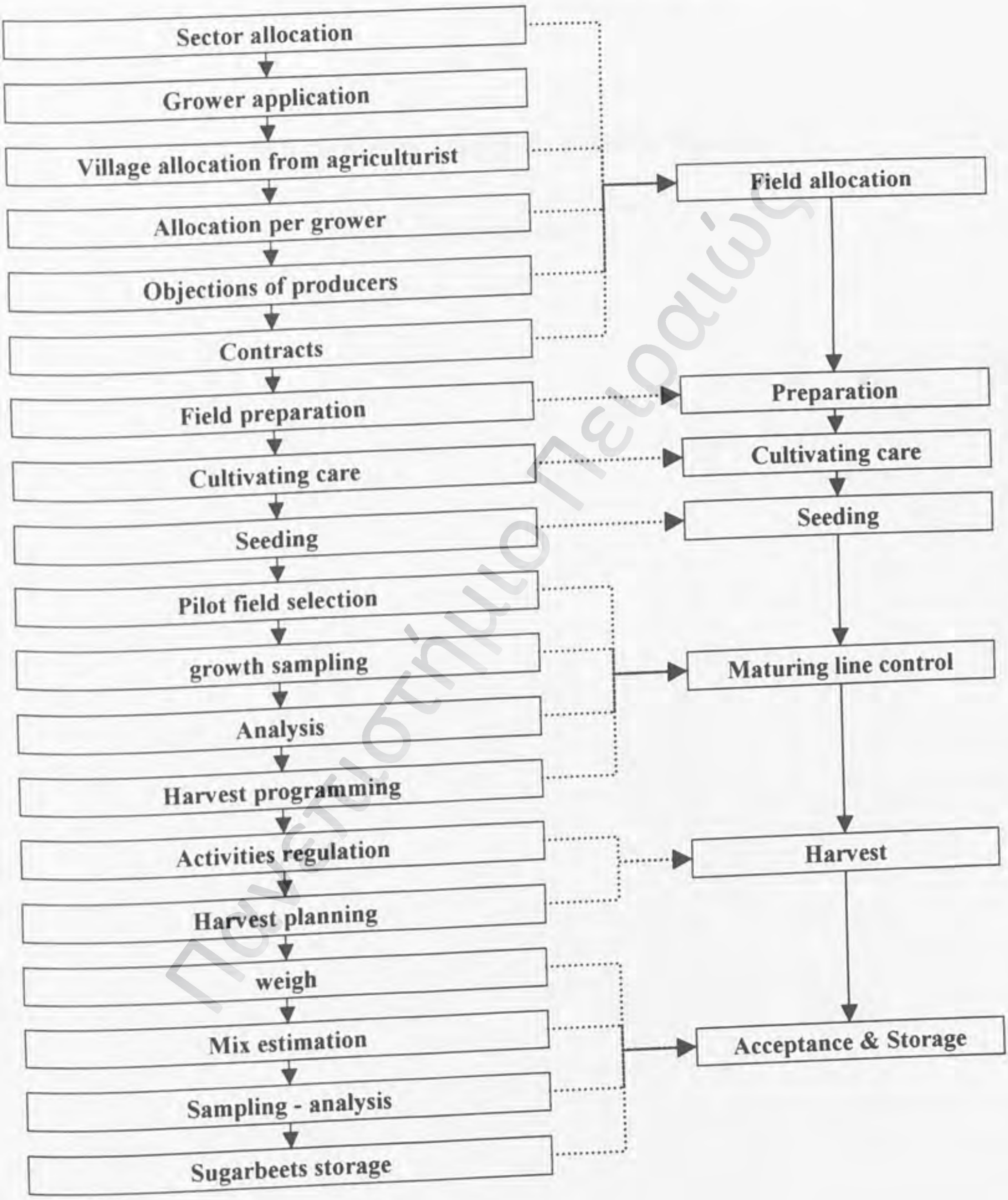
MEASUREMENT AND TESTS CONTROL	
Aim	The reliability of the reading and the elimination of the deviation during gauges' function.
Application area	Staff that belongs to the Electromechanical Department and accounts of measurement gauges serves this process.
Responsibilities	Responsible is the manager of the Electromechanical Department and apposite is the respective department foreman who is occupied with the measurement or test gauge. Co-apposite can also be the technician who is contained in the maintenance and calibration process.

ELECTROMECHANICAL SUPPORT IN PRODUCTION PROCESS	
Aim	The aim of this process is the sufficient function of the industry settlement and the equipment alertness. It also includes the technical supply by the side of Electromechanical Department (such as mechanical – greasing, electromechanical and automation supply).
Application area	This process is applied during the production function of the industry and indicates the Electromechanical Department.
Responsibilities	Responsible is the manager of the Electromechanical Department and apposite are the department foremen with their colleges-head-technicians and technicians who work during the day in shifts.

EQUIPMENT GAUGES AND SYSTEMS CONTROL – TECHNICAL EQUIPMENT SUPPORT	
Aim	The appropriate and sufficient function of all the automation equipment and systems during the production process and the maintenance process.
Application area	This process concerns the Electromechanical Department and especially the part specialised in automation.
Responsibilities	Responsible is the manager of the Electromechanical Department and apposite is the automation department foreman with his colleges-automation technicians.

APPENDIX 13

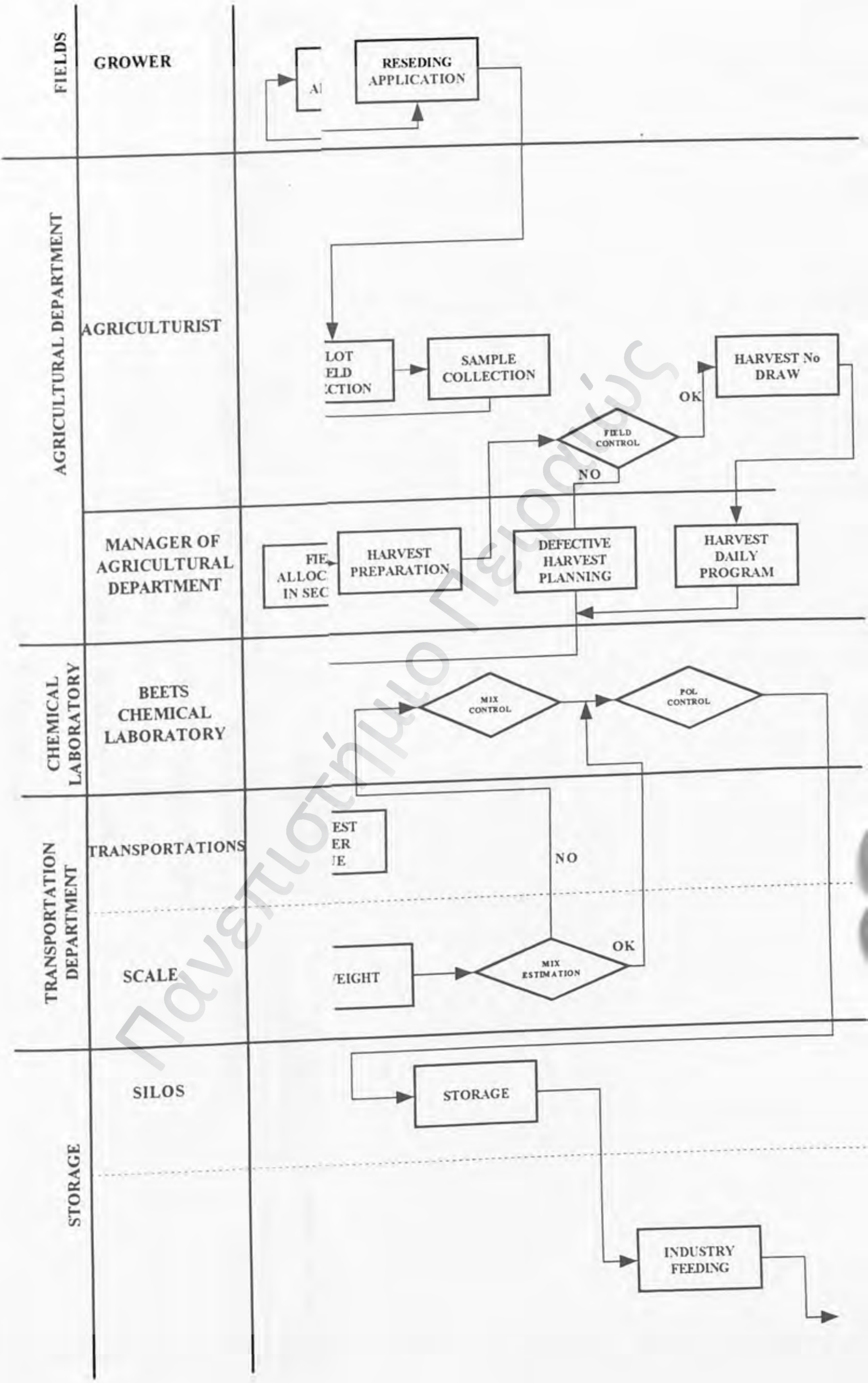
BLUEPRINT OF RAW MATERIAL PRODUCTION AND QUALITY CONTROL



APPENDIX 14

Process Map of sugarbeets production process

(see next page)


FIELDS
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DEFECTIVE HARVEST PLANNING
HARVEST DAILY PROGRAM
CHEMICAL LABORATORY
BEETS CHEMICAL LABORATORY
MIX CONTROL
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TRANSPORTATION DEPARTMENT
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STORAGE
INDUSTRY FEEDING

APPENDIX 15

PREVENTION COST

PRODUCT DESIGN DEVELOPMENT

CODE COST	ACTIVITIES	RESP. SECTOR	No OF EMPLOYEES	EMPLOYMENT TIME	HOURLY PAY
– ***design quality progress reviews*** – ***design support activities*** – ***product design qualification test*** – ***service design - qualification*** – ***field trials***	The process are served by a small experimental laboratory with limited capabilities	AGRICULTURAL DEP. EXPERIMENTAL LABORATORY Resp.: Manager of Agric.	Manager og Agr. 1 Agriculturists 4	Mar-Aug 160h **Sept 32h** Mar-Aug 4*64 h= 256h **Sept 4*16h= 64h**	3175*160= 508000 **4175*32= 132384** 3175*256= 808192 **4137*64= 264768**
TOTAL					**1.713.344**

OPERATIONS PREVENTION COSTS

CODE COST	ACTIVITIES	RESP. SECTOR	No OF EMPLOYEES	EMPLOYMENT TIME	HOURLY PAY
operations process validation ***operations quality planning***	1. Raw material production design which aimed on the industry specifications 2. Production inspection, test and control processes design and setup, system documentation 3. Process standard set-up	AGRICULTURAL DEP. Resp.: Manager of Agric.	Manager og Agr. 1 Agriculturists 4 Ass. Agriculturists 6	Jan-Aug 224h **Sept-Oct 64h** Jan-Aug 4*176h= 704h **Sept-Oct 4*40h= 160h** Jan-Aug 6*176h= 1056h **Sept-Oct 6*40h= 240h**	3175*224= 711200 **4137*64= 264768** 3175*70= 222250 **4137*160= 661920** 3175*1056= 3352800 **4137*240= 992880**
	Design and development of raw material production process quality measurement.	CHEMICAL LABORATORY DEPARTMENT (C.L.D.) Resp.: Manager of C.L.D.	Manager of CLD 1 Ass. Manager CLD 2 Analysts 3	10d*4h= 40h 2*10d*4h= 80h 3*10d*8h= 240h	3786*40 = 151440 3786*80 = 302880 1333*240 = 319920
TOTAL					**6.980.058**

OPERATIONS PREVENTION COSTS

COST CODE	ACTIVITIES	RESP. SECTOR	No OF EMPLOYEES	EMPLOYMENT TIME	HOURLY PAY
data analysis preventive actions	That matters because the data analysis and preventive actions take place from the beginning of the next process stage	AGRICULTURAL DEP. Resp.: Manager of Agric.	Manager og Agr. 1 Agriculturists 4 Ass. Agriculturists 6	Jan-Aug 176h **Sept-Nov 96h** Jan-Aug 4*80h= 480h **Sept-Nov 4*64h= 256h** Jan-Aug 6*120h= 720h **Sept-Nov 6*64h= 384h**	3175*176= 558800 **4137*96= 397152** 3175*480= 1524000 **4137*256= 1059072** 3175*720= 2286000 **4137*384= 1588608**
TOTAL					**7.413.632**
Calibration and maintenance of quality measurement and test equipment	e.g. polarimeter, scales, flaume-fotometer, colorimeter of beet chemical laboratory and solutions' and reagents' production control	CHEMICAL LABORATORY DEPARTMENT C.L.D.) Resp.: Manager of C.L.D.	Manager of CLD 1 Ass. Manager CLD 2 Analysts 3	**88d*0,8h= 70,4h** **2*88d*0,8= 140,8h** **3*2*88d*1,6h= 844,8h**	**4933*70,4= 347283** **4933*140,8= 694566** **1736*844,8= 1466572**
TOTAL					**2.508.421**
Calibration and maintenance of production equipment used to evaluate quality	Calibration and maintenance of production equipment used in automatic systems, electrological and mechanical setting	ELECTROMECHANIC DEPARTMENT (E/C) Resp.: Manager of E/C Dep. Manager E/C AUTOMATION SECT. Resp.: Foreman MECHANICS SECT. Resp.: Foreman ELECTROLOGY SECT. Resp.: Foreman	Manager of E/C 1 Dep. Manager E/C 1 Foremen (Aut) 3 Foremen (Mech) 3 Foremen (Elect) 3	**88d*0,16h= 14,08h** **88d*0,16= 14,08h** **3*88d*0,08h= 21,12h** **3*88d*0,04= 10,56h** **3*88d*0,04h= 10,56h**	**4786*14,08= 67387** **4786*14,08= 67387** **4786*21,12= 101080** **4786*10,56= 50540** **4786*10,56= 50540**
TOTAL					**352.448**

OPERATIONS PREVENTION COSTS

COST CODE	ACTIVITIES	RESP. SECTOR	No OF EMPLOYEES	EMPLOYMENT TIME	HOURLY PAY
design and development of quality measurement and test equipment	design and development of quality measurement and test equipment (POL measurement gauges in beet chemical laboratory, e.g. polarimeter, scales, ashesmeter etc.)	CHEMICAL LABORATORY DEPARTMENT C.L.D.) Resp.: Manager of C.L.D.	Manager of CLD 1 Ass. Manager CLD 2	2days*4h= 8h 2*2days*4h= 16h	3786*8= 30288 3786*16= 60576
		TOTAL			**90.864**
operations support quality planning	Design of quality processes that support the raw material production.	- PHYTOPATHOLOGY SECTOR - NOURISHMENT OBSERVATION LABORATORY	Manager og Agr. 1 Agriculturist 1	8days*8h= 64h 8days*8h= 64h	3175*64= 203200 3175*64= 203200
		TOTAL			**406.400**

QUALITY ADMINISTRATION

COST CODE	ACTIVITIES	RESP. SECTOR	No OF EMPLOYEES	EMPLOYMENT TIME	HOURLY PAY
– ***quality training*** – ***quality program planning*** – ***acquisition analysis and reporting of quality data*** – ***quality improvement*** – ***quality system audits***		QUALITY ASSURANCE DEPARTMENT Resp.: Manager of C.L.D.	Manager of CLD 1	16h	3175*16= 50800
		TOTAL			**50.800**

APPENDIX 16

APPRAISAL COST

OPERATIONS APPRAISAL COSTS

COST CODE	ACTIVITIES	RESP. SECTOR	No OF EMPLOYEES	EMPLOYMENT TIME	HOURLY PAY
set up inspections and tests	Controls that ensure the good situation of fields and equipment (seeding and spraying) in order to begin the raw material production process (seeding)	AGRICULTURAL DEP. Resp.: Manager of Agric.	Manager og Agr. 1 Agriculturists 4 Ass. Agriculturists 6	Feb,May,Aug 48h **Sept 16h** Feb,May,Aug 4*48h=192h **Sept 4*16h= 64h** Feb,May,Aug 6*48h=288h **Sept 6*16h= 96h**	3175*48= 152400 4137*16= 66192 3175*192= 609600 4137*64= 264768 3175*288= 914400 4137*96= 397152
TOTAL					**2.404.512**
planned operations, inspections, tests, audits	Raw material development and sugarbeets test processes. The test take place daily.	AGRICULTURAL DEP. Resp.: Manager of Agric.	Manager og Agr. 1 Agriculturists 4 Ass. Agriculturists 6 Seasonal Agriculturists 2	Jan-Aug 256h **Sept-Nov 200h** Jan-Aug 4*632h=2528h **Sept-Nov 4*400h=1600h** Jan-Aug 6*584h=3504h **Sept-Nov 6*400h=2400h** **2*113days*8h= 1808h**	3175*256= 812800 **4137*200= 827400** 3175*2528= 8026400 **4137*1600= 6619200** 3175*3504= 11125200 **4137*2400= 9928800** **1986*1808= 3590688**
	Control processes for: 1. the sugarbeets quality determination during the cultivation and 2. the POL determination during the raw material acceptance	CHEMICAL LABORATORY DEPARTMENT C.L.D.) Resp.: Manager of C.L.D. (sugarbeets chemical laboratory)	Manager of CLD 1 Ass. Manager CLD 2 Analysts 3 Workers-technicians 4	**88days*3,2h= 281,6h** **2*88days*3,2h= 563,2h** **3*2*88d*6,4h= 3379,2h** **4*2*88days*8h= 5632h**	**4933*281,6= 1389133** **4933*563,2= 2778266** **1736*3379,2=5866291** **1736*5632= 9777152**
TOTAL					**60.741.330**

OPERATIONS APPRAISAL COSTS

COST CODE	ACTIVITIES	RESP. SECTOR	No OF EMPLOYEES	EMPLOYMENT TIME	HOURLY PAY
process control measurement	It contains the equipment designed measures of the production line, according to prescribed standards. The control of automative equipment and systems, the mechanological and electrological settings is a Electromechanical department responsibility.	ELECTROMECHANIC DEPARTMENT (E/C) Resp.: Manager of E/C Dep. Manager E/C	Manager of E/C 1 Dep. Manager E/C 1	**88d*1,44h= 126,7h** **88d*1,44h= 126,7h**	**4786*126,7= 606386** **4786*126,7= 606386**
		AUTOMATION SECT. Resp.: Foreman	Foremen (Aut) 3	**3*88d*0,72h= 190,1h**	**4786*190,1= 909818**
		MECHANICS SECT. Resp.: Foreman	Foremen (Mech) 3	**3*88d*0,36h= 95,05h**	**4786*95,05= 454909**
		ELECTROLOGY SECT. Resp.: Foreman	Foremen (Elect) 3	**3*88d*0,36h= 95,05h**	**4786*95,05= 454909**
TOTAL					**3.032.408**
laboratory support	This is the labor cost that contains tests which are carried out for the Phytopathology Sector and Nourishment Observation Laboratory.	- PHYTOPATHOLOGY SECTOR - NURISHMENT OBSERVATION LABORATORY	Manager og Agr. 1 Agriculturist 1	March-Aug 192h March-Aug 600h	3175*192= 609600 3175*600= 1905000
TOTAL					**2.514.600**

PURCHASING APPRAISAL COSTS

COST CODE	ACTIVITIES	RESP. SECTOR	No OF EMPLOYEES	EMPLOYMENT TIME	HOURLY PAY
receiving or incoming inspections and tests	Quantitative (not qualitative) control of seed and pesticide acceptance and delivery to the growers.	ADMINISTRATION – FINANCE DEPARTMENT Resp.: Administration sector	Worker of Adm. Sec. 1 Seeds Pesticides	Febr-April 180h May-Aug 320h **Sept-Oct 160h**	2928*180= 527040 2928*320= 936960 **3815*160= 610400**
TOTAL					**2.074.400**
qualification of supplier product	Controls and tests in order to certificate the use of the purchased products (seeds and pesticide) in sugar beet production. Equivalence experiments in order to determine the seed performance in production.	AGRICULTURAL DEP. Resp.: Manager of Agric.	Manager og Agr. 1	March-Aug 160h **Sept-Nov 40h**	3175*160= 508000 **4137*40= 165480**
TOTAL					**673.480**

APPENDIX 17

INTERNAL FAILURE COSTS

OPERATIONS FAILURE COSTS

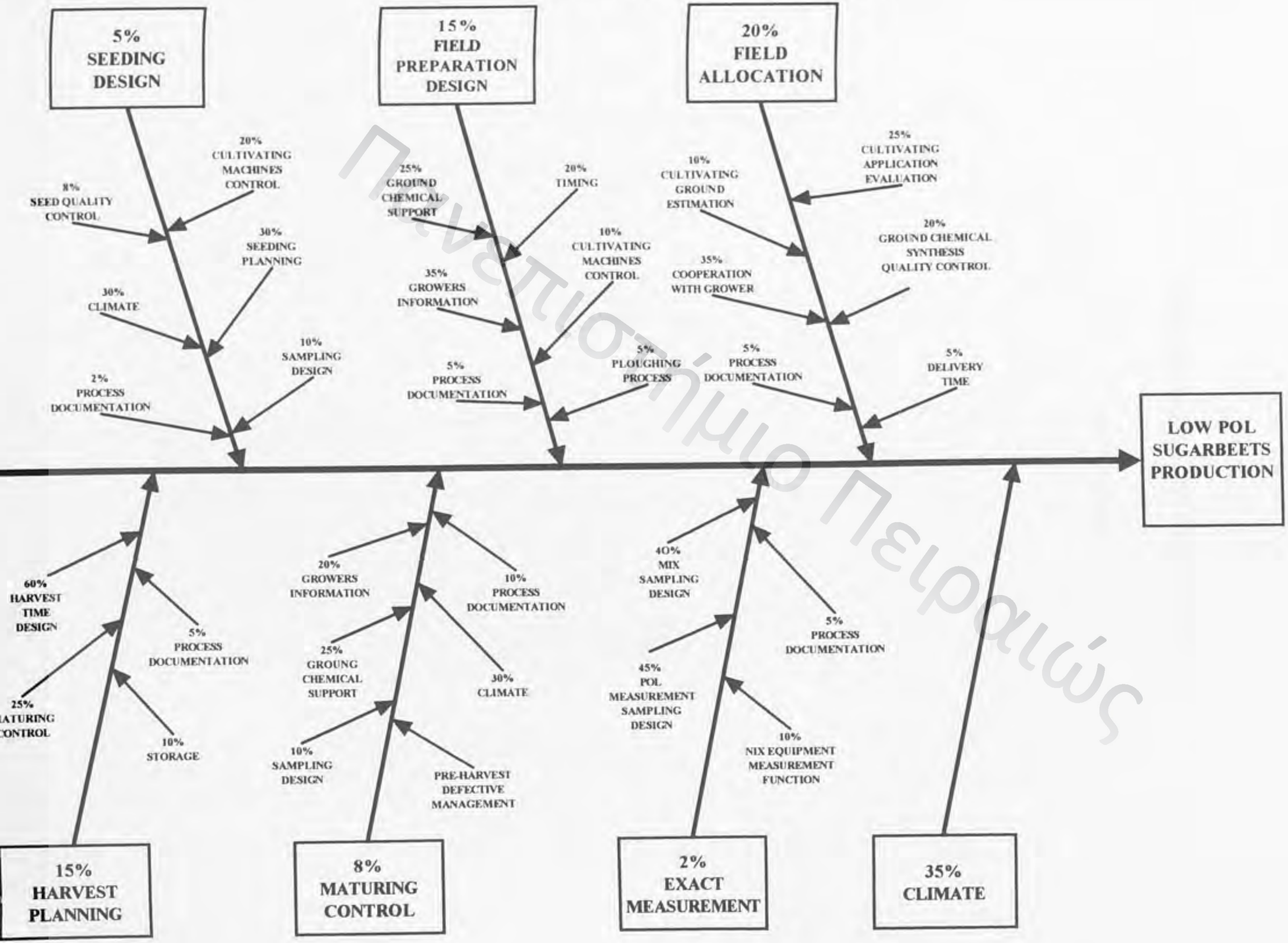
COST CODE	ACTIVITIES	RESP. SECTOR	No OF EMPLOYEES	EMPLOYMENT TIME	HOURLY PAY
operations corrective action	Corrective actions after inspections and analyses in order to eliminate defective products causes as: rearrangements of field allocation, seeding preparation, maturing and harvest control	AGRICULTURAL DEP. EXPERIMENTAL LABORATORY Resp.: Manager of Agric.	Manager og Agr. 1 Agriculturists 4 Assst. Agriculturists 6	Feb-Aug 112h **Sept-Nov 104h** Feb-Aug 4*140h= 560h **Sept-Nov 4*96h= 384h** Feb-Aug 6*124h= 744h **Sept-Nov 6*96h= 576h**	3175*112= 355600 **4137*104= 430248** 3175*560= 1778000 **4137*384= 1588608** 3175*744= 2362200 **4137*576= 2382912**
TOTAL					**8.897.568**
rework	It takes place during the seeding phase when field re-seeding is required.	AGRICULTURAL DEP. EXPERIMENTAL LABORATORY Resp.: Manager of Agric.	Manager og Agr. 1 Agriculturists 4 Assst. Agriculturists 6	Jan-May 24h Jan-May 4*72h= 288h Jan-May 6*72h= 432h	3175*24= 76200 3175*288= 914400 3175*432= 1371600
TOTAL					**2.362.200**
reinspection / retest costs	It concerns reinspections, recontrols, and tests from the agriculturists in order to determine the product acceptance after the rework or the corrective actions.	AGRICULTURAL DEP. EXPERIMENTAL LABORATORY Resp.: Manager of Agric.	Manager og Agr. 1 Agriculturists 4 Assst. Agriculturists 6	Feb-Aug 68h **Sept-Nov 64h** Feb-Aug 4*124h= 496h **Sept-Nov 4*80h= 320h** Feb-Aug 6*100h= 600h **Sept-Nov 6*80h= 480h**	3175*68= 215900 **4137*64= 264768** 3175*496= 1574800 **4137*320= 1323840** 3175*600= 1905000 **4137*480= 1985760**
TOTAL					**7.270.068**

APPENDIX 18

Cause and Effect diagram

(see next page)

CAUSE AND EFFECT DIAGRAM

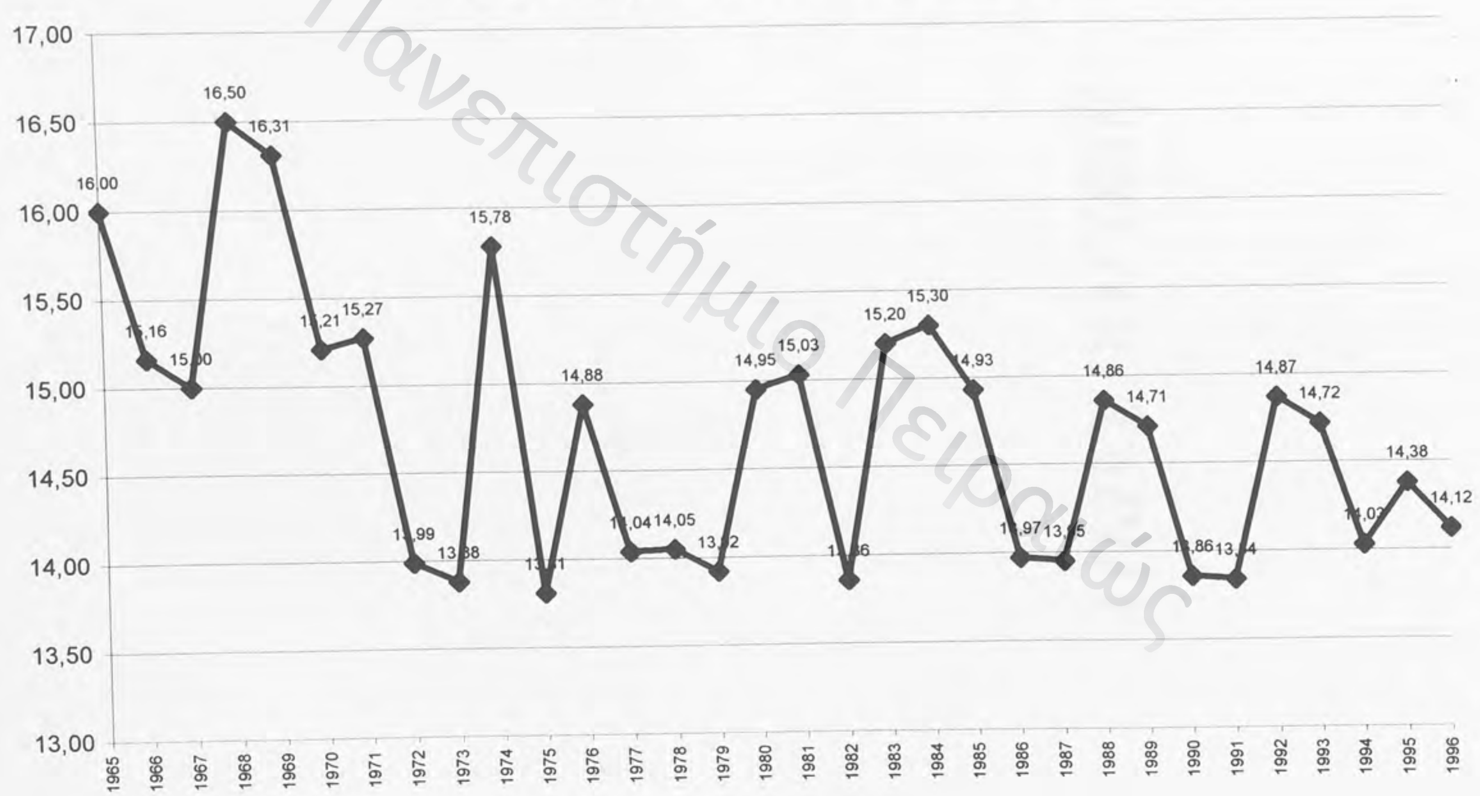


APPENDIX 19

POL of imported sugarbeets variance

(see next page)

POL of imported beets variance



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