

# VENDOR EVALUATION AND QUALITY AUDITING

By

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## Abstract

This thesis reveals the quality system elements that concerns the Saudi investors and other similar growing industries in the Arabian Gulf region where the subject of "quality" along with its associated subjects. As "Quality Control/Quality Assurance" and "quality audits" is still not properly defined among many vendors (manufacturers), they will eventually start to re-establish their quality systems with the increased competition through the rapid increase in the number of local manufacturers, and the new trend of the local consumers' needs towards the quality products.

A vendor ranking system that provides a final numerical value for each evaluated or audited vendor is provided. A ranking formula has been developed based on data collected from local vendors and specialists. This formulas is used in the vendor ranking process

The thesis provides a vendor evaluation program that can be utilized by any purchaser to evaluate his vendors in order to be sure that those vendors are capable pf producing the desired quality products.

A comprehensive audit program is also provided in this thesis. This program may assist any manufacturer to establish or re-establish his quality audit procedures that will assure compliance with his own quality audit requirements as an internal audit, or to assure his vendor's effectiveness and compliance with the applicable requirements, as external audits.

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## Introduction

During the past ten years, there has been substantial growth in the Saudi industries. With this growth, the competition in the market is increasing. It is expected, with the huge investments in the local industries, to notice a significant growth in the quantity and quality of the Saudi products within the next few years.

The high quality of vendors' products is an important factor to the success of the company's quality control function. Therefore, the quality commitment of vendors is essential. To achieve the company's goals through the quality assurance/quality control function, it is important to issue instructions and procedures for the evaluation, approval and auditing of incoming-material from suppliers or manufacturers.

The evaluation of the quality program is a joint vendor-vendee activity, and when properly accomplished, is mutually beneficial for all parties concerned. The vendor evaluates his quality program in order to be sure that the program is accomplishing its intended functions effectively and economically. The vendee, however, evaluates his vendor's

quality program in order to be sure that his vendor is capable of producing the desired quality product. In addition to that, he may establish a ranking system by providing a numerical value. This value, which will be assigned to each vendor, should have recognition and can be used as the basis of the vendee and vendor corrective action and vendor comparisons within the vendee's organization.

The owner (vendee) may establish a comprehensive audit program covering all phases of plant design, procurement, construction and operation, either within his organizational structure, or by contractual requirements. i.e. specified in the purchaser order to audit the vendor's facilities. The main objective of the quality audits is to assure compliance with the quality assurance program requirements.

This research will attempt to reveal the Quality System elements that concern the Saudi Industries and other similar growing industries in the Arabian Gulf region and will identify those factors that influence the products quality.

### 1.1 Statement of Problem

There are some companies in Saudi Arabia whose knowledge and experience in the field of quality is limited, especially in today's environment where much of the work requires technical expertise, special machines, capabilities, and materials.

This study should offer assistance to those companies and to newly established companies to set-up a Quality System that will evaluate the capabilities of vendors and subvendors to ensure the quality of incoming materials. It should help to establish a quality audit system that will effectively and progressively ensure the continuous flow of incoming materials.

### 1.2 Objectives

The main objectives of this research can be summarized as follows:

- Develop an Evaluation Framework that will assist in identifying the capabilities of a certain manufacturer to produce the purchased products.
- Develop a Vendor Ranking System that will comprise an effective incoming material control mechanism of the company.
- Develop a Quality Audit System that will measure the degree of effectiveness of quality operations of the Saudi vendors

### 1.3 Scope and Limitation

The scope of the study is limited to the manufacturers in the Eastern Province of Saudi Arabia (Dammam first and second Industrial Cities). Therefore, Questionnaire Population in this study only included those manufacturers (Vendors). There are a total of 153 manufacturers under operation in both industrial cities as listed in the latest records by the Industrial City Management.

In addition to the vendor's population, specialists with different disciplines will also be sampled, with efforts to include most of the local vendor's product disciplines. At least one specialist will represent quality procedures. Those specialists are from local organizations where rigid quality procedures are imposed such as Aramco, Bechtel, and Jubail Royal Commission.

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## Literature Review

### 2. General

"Total Quality Control" is a title of a book that was written by A. V. Feigenbaum (1). He lists nine basic areas that directly influence the quality of products and services, and named them as the "9 M's". These 9 M's are:

1. Markets
2. Money
3. Management
4. Men
5. Materials
6. Motivation
7. Machines and Mechanization
8. Modern Information Methods
9. Mounting Product Requirements

Fig. 2.1 shows the four jobs of product control; these are new design control, incoming materials control, product control, and special process studies.

The organization pattern of a particular type of manufacturing plant plays an important role in the effectiveness of the quality control function. Norbert Enrick (2) explains three different types of organizational approach. Enrick describes these patterns as follows:

1. Advisory organization: where inspectors, inspection supervisors, and other inspection specialist are organized as "process advisors" to production and engineering, without any authority.

2. Departmentalized organization: where definite duties and authorities are established in the form of an inspection and quality control department.
3. Top management function: where quality control is made as a functional part of top management. A quality chief is placed in a position similar to that of a controller.

Edward Fisher (5) outlines the following items as procurement planning objectives:

1. To determine:
  - WHAT is to be accomplished?
  - WHO is to accomplish it?
  - HOW it is to be accomplished?
  - WHEN it is to be accomplished
2. To accomplish:
  - a. Things as early as practicable
  - b. No later than the start of those activities which require control to assure interface compatibility and a uniform approach to the procurement process

### 1.1 Vendor Evaluation

There are at least three different types of vendor evaluation (4). These are: Informal use of records, After-The-Fact-Evaluation, and Before-The-Fact-Designed.

1. Informal use of records: gathering data from many sources such as journals, diaries, log books, or financial records, and knowing what happened in the past allow one to evaluate an event in order to make better decisions for the future.
2. After-The-fact-Evaluation: after an event has occurred, when a manager may ask? What happened? How did it happen? Why did it

succeed? or why did it fail? How well did it do? Answers to such questions normally provide data for decisions and future planning after an event has been completed.

3. Before-The-Fact-Designed, evaluation: this type occurs when the evaluator plans and starts gathering data early in the history of the project. Evaluation vendor capabilities can be an example of this type.

Frank Caplan (3) describes the vendor surveys and capability determination as important tasks to the purchaser's organization to determine, in advance, the ability of the vendor to produce quality products on schedule. When the material needed for production arrives late or is rejectable for quality reasons, it is too late to find out that the vendor is incapable of doing the job satisfactorily.

### 2.2 Vendor Rating (Ranking) and Certification

The vendor rating system, which is used worldwide by many companies, is explained by Feigenbaum (1) as a technique that provides vendor-to-vendor assessment, whereby each vendor is measured against another specific vendor or group of vendors for price, quality and delivery. Rating results are reported quarterly, and used to determine all future business activities with the vendor.

There are different types of vendor ratings established to fit the varying needs of plants and companies. The basic and widely used vendor rating plan weighs the key factors as follows:

Quality	40 points
Price	35 points
Service	25 points
	-----
Total	100 points

Where \*Quality rating is based on:

$$\frac{\text{Total Accepted Lots}}{\text{Total Delivered Lots}} \times 40$$

\*Price rating is:

$$\frac{\text{Lowest net price (any vendor)}}{\text{Price of vendor being rated}} \times 35$$

\*Service rating is based on the percentage of promises kept. If vendor kept 90% of his promises, then, service rating is equals  $0.90(25) = 22.5$

### 2.3 Quality Audit

Quality audit is evaluation to verify the effectiveness of the quality system, and to determine the degree to which objectives are being achieved. There are several different considerations in the establishment of quality audits to meet different quality program objectives, such as:

- Quality purpose: Including audits that may be directed to product; process, specific areas such as measurements, producers, and the quality system itself.
- quality-Audit performance: Including audits that may be performed by a single process control engineer, a group from the quality function, and others
  - Audit frequency: such as daily, weekly, monthly, quarterly on predetermined basis, or those without advanced notice.
  - Quality audit reporting and documentation: including that are quantitatively measured in index numbers or reported in a summary document with both quantitative and qualitative data, measured in terms of comparative trends showing improvement or deterioration, or evaluated in terms of performance standards.
  - Audit corrective action: including corrective actions explicitly identified by

product, area, process, time, schedule, and follow-up responsibility.

Spinder (6) indicates five typical classifications of audit which are:

- Internal: when organization audit a quality assurance program under its control and within is organizational structure.
- External: when organization audits a quality assurance program not under its control, and not within its organizational structure, such as supplier
- Pre-award: When audit of the quality assurance program of a potential supplier prior to the placement of the purchase order (PO) or contract.
- Post-award: When audit of the quality assurance program of a supplier is performed after the placement of the PO or contract
- Supplemental: These are special audits, in addition to regularly scheduled audits

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## Methodology

### 3.1 Evaluation Framework

3.1.1 The factors that influence the quality of products in Saudi Arabia, and the quality elements that should be considered in the Quality System were identified through studying the basic elements that were determined previously by others in different countries, and through data collected from local vendors and specialists. Machines, materials, and specialists are example of factors that may influence the quality, while design control, procurement control are examples of quality elements that may be included in a vendor's Quality System

- 3.1.2 All the common important Quality System elements (status of the production process), from the engineering design through the final assembly and packaging of the product, were identified along with their degree of importance from very important to very low.
- 3.1.3 From step 3.1.2, a check list common to most of the production processes was formulated using the average point value (weight) for each element as identified in step 3.2.2. This check list is to be used as the basis of the Evaluation Frame work. Site visits were conducted to obtain the checklist's required data through interviews, observations, and examinations or records. Ready mix concrete batch plant and asphalt batch plant, which are released to construction industry, were selected as a case studies
- 3.1.5 All the collected data were examined. Redesigning of the checklist was not necessary.
- 3.1.6 An Evaluation Framework that will assist in evaluating and determining the capabilities of the vendors was designed.

### 3.2 Vendor Ranking System

- 3.2.1 The intent was to use all the quality elements that have been considered in step 3.1.3 checklist as having integrated influence on the product, and prepare a separate questionnaire that will be distributed to vendors and specialists. The questionnaire will request assigning percentage weight to each quality element. However, almost none of the specialists or the vendors

who responded have added any other quality element other than what was listed in the questionnaire.

- 3.2.2 All the data required for step 3.2.1 were gathered from vendors and specialists and the recommended average point values for each quality element was established
- 3.2.3 The recommended ranking formula, that will be used to assign numerical value to each vendor was developed and fed into step 3.1.3 (evaluation checklist) and step 3.3.3 (quality audit system).

### 3.3 Quality Audit System

- 3.3.1 A list of elements that contribute to the Quality Audit process was prepared, using the list of elements as identified in 3.1.1, and the average point value (weight) for each element as identified in step 3.2.2.
- 3.3.2 The necessary formats for the quality were developed. The common evaluation checklist of section 3.1.3 can be utilized for the audit of each quality element.
- 3.3.3 The quality audit system was established

### 3.3 Sample Size

To obtain the proper sample size, the following formula (8) was used:

$$n = (ts / d)^2 / (1 + [(ts / d)^2 / N])$$

Where,

N = Sample Population  
n = Sample Size  
T =  $t_{\alpha / 2}$  is the abscissa of the normal curve that cuts off an area of the tails (normal distribution)  
s = Maximum standard deviation in proportion of estimation and equals  $p * q$ . in this case,  $p = 0.5$  and  $q = 0.5$   
d = The value of accuracy

Two methods of sampling were used, the "Stratification" and the "Expert Choice". The stratified sampling was used to obtain a great degree of representatives. The vendors were stratified into several subpopulations" according to their product class, electrical, mechanical, construction/civil, and structural product manufacturers. Then, the "Expert Choice" method of sampling was used to pick representative specialists. Although the required minimum sample was 16, the actual vendor's sample size was 27. The actual specialists' sample size was 14.

### Research and Findings

Questionnaires were handed to 30 vendors and 14 specialists with different disciplines.

#### 4.1 Data Collected

Data collected consists of: quality elements, quality factors, and source of vendors' quality system.

##### 4.1.1 Quality Elements

The degree of importance of each quality element (weight) as considered by vendors and specialists are shown in Tables 4.1 & 4.2. Degrees of importance used are: Very important (5), Important (4), Average (3), Low (2), and Very low (1).

##### 4.1.2 Quality Factors

Tables 4.3 & 4.4 show percent of specialists and vendors who identified the factors that influence their products and the average between the specialist's and vendors' percent.

#### 4.1.3 Source of Vendors' Quality System

Table 4.5 shows the source from which vendors have derived their quality systems

#### 4.2 DATA ANALYSIS

Analysis of the collected data is as follows:

##### 4.2.1 Quality Elements

Table 4.6 shows the average of weight identified by vendors and specialist.

##### 4.2.2 Ranking Formula

A ranking formula was developed based on the collected data.

$$R = [(W_1 \times S_1 + W_2 \times S_2 + W_3 \times S_3 \dots + W_e \times S_e)] / (E_s \times E_{N/A})$$

Where,

R = Ranking

$E_s$  = Number of elements that influence the quality

$E_{N/A}$  = Number of elements that are assigned "Not Applicable" during the evaluation (auditing)

$W_e$  = Weight of element or the degree of its importance

$S_e$  = Score, which should be assigned to each quality element during the evaluation.

Using the data in Table 4.6:

$$R_e = [90.3(S_1) + 81.5(S_2) + 87.6(S_3) + 92.7(S_4) + 84.4(S_5) + 79.4(S_6) + 82.6(S_7) + 82.8(S_8)] / (8 - E_{N/A})$$

Where  $S_1 \dots S_8$  denotes numbers in table 4.7.

##### 4.2.3 Quality Factors

Figure 4.1 illustrates a comparison between vendors' and specialists' opinions regarding the quality factors.

#### 4.2.3 Source of Vendors' Quality System

Figure 4.2 illustrates the percentage of vendors who have used different sources to prepare their own quality systems with almost half the vendors use affiliate's QC system as a source for their quality system. 30% of them use "ASME" or "API" and 19% use the QC system of their plants' equipment manufacturers. Some vendors use other American and/or European codes and standards.

#### 4.3 Findings

1. Both vendors and specialist do exhibit the same concern towards quality elements.
2. The specialists have assigned the Design Control as the highest weight (degree of importance) among other elements, while the Manufacturing Control as the second highest. The vendors have assigned the Manufacturing Control as the highest, the Incoming Material Control as the second highest, but the Design Control has become the fourth. The reasons may be one or a combination of the following:
  - a) Specialists normally consider the design drawings and/or specifications as the most important stage towards a quality product, while vendors consider the manufacturing as the most important stage because it reflects their job.
  - b) Local vendors use certain fixed specifications and drawings for long time without any revision, or updates.
  - c) The absence of R&D departments within the local vendors' organizations encourages the use of fixed

specifications and drawings that stay the same over and over without any changes or updates.

- d) Local vendors believe that those specification and drawings obtained from affiliate companies should stay the same without any changes or updates.
  - e) There are no engineering departments within some local vendors' organization.
  - f) Specialists who have responded to the questionnaires are working with large organizations where the Engineering Department is large and very important to the success of the company's business.
3. Only one vendor has added the "Quality System Audits" as a quality element. Another vendor has added the "End Use" as quality element.
  4. A structural specialist has added another element "Post Concreting operations (curing) and follow up tests on compressive strength after 28 days".
  5. The "Materials" was the most important quality factor for vendors, as 92% of the vendors have assigned it as a quality factor. "Market" follows with 88%. The third quality factor was "Machines & Mechanization" with 80% of vendors' selection. Only 56% of the vendors have assigned "Management" factor. The least important factors were "Money" and "Modern Information Methods" which have been assigned by 40% of the vendors. This indicates that large percentage of local vendors do not feel the need for new automation and mechanization that will get cost reductions, and the use of the computer is still not common in their manufacturing. This may need to conclude that large percentage



of local industry is still not sophisticated and complex to use new computerized machines.

6. All the specialists (100%) have circled "management" and "men" as quality factors, while 93% have assigned "Materials". "Motivation", "Machines and Mechanization", and "Market" come later with around 75% of the specialist have assigned these factors.
7. Forty four percent (44%) of the local vendors use their affiliate company's QC system as a source for their quality system; this indicates that large number of companies still depends on their affiliates.
8. "ASME" or "API" codes and standards are utilized by 30% of the vendors. While 19% of the vendors' quality systems are derived from their plant equipment manufacturers' QC system. Other vendors are utilizing other American or European codes and standards.

#### 4.3 Discussion of Findings

Almost all audited people who were contacted to fill out the questioners or interviewed were expatriates, with different native languages, education, background, and training. However, the English language was dominant among these people. The development and implementation of the vendors' quality systems were greatly influenced by those people.

Most of the quality elements listed in the questionnaires are supposed to be part of the quality system of some vendors, however, they were not considered by those vendors. And although most of the quality elements listed in the questionnaires should really influence the quality of some vendors, they were not considered by those vendors.

Some vendors, especially ready-mixed concrete and hot-mix asphalt concrete, where their products performance will appear later after

a few years, are encouraged to provide substandard products knowing that it will fail after some years, or because of lack of experience, or they will not be liable of any unsatisfactory results. For example, providing raw mixing water for the concrete instead of sweet water, or using aggregate that have soundness values exceeding the requirements.

### **Vendor Evaluation and Quality Auditing Program:**

#### **Vendor Evaluations**

The vendor evaluation and quality auditing should define the means of evaluating the capabilities of local manufacturers in Saudi Arabia and other manufacturers in the Arabian Gulf with similar manufacturing environment, and also means of auditing their quality systems.

#### **5.1 Vendor Evaluation vs. Quality Auditing**

Both vendor evaluation and quality auditing have similar activities, but different purposes or objectives. Similarities and differences are shown in Table 5.1.

#### **5.2 Vendor Evaluation**

The vendee has the responsibility to evaluate his vendor's quality performance to ensure that the vendor is capable of producing the desired quality product. Vendors should be prepared to institute a quality system necessary to ensure that their products or services conform to requirements and are delivered on schedule at the agreed price (12).

##### **5.2.1 Sequence of Activities**

Figure 5.1 shows the sequence of these activities, which practically follows the sequence of 4 main tasks. Identification of vendor, method of evaluation, and evaluator/team participants as the 1<sup>st</sup> task, then followed by

evaluation preparation, evaluation (survey) performance and finally evaluation reporting.

### 5.2.2 Evaluation Parameters

The Quality Management, QA/QC Program, and Product Evaluation are the three basic parameters to consider for a successful evaluation. Fig 5.2 illustrates schematically the role of each parameter.

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#### **Vendor Evaluation and Quality Auditing Program:**

##### **Quality Auditing**

The quality audit can be carried out internally by vendor's personal or independent auditing agency or externally by vendee representatives. Established systems of any vendor need to be periodically reviewed and evaluated by the vendee to ensure their effectiveness and compliance with applicable requirements. The audit is to be formulated to bring the vendor's conformability to an acceptable level.

Figure 6.1 shows the sequence of Audit Flowchart. Figure 6.2 shows quality audit format. Fig 6.3 shows corrective action format,

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#### **CONCLUSION AND RECOMMENDATIONS**

##### **7.1 CONCLUSION**

The rapid increase in the world competition and the increased customer needs are the two main factors that enforce the industries to redevelop or re-reestablish their quality standards. Any company to stay in business will have to change its traditional practices to produce products that meet the clients' needs on time and reasonable price. Therefore it is advisable that the Saudi or Gulf industries to re-establish their quality systems as soon as possible before it is too late.

The following are suggestions to improve the product quality of local vendors:

- Get top management commitment
- Review/revise the quality system and/or procedures
- Encourage team work
- Help to redevelop or reestablish the quality elements that constitute QA/QC program
- Establish early engineering involvement
- Provide free training/recognition policy to increase the quality competition
- Establish effective follow-up system

##### **7.1 Recommendations**

The vendor evaluation and quality auditing program has been established on the basis of the quality elements that were part of the data collected from the vendors and specialists. The quality factors that influence the quality of local products were also part of the data collected. However, these quality factors were not used to establish the vendor evaluation and quality auditing program. Further studies regarding any quality subject of local products may benefit from these quality factors as collected from both vendors and specialists.

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##### **Acknowledgment**

The writer appreciates the support of the class's professor during my study in construction contractor course.

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# INTRODUCTION

## ■ **History**

During the past ten years, there has been substantial growth in the Saudi industries. With this growth, the competition in the market is increasing. It is expected, with the huge investments in the local industries, to notice a significant growth in the quantity and quality of the Saudi products within the next few years.

## ■ **Quality Commitment**

The high quality of vendors' products is an important factor to the success of the company's quality control function. Therefore, the quality commitment of vendors is essential. To achieve the company's goals through the quality assurance/quality control function, it is important to issue instructions and procedures for the evaluation, approval and auditing of incoming-material from suppliers or manufacturers.

## ■ **Vendor-Vendee Relationship & Responsibility**

The evaluation of the quality program is a joint vendor-vendee activity, and when properly accomplished, is mutually beneficial for all parties concerned.

- The vendor evaluates his quality program in order to be sure that the program is accomplishing its intended functions effectively and economically.
- The vendee, however, evaluates his vendor's quality program in order to be sure that his vendor is capable of producing the desired quality product.
- The vendee may establish a comprehensive audit program covering all phases of plant design, procurement, construction and operation, either within his organizational structure, or by contractual requirements. i.e. specified in the purchaser order to audit the vendor's facilities. The main objective of the quality audits is to assure compliance with the quality assurance program requirements.

## **STATEMENT OF PROBLEM**

- Limited Experience
- Study Help

## **OBJECTIVES**

- Develop an Evaluation Framework
- Develop vendor ranking system
- Develop quality audit system

## **SCOPE AND LIMITATION**

- The scope of the study is limited to the manufacturers in the Eastern Province of Saudi Arabia

## TOTAL QUALITY CONTROL

- The direct influence on quality (9 M's)
    - Markets
    - Money
    - Management
    - Men
    - Materials
    - Motivation
    - Machines and Mechanization
    - Modern Information Methods
    - Mounting Product Requirements
  
  - Four jobs of product control (production cycle)
    - New design control
    - Incoming material control
    - Product control
    - Special process studies
  
  - Planning objectives
3. To determine:
- WHAT is to be accomplished?
  - WHO is to accomplish it?
  - HOW it is to be accomplished?
  - WHEN it is to be accomplished
4. To accomplish:
- c. Things as early as practicable
  - d. No later than the start of those activities which require control to assure interface compatibility and a uniform approach to the procurement process

## VENDOR EVALUATION

There are at least 3 different types of vendor evaluation

- Informal use of records
- After-The-fact-Evaluation
- Before-The-Fact-Designed, evaluation

## VENDOR RATING (RANKING) AND CERTIFICATION

- Quality            40 points
- Price                35 points
- Service            25 points
- Total                100 points

Where        \*Quality rating is based on:

$$\frac{\text{Total Accepted Lots}}{\text{Total Delivered Lots}} \times 40$$

\*Price rating is:

$$\frac{\text{Lowest net price (any vendor)}}{\text{Price of vendor being rated}} \times 35$$

\*Service rating is based on the percentage of promises kept. If vendor kept 90% of his promises, then, service rating is equals  $0.90 (25) = 22.5$



## **QUALITY AUDIT**

Typical Classifications of Audit

- o Internal
- o External
- o Pre-award
- o Post-award
- o Supplemental

## **EVALUATION FRAMEWORK**

Factors that influence the quality were pre-determined (OOK) and through local data collected (questionnaires).

- Checklist was formulated using average point value for each element.
- collected data were examined
- An Evaluation Framework that will assist in evaluating and determining the capabilities of the vendors was designed

## **VENDOR RANKING SYSTEM**

To assign percentage weight to each quality system, questionnaire will be distributed to vendors and specialists.

Data required were gathered and recommended average point values for each quality element was established.

Recommended ranking formula, that will be used to assign numerical value to each vendor was developed and fed.

## **SAMPLE SIZE**

$$n = ( ts / d )^2 / (1 + [ ( ts / d)^2 / N ]$$

Where,

N = Sample Population

n = Sample Size

T =  $t_{\alpha / 2}$  is the abscissa of the normal curve that cuts off an area of the tails (normal distribution)

s= Maximum standard deviation in proportion of estimation and equals  $p * q$ . in this case,  $p = 0.5$  and  $q = 0.5$

d = The value of accuracy

Two methods of sampling, the "Stratification" and the "Expert Choice" were used.

The stratified sampling was used to obtain a great degree of representatives. The vendors were stratified into several subpopulations" according to their product class, electrical, mechanical, construction/civil, and structural product manufacturers.

The "Expert Choice" method of sampling was used to pick representative specialists.

## Research and Findings

Questionnaires were handed to 30 vendors and 14 specialists with different disciplines.

- **Data Collected**

Data collected consists of: quality elements, quality factors, and source of vendors' quality system.

- **Quality Elements**

The degree of importance of each quality element (weight) as considered by vendors and specialists are shown in Tables 4.1 & 4.2. Degrees of importance used are: Very important (5), Important (4), Average (3), Low (2), and Very low (1).

- **Quality Factors**

Tables 4.3 & 4.4 show percent of specialists and vendors who identified the factors that influence their products and the average between the specialist's and vendors' percent.

- **Source of Vendors' Quality System**

Table 4.5 shows the source from which vendors have derived their quality systems.

- **Quality Elements**

Table 4.6 shows the average of weight identified by vendors and specialist.

## Ranking Formula

A ranking formula was developed based on the collected data.

$$R = [(W_1 \times S_1 + W_2 \times S_2 + W_3 \times S_3 \dots + W_e \times S_e)] / (E_s \times E_{N/A})$$

Where,

R = Ranking

$E_s$  = Number of elements that influence the quality

$E_{N/A}$  = Number of elements that are assigned "Not Applicable" during the evaluation (auditing)

$W_e$  = Weight of element or the degree of its importance

$S_e$  = Score, which should be assigned to each quality element during the evaluation.

Using the data in Table 4.6:

$$R_e = [90.3(S_1) + 81.5(S_2) + 87.6(S_3) + 92.7(S_4) + 84.4(S_5) + 79.4(S_6) + 82.6(S_7) + 82.8(S_8)] / (8 - E_{N/A})$$

Where  $S_1 \dots S_8$  denotes numbers in table 4.7.

- **Quality Factors**

Figure 4.1 illustrates a comparison between vendors' and specialists' opinions regarding the quality factors.

- **Source of Vendors' Quality System**

Figure 4.2 illustrates the percentage of vendors who have used different sources to prepare their own quality systems with almost half the vendors use affiliate's QC system as a source for their quality system. 30% of them use "ASME" or "API" and 19% use the QC system of their plants' equipment manufacturers. Some vendors use other American and/or Europeans codes and standards.

## Findings

9. Both vendors and specialist do exhibit the same concern towards quality elements.
10. The specialists have assigned the Design Control as the highest weight among other elements, while the Manufacturing Control as the second highest.
11. The vendors have assigned the Manufacturing Control as the highest, the Incoming Material Control as the second highest.
12. Only one vendor has added the "Quality System Audits" as a quality element. Another vendor has added the "End Use" as quality element.
13. A structural specialist has added another element "Post Concreting operations (curing) and follow up tests on compressive strength after 28.

14. The "Materials" was the most important quality factor for vendors, as 92% of the vendors have assigned it as a quality factor.
15. All the specialists (100%) have circled "management" and "men" as quality factors.
16. Forty four percent (44%) of the local vendors use their affiliate company's QC system as a source for their quality system.
17. ASME or API codes and standards are utilized by 30% of the vendors.

## **Discussion of Findings**

1. Almost all audited people who were contacted to fill out the questioners or interviewed were expatriates, with different native languages, education, background, and training. However, the English language was dominant.
2. Most of the quality elements listed in the questionnaires are supposed to be part of the quality system of some vendors, however, they were not considered by those vendors.
3. Some vendors, especially ready-mixed concrete and hot-mix asphalt concrete, where their products performance will appear later after a few years, are encouraged to provide substandard products knowing that it will fail after some years, or because of lack of experience, or they will not be liable of any unsatisfactory results.

## **Vendor Evaluations**

The vendor evaluation and quality auditing should define the means of evaluating the capabilities of local manufacturers in Saudi Arabia and other manufacturers in the Arabian Gulf.

Both vendor evaluation and quality auditing have similar activities, but different purposes or objectives. Similarities and differences are shown in Table 5.1.

### **Vendor Evaluation (Sequence of Activities)**

Figure 5.1 shows the sequence of these activities, which practically follows the sequence of 4 main tasks.

### **Evaluation Parameters**

The Quality Management, QA/QC Program, and Product Evaluation are the three basic parameters to consider for a successful evaluation. Fig 5.2 illustrates schematically the role of each parameter.

## **Conclusion and Recommendations**

### **Conclusion**

The rapid increase in the world competition and the increased customer needs are the two main factors that enforce the industries to redevelop or re-reestablish their quality standards.

Any company to stay in business will have to change its traditional practices to produce products that meet the clients' needs on time and reasonable price.

The following are suggestions to improve the product quality of local vendors:

- Get top management commitment
- Review/revise the quality system and/or procedures
- Encourage team work
- Help to redevelop or reestablish the quality elements that constitute QA/QC program
- Establish early engineering involvement
- Provide free training/ recognition policy to increase the quality competition
- Establish effective follow-up system

### **Recommendations**

The vendor evaluation and quality auditing program has been established on the basis of the quality elements that were part of the data collected from the vendors and specialists.

The quality factors that influence the quality of local products were also part of the data collected. However, these quality factors were not used to establish the vendor evaluation and quality auditing program.

Further studies regarding any quality subject of local products may benefit from these quality factors as collected from both vendors and specialists.