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ISTANBUL TECHNICAL UNIVERSITY ★ INSTITUTE OF SCIENCE AND TECHNOLOGY

**INTEGRATED SYSTEMS FOR QUALITY IN
BUILDING DESIGN PROCESS:
QUALITY- ENVIRONMENT- SAFETY MANAGEMENT**

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PREFACE

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ABBREVIATIONS

UNCED	1992 United Nations Conference on the Environment and Development
SAGE	1991 Strategic Advisory Group for the Environment
ISO	International Organization for Standardization
TC	Technical Committee
BSI	British Standard Institute
BS	British Standards
CIA	Chemical Industries Association
SHEMS	Safety, Healthy, and Environment Management System
EU	European Union
EMAS	Eco- Management and Audit Scheme
CEN	Comite European de Normalisation
IEC	International Electrotechnical Commision
A/E	Architecture/ Engineer
CII	Construction Industry Institute
QA	Quality Assurance
TQM	Total Quality Management
QFD	Quality Function Deployment
HOQ	House of Quality
EMS	Environmental Management System
IMS	Integrated Management System
NSAI	National Standards Authority of Ireland
TCA	Turkish Contractors Association
QMFT	The Quality Management Task Force
CII	Construction Industry Institute
QPMS	Quality Performance Management System

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SUMMARY

In today's world, the importance of the international standards has been accelerated by the help of the competitiveness. Especially, ISO 9000 Quality Management System, which started with inspection concept and developed rapidly until today, has been used for years in a wide area consists of the construction industry. In recent years, the increasing the rivalry through the international projects, assuming the customer focused production, and the rising the market place in the world trade have ensured to occur the targets which based on the quality concept. By development of the advanced management systems, increase of the technological opportunities and improvement of the systems based on the high customer satisfaction, another concept which will directly affect the quality have been started to be discussed. These are the concepts of environment and safety which are very important in construction industry. Apart from this, ISO 14001:1996 Environmental Management System and OHSAS 18001:1999 Occupational Health and Safety Management System, which can be integrated with ISO 9000 Quality Management Systems, have came out. Especially, after the year of 2000's, integration of the systems and standards as three in one or two in one have been emphasized in the construction industry.

With this scope, a method was followed among the general structure of the thesis which comprises a literature view on each international standard and their integrated versions in construction sector. The core objective of this thesis is, determining the benefits of integrated systems in the design stage of the construction, investigating the reflections and impacts of this system to the design phase and researching how these systems can be used in this stage effectively and successfully.

The thesis consists of seven chapters. In the first part of the thesis, as appropriate to the goal of the study, quality concept evolution was explained beginning from past to present and the role of the quality was generalized from inspection to the integrated systems. In the second chapter, before explanation of the integrated standards, quality definitions and definitions derived from the quality at last decades were presented as literature review.

In the third chapter of the thesis, the international standards were generally defined, and then, the international standards of ISO 9001:2000 Quality Management System, ISO 14001:1996 Environment Management System and ISO 18001:1999 Occupational Health and Safety Management System were explained respectively. Also the benefits of these systems in construction industry were dwelt upon essentially. After that, the integration of all the three standards and its benefits in general and in construction industry was explained in the forth chapter.

The fifth chapter is the core part of the thesis that the literature review about the concepts – quality, environment, and safety -, which would ensure to reach the information of implementation of the integrated systems through the design phase, was presented. In this chapter serving this aim, firstly the design process, design management; and constraints and problems that could be occurred during this process were broadly outlined. Then, the concepts of quality, environment and safety which are the fundamentals of the integrated systems and which have an important role in this integration, was explained separately through design.

In the sixth chapter, a case study was investigated to understand the process of the integrated system, outlined widely in previous chapters, practically in the construction companies and especially in the design .This questionnaire study was applied to top ten construction companies which have all three standards in their organizations and recorded to the Turkish Contractors Association. The questionnaire consists of two parts, one of which highlights the benefits of the integrated systems through the construction companies' view and the one which dwells upon the importance, reflections and the impacts of the integrated system in the design stage of the construction. In this chapter, the responses of the questions were illustrated by tables and bar hart diagrams.

In conclusion, the findings of the case study were discussed in the view of the literature search. The evaluations are made on the responses of ten companies' system directors, on findings of the case study, respectively. Then some general proposals were explained according to the conclusions.

ÖZET

Günümüzde, uluslararası standartların önemi, rekabetçi dünya piyasasında gittikçe ivme kazanmaktadır. Özellikle 1900'lerin ilk çeyreğinde muayene ile başlayan ve günümüze kadar gelişerek gelen, toplam kalite yönetiminin son durağı olan ISO 9000 serisi Kalite Yönetim Sistemleri standartları, inşaat sektörünü de içine alan geniş bir endüstri yelpazesinde yıllardır kullanılmaktadır. Son yıllarda inşaat sektöründe yurt dışı işlerde rekabetin üst seviyelere tırmanması, müşteri odaklı üretimin benimsenmesi ve dünya sektöründeki pazar paylarının artış göstermesi, firmalar arasında kaliteyi baz alan hedeflerin ortaya çıkmasını sağlamıştır. Çeşitli ileri düzeyde yönetim sistem konseptlerinin geliştirilmesi, teknolojik imkanların artması ve kalite bazlı müşteri memnuniyetine dayalı sistemlerinin ortaya çıkarılmasıyla, kaliteyi doğrudan etkileyecek başka etkenlerin de olması gerektiği üzerinde durulmuştur. Bu faktörler, özellikle inşaat sektöründe çok önem taşıyan çevre ve güvenlik tanımlamalarıdır. Bundan yola çıkarak, son yıllarda kalite sistemleri ile bütünleştirilebilecek ISO 14001:1996 Çevre Yönetimi ve OHSAS 18001:1999 Güvenlik Yönetimi sistemleri gündeme gelmiştir. Özellikle 2000'li yıllardan sonra hem ikili hem de üçlü olarak standartlar arasında bütünleme sağlanmaya başlanmıştır.

Bu kapsamda çalışmada, standartların inşaat sektöründe gelişimine yönelik literatür çalışmasının yapıldığı ve her bir sistemin hem ayrı ayrı, hem de bütünleşik olarak ele alındığı bir anlatım metodu izlenmiştir. Çalışmada asıl amaç, bütünleşik sistemlerin inşaat firmalarında tasarım sürecinde kullanılmasının getirdiği yararları belirlemek; bu sistemlerin tasarım sürecine yansımalarını incelemek ve bu süreçte sistemlerin ne kadar etkili kullanılabileceğini araştırmaktır.

Tezin ilk bölümünde, çalışmanın amacına ve önemine yönelik olarak kalitenin geçmişten günümüze bütünleşik sistemlerdeki rolüne değinilmekte ve diğer sistemlerle olan ilişkisi tanıtılmaya çalışılmaktadır. İkinci bölümde ise, kalite kavramı ve son zamanlarda bu kavramdan türeyen tanımlara yer verilmektedir.

Üçüncü ve dördüncü bölümlerde, uluslararası standartlar hakkında genel bilgi verilerek, bu standartların ikili, üçlü kullanılmalarının inşaat sektöründe sağlayacağı yararlar üzerinde durulmaktadır. Bu kapsamda, sırasıyla ISO 9001:2000 Kalite Yönetim Sistemi, ISO 14001:1996 Çevre Yönetim Sistemi ve son olarak da OHSAS18001:1999 Güvenlik Yönetimi Sistemi tanımlanmaktadır.

Beşinci bölüm, araştırmanın bütünleşik sistemlerin tasarım aşamasında kullanılmasına zemin hazırlayacak kavramlardan bahsedilen bölümdür. Bu bölümde tasarım süreci, tasarım yönetimi ve bu süreçte ortaya çıkabilecek problemler ve sınırlamalar tanımlanmıştır. Daha sonra bu problemlerin minimize edilmesinde büyük paya sahip

olacak olan bütnleřik sistemleri oluřturacak kavramlar –kalite, evre, gvenlik- ayrı ayrı tasarım baęlamında ele alınmıřtır.

Literatrden yapılan bu teorik arařtırmanın pratikte nasıl iřledięini grmek iin altıncı blmde bir saha alıřmasına yer verilmektedir. Bu saha alıřmasında, Trk Mteahhitler Birlięi'ne ye firmalardan, her  standarda da sahip olanların arasından en byk 10 firma seilerek anket uygulaması yapılmıřtır. Anket iki blmden oluřmaktadır. Birinci blmde btnleřik sistemlerin kullanılmasının yararlarına ynelik iki soru ve alt bařlıkları yer almaktadır. İkinci blmde ise amaca ynelik olarak btnleřik sistemlerin pratikte tasarım ařamasında kullanılmasına ynelik sorulara yer verilmiřtir. Bu blmde bu anket alıřmasının cevapları tablolar ve ubuk diyagramlarla grselleřtirilmiřtir.

Son blm, ilk blmlerde irdelenen ierięin, altıncı blmde yapılan anket bulgularının iřıęında tartıřılmasına ayrılmaktadır. Bu tartıřmada, Trk inřaat firmalarının btnleřik sistemler ve standartlar hakkındaki temel fikirleri, ankette verilen cevaplar doęrultusunda deęerlendirilmekte, ve genel olarak neriler sunulmaktadır.



1. INTRODUCTION: Why do we need integrated standards and their management systems in building construction?

Standard is a kind of reference which determines the quality of similar procedures and products' technical and non-technical specifications. International standard is the standard which is accepted in the era of borderless trade and is very important for achieving competitiveness and having a permanent situation in the world market. In various industries, appropriateness of the standards is the main factor for ensuring the high product quality and for giving the companies and also the countries a chance of being a trademark. Serving this aim, many industries around the world have raced against each other to have these standards in their organizations. Over the last decade, with the high competitiveness and the globalization, construction industry has gained a considerable position among other industries. Moreover, the wide range of construction activities and the high amount of service scope give this industry the features of complexity, and dynamism. Besides, it accommodates many factors inside its structure like human, which makes the quality concept unavoidable in the international market. Because of these characteristics, construction industry needs to be in a position of highly standardized and managed.

The well known and accepted standards for construction and (also other industries) is the ISO 9001 (International Organization for Standardization) standards which was first published in 1987 after a process of consensus, handled by ISO European Technical Committee 176 and since that date, more than 150 countries throughout the world have adopted the ISO 9000 standards. ISO 9001 specifies requirements and recommendations for the design and assessment of quality management system (QMS). Actually ISO 9001 standards are the last point of a process which was started at the first quarter of 19. Century by the inspection and lasted as quality control, quality assurance and total quality management which has been started to

be met frequently as the advanced management systems in last decades, especially in Europe.

By the development of this ISO 9001 quality management standard, over the last ten years, and arising of other factors like environment and safety, which are the most important levels for achieving the high quality in construction, the same principles of audited management systems have been extended to the avoidance of environmental risks in the ISO 14001 standard and the management of occupational health and safety in OHSAS 18001 guidelines. Both of these documents are prepared in such a manner that they can be used alone or integrated with ISO 9001. At the beginning, the integration was between both ISO 9001 and ISO 14001 or ISO 9001 and OHSAS 18001. But for several years, these standards and related management systems have started to hold up as three in one approach –integrated management system which seeks to combine similar aspects of different standards in order to simplify management procedures, minimize paperwork and reduce costs in construction industry. The quality, environment and safety (QES), previously managed separately under different sections involving quality, environmental concerns, and safety, is now collectively grouped into one department responsible for implementation and maintenance of ISO 9000, ISO 14000, and OHSAS 18000 rules and regulations. Merging of the functions into a one-body system helps the company to synergize their closely related activities so as to improve productivity and quality.

In the literature, these systems in construction sector generally hold up by containing only the construction stage. Most of the datum and the applications incline the construction phase. There is limited data about the reflections of the concepts of quality, environment and safety; and the management systems to the design phase. So, this study is an attempt to pursue the application of integrated standards and their management systems; and the concepts of quality, environment and safety in construction industry, beginning with the design stage.

Serving the aim of exploring the impacts of the integrated systems in construction sector, a literature review has been done. First of all basic definitions of quality has been studied and then, the concepts like constructability, buildability derived from the quality and will be used in other chapters frequently has been explained. Secondly, in the following chapter, the evolution and benefits of the standards of ISO 9001:2000, ISO 14001:1996 and OHSAS 18001 has been explained and the integration of these standards have been clarified. In these chapters, these standards and systems are held up concerning the whole construction period. Then,

it is aimed to determine the impacts of the integrated systems to the design phase. For this aim, first of all general information has been given about the stages of the construction and then design phase of construction has been explained widely. In this part, the management problems and constraints have been taken into hand and the solution proposals in the view of the standards have been determined. In the same chapter, after the explanation of the design phase, the fundamental concepts (quality, environment and safety) of the standards and relating systems in the view of design phase have been defined.

In addition to the literature review about the subject, a case study, highlighting application of the integrated management systems in design phase, for Turkish construction companies has been done. For this study a questionnaire was prepared according to the literature information and was applied to Turkish construction companies selected according to having all three standards in their organizations. The main goal of this study is to understand the present status of the construction companies in the view of integrated standards; and to learn the opinions and levels of the application of the standards especially during the design phase in their constructions. At the end of the study it is predicted to find out that the integrated standards are use efficiently and regularly both in whole organization and during the design stage.

2. DEFINITIONS

2.1 The Definitions of Quality

Quality is a very relative concept which has caused many incompatibilities between various types of people for years. The main reason of this is recently occurrence of the quality concept in the area of which shapes people's life and the varieties of expectation of people, who participate the formation of the physical environment, use environment and impact directly from environment as mentioned in one of the researches of Esin (2000). This variety is shaped by the help of the development of technology and implementation people's conscious. This subject has been discussed and investigated both in academics and commercial activities seriously and also has been encouraged by many organizations.

Since the earliest time, many definitions have been done about "quality" from gurus to professions. For instance, according to Juran (1988), quality can be defined in terms of (which The American Society for Quality (www.asq.org) and Crosby (1992) support);

1. Conformance to the agreed requirements of the customer and
2. A product or service free of deficiencies.

In literature the term "quality" should not be used as an expression of degree of excellence, as may be implied by a dictionary definition (Chini & Valdez, 2003). This term should be used and defined as "a measure of fitness for purpose, in the sense of meeting the needs of a customer, at a price commensurate with the extent of those needs."

Institute of Quality Assurance states that; "Quality is essential to the success of business. To make a difference, good quality practice must be embraced by senior management and instilled within an organization's culture. Quality is not just about

implementing a system or working towards a set standard. It is an attitude, a way of working, which not only improves businesses but the way people work and live.”
(<http://www.iqa.org/>)

ISO defines quality, as the totality of characteristics of an entity that bear on its ability to satisfy stated or implied needs (ISO 2000). When we categorize quality, it can be parted into some headings like aesthetic, legal, functional point of view, manufacturing and also construction. If the definition of the quality is taken into hand by the means of aesthetic, it is explained by some design professions who think that quality measured by the aesthetic properties;

- How well a building blends into its surrounding
- A building's psychological impacts on its inhabitants
- The capability of a landing design to match the theme of adjacent structure
- The use of bold new design concepts that capture people's imaginations.

In terms of professional liability, design quality is defined as a legal concept which requires all professionals (doctors, lawyers, architects...) to know their trade and practice it reasonably. And as the functional definition, “quality “is defined by the how can a project conforms to its requirements closely. In this definition a high quality design can be described as;

- Easily understood drawings
- The less conflicts in drawings and specifications
- Easy to operate
- Easy to maintain
- Energy efficient

Definitions of quality have been done in terms of construction many times. One of these definitions is proposed by Arditi and Gunaydin (1999) in which they define quality in terms of conformance to the agreed requirements of the customer and a product or service free of deficiencies. According to the CII, quality in construction is defined as conformance to the established requirements.

When the expression “quality” is used, it is usually thought in terms of an excellent product or service that fulfills or exceeds our expectations. These expectations are based on the intended use and selling price. When a product surpasses our expectations we consider that quality. Thus, it is somewhat of an intangible based on perception. Quality can be quantified as follows;

$$Q = P / E$$

Where, Q =quality

P =performance

E =expectation

If Q is greater than 1.0 then the customer has a good feeling about the product or service.

A more comprehensive definition of quality is given in ISO 9000:2000. It is defined as the degree to which set of inherent characteristics fulfills requirements. *Degree* means that quality can be used with adjectives such as poor, good and excellent. *Inherent* is defined as existing in something, especially as a permanent characteristic. *Characteristics* can be quantitative or qualitative. *Requirements* are a need or expectation that is stated: generally implied by the organization, its customers, and other interested parties; or obligatory (Bersterfiel, 2003).

Quality has nine different dimensions. Table 2.1 displays these nine dimensions of quality with their meanings and explanations in terms of a slide projector. These dimensions are somewhat independent; therefore, a product can be excellent in one dimension and average or poor in another. Marketing has the responsibility of identifying the relative importance of each dimension of quality. These dimensions are then translated into the requirements for the development of a new product or the improvement of an existing one (Bersterfiel's, 2003).

2.2 Historical Background of the Quality

The quality approach can be examined into four stages such as inspection, quality control, quality assurance and total quality; which has had a long and important development process since 1920's.

2.2.1 Quality Control

Quality control is the specific implementation of the quality assurance program and related activities. Effective quality control reduces the possibility of changes, mistakes and omissions, which in turn results in fewer conflicts and disputes. The term "quality control" has had a short history. The development of the quality control can be explained by four periods;

1. It is possible to say that the beginning of the quality control is the 19. and 20. Centuries during the development of management science. In this period, product activities, started in the small sized manufactured fabrics, developed and these organizations turned to the big fabrics. The quality of the product

design was directly under the responsibility of the worker in small fabrics; all employees were having a duty of controlling their own work.

Table 2.1 The Dimensions of Quality *

Dimension	Meaning and Example
<i>Performance</i>	Primary product characteristics
<i>Features</i>	Secondary characteristics, added features
<i>Conformance</i>	Meeting specifications or industry standards, workmanship
<i>Reliability</i>	Consistency of performance over time, average time for the unit to fail
<i>Durability</i>	Useful life, includes repair
<i>Service</i>	Resolution of problems and complaints, ease of repair
<i>Response</i>	Human to human interface
<i>Aesthetics</i>	Sensory characteristics
<i>Reputation</i>	Past performance and other intangibles

(*) This table is taken from Besterfield, 2003; on page 8

2. At the beginning of the 20. century, after the transforming of the small fabrics with the big fabrics, the fabric management approaches started to be insufficient and this caused to be made new researches for managing the manufacturing system more efficiently. During this period, F. Taylor suggests to apply a new manufacturing management system which depends on the hypothesis of the Rational Human Period. The main feature that describes the Taylor's most important management system was depending on the excessive sharing of the works between workers and comparison of workers to an engine. In this period because of the division of labor, the responsibility of Quality Control was separated from the manufacturing and foremen were charged by this work.
3. During the World War I, the manufacturing systems started to be much more complex and some difficulties occurred because of the fact that many workers reported only one foreman. So, this approach was given up and some inspectors were charged to only control the works.
4. Early in the twentieth century, it began to be used as a synonym for defect prevention. However, according to Juran, during the 1940s and 1950s there was a wave of enthusiasm for the use of statistical methods in quality control which is used firstly in the Bell Labrotiries by Dr. W. A. Shewhart. The proponents of this movement coined the phrase "statistical quality control"

and publicized it so widely that many managers gained the impression that quality control consisted of the use of statistical methods in industry. As a consequence, the statistical quality control movement weakened the use of quality control as an accepted term for the regulatory process (Arditi & Gunaydin, 1999)

Quality was only applied to the manufacturing activity In the 1960s and 1970s, various terms such as “total quality control,” “zero defects,” and “product assurance” emerged as alternatives to the use of quality control as an all-inclusive term for the regulatory process (Juran 1988). During the mid-1980s there emerged a revival of keen interest in statistical methodology, this time under the name “statistical process control” (Arditi & Gunaydin, 1999)

The standard for all actions and activities in quality control is that they must contribute to the satisfaction of the customer. On the other hand, according to Crosby (1967), quality control concepts, techniques, and practices were developed around assumptions of the inevitability of error and made no room for a defect-free situation. When one occurred, the assumption was that something had been missed and that it was due only to the inadequacy of the appraisal effort.

2.2.2 Quality Assurance

The evolution of QA from techniques of final inspection in 1930s, followed by quality control, mainly in the manufacturing industries, during the 1940s and 1950s, then a further extension of controls into the engineering/ design phase of these industries during the 1960s, is well documented.

There are many quality standards, all of which define in almost identical terms those things which an organization should recognize if it aims to achieve quality consistently and a cost effective manner. What standards such as ISO 9000 (that will be explained in the next chapter) tell us very clearly is that;

1. Business is a team involvement; in which everyone should play their part and know what their part is (This indicates clear organization and responsibility information).
2. There needs to be a policy for quality attainment set down by management and understood by all. (This indicates clear management initiative and training for all.)
3. Activities need to be carried out in ways which are as effective and as efficient as possible for the business concerned. (This indicates the need for

property though-out procedures and instructions and training for those who are to implement them.)

4. Business scopes and technologies change and therefore any management system must be dynamic, updated and monitored for relevance to current needs and continuing adherence to its requirements by all concerned (This indicates the need for ongoing review and audit.)

The various clauses of the quality standards identify those things which should be considered with respect to both specific and varying scopes of activities, when developing and using a quality system. The term of “quality assurance” tends to make people think of the finished product and services.

Finally, the definition of *Quality Assurance* is “a structured approach to business management control which enhances the ability to consistently provide products and services to specification, programme and cost” (Thorpe, Sumner & Duncan, 1996).

2.2.3 The Need for Quality Assurance and Quality Control in construction

The assessment of quality in a construction project involves two components: quality control and quality assurance. Quality assurance is considered as a “system of controlling the provision of a product or service so as to satisfy the needs of the customer”; it is identified as an external quality system, covering activities aimed at inspiring confidence in the client regarding the product or service being provided. As it is mentioned in the previous part, Arditi and Gunaydin (1999) say that quality control is the “specific implementation of the quality assurance program and related activities” (Chini &Valdez, 2003)

According to the Manual of Professional Practice for Quality in the Constructed Project, “Quality Assurance (QA) is a program covering activities necessary to provide quality in the work of meeting the project requirements”. QA involves establishing project related policies, procedures, standards, training, guidelines, and system necessary to produce quality. The design professional and constructor are responsible for developing an appropriate program for each project. Quality assurance provides protection against quality problems through early warnings of trouble ahead. Such early warnings play an important role in the prevention of both internal and external problems.” According to Juran, the assurance is provided from objective evidence, but the type of evidence differs widely according to the persons requiring the assurance and the nature of the product.

Quality assurance is important in the engineering and construction industry because of the risk involved in any project. Because of the many external factors that will

affect the performance of the project, the risk involved in not completing the project on time is so high. It is vital that a built-in quality assurance system is developed to avoid any inefficiency that could result in poor quality of products and service being delivered to the customer. Everyone involved in the engineering and construction business has, in different ways, benefited from a common approach to quality work. Systematic quality work reduces the costs of failure in one's own work and in the final product. The standards can make quality work more efficient by creating uniformity. A contractor's in-house quality assurance system is so importance such as to prevent problems and their reoccurrence and allow his or her clients to relax (Bubshait & Al-Atiq, 1999).

Several approaches to quality assurance and control in construction have been proposed and adopted in recent years. These include;

1. Partnering that attempts to improve the communication flow on a specific construction project;
2. Business process reengineering, which is a fundamental and radical approach to process redesign in terms of meeting customer demands;
3. Constructability reviews, which consist in a review of the project plans and specifications in an effort to improve the quality of the construction process and the completed product;
4. Value engineering, which attempts to improve the value and optimize the life-cycle costs of a facility from the preconstruction phase; and
5. Total Quality Management (TQM), which is an operational philosophy that emphasizes continuous improvement of all facets of an organization (Chini & Valdez, 2003)

Ferguson and Clayton (1988) mention that the terms quality assurance and quality control are frequently used interchangeably. Because quality control is a part of quality assurance, maintaining a clear distinction between them is difficult but important. Quality assurance is a planned and systematic action necessary to provide adequate confidence that a structure, system, or component will perform satisfactorily and conform to project requirements.

On the other hand, quality control is a set of specific procedures involved in the quality assurance process. These procedures include planning, coordinating, developing, checking, reviewing, and scheduling the work. The quality control function is closest to the product in that various techniques and activities are used to

monitor the process and to pursue the elimination of sources that lead to unsatisfactory quality performance (Chini & Valdez, 2003).

Most design-related quality assurance and quality control activities are covered by a design organization's standard office procedures. Developing and implementing the activities within the quality assurance program in the construction phase are the responsibility of the construction company; which is monitored either by the designer or the construction management firm depending on the project delivery system in use (Arditi & Gunaydin, 1999)

2.3 Definition of Total Quality Management

Today, different from conventional product oriented methods of quality control and quality assurance systems of past, the emphasis is on establishing an integrated whole system – a total quality management system (TQM) – to collectively improve all aspects of operational and functional efficiency.

“What does the “TQM” mean? “

“It would be fair to say that concepts of TQM are a bit like concepts of ‘God’: it all depends on which sect you belong to; which discipline you follow.” (Nelson, 1995)

TQM is simply a set of system elements which when implemented properly, bring regimentation, systematization and discipline into the routine operational and functional frame-work of company, by virtue of which quality of products and services can be achieved, maintained, and improved (Puri, 1996) Total quality management (TQM) may be defined as an operational philosophy developed from a set of basic management principles. The goal of TQM is to continuously improve all facets of an organization in order to meet existing and future customer needs (Mcintyre, Kischenman, 2000)

There are six basic concepts that are required for TQM (Besterfield 1998);

- 1) A commitment by management to provide long term top-to-bottom organizational support
- 2) An unwavering focus on the customer, both internally and externally
- 3) Effective involvement and utilization of the entire work force
- 4) Continuous improvement of the business and production process
- 5) Treating suppliers as partners
- 6) Establishing performance measures for the processes (Mcintyre, Kischenman, 2000)

The purpose of the TQM is to provide a quality product and/or service to customers, which will, in turn, increase productivity and lower cost. With a higher quality product and lower price, competitive position in the market place will be enhanced. This series of events will allow the organization to achieve the objectives of profit and growth with greater ease. In addition, the work force will have job security, which will create a satisfying place to work.

2.3.1 The Evolution of Total Quality Management

Total quality management has been described as the third industrial revolution, which has emerged from a rapid development in the third quarter of the 20th century. It has two main streams contributing to its development; *scientific management*, and *quality*.

The Scientific Management Stream

The first level in management is the period of "Rational Human", which started by the help of Weber in 1900's. In that period the rules of the bureaucracy were in use and in all levels of the management, the rules and standards were applied. Thus man was seen as a machine and the theory of X was assumed. This opinion was exposed to the many criticisms in the period of "Social Human (Irrational Human)", which started in 1927's.

In the third period, which followed the "Irrational Human" period and mentioned as the man who realized oneself or the Industrial Humanism, the importance and value of the element of man were emphasized by the researches of some scientist such as McGregor, Argyris, Herzberg and Maslow. In the Maslow's hierarchy of needs theory, it was mentioned that after the physiological and safety needs, people need to belonging to a social group and wanted to develop themselves by exposing their creativity. But during the establishment of the motivational theory in 1950 and 1960's, Industrial Humanism was transmitted to the application area by the result of the influence of the new technology from the individual opinion system of the capitalism.

The second stage of the Industrial Humanism has developed as the period of which the contribution management principles had occurred and leadership styles had been discussed. The other approach that dwelled upon in that period was the Situational Approach. This system takes into hand as both organizational system and management and leadership style. Organizations have to keep up with external conditions which change continuously, to try to be alive like an organism. In this scope, the main stream of evolution of scientific modern management resulted from

the study of work at the end of the 19th century by Taylor and Gilbreth, who applied their mind to the methods machines and materials involved in time study. They recognized that the development of techniques for improved performance required first the development of proper measuring techniques; techniques to measure input against output, and the balance of requirements against sources, so that productivity measures could be established and through them better ways found to improve performance within an organization.

Time was seen as an important measurement tool and finer measurement of performance in both production and people systems were necessary. New terms and concepts needed to be identified so that the results could be communicated and so that an understanding of them could be developed by other people. Work study produced terms such as “Therbling” (Gilbreth’s backwards), a time unit for micro measurement; “standard performance”, from “standard rating” relaxation allowances; predetermined motion time systems; and “activity sampling”, leading much later to “critical path networking”, with particular application to one-off projects. All this reflected that management systems are technical systems for the direction of men and material towards a stated objective (Hellard, 1993).

In the construction industry, the application of materials embraces also the operation of machines and methods, all of which have financial implications, which have long been audit.

The Quality Stream

The addition of the quality stream into this evolution of management began approximately 20 years later in manufacturing organizations. The first move was the inspection of finished goods before they were dispatched from the manufacturing plant to prevent, wherever possible, the delivery of imperfect or unsatisfactory products. This inspection process received particular attention in armaments factories during the First War.

Later the inspections process applied at the end of the production line was recognized as being too late, as correction still involved reprocessing, with unnecessary cost. *Quality control*, which defined in the previous part, the application of control procedures during and at the start of the production process, was then developed. Later still, quality assurance, the systematic examination of documentation through a paperwork management system, further improved the cost-effectiveness and reliability of the manufacturing process. The work of Deming, Crosby, Juran and, in particular, Freigenbaum in development of mathematical

theories of statistical process control, and many other in the renaissance of Japanese industry after the Second World War, contributed greatly to the quality management philosophy. The contribution of these gurus whose ideas are different or similar and whose practices can be affected by another's embrace (Nelson, 1995), has emphasized the importance of monitoring, through audits, to the never-ending process of improvement. An overview of the development of scientific management and quality consideration is shown in figure 2.1 (Hellard, 1993).

TQM requires a cultural change. Table 2.1 compares the previous state with the TQM state for typical quality elements. This change is substantial and will not be accomplished in a short period of time. Small organizations will be able to make the transformation much faster than large organizations (Besterfield, 2003).



Figure 2.1 The evolution of technique, practice and philosophy leading to total quality management in construction in the 1990's

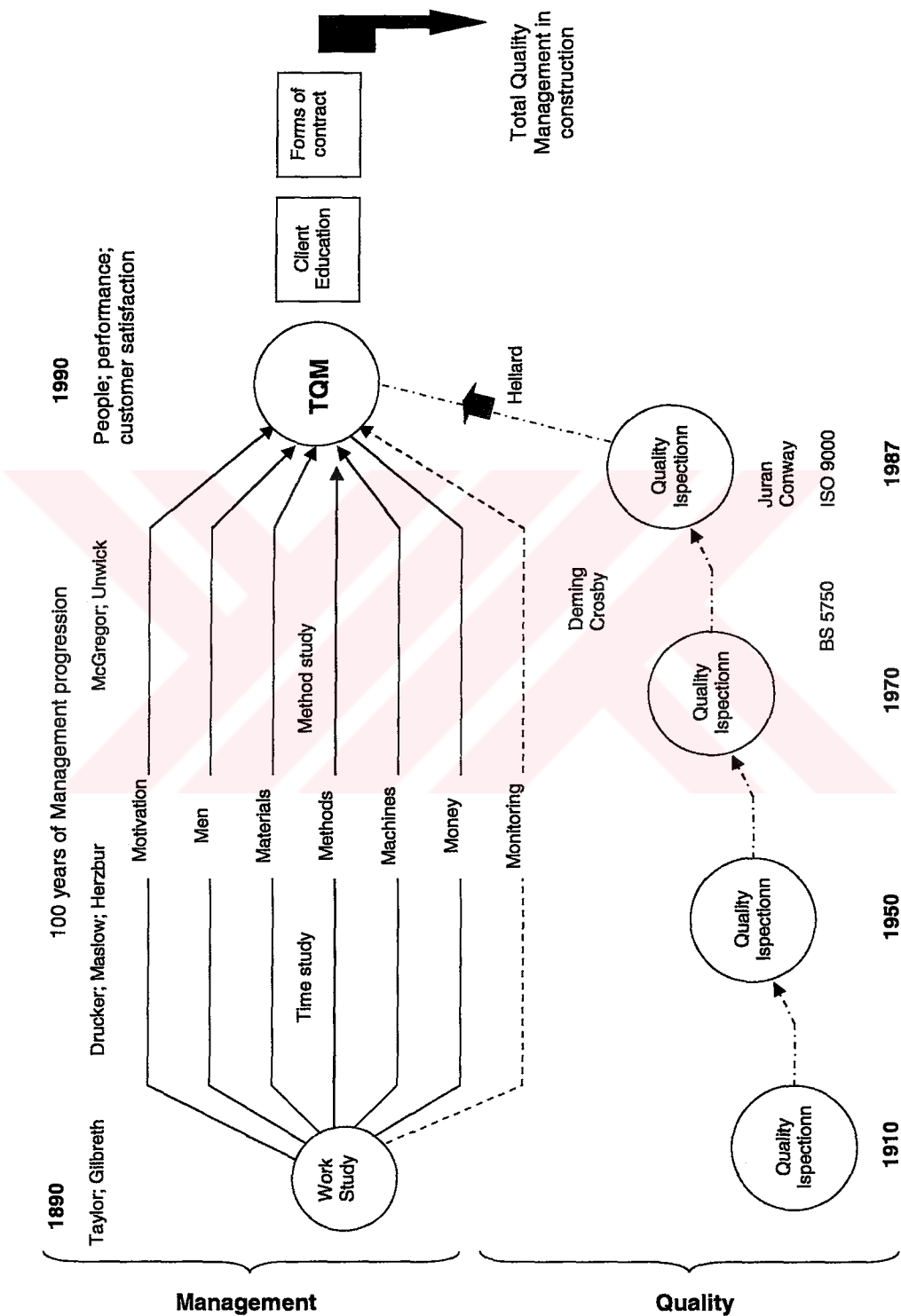


Table 2.2 New and old Culture *

Quality Element	Previous State	TQM""""
<i>Definition</i>	Product-oriented	Customer-oriented
<i>Priorities</i>	Second to service and cost	First among equals of service and cost
<i>Decisions</i>	Short-term	Long-term
<i>Emphasis</i>	Detection	Prevention
<i>Errors</i>	Operations	System
<i>Responsibility</i>	Quality Control	Everyone
<i>Problem</i>	Manager	Teams
<i>Solving</i>	Price	Lifecycle costs, partnerships
<i>Procurement</i>	Plan, assign, control, and enforce	Delegate, coach, facilities, and mentor
<i>Manager's role</i>		

(*) This table is taken from Besterfield, 2003; on page 3"

Benefits of Implementing TQM

Generally, contractors who use TQM reported that higher customer satisfaction, improved schedule performance, and improved relationships were the primary benefits of adopting a TQM management philosophy.

In literature, it is known that many surveys have been done in many countries in order to document and quantify the use of the TQM philosophy within a regional segment of the construction industry and these kind of surveys have been constructed to solicit response from construction firms concerning several key areas of TQM, including TQM policies and practices; the use of selected quality control tools; the overall benefits of TQM, and the possible obstacles for implementing a TQM program.

Generally, contractors who use TQM have reported that higher customer satisfaction, improved schedule performance, and improved relationships with A/E firms are the primary benefits of adopting a TQM management philosophy, as shown below;

- Improved relationships with subcontractors
- Higher customer satisfaction
- Improved schedule performance
- Improved relationships
- Reduced rework

- Improved safety
- Higher productivity
- Lower employee turnover

The results of these kind surveys indicate that even with a minimal commitment to TQM, contractors have experienced some improvements in productivity. However, several issues must be addressed in order to achieve a successful level of TQM, including;

1. an increased effort in the education and training requirements regarding the implementation and application areas of TQM,
2. an increased effort in determining, satisfying, and measuring customer needs and customer satisfaction,
3. an increased emphasis on the concepts of team building and teamwork, and
4. a more systematic approach to the collection and analysis of data concerning the overall TQM process. (Mcintyre, Kischenman, 2000).

2.4 Definitions Related to the Quality Concept

Quality is a relative concept which has been discussed for years in many organizations and changes according to person to person, or organizations to organizations. In literature, there are many definitions derived from the main quality concept and used very effectively in many areas such as construction and design. Despite of the fact that many definitions are not done for the construction industry, in the course of time, many concepts such as quality function deployment, constructability and buildability have started to be applied on the phases of the construction or design .

2.4.1 Quality Function Deployment

Quality Function Deployment (QFD) is a planning tool used to fulfill customer expectations. It is a disciplined approach to product design, engineering, and production and provides in-depth evaluation of a product. An organization that correctly implements QFD can improve engineering knowledge; productivity, and quality and reduce costs, product development time, and engineering changes (Besterfield, 2003).

Evolution of Quality Function Deployment

The concept of QFD was developed in 1972 as part of the implementation of the total quality management system at the Mitsubishi Shipyard in Kobe, Japan. In the

late 1970s, Toyota further developed the QFD concept to a detailed process that has been used in many manufacturing industries. In 1986 Sullivan reported that Toyota auto body started using QFD in 1977. As a result, Toyota auto body introduced four new van-type vehicles between 1977 and 1984, which is a record time for such an accomplishment. Using 1977 as a base, Toyota reported a 20% reduction in start-up costs on the launch of its new van in 1979, a 38% reduction in 1982, and a cumulative 61% reduction in 1984. During this period, the product development cycle (time to market) was reduced by one-third, and quality was improved because of the significant reduction in the number of engineering changes and rework incidents.

In the early 1980s, Ford Motor Company and Xerox brought the QFD concept to the United States. As a result of the QFD process, the significant savings in design costs and the reduction in design time encouraged these two companies to permanently adopt QFD (Eldin & Hikle, 2003).

QFD focuses on the customer's needs and the precedence of those needs to produce competitive quality products in the design phase. It is a systematic approach that maps the customer's needs into definable and measurable product and process parameters, using a series of matrices and other quantitative and qualitative techniques. QFD is a powerful tool for consistent communication and for the transfer of information throughout the design or product development phases; and also the QFD process is an effective planning tool that invites the participation of the customers who could affect or be affected by the proposed design. QFD starts with a structured list of customer wants and needs. It is not just a precedence tool, but is also a deployment tool. Sullivan (1986) says that the deployment process is generally referred to as the four phase approach, whose four elements may vary depending upon application and can be;

1. program planning,
2. product design,
3. process planning, and
4. process control planning. (Ahmed, Sang & Torbica, 2003)

QFD provides a set of communication routines that coordinates the efforts and skills available in an organization from the project's inception to its completion. The QFD culture that is noticeably different from the traditional culture, which assumes that designers knew best and customers would automatically be satisfied with the end product, is a culture in which all customers are kept at the heart of the development

process of the product. The term “all customers” means not only the owner’s staff, but also those who use, maintain, or participate in making the subject product. Unless all customers are satisfied, a product would not be viewed as fully successful. Namely, focus groups, HOQ (House of Quality), affinity diagrams, tree diagrams, benchmarking, value engineering, and market research are part of the QFD process. Although nothing here is being added to these tools, the QFD process provides a series of structured steps in which these tools are utilized effectively to guarantee customers’ satisfaction with the end product (Pheng & Yeap, 2001).

Today, QFD has been successful in developing new products that achieved high customer satisfaction in a large number of companies in many industries, such as automotives, electronics, banking, insurance, healthcare, utilities, and food processing. Except for these industries, the QFD has been started to be applied in the construction industry, beginning with the small scale projects by adapting all house of quality matrix which is shown in figure 2.2, house of quality series which is shown in figure 2.3, implementations and procedures to the design phase of the construction. Nowadays, by the result of the researches, it is thought that the application of the QFD should be successful also on larger projects in the construction industry.

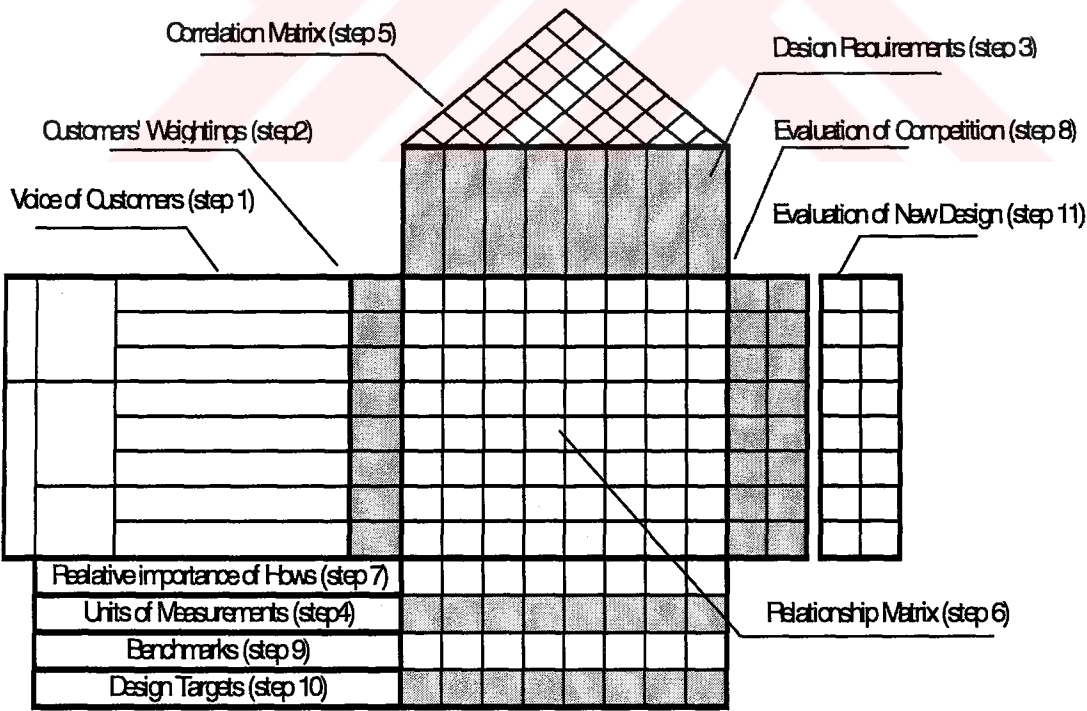


Figure 2.2 House of quality matrix for building design *

(*) This figure is taken from Eldin, 2003, pp.318

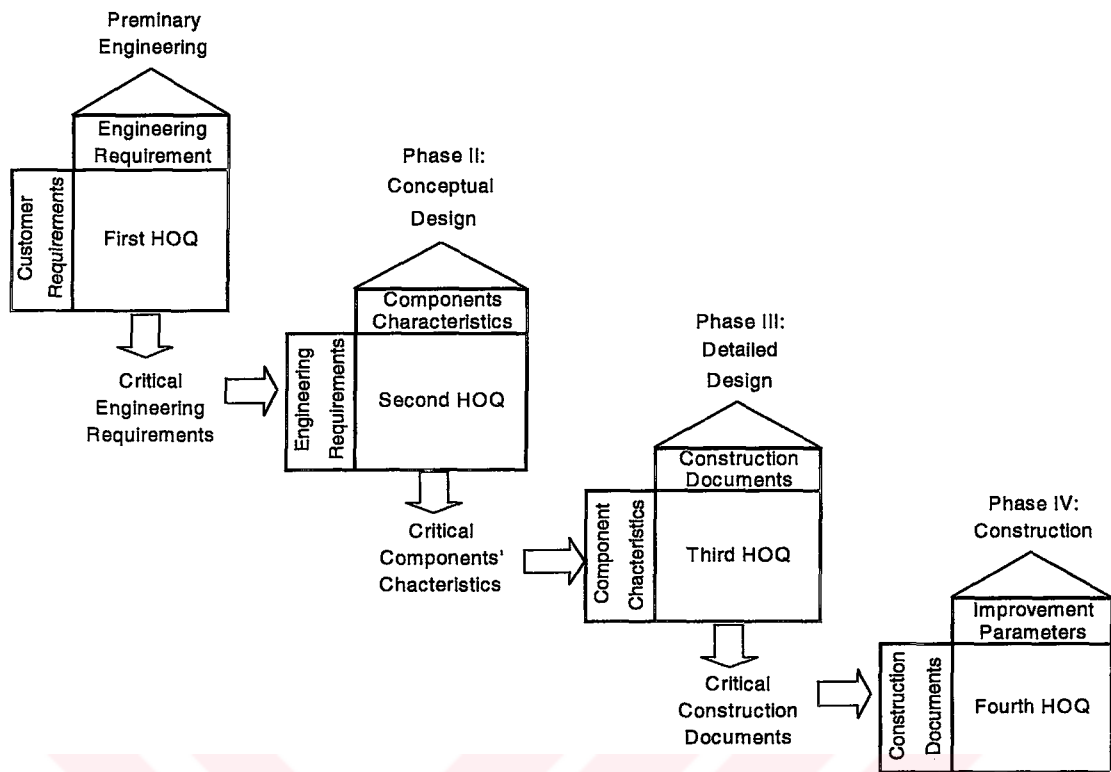


Figure 2.3 Proposed houses of quality series for construction industry.

(*) This figure is taken from Eldin, 2003, pp.319

2.4.2 Quality and Constructability

The concept of constructability was introduced by the CII in 1986. According to the CII;

“Constructability is the optimum use of construction knowledge and experience in planning, design, procurement, and field operations to achieve overall project objectives”.

Since this definition of constructability, various new definitions have emerged based on the individual project needs and requirements. All definitions focus on the issue that the benefits of constructability can only be achieved by the integration of the construction knowledge and experience into each phase of the project delivery process (Jergeas & Put, 2001). According to Fischer and Tatum, constructability should be an important objective in all phases of the construction project, and designers play an important role in achieving superior constructability. Most projects however, do not receive constructability input although previous research has demonstrated numerous benefits of such an input. One reason for this lack of constructability input is the lack of formal, explicit constructability knowledge bases

that can link constructability issues to design decisions and that can be made available on-line to interested parties in the form of some kind of database.

A model is presented by Gugel and Russell for selecting an approach to implement constructability. Constructability can be implemented using an informal or formal approach. Based upon this research, three approaches, one informal and two formal, have been identified;

1. informal approach;
2. formal project level; and
3. Comprehensive tracking.

To be successful of any constructability implementation program, a strong database for constructability ideas is an important factor (Jergeas & Put, 2001).

Improving Constructability during Design Phase

The constructability of a design is a qualitative concept that is difficult, if not impossible, to measure objectively. Each construction project is unique, and conclusion based on historical data may not yield valid conclusions. Intuitively, however, the higher the degree of constructability, the more efficiently a builder can proceed with construction and the more economical the final project is for the owner. It should also be noted that the constructability of a design must be evaluated within the context of the project-management system used (Glavinich, 1995)

Efficient Design

A project's construction documents include not only the plans and specifications, but also the general special and supplemental conditions as well as the contract itself. In considering the constructability of a design, there is a tendency to consider only the plans and specifications and ignore the other contract documents. As in the plans and specifications, excessive and wasteful constraints and limitations in the general, special and supplemental conditions hinder the construction process and result in a less than optimum use of available resources by the builder. Constraints contained in the contract documents regarding such things as access to and use of the site, security, temporary utilities, and points of delivery can have significant impact on how a builder carries out and schedules the work (Glavinich, 1995).

Therefore in reviewing a design for constructability, the A/E should be concerned not only with the plans and specifications but with the entire set of construction documents. The efficiency of a set of construction documents can best be measured by how easily a builder can meet project milestones set by the owner using a logical

sequence of construction and average workmanship for the locale. This requires the A/E to consider local conditions and construction practices as well as the availability of labor, materials and equipment in the design.

Therefore, in considering the constructability of a project, the efficient design requires items such as;

- Activities inherent in a particular design that result in unavoidable delays and slowdowns in what otherwise would be a normal construction process.
- Specification of special or custom equipment or materials where design requirements could be satisfied using standard off-the-shelf products with minor design modifications
- Use of exotic state-of-art technologies where a more familiar and tested technology would fulfill design requirements
- Specification of obsolete materials, equipment, and construction techniques (Glavinich, 1995)

Achieving an Efficient Design

There are two methods for increasing the efficiency of a design, and thereby improving its constructability;

- 1. Design-phase scheduling:** It involves the development and subsequent revision of a construction schedule throughout the design process. The purpose of preparing and updating a design schedule is to detect and correct potential construction and scheduling problems during the design process. This is the time when these problems can be corrected relatively easily and economically with the minimum impact on the overall project schedule. Any preconstruction scheduling effort should involve not only looking at activities and their projected durations but also procurement of necessary materials and equipment. In addition to avoiding problems during construction, preconstruction schedules included for information as part of the bid documents can also provide advantages for the owner. By including the preliminary schedule in the bid documents, A/E highlights what it perceives as the project's critical activities and milestones. This information helps the builder better understand the intent of the design and reduce both uncertainty and risk, which should result in a lower bid.
- 2. In-house design-phase constructability:** Most A/Es consider it good practice to perform a detailed independent check of drawings and specifications prior to issuing them. This check is normally aimed at picking

up errors and discrepancies as well as detecting any conflicts within or between plans and specifications. While this procedure is aimed at assuring the technical correctness of the design documents, it is normally does not address basic design philosophies or constructability. Also, the checking process usually takes very late in the design process, which can cause difficulty and fundamental changes in the design that would enhance its efficiency. One method of circumventing this problem is to form an in-house review team at the beginning of the project. The purpose of the design-review team would be to review basic design philosophy in relation to design criteria as well as project constructability during the design process. The design reviews should occur at pre-determined points in the design process and be concerned with the quality of the design and not detailed checking.

In conclusion, the designer must always be cognizant of the fact that the project plans and specifications are implemented by the builder at the owner's expense. Therefore, the A/E must strive to provide a complete design that allows the builder to use resources efficiently in order to deliver an economical project to the owner. The A/E must be aware of its responsibility for coordinating and integrating all the various systems and components that make up the project (Glavinich, 1995).

2.4.3 Quality and Buildability

Buildability is related to all aspects of a project which enable the optimum utilization of construction resources. It ensures that there is continuity of work by managing labor, plant and equipment in such a manner that the flow of materials, components and sub-assemblies into the growing building is maintained and optimized to achieve efficient and economic production. It is concerned with activities on site and specifically with the logical sequence of operations and construction methods. Good buildability can improve design empathy for production, encourage more effective communication between the design/construction parties, simplify construction techniques and optimize the approach to construction management (Phenga & Abeyegoonasekerab, 2001).

In a demanding market, the client expects his building to be completed on time and within the anticipated budget, to be of good quality and not too troublesome or expensive to maintain. Experience has shown that many clients have complained of building designs which do not provide value for money in terms of the efficiency with which the construction process was executed. Good buildability is known to be able to fulfill these objectives through speedy construction, improved quality and lower

costs.(Phenga & Abeyegoonasekerab, 2001).Key aspects relating to buildability principles are explained in Table 2.3. The benefits achieved through a good buildability programme were noted to extend across the total design/ construction process as shown in the literature.

Table 2.3 Principles of buildability *

Principles	Key aspects
1. Investigate thoroughly	The investigation of site conditions and other circumstances likely to affect the course of the project should be thorough and complete to avoid the risk of subsequent costly delays and alterations after construction has commenced.
2. Consider access at the design stage	The location of access to and around the site during construction should be carefully considered at the design stage.
3. Consider storage at the design stage	Consideration should be given at the design stage to the location of material storage and unloading facilities.
4. Design for minimum time below ground	Consideration should be given to minimize the amount of time taken by the work in the ground, particularly where the ground is poor, wet or hazardous.
5. Design for early enclosure	The construction and detailing of a building shell, including the roof, should facilitate the enclosure of the building at the earliest possible stage so that work can be carried out without hindrance from inclement weather.
6. Use suitable materials	Select robust and suitable products and materials which utilize normal site assembly methods and sequence, with subsequent operations as well as wear and tear in mind.
7. Design for the skills available	Design must include a realistic assessment of the level of skills likely to be available from appropriately chosen contractors and specialists.
8. Design for simple assembly	Designers should endeavor to produce the simplest possible details compatible with the overall requirements for the building to achieve efficient and defect-free works.
9. Plan for maximum repetition and standardization	The design of building elements and details should encourage appropriate repetition and standardization so as to reduce learning time, construction duration, costs and increased risks of error from construction of special projects.
10. Maximize the use of plant	The site layout should allow for the maximum use of mechanical plant, particularly for the movement of materials.
11. Allow for sensible tolerances	The design of the building assembly should recognize the tolerances which are normally attainable in site conditions, making allowances for differences between factory tolerances and those of normal site construction.
12. Allow for a practical sequence of operations	The method of construction should encourage the most effective sequence of building operations.

13. Avoid return visits by trades	The design should arrange work sequencing in such a way that a trade can complete all its work at one location with as few return visits as possible.
14. Plan to avoid damage to work by subsequent operations	The design should enable work to be carried out in a workmanlike manner without risk of damage to adjacent finished elements and with minimum requirements for special protection.
15. Design for safe construction	The design should be arranged so as to facilitate safe working in foundations and earthworks, when materials and components are being handled and wherever traversing for access is necessary.
16. Communicate clearly	Buildability is assisted by the thorough and clear presentation of information before the start of construction. Complete project information should be planned and coordinated to suit the construction process and to facilitate the best possible communication and understanding on site.

(*) This table is taken from Phenga & Abeyegoonasekerab, 2001, pp.301

One of the systems that can be used as a tool in enhancing the buildability of building projects by integrating buildability principles within its processes is ISO 9000 quality management systems, which will be explained in the next chapter. The policies and procedures in ISO 9000 quality management systems can be extended to incorporate buildability principles. The quality management system can be used to encourage buildability reviews to ensure that only the most efficient construction solution is adopted. ISO 9000, which encourages communication, can be used to ensure co-ordination between design and construction, and among the different trades. It also gives an organization the capabilities and tools to implement continuous improvement programmes on buildability that will ultimately be translated into more buildable designs and higher quality products. The matching of the principles with relevant ISO 9000 quality system elements is summarized in Table 2.4.

Table 2.4 Buildability principles and relevant ISO 9000 elements *

Buildability principles	Relevant ISO 9000 elements
1. Investigate thoroughly	Quality system (4.2) / Contract review (4.3) / Design control (4.4) / Document and data control (4.5) / Process control (4.9) / Inspection and testing (4.10) / Control of nonconforming product (4.13) / Corrective and preventive action (4.14)
2. Consider access at the design stage	Quality system (4.2) / Design control (4.4) / Process control (4.9)

3. Consider storage at the design stage	Design control (4.4) / Control of customer-supplied product (4.7) / Product identification and traceability (4.8) / Process control (4.9) / Corrective and preventive action (4.14) / Handling, storage, packaging, preservation and delivery (4.15) / Control of quality records (4.16)
4. Design for minimum time below ground	Contract review (4.3) / Design control (4.4) / Process control (4.9) / Corrective and preventive action (4.14) / Training (4.18)
5. Design for early enclosure	Quality system (4.2) / Contract review (4.3) / Design control (4.4) / Purchasing (4.6) / Process control (4.9) / Corrective and preventive action (4.14) / Training (4.18)
6. Use suitable materials	Quality system (4.2) / Contract review (4.3) / Design control (4.4) / Control of customer-supplied product (4.7) / Process control (4.9) / Inspection and testing (4.10) / Inspection and test status (4.12) / Control of nonconforming product (4.13) / Corrective and preventive action (4.14) / Training (4.18)
7. Design for the skills available	Quality system (4.2) / Contract review (4.3) / Design control (4.4) / Purchasing (4.6)
8. Design for simple assembly	Quality system (4.2) / Contract review (4.3) / Design control (4.4) / Process control (4.9) / Corrective and preventive action (4.14) / Training (4.18)
9. Plan for maximum repetition and standardization	Quality system (4.2) / Contract review (4.3) / Design control (4.4) / Process control (4.9) / Corrective and preventive action (4.14) / Training (4.18)
10. Maximize the use of plant	Quality system (4.2) / Contract review (4.3) / Design control (4.4) / Control of customer-supplied product (4.7) / Process control (4.9) / Control of inspection, measuring and test equipment (4.11)
11. Allow for sensible tolerances	Contract review (4.3) / Design control (4.4) / Process control (4.9) / Corrective and preventive action (4.14)
12. Allow for a practical sequence of operations	Quality system (4.2) / Contract review (4.3) / Design control (4.4) / Process control (4.9) / Corrective and preventive action (4.14) / Training (4.18)
13. Avoid return visits by trades	Quality system (4.2) / Contract review (4.3) / Design control (4.4) / Process control (4.9) /

	Corrective and preventive action (4.14) / Training (4.18)
14. Plan to avoid damage to work by Design subsequent operations Corrective and	Quality system (4.2) / Contract review (4.3) / control (4.4) / Process control (4.9) / preventive action (4.14)
15. Design for safe construction	Contract review (4.3) / Design control (4.4) / Process control (4.9) / Inspection and testing (4.10) / Inspection and test status (4.12) / Corrective and preventive action (4.14)
16. Communicate clearly	Contract review (4.3) / Design control (4.4) / Control of customer-supplied product (4.7) / Process control (4.9) / Inspection and testing (4.10) / Inspection and test status (4.12) / Control of nonconforming product (4.13) / Corrective and preventive action (4.14)

(*) This table is taken from Phenga & Abeyegoonasekerab, 2001, pp.303

3. INTERNATIONAL STANDARDS AND THEIR MANAGEMENT TECHNIQUES/ INTEGRATED SYSTEMS

3.1 International Standards and Their Advantages in General

A *standard* is a procedure, or product, used as a reference to determine the quality of similar procedures and products. It is established by determining the technical and non-technical specifications of the procedure or product. *Standardization* is the use of standard components or module, the development and production overhead costs of which are shared across a number of projects, and thereby benefit from the learning curve in repeated tasks. Many projects are highly standardized at the component level, with components. Standardization may also imply the definition of a standard dimensional grid for the facility (Winch, 1999)

In the era of borderless trade, international standards are very important for achieving competitiveness and having a permanent situation in the world market. In the World Trade Organization's Agreement on Technical Barriers to Trade, governments are urged to use international standards to prevent the institution of unnecessary barriers to the free flow of goods and services.

Increasing cooperation with the international standard setting community will lead to the following:

- Increase the efficiency of improving, adopting, and maintaining international standards
- Influence the adaptation of standards that recognize the needs of the construction industry
- Provide strategies for construction to remain competitive or increase their competitiveness in the global engineering and construction arena.
- Provide a service to assist in the more efficient delivery of global construction projects

- Break barriers which cause conflicts or misunderstandings on global projects. (Yates,1997)

Standards have some advantages for customers in different sectors;

- Various technologies become compatible; a wide choice of products from around the world, conforming to adequate levels of quality, reliability and safety become available; and benchmarks and expectations are established, synchronizing the need and the function of the product or service. Producers and suppliers save money by offering one product based on internationally standardized specifications in all markets to suit particular national requirements, thus, gaining economies of scale, and improvements in inter-connectivity and inter-operability and worldwide recognition. They attain greater productivity and improved employee performance by applying technologies, which can be transferred to different sites, or operating plants, and allow inter-operability of networks and components.
- Work processes can be checked by via objective standards, and external auditors, enabling the company to learn from the evaluation and achieve self-renewal. Employees can be motivated by communicating the objectives and importance of the standards and the steps to achieve them. Management's activities are also open to scrutiny, allowing for transparency. The Singapore Accreditation Council (SAC), established in 1996, undertakes independent accreditation of conformity assessment activities to ensure that certification systems and practices in Singapore conform to international requirements.
- It aims to maintain the credibility, integrity, professionalism and impartiality of certification bodies in the country. It consists of representatives from industries, suppliers, purchasers, government bodies, professional institutions, the national standards authority, academic and certification bodies, and consumer interests. It seeks to establish mutual recognition agreements with similar organizations, and is a member of various international groupings of accreditation bodies. (Ofori, Gang & Buri, 2002)

In the literature it is mentioned that twelve percent of the standards are used internationally and approximately 11,000 of them belong to the construction sector. ISO, which was settled in 1947, is one of the main organizations included in the development of the standardization to facilitate the international exchanges and to

encourage the cooperation between countries technically, economically and scientifically.

3.2 ISO 9001:2000 Quality Management System

3.2.1 Evolution of ISO 9000

ISO (International Organization for Standardization) is a worldwide federation of national standards bodies, which are prepared by technical committees. ISO 9000 is the series number and a generic name given to a group of standards, developed to build a management system, which will support continuous improvement in quality as well as integration with other business processes and requirements. It is all related with customer demand or the market place and it is applicable to any industry including construction. (Koehn & Datta, 2003)

So, it can be explained as that ISO 9000 is a set of defined standards, rather than a management philosophy, that was created to provide uniform quality assurance standards for product manufacturing and service providers in a globalization perspective and has been adopted by numerous organizations all over the world. (Chini & Valdez, 2003)

This family of standards was first published in 1987 after a process of consensus handled by ISO Technical Committee 176 and since that date, more than 150 countries throughout the world have adopted the ISO 9000 standards. ISO 9000 was widely accepted from the start; at the end of 1999, at least 343,643 certificates had been awarded in 150 countries, representing an increase of 26.4% over the total number of certificates awarded up to 1998. A large percentage of the certificates (56%) correspond to European firms, where acceptance has been widespread due to European Union standardization policies. The United States had 33,054 certified organizations at the end of 1999, has experienced a high growth in the number of certificates (second only to Australia in 1999), and has experienced a 32% increase in its number of certificates from 1998 to 1999. (Chini & Valdez, 2003)

The ISO 9000 specifies requirements and recommendations for the design, and assessment of a management system. The ISO 9000 standard is a series of five international standards on quality management, quality assurance and quality systems. They deal with the structure, procedures, requirements and the elements of quality management, quality assurance and quality systems. There are five international ISO standards as shown below. The specific standard, which applies to the design professions, is ISO 9001:1994: *Quality systems-Model for quality*

assurance in design, development, production, installation and servicing (Nelson, 1995).

The five international standards are:

- *ISO 9000* Quality Management and Quality Assurance Standards Part 1: Guidelines for Selection and Use.
- *ISO 9001* Quality Systems Specification for Quality Assurance in Design/ Development, Production, Installation and Servicing.
- *ISO 9002* Quality Systems Specification for Quality Assurance in Production, Installation and Servicing.
- *ISO 9003* Quality Systems Specification for Quality Assurance in Final Inspection and Test.
- *ISO 9004* Quality Management and Quality System Elements – Part 1: Guidelines.

The ISO 9000 family of standards embraces the use of Plan-Do-Check-Act principles and various project management procedures to ensure and enhance quality.

Before ISO 9001:2000 came into effect, the ISO 9000 series was last updated in 1994, mostly with a few wording changes for clarification, but no real change in substance. During the year 2000, the ISO 9000 standards have undergone a major overhaul. The year 2000 update was a major structural and strategic revision of the Standards. It consists of several concepts that will bring it into better alignment and harmony with what are generally considered ‘best practices’ for successful quality management systems. The key standard within the ISO 9000:1994 family of standards (ISO 9001:1994, ISO 9002:1994 and ISO 9003:1994) have been merged into a single ISO Standard, ISO 9001:2000. In addition, the old ISO 9002:1994 and ISO 9003:1994 have become obsolete. (Pheng & Fong)

To facilitate the success of quality objectives, eight quality management principles have been identified. Each major clause of the new ISO 9001:2000 standards is based on these eight principles:

1. *Customer focus*: Organizations depend on their customers and the customers’ needs, requirements and expectations.
2. *Leadership*: Leaders show unity of purpose, direction and the internal environment of the organization. They create the environment in which people can become involved in achieving the organization’s benefit.

3. *Involvement of people:* People at all levels are the essence of an organization and their full involvement enables their abilities to be used for the organization's benefit.
 4. *Process approach:* A desired result is achieved more efficiently when related resources and activities are managed as a process.
 5. *System Approach to management:* Identifying, understanding and managing a system of interrelated processes for a given objective can contribute to the effectiveness and efficiency of the organization.
 6. *Continual improvement:* One of the permanent objective of the organization is the Continual improvement
 7. *Factual approach to decision making:* Effective decisions are based on the logical analysis of data and information
 8. *Mutually beneficial supplier relationships:* The ability of the organization and its suppliers to create value is enhanced by mutually beneficial relationships.
- ([Pheng & Fong, 2003])

The ISO 9001:1994 structure (the ISO 9000 quality management system) is formed by the 20 headings or 'system elements. These are;

Items 1-3 are introductory

- 4.1 *Management Responsibility*
 - 4.1.1 *Quality policy*
 - 4.1.2 *Organization*
 - 4.1.3 *Management review*
- 4.2 *Quality System*
 - 4.2.1 *General*
 - 4.2.2 *Quality system procedures*
 - 4.2.3 *Quality planning*
- 4.3 *Contract review*
 - 4.3.1 *General*
 - 4.3.2 *Review*
 - 4.3.3 *Amendment to contact*
 - 4.3.4 *Records*
- 4.4 *Design Control*
 - 4.4.1 *General*
 - 4.4.2 *Design and development planning*
 - 4.4.3 *Organizational and technical interfaces*
 - 4.4.4 *Design input*

- 4.4.5 *Design review*
 - 4.4.6 *Design verification*
 - 4.4.7 *Design validation*
 - 4.4.8 *Design changes*
- 4.5 *Document and data control*
 - 4.5.1 *General*
 - 4.5.2 *Document and data approval and issues*
 - 4.5.3 *Document and data changes*
- 4.6 *Purchasing*
 - 4.6.1 *General*
 - 4.6.2 *Evaluation of subcontracts*
 - 4.6.3 *Purchasing data*
 - 4.6.4 *Evaluation of purchased product*
- 4.7 *Control of customer*
- 4.8 *Product identification and traceability*
- 4.9 *Process control*
- 4.10 *Inspection and testing*
- 4.11 *Control of inspection, measuring and test equipment*
- 4.12 *Inspection and test status*
- 4.13 *Control of non-conforming product*
 - 4.13.1 *General*
 - 4.13.2 *Review and disposition of non-conforming product*
- 4.14 *Corrective and preventive action*
 - 4.14.1 *General*
 - 4.14.2 *Corrective action*
 - 4.14.3 *Preventive action*
- 4.15 *Handling, storage, packing, preservation and delivery*
- 4.16 *Control of quality records*
- 4.17 *Internal quality records*
- 4.18 *Training*
- 4.19 *Servicing*
- 4.20 *Statistical techniques*
 - 4.20.1 *Identification of need*
 - 4.20.2 *Procedure*

These 20 elements that formed the structure of the old ISO 9001:1994 standards were afterward merged into a new structure with five main parts, which are;

1. Quality management System
2. Management responsibility
3. Resource management
4. Product and/or service realization
5. Measurement, analysis and improvement

These sections, in turn, are further broken down into 23 clauses and 41 sub-clauses containing, all the elements that must be addressed in a QMS. These elements are listed as;

4. Quality management system

4.1 General requirements

4.2 Documentation requirements

4.2.1 General

4.2.2 Quality Manual

4.2.3 Control of Documents

4.2.4 Control of Records

5. Management responsibility

5.1 Management Commitment

5.2 Customer focus

5.3 Quality policy

5.4 Planning

5.4.1 Quality objectives

5.4.2 Quality management system planning

5.5 Responsibility, authority and communication

5.5.1 Responsibility and authority

5.5.2 Management Representative

5.5.3 Internal communication

5.6 Management review

5.6.1 General

5.6.2 Review input

5.6.3 Review output

6. Resources management

6.1 Provision of resources

6.2 Human resources

6.2.1 General

6.2.2 Competence, awareness and training

6.2.3 Infrastructure

8.4 Analysis of data

8.5 Improvement

8.5.1 Continual improvement

8.5.2 Corrective action

8.5.3 Preventive action

These five parts describe the five phases of a fundamental concept for the new Standard. This New standard, which has a new process oriented structure, mentioned as the “Process Model” as shown in figure 3.1 (Pheng & Pong). It is aimed to use in a similar way with the plan-do-check-action model of the continual improvement process popularized by Deming. Both the ISO 9001:1994 and ISO 9001:2000 Standards are organized to keep the same structure and sequence, based on these four phase model.

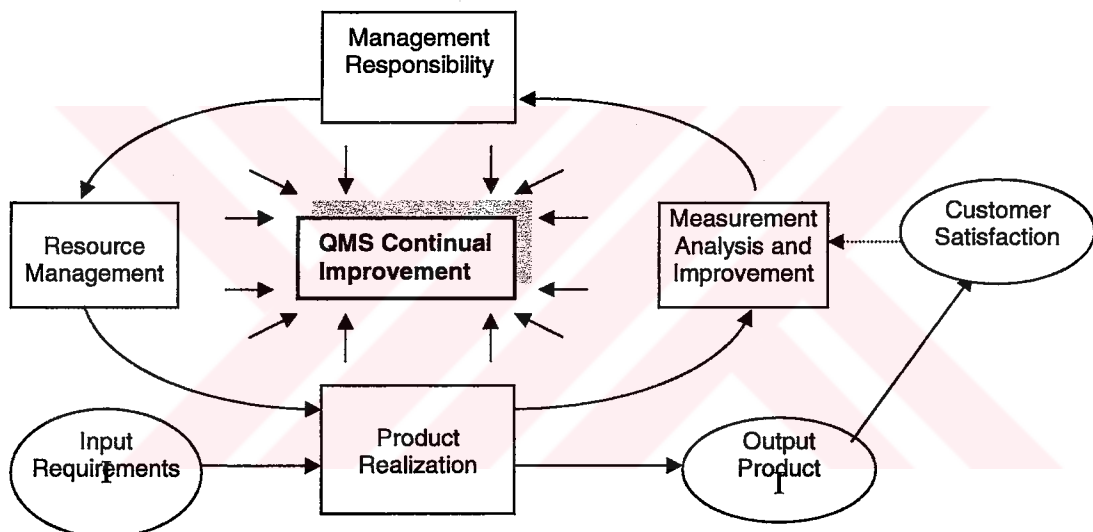


Figure 3.1 Model of a Process- Based Quality Management System *

(*) This figure is adapted from Besterfield 2003, pp. 259

3.2.2 Benefits and Advantages of ISO 9000 Quality Management System

Benefits associated with the adoption of ISO 9000 quality standards have been found to include the following:

- Increased profitability,
- Expanded market share,
- Increased customer satisfaction,
- Reduced operating costs,
- Heightened demand for products and services, and
- Better employee working conditions. (Koehn & Datta, 2003)

In literature, different writers define many advantages of ISO 9000 like the /benefits. For instance Calingo (1995) cited the following advantages of ISO 9000 QMS implementation:

- Compliance with clients' requirements;
- Gaining a competitive edge;
- Ability to export products and services; and encouragement of teamwork.

According to the Quazi and Padibjo (1998) , advantages of the ISO are identified as;

- Improved company reputation;
- Increased customer preference;
- Quality awareness of employees;
- Competitive advantage;
- Improved sales, profit and growth;
- Streamlined procedures;
- Greater consistency in quality of workmanship;
- Provision of a base for TQM and ISO 14000 certification. (Ofori & Gang, 2002)

Therefore, according to the Hayden, the benefits in using ISO 9000 voluntarily to formulate QMS are mentioned as;

1. For clients: ISO 9000 provides a strong measure of confidence that the firm has systematic process capability to deliver on its contractual promises.
2. For employees: ISO 9000 documents what is expected, makes indoctrination and training more useful, and serves as a knowledge-transfer tool within the existing and expanding workforce of your firm.
3. For practice: ISO 9000 verifies that what is intended really happens, consistently. (Hayden, 1996)

On the other hand, some disadvantages and problems in ISO 9000 QMS implementation have been mentioned in the literature by these same writers and others. Calingo (1995) found a lack of commitment of managers and employers; time involved in training, meetings and system development; and difficulty in understanding the QMS and overcoming communications barriers. Quazi and Padibjo (1998) added high cost of implementation; extra effort in documentation; shortage of manpower; and resistance of supervisors and employees. The Productivity and Quality Research Center found that the certified companies did not achieve the expected increase in sales. (Ofori & Gang, 2002)

3.2.3 Application of ISO 9000 Quality Management System in Construction

Due to the general nature of ISO 9000, it has also been implemented in the construction industry. Particularly, following the 1994 revisions, ISO 9001 and 9002 can be applied to construction-related firms. The previous standard addresses design, development, and servicing capabilities, whereas the latter addresses the same elements except for design control. However, they have been adapted for construction procedures and are believed by some parties to cover a wide scope of quality related activities of construction-related firms.

Construction firms for a variety of reasons follow ISO 9000. There are many reasons ideally, for the implementation of this activity. It is believed that the main motivation factor for certification should be the success of quality in a company's internal procedures in order to increase the efficiency of the resources and satisfy the customers' requirements in a better way. For this reasons many firms strongly prefer to work or target projects for owners which are either certified to ISO 9000 or require certifications for their suppliers.

The other main motivator for certification is the government requirements. At a worldwide level, other organizations are obtaining certification due to increasing government requirements. It is thought that this is true for local and international firms working in Asian markets, where ISO 9000 is increasingly becoming a mandatory requirement for bidding in public projects (Chini & Valdez, 2003). Other firms take advantage of ISO 9000 as an effective marketing tool in order to improve company reputation. Generally for contractor to finish the project within a certain time, at an accepted cost and at a certain standard are the main requirements to maintain the quality.

In the international construction market, ISO 9000 has gained wide acceptance and popularity. If we consider the construction sector at a worldwide level, it is seen that construction has the third highest number of certificates of all industrial sectors, behind the electrical and optical equipment and basic metal/fabricated metal products.

In literature, it is thought that the acceptance of ISO 9000 standards in the construction industries is not as wide as in other industries, such as manufacturing. There are special features in the construction industry that limit the implementation of the ISO 9000 standard. The following are some of these features; (Phenol 1994)

- A construction project is usually a unique collection of people, equipment, and materials brought together at a unique location under unique weather

conditions, while most manufacturing is a system of mass production wherein all of these factors are consistent with producing typical products over and over again.

- Performance testing in construction is generally not feasible as a basis for acceptance.
- It is common to have separate contracts for design and construction.
- It is not feasible to reject the whole constructed project after completion while attached to the purchaser's land.
- Decisions to reject a defective part of a constructed project need to be taken promptly before succeeding parts are constructed or installed.
- The number of parties involved in the constructed project's procurement is more than those involved in manufacturing procurement. Achieving quality construction requires effort from all parties. This makes the interface and responsibilities of the various individuals and organizations more complicated than in manufacturing.
- The organizational structure of a construction company varies depending on the nature of the project, while the same structure in a manufacturing company is almost unchanging. This affects the smoothness of communication and interface between the responsible individuals.
- Turnover of manpower in construction is higher than in manufacturing, which affecting the precision of long-term plans.
- Construction projects are very complicated and their execution may take years. (Bubshait & Al-Atiq, 1999)

Integration of ISO 9000 and Quality Management System:

As we mentioned before, ISO 9001 Quality Systems has a structure and some principles. And also we know that ISO serves to clients according to their requirements and expectations which are standardized in a global sector by the affect of the quality trilogy of quality planning, quality control and quality improvement. This trilogy supports the launching of a quality process, project by project.

Each firm in construction industry has their intended activities or tasks related to assuring quality. What far too many suffer from is the lack of consistency and in their use and systematic improvement. The missing point here is a quality management system (QMS) baseline to connect and transform these random acts into a visible system. If consistency is to be supported by creating a learning organization, then a

fourth dimension is needed – measurement. And for design and construction organizations from three persons to more than 3000 persons, it is suggested that measurement of the operating QMS itself, not asking “Who did it?” but instead “What is broken, how can we fix it?” Then “Let’s improve the process.”

The principles of TQM create the foundation for developing an organization’s system (Deming 1993) for planning, controlling and improving quality. Quality principles summarize the five points; (Hayden, 1996)

1. Asking the customers what they want
2. Translate customer needs into requirements
3. Improve work process cycle time
4. Measure the system, not people’s behavior
5. Make sure everyone feels like a stakeholder

Thus it can be said that the main purpose of the ISO 9000 QMS is to achieve customer satisfaction by the help of prevention of nonconformity at all stages, from design through servicing. Figure 3.3 illustrates the connection between selected ISO 9001:1994 requirements, the quality trilogy (Juran and Gyron 1993) and the Shewhart/Deming plan-do-check-act (P-D-C-A) cycle and figure 3.2 illustrates the ISO 9001:2000 continual improvement cycle where we can demonstrate the inherent continual improvement properties of the standard if we indicate the relationship between the five operational sections and their corresponding paragraph of the Standard and the Shewhart cycle of plan-do-check-act.

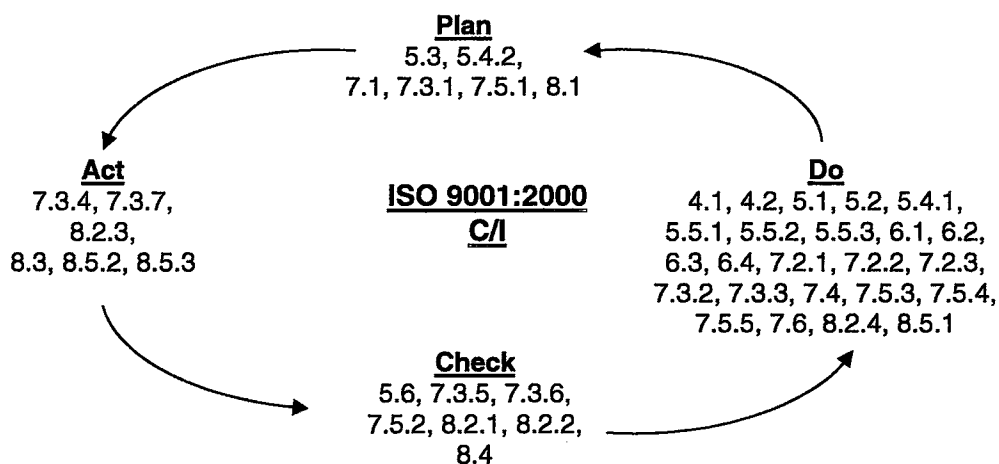


Figure 3.2 ISO 9001:2000 continual improvement cycle by paragraph
(*) This figure is taken from Schlickman 2003, pp. 41

Design and implementation of QMS is affected by the client requirements, business needs, organizational objectives, services supplied, and specific practices used. It is

expected within a good business sense that adding or deleting QMS requirements is a normal part of a contractual situation

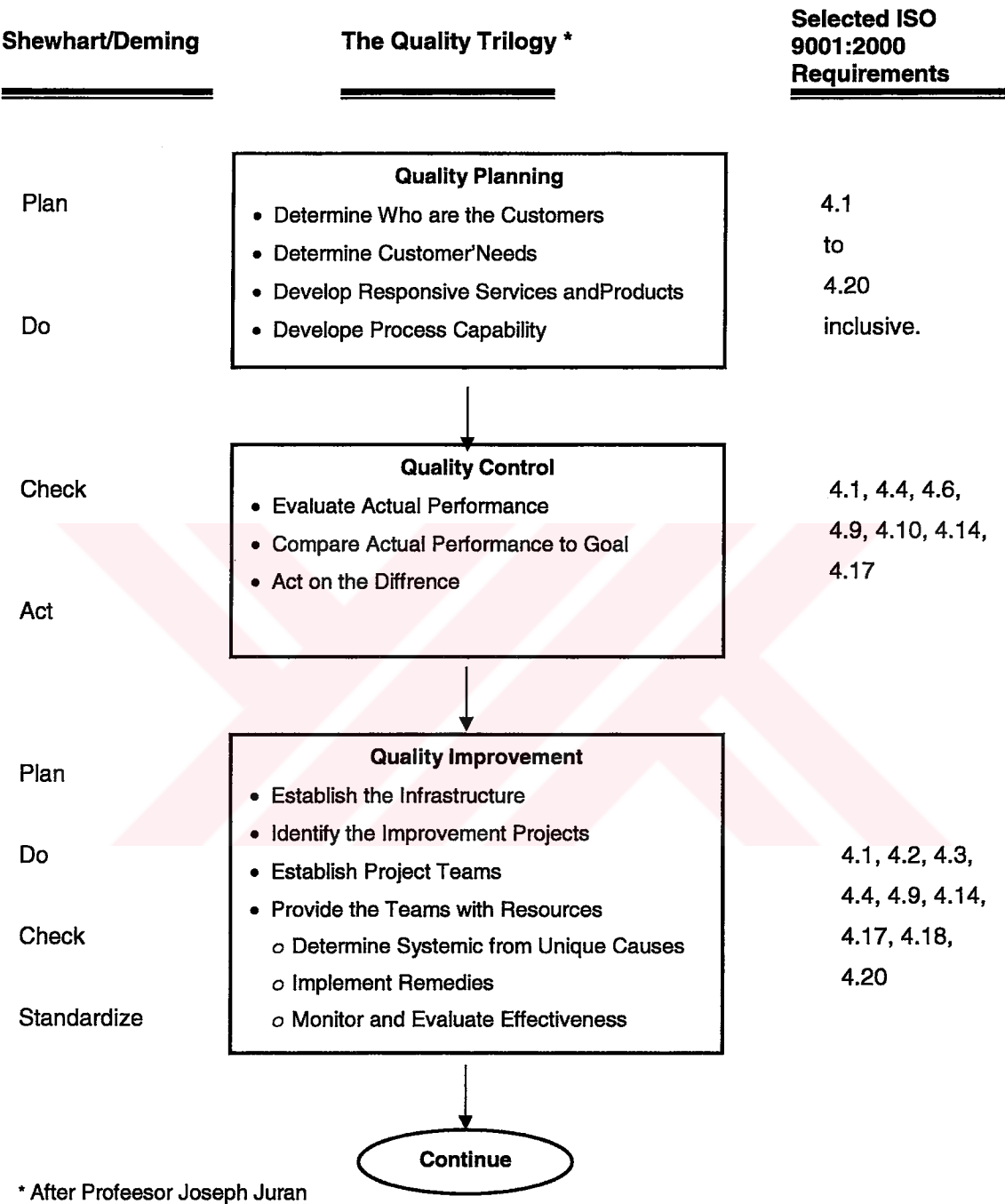


Figure 3.3 Integrating ISO 9000 and TQM *
 (*) This figure is formed by being inspired from Hayden 1996, pp. 41

3.3 ISO 14001:1996 Environmental Management System

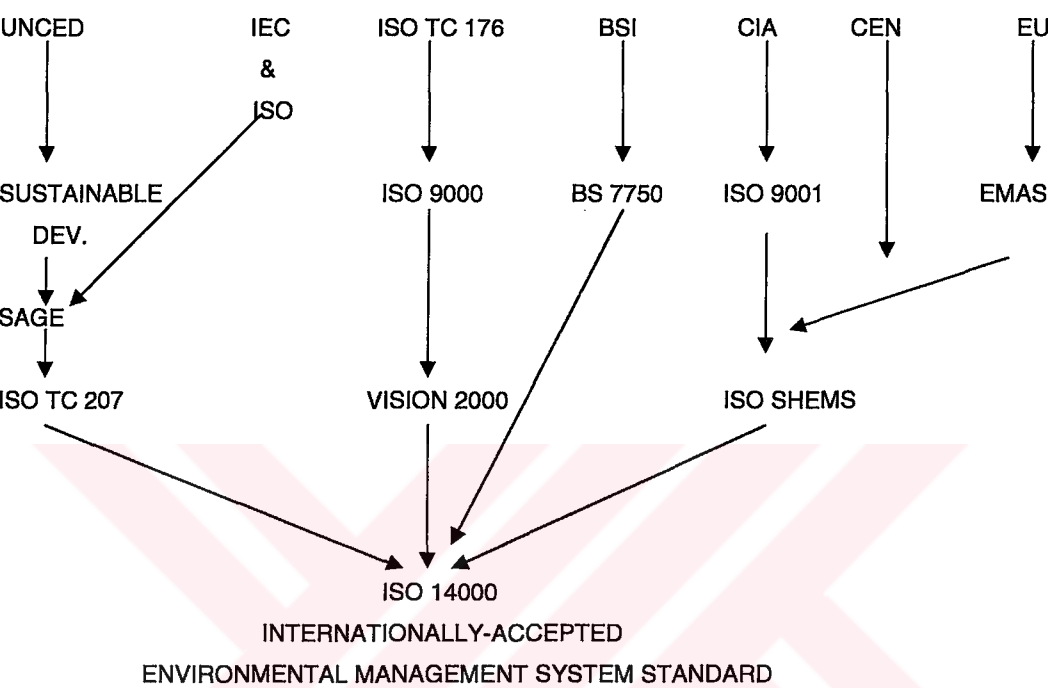
The main principles of a quality system are the same whether the system is for the quality management of products and services or for the management of environmental quality. The differences arise in the nature of the entity, its specific requirements, and the scope of its applications. To develop a suitable quality management system for environmental issues, we need to reengineer the main principles of quality management to address the specific nature and requirements of the issues relating to the environment. This means that in order to establish an environmental management system (EMS), the nature of the activities, products, processes, and services must be identified attentively and for the organizations to be aware of the environmental concerns of all the stakeholders and identify any convenient legal and regulatory requirements (Puri, 1996). The international response to the environmental concerns is being addressed through the technical committee ISO/TC 207 of the International Organization for Standardization. While the standards in the current ISO 9000 series address the issues of quality assurance and quality management of products and services, the standards in the ISO 14000 series address the environmental aspects of those products and services. ISO 14001 is one of the most important of the initial set of standards which specifies the core requirements for environmental management system, and is intended to be used as a conformance standard for EMS.

3.3.1 Evolution of ISO 14000

Both standardization and environment management have existed and known for years, and they were used by professions separately in many times. Like the ISO 9000 standards, which do not address the performance of the product or service, the committee used the concept that the standards addressed the process rather than the end goal. Thus they are process standards rather than performance standards. Standardization on a worldwide basis was accelerated with quality and occurred generally independent of environmental management. Merger of these two factor- environmental management and the standardization movements – was happened in the early 1990's. This has occurred through the hard work of many individuals and organizations such as the International Organization for Standardization (ISO), The British Standards Institute (BSI), the American National Standards Institute (ANSI) and numerous other organizations in many countries.

The development of such standards certainly is global. As indicated in figure 3.3, there are many proposed standards involved in this merger of environmental

management and standardization. Representatives from 57 countries, including the United Kingdom, the Netherlands, Australia, France, Norway, and the United States, assisted with the draft standards and fifteen more had observer status. Figure x shows some of these standards such as BS 7750 that are being considered (Kuhre).



The abbreviations are explained in the Abbreviation List

Figure 3.4 Evolution of ISO 14000 *
 (*) This figure is taken from Kuhre 1995, pp. 8

Today, the use of recognized environmental management frameworks, such as the ISO 14001 standard is being encouraged by the Environmental Protection Agency as a basis for designing procedures and implementing outcomes aligned with the nation’s environmental policy goals (Koehn & Datta, 2003).

An EMS (Environmental Management System) is defined as the part of the overall management system which includes the organizational structure, planning activities, responsibilities, practices, procedures, processes and resources for developing, implementing, achieving, reviewing and maintaining a company’s environmental policy. ISO 14000 provides organizations the framework for managing environmental impacts. The EMS maximizes company participation in environmental performance now and in the future (Bestefield’s, 2003). International environmental standards are being developed for construction, utilizing the principles of the ISO 9000 and ISO 14000 series (Ofori, Gang& Bri, 2002).

Concept of ISO 14001

This standard provides organizations with the elements for an environmental management system (EMS), which can be integrated into other management systems to help achieve environmental and economic goals. It was written to be applicable to all types and sizes of organizations and to accommodate diverse geographical, cultural and social conditions.

The basic approach to EMS is shown in Figure 3.4. It begins with the environmental policy, which is followed by planning, implementation and operation, checking and corrective action, and management review. The approach follows the PDSA cycle. There is a logical sequence of events to achieve continual improvement.

As mentioned in the previous paragraphs, standards are formed with some requirements which give the main shape of the system and based on only the process. The ISO 14001 standard is divided into six parts and has a total of 18 requirements as follows;

5.1 General Requirements

5.2 Environmental Policy

5.3 Planning

5.3.1 Environmental Aspects

5.3.2 Legal and Other Requirements

5.3.3 Objectives and Targets

5.3.4 Environmental Management Program(s)

5.4 Implementation and Operation

5.4.1 Structure and Responsibility

5.4.2 Training, Awareness, and Competency

5.4.3 Communication

5.4.4 Environmental Management System Documentation

5.4.5 Document Control

5.4.6 Operational Control

5.4.7 Emergency Preparedness and Response

5.5 Checking and Corrective Action

5.5.1 Monitoring and Measuring

5.5.2 Nonconformance and Corrective and Preventative Action

5.5.3 Records

5.5.4 EMS Audit

5.6 Management Review

In addition, to develop an effective EMS with the tangible requirements, some fundamental environmental management principles that should become an integral part of an organization's operability have to be assumed by organization. Indeed, without these principles, it is clear that, systems will not be sustainable. Some of these guiding principles can be listed as follows;

- Commitment to do good to the environment
- Minimizing activities that are unfriendly to the environment
- Designing environmentally safety projects and services
- Improving project quality and performance
- Working towards sustainable developments
- Using environmentally safe energy resources
- Utilizing natural resources sustainably
- Practicing the 4 R': reduce, reuse, recycle, recover

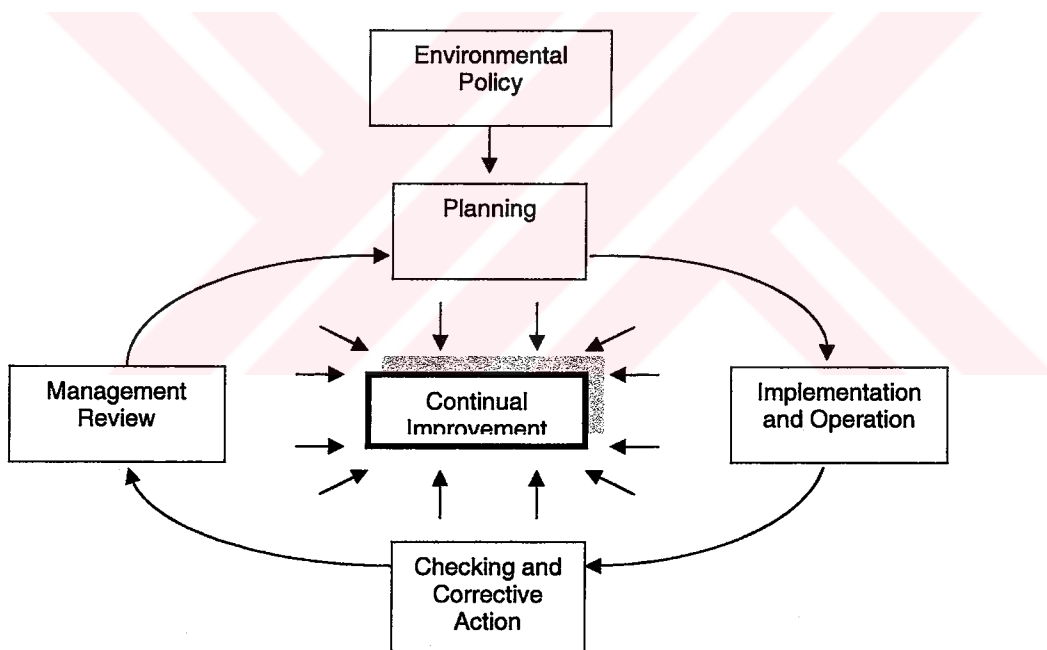


Figure 3.5 Environmental Management System Requirements *
 (*) This figure is taken from Besterfield 2003, pp. 297

3.3.2 Benefits of ISO 140001 Environmental Management Systems

There are numerous benefits of ISO 14001 certification, both in globally and organizational, most of which could also be considered benefits of environmental management. These are;

- *Protection of the Environment (improved environmental performance):* The main purpose of the ISO 14001 is to protect the environment and living things in it against to the hazardous materials. If we take environmental management into hand in construction, we can say that this certification system ensures people to use the environment resources better and appropriate to the requirements of users and building designs.
- *Potential impact on world trade to allow competition on an equal basis:* Nowadays, there is no uniformity in the amount of time and money that organizations currently spend to protect the environment. In this case certification will help to put organizations and firms on a more equal basis in terms of the time and money they spend to help protect the environment.
- *Demonstrated Compliance with Regulations:* many organizations which have been in existence for an insufficient period (for a few years) are probably in partial compliance with most of the applicable regulations. For this kinds of firms or organizations, having The ISO certification for environmental management is a good chance that the written documentation necessary to demonstrate compliance with the regulations will be present.
- *Establishment of effective management systems:* There are many variables which could keep the organization or the firm viable and live. By the help of the quality and then the help of the environmental management standards, it will be forced management to be more effective. The standards that must be met to achieve ISO certification in terms of environmental management contain many good management techniques, such as environmental personal management, accounting, vendor control, document control, and other common systems.
- *Reduced operating costs:* In spite of the big amount of initial costs, there should be the long term cost savings. For example in construction, to evaluate the all construction site environmental resources according to he standards and use them in the projects due to the environment management system of the organization can costs much more than the expected price; but in the long-term period it will effort its expense. If initial and ongoing certification costs are properly managed, there should be a long-term reduction in environmental costs and increase in competitive edge.
- *Reduced injuries:* by the reduction of the hazardous things on site, the number of people injured by these substances will also decrease. For

instance, as we think about a site which has a critical impact during the earthquake, the management systems that must be applied both in design and construction phases will not only protect lives, but also reduce the costs associated with the loss of productivity and morale, equipment replacement costs and loss in time to correct and prevent recurrence.

- *Improved community Relations:* If an organization improves their environmental management program, it will surely improve their community relations as well as whether they obtain an ISO 14001 certification or not.
- *Improved Customer Trust and Satisfaction:* Relate to the improving community relations is the subject of customer trust and satisfaction. Once the organization has the ISO 14001 certification, the customer feel more secure that the environment and they are being protected.
- *Improved upper management attention:* The whole process of obtaining ISO 14001 certification will give upper management in most organizations an increased and more positive appreciation for environmental management.
- *Increased access to markets:* Like other ISO standards, ISO 14001 Environmental Management Specification gives organization the chance and opportunity to exist in the international market. Once it is thought through the construction industry, this gains an important meaning as other industry arenas because of the competitiveness of the world trade.
- *Ensuring employee involvement and education:* The main utility of the standards is having the function educate people according to the world standards and new techniques. This will help people and employees to be more sensitive and educated about environment and the importance of the ways used.
- *Savings in consumption of energy and materials:* As we know, environment has the main energy resource of the world. These resources are used in different industries from chemical to construction. Just in case of using these resources according to the standards and managing the process in good manners, it is unavoidable to save energy and materials.

3.3.3 ISO 14000 in Construction

The ISO 14000 family addresses various aspects of environmental management. Since its adoption in 1996, more than 430,000 organizations in 158 countries have achieved ISO 14001 registration, the majority of which are in the manufacturing

industry. ISO 14001, an integral part of the ISO 14000 series of global environmental management standards, integrates business practices and environmental goals that enable an organization to manage its potential impact on the environment.

Nowadays, environmental management frameworks are being encouraged by the Environmental Protection Agency, such as the ISO 14001 standard, as a basis for designing procedures and implementing outcomes aligned with the nation's environmental policy goals.

Specifically, an environmental management system (EMS) may be an integral part of an organization's overall management system, which provides an order and consistency for the firm to address environmental concerns. This may be accomplished through the allocation of resources, assignment of responsibilities, and an ongoing evaluation of practices, procedures, and processes. In the past, some construction firms dismissed the application of EMS as too expensive. But as mentioned in ISO 1994b, a closer look may reveal the following benefits (which are in the same direction with the benefits we mentioned for general companies above) to a construction company through proper implementation of an EMS (Koehn & Datta, 2003);

- Conservation of materials and energy,
- Improved cost control,
- Satisfaction of customer demand for a commitment to the environment,
- Maintenance of good public/community relations,
- Lower insurance rates,
- Enhanced image and market share, and
- Improved industry/government relations.

3.4 OHSAS 18001:1999 Occupational Health and Safety Management System

3.4.1 Evolution of OHSAS 18000

OHSAS 18000 is an international occupational health and safety management system specification to enable an organization to control its OH&S risks and improve its performance. It comprises two parts, 18001 (Occupation health and Safety Assessment Series) and 18002 (Occupation Health and Management System-Guidelines for the implementation of OHSAS 18001) and embraces a number of other publications (<http://www.ohsas-18001-occupational-health-and-safety.com>).

OHSAS 18001 was developed in response to urgent customer demand for a recognizable occupational health and safety management systems standard against which their management system may be assessed and certified.

OHSAS 18001 was created via a concerted effort from a number of the worlds leading national standards bodies, certification bodies, and specialist consultancies. A main driver for this was to try to remove confusion in the workplace from the proliferation of certifiable OH&S specifications.

The participants were as follows:

- National Standards Authority of Ireland
 - * Standards Australia
 - * South African Bureau of Standards
 - * British Standards Institution
 - * Bureau Veritas Quality International
 - * Det Norske Veritas
 - * Lloyds Register Quality Assurance
 - * National Quality Assurance
 - * SFS Certification
 - * SGS Yarsley International Certification Services
 - * Asociation de Normalization Certification
 - * International Safety Management Organization Ltd
 - * Standards and Industry Research Institute of Malaysia
 - * International Certification Services (<http://www.ohsas-18001-occupational-health-and-safety.com>)

The specification takes a structured approach to OH&S management. The importance of the system is based on to be proactive and preventive by the identification of hazards and the evaluation and control of work related risks. OHSAS 18001 can be used by organization of all sizes regardless of the nature of their activities or location. Organizations can now achieve third party certification for their Occupational Health and Safety management system.

OHSAS 18001 contains specified requirements as shown in figure 3.5 include the following elements:

- OH&S policy
- Planning
- Implementation and Operation
- Checking and corrective action

- Management Review
- Continual Improvement

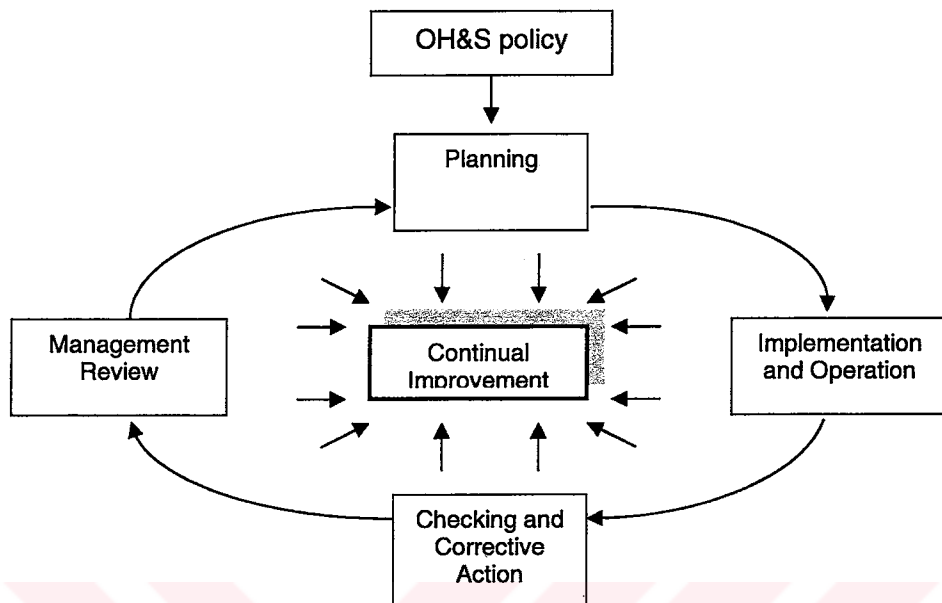


Figure 3.6 Safety Management System Requirements

The OHSAS 18000 criteria have been suggested for the development of an occupational health and safety management system. There are mainly similarities between ISO 14001 environmental management system and OHSAS 18001 occupational health and safety management system requirements. Even the section numbering is nearly the same. The primary difference is the “risk assessment” section, which replaces the environmental aspects section of ISO 14001, and the substitution of the words “health and safety” for “environmental.” The other difference is that it requires a management system that identifies, controls, and seeks continuous improvement in occupational health and safety (Koehn & Datta, 2003) Many contractors do not comply with the international, national, and regional legal safety requirements. This may result in major problems when employees become injured on the job site. OHSAS 18000 recommends the development of a holistic risk management process to ensure compliance with international, national, and regional safety requirements.

Safety and risk management process provide many people or employee to be appointed to manage health and safety and to train the employees and understand the importance of job site safety. Unfortunately, the international organization for standardization has not yet released OHSAS 18000, but it is being utilized on a national level in some countries like the United Kingdom, Australia, and Singapore.

It may be considered an improved version of a safety management system (SMS) which itself is a relatively new approach of controlling safety policies, procedures, and practices within a company. This philosophy is currently being implemented by many construction companies to limit their liabilities and costs, thereby making them more competitive in the construction market place (Koehn & Datta, 2003)

OHSAS 18001: 1999 was developed in the hope that it would eventually be adopted as an ISO standard in much the same way that BS 5750 was adopted as ISO 9000 for quality management, and BS 7750 as ISO 14000 for environmental management. OHSAS 18001: 1999 was also designed to address the issue of plan-do-check-act at the functional management level to formulate a self-regulating OHS environment (Pheng & Pong, 2002).

3.4.2 Benefits of OHSAS 18001

OHSAS 18001 is the sound solution for most of the organizations which meet challenges due to;

- high injury and illness,
- lost work days,
- increasing occupational health and safety regulations,
- large citations/penalties,
- rising worker's compensation costs,
- costly medical claims,
- worker retention and employee satisfaction.

Traditional occupation health and safety management usually meant reacting to work related incidents rather than planning for the control of work related risks that compose OHSAS 18001:1999. Other costs facing organizations include but are not limited to, investigation time, wages paid for lost time, training replacements, extra supervisory time, clerical time, decreased output of injured worker upon return and the loss of business and goodwill.

Organizations that have been the pioneers in attaining OHSAS 18001:1999 already report realized benefits of this standard as;

- Increased operational benefits,
- Reduction in lost work days,
- Fewer accidents and medical claims,
- Recognition by insurers and regulars
- Improved workers' retention and satisfaction.

These organizations report the process of attained registration through the NSAI approach has improved internal and external communication of the organization occupational health and safety commitment. Employees have responded favorably to registered organization's overt commitment to continued occupational health and safety improvements. Enhanced employee awareness and individual commitment to occupational health and safety has served as the basis for positive organizational change.

Much of the improvement is attributed to employee education and awareness of safety issues and understanding. This increased awareness has been the key factor for OHSAS 18001 organizations' saving in legal expenses, building damage, tool and equipment damage, product and material damage and production delays and interruptions. Bottom line improvements for organizations that have a registered OH&S management system include efficient organizational discipline. Employee awareness and satisfaction, recognition by insurers, lower workers' compensation and medical costs, and increased control of regulatory issues (<http://www.nsaicert.com/ohas.html>).

In addition, the OHSAS specification is applicable to any organization that wishes to;

- Establish an OH&S management system to eliminate or minimize risk to employees and other interested parties who may be exposed to OH&S risks associated with its activities
- Assure itself of its conformance with its stated OH&S policy
- Demonstrate such conformance to others
- Implement, maintain and continually improve an OH&S management system
- Make a self-determination and declaration of conformance with this OHSAS specification.
- Seek certification/registration of its OH&S management system by an external organization

In conclusion, essentially, OHSAS helps in a variety of respects. It helps minimize risk to employees/etc; improve an existing OH&S management system; demonstrate diligence; gain assurance; etc. (<http://www.ohsas-18001-occupational-health-and-safety.com>)

3.4.3 OHSAS 18001 in Construction

OHSAS 18001 Safety management system (SMS), itself, is a relatively new approach of controlling safety policies, procedures, and practices within a company. This philosophy is currently being implemented by many construction companies in construction industry, which is one of the most dangerous occupations in all over the world accounting for a big deal percentage of the disability injuries and the facilities that occur in the industrial work force, to limit their liabilities and costs that making them more competitive in the construction market place (Koehn & Datta, 2003). For this reason, the interest in safety awareness among construction companies has greatly increased in the past decades. This increased awareness in safety can be attributed to many factors. As an example, the construction industry has come to recognize the relationship between risk management and return on investment (Davis 1998). After the fact that most successful construction companies have recognized the importance of safety management, they have started to develop effective company safety programs which include new employee orientation, safety training, safety planning and job site safety surveillance etc. The ever-increasing cost of medical treatment, convalescent care, and the potential for lawsuits all add up to higher insurance premiums, which in turn tend to have a negative impact on a company's profit (Hinze 1998). In addition, companies with high experience modification ratings are often prohibited from bidding on a certain type of work. It is, therefore, in the company's best interest to take whatever means necessary to manage safety on the work site (Wilson& Koehn, 2000).

All construction sites have their own unique aspects of safety, which must be considered, and safety practices changed according to some feature of the sites such as the size of the project and site. For example larger construction projects generally are better organized from a safety standpoint. These types of projects are often high profile. The companies involved in such visible construction projects have reputations to uphold as well as safety records to maintain; they are generally better prepared to manage the safety aspects of a project. Almost all of the larger construction firms have a full-time safety director or at least one person who is responsible for the company's safety program. Having full-time safety personnel relieves the pressure, somewhat, on the onsite construction project team (Wilson& Koehn, 2000). This may be accomplished by keeping the team members informed of possible safety problems, by making sure that subcontractors are implementing their safety programs adequately, and by assisting in the routine day-to-day aspects of

OHSAS 18001 Occupational Health and Safety Management. This allows the project personnel to focus their efforts on the project itself.

The other important factor which will encourage this standard and management system in construction is the overall project specific phased safety plan and safety record for the projects which ensure quite well process with no lost time accidents being experienced during construction. A project specific phased safety plan is a detailed accident prevention plan that is focused directly on the hazards that will exist on a specific project and the specific measures to be taken to reduce the likelihood of accidents. These plans are generally required project managers to submit at preconstruction stages. A project specific phased safety plan serves several purposes such as;

- Defining individual hazard prevention responsibilities of each member of the project management team.
- Identifying potential hazards that may occur on the job site during each phase of construction and identifying specific avoidance or mitigation measures to be taken.
- Lists equipment to be used on the project, the hazards associated with each, and specific safeguards to be taken
- Listing construction methods to be employed during each phase of construction and safety procedures that are to be incorporated with each method
- Describing the specific safety awareness training program to be used on the site (Schaufelberger, 2003).

Moreover the success of this standard system is also due, in part, to the willingness of the workers to try something new and to their flexibility in adapting to change. If this standard and management system is applied with all its requirements in the whole project stages effectively, it is unavoidable of the employees to be motivated by knowing that they are in a safety environment.

On the other hand, there is one more important thing that should be taken into consideration about the application of the system and standard in construction industry, which is related with the safety of the users of the outcome. It shouldn't be forgotten that the safety of the users are important as the safety of the employees working on site because of the fact that they are the main elements under the risk in

long term. At this point of view, the appropriate and convenient application of these standard and management system in the whole processes of the construction, starting to the preliminary design to construction phase, gain another importance for ensuring the safety of the last users in the maintain phase.



4. INTEGRATED STANDARDS AND MANAGEMENT SYSTEMS

In last decade, after the new revision of the ISO 9001 standards, the international standards have gained a specific feature and structure which ensures companies to take some fundamental standards together and make their management systems integrated which will help the companies to save resources as common elements such as policy, document control, records management, internal audit and management review that can be audited together. Because of this flexible configuration of these standards separately, a possibility of integrated standards two in one or, especially in recent years, three in one has come into existence in many sectors such as construction in the world trade.

Besides, quality systems have been widely accused of being bureaucratic, costly and with the potential for creating burdensome paperwork. The introduction of more systems may only serve to intensify such an opinion. The quality industry is well aware of such difficulties. In recent years, it has been actively seeking an alternative approach, which has resulted in the development of integrated management systems (IMS). An IMS seeks to combine similar aspects of different standards in order to simplify management procedures, minimize paperwork and reduce costs.

In conclusion, today, this integrated management systems related with the international standards of ISO 9001:2000, ISO 14001:1996, and OHSAS 18001 are so widespread in the international market which are also forced to be taken by governmental factors in some countries because of the global competitiveness.

4.1 Integration of ISO 9001:2000 and ISO 14001:1996

If an organization currently is certified to an ISO 9000 standard, an obvious question arises: How may the ISO 14000 series be integrated into the existing management system? Firstly, this question can be answered by considering the management

systems (quality management and environmental management systems) as a whole.

The majority of organizations may feel that they are operating effectively, and so integration of quality and environmental management systems gives nothing more than a great deal of unnecessary paperwork and . However, when these organizations decide to integrate these systems they see that many procedures, required by the environmental management system, already exist as part of the quality management system and to use QMS procedures in support of EMS requirements actually reduces the paper work.

But last decade, the aspect of the organizations against this integration system is developed and the rate of the firms that accepted this system has been increasing day by day. Also this increased is noted by some writers that work on the integration of ISO 9000 and ISO 14000 appeared soon after the latter was released in 1996 rapidly. In construction, the potential of IMS have been considered since 1997. In July 1997, a battery plant obtained ISO 9001 and ISO 14001 certifications believed to be the first to be certified in South-East Asia. The consultants, CCIS Singapore, described as “an active promoter of integrated systems”, devised a procedure for integrating the two standards in 1998, and have been helping several organizations certified to ISO 9000 QMS to integrate it with ISO 14001. It has also been enabling companies to obtain both certifications in one audit. In 1999, another Engineering Construction Firm became the first construction enterprise to have an integrated system combining certified QMS and EMS (Ofori, Gang & Bri, 2002).

The ISO 14001 standard describes the relationship between the ISO 9000 series and ISO 14001:

“This standard shares common management system principles with the ISO 9000 series of quality system standards. Organizations may elect to use an existing management system consistent with the ISO 9000 series as a basis for its environmental management system. It should be understood, however, that the application of various elements of the management system might differ due to the different purposes and different interested parties. While quality management systems deal with customer needs, environmental management systems address the needs of a broad range of interested parties and the evolving needs of society for environmental protection.” (Kuhre, 1995)

In terms of resource savings and improvement in environmental responsibility, there is value in integrating the two standards. The ISO 9000 standards strive to assure

consistency of products and services delivered through a structured and systematic approach to their production. When similar principles are applied to environmental issues, improvements occur to which reduce both actual and perceived environmental and regulatory liabilities. Organizations which link ISO 9000 and ISO 14000 have the opportunity to develop a consistent management system which is cost-effective and represents a higher chance of implementation success. There is a synergy between ISO 9000 and ISO 14000 in terms of multitask management of QMS and EMS. The areas most adaptable to this type of integration include: document and data control; process control; training; and internal auditing (Ofori, Gang & Bri, 2002).

4.1.1 Benefits of Integration

In the early 2001, many companies from all over the world (from Europe to USA) were registered to ISO 9000 Quality Management standards. Many of these organization plan to implement ISO 14001. Implementing ISO 140001 into an existing quality management system such as ISO 90001 has some advantages;

- Firstly the advantages of these systems which are defined one by one in the previous sections are valid and these benefits separately have a great deal of impact to this integrated system, like reduced cost; establishment of effective management systems; improved customer trust and satisfaction, and upper management attention; community relations; increased access to markets; ensuring employee involvement and education; allowing competition on an equal basis increased profitability; expanded market share; increased customer satisfaction; reduced operating costs; heightened demand for products and services; and better employee working conditions.
- Both ISO 9001 and ISO14001 systems are parallel systems and they require a number of procedures that are virtually identical. So using quality management procedures to fulfill ISO14001 requirement eliminates the unnecessary works and ensures consistency.
- The use of such a system also ensures significant savings in the cost of developing and implementing an EMS.
- The environmental management is introduced as a way of doing business. When the system is integrated, the EMS is likely to be viewed as a 'program' that is the responsibility of the environmental department. From an operational viewpoint, a fully integrated system creates an umbrella that covers all aspects of business, from product quality and customer service to

maintaining operations in a safe and environmentally acceptable way (Block & Marash, 2002)

4.1.2 Comparison of ISO 9001:2000 and ISO 14001:1996

The ISO 14000 EMS was developed following the success of the 'sister' standard of the ISO 9000 series, and the multiplication of environmental standards worldwide. ISO 9000 was the template for ISO 14000. Table 4.1 presents similarities and differences between the ISO 9000 and ISO 14000 series (Ofori, Gang & Bri, 2002). As indicated in the table, the main similarities are listed as components; policies and objectives; training; monitoring; review; documentation; and performance. On the other hand, the differences are mentioned as impetus; companies' motivation; target audience; focus; continual improvement; and supplier involvement.

4.2 Integration of ISO 9001:2000 and OHSAS 18001:1999

After the revision of the ISO 9000 family of quality assurance standards which was published in the last quarter of 2000, the latest ISO 9001:2000 Quality Management Standard that was adopted more consistent terminology gained a feature of to be more compatible with other management systems such as ISO 14001:1996 for Environmental Management System. According to ISO (2000), the primary aim in making in making ISO 9001: 2000 compatible with other management systems is to encourage organizations to implement various fragmented management systems as an integrated management system.

OHSAS 18001: 1999 was developed in the hope that it would eventually be adopted as an ISO standard in much the same way that BS 5750 was adopted as ISO 9000 for quality management, and BS 7750 as ISO 14000 for environmental management. OHSAS 18001: 1999 was also designed to address the issue of plan-do-check-act at the functional management level to formulate a self-regulating OHS environment. The major requirements of ISO 9001: 2000 and OHSAS 18001: 1999 are presented in Table 3.2.

Although there are many requirement similarities there are some arguments between the experts. It is thought that management' influence on an organization's decision-making structure is critical to the success of its safety program. According to the Shetty and Buehler (1988) there is a growing trend for the integration of management's decision structure across an organization's functions and operations to improve both quality and safety in fact suggested that the concepts of total quality management and strategic safety management are complementary in nature. With

an integrated system, it becomes a management responsibility with total management involvement (Pheng & Pong 2003).

Table 4.1 ISO 9000 and ISO 14000: similarities and differences*

Features	ISO 9000 Series	ISO 14001 Series
Similarities		
Components	Both contain standards which are advisory or guidance documents, and standards to which a business may elect to become certified: one in ISO 14000 and three in ISO 9000	
Policies and objectives	Both require clearly stated policies and objectives and well-defined assignments of responsibility	
Training	Both series require employees to be trained on what is expected of them and how those expectations are to be met	
Monitoring	Monitoring and measuring activities and performance are a requirement of both standards	
Review	Management and audit reviews are required by both. Each requires that results be monitored and recorded so that an outside party can observe and report that the system is working	
Documentation	Both standards require documentation that all programme and system requirements are in place	
Performance	Neither standard specifies the performance results specification	
Differences		
Impetus	Impetus for development was the desire to improve and maintain the consistency of the quality of products internationally	Development was driven by the explosion of environmental laws and regulations worldwide
Companies' motivation	Companies became interested from a desire to protect and expand their market position	Firms sought to ease the problem of conforming to laws and regulations and improving market place acceptance
Target audience	Purpose of compliance is focused to demonstrate to customers that the registrant is a quality producer	Audience for certification includes customers, government, local communities, employees, shareholders, lenders, investors and the general public.
Focus	Concentrates on what it takes to consistently produce a quality product or service	Focuses on what is necessary to achieve continuing improvement in environmental performance
Continual improvement	Continual improvement is an implicit requirement	Continual improvement is an explicit requirement
Supplier involvement	To maintain the quality chain, a certified company must use certified suppliers	Supplier condition is not present in ISO 14000

(*) This table is taken from Ofori, Gang & Bri 2002, pp. 1400

Table 4.2 The ISO 9001: 2000 and OHSAS 18001:1999*

SO 9001:2000	OHSAS 18001:1999
Quality management system • General requirements • Documentation requirements Management responsibility • Management Commitment Customer focus • Quality policy • Planning • Responsibility, authority and communication Resources management • Provision of resources • Human resources • Infrastructure • Work environment Product realization • Planning of product realization • Customer related process • Design and development • Purchasing • Production and service provisions • Control of monitoring and measuring Measurement, analysis and improvement • General • Monitoring and measurement • Control of nonconforming product • Analysis of data • Improvement	OHS Policy Planning • Planning for hazard identification, risk assessment and risk control • Legal and other requirements • Objectives • OHS Management program Implementation and operation • Structure and responsibility • Training, awareness, and competence • Consultation and communication • Documentation • Documentation and data control • Operational control • Emergency and records management Checking and corrective action • Performance measurement and monitoring • Accidents, incidents, nonconformance, and preventive action • Records and records management • Audit Management Review

(*) This table is taken from Ofori, Gang & Bri 2002, pp 1400

Benefits of Integration

An integration of OHSAS 18001: 1999 with ISO 9001: 2000 ensures many advantages to the firms as other integrations like ISO 9001 and ISO 14001. It is able to lead to individuals being more responsible for working safely and participating in

hazard identification. Evaluation and control can also lead to more careful behavior and planning of work activities, more caring task performance, more reliable production planning, and defect-free products.

An integration of OHSAS 18001: 1999 with ISO 9001: 2000 essentially delivers three major enterprise wide benefits;

- controlling business risks,
- reducing total OHS-related costs, and
- producing a competitive advantage.

Other benefits include;

- an optimized management system,
- more comprehensive involvement of stakeholders,
- better utilization of resources,
- derivation of synergy from the integrated system,
- advocating technology development and transfer,
- enhancing internal management methods and cross-functional teamwork,
- reducing interfunctional conflicts, and
- higher staff motivation, as well as streamlining audits.

Despite of the fact that OHSAS 18001 is in a manner compatible with ISO 90001, OHSAS requirements has some peculiar objectives such as OHS policy; planning for hazard identification, risk assessment, and risk control; emergency preparedness and response; and accidents, incidents, nonconformance, and corrective and preventive action, which causes differences and challenges between two management system.

According to Wilkinson and Dale (1999), these challenges include;

- realizing the importance of differences in scope between the systems,
- recognizing the cultural differences in implementation of different systems, and
- perceiving that integration is more than combining documentation of various systems into one manual that enables the integrated system to employ the plan-do-check-action cycle to resolve quality and OHS issues simultaneously (Pheng & Pong 2003).

But despite these challenges, as shown in Table 4.2, comparison between two systems display that integration is feasible, since common elements serve for similar purposes. However, while it is feasible to integrate ISO 9001: 2000 with

OHSAS 18001: 1999 in the documentation sense, it is unclear if such integration would be received positively by the construction industry.

For that reason, to make this theory to be clearer, examine the current status of the construction industry in terms of certification to OHSAS 18001: 1999 and the attitude of the industry toward an integrated quality and OHS management system, a research was made in Singapore. In Singapore, 215 G6^{1*} to G8^{1*} construction firms, which are registered with the Building and Construction Authority's Central Registry of Public Sector Contractors in one of eight financial categories, were listed and a questionnaire was sent to these firms. The questionnaire consists of two parts, one of which determines if the responding organization has been certified to OHSAS 18001:1999 requirements. The second part of the questionnaire determines if it is possible for the responding organization to integrate the 20 elements of OHSAS 18001:1999 into ISO 9001:2000 systems, as well as the cost associated with such an integrated system.

A Likert scale of 1 to 5 was used in the questionnaire for this study. 99 out of the 215 G6 to G8 contractors responded to the survey and because of some reasons a total of 96 valid responses were used in the final analysis.

First Stage Findings

Of the respondents, it is seen that 91 (95%) have not been certified to OHSAS 18001:1999 requirements, and of these 91 respondents, only 39 (43%) indicated that they would consider implementing OHSAS 18001:1999 in their organization. All 5 respondents who indicated they have implemented OHSAS 18001: 1999 claimed they implemented it as an integrated system. Of the 39 respondents who indicated they would consider implementing OHSAS 18001:1999, 31 (79%) pointed out that they would consider implementing it as an integrated system; 7 (18%) would consider implementing it as a stand-alone system; and the one remaining respondent (3%) was undecided.

The above findings suggest that the performing of OHSAS 18001:1999 is still in its infancy stage in the construction industry in Singapore, but it is however encouraging to note that of the 91 respondents who have not implemented OHSAS 18001:1999, 43% are considering implementing it at some point in time (Pheng & Pong, 2003).

Second Stage Findings

The second part of the survey was addressed to respondents who had already implemented OHSAS 18001: 1999 (5 respondents) or are considering implementing

it (39 respondents). The respondents were first asked to point out the possibility as well as the degree of difficulty in integrating the 20 elements of OHSAS 18001:1999 with ISO 9001:2000 requirements. This question requires the respondents to provide a yes or no answer to the possibility of integrating the elements of OHSAS 18001:1999 with ISO 9001: 2000 requirements. It also requires the respondents to indicate the degree of difficulty in integrating on a scale of 1 to 5, which denote “easy” and “difficult,” respectively. The results of second stage findings, which are listed at the appendix section, shows that the respondents were generally positive in integrating most of the elements of OHSAS 18001: 1999 with ISO 9001: 2000 requirements.

In addition, it can be said that these standards are feasible to be integrated and managed less than one integrated management system. The findings from the field survey seem to support such integration and OHSAS 18001: 1999 certification is still foreign to a majority of the construction firms in Singapore.

Consequently, integrating OHSAS 18001: 1999 elements into ISO 9001: 2000 should be conceivable. Some OHSAS 18001: 1999 elements were, however, peculiar only to the standard. Hence, OHS policy and planning (which aim to set the principal directions and actions for minimizing safety hazards) may not relate well to ISO 9001: 2000 (which aims to meet set quality standards). In addition, there are no “legal and other requirements” and “emergency preparedness and response” requirements for ISO 9001: 2000 (Pheng & Pong, 2003).

Finally, the management of two or more different systems under one single umbrella may be a cause for concern to some organizations. This is because it may be difficult to find someone who is proficient and possesses the necessary knowledge in all the different areas of quality and safety (and possibly environment) to handle such an integrated system.

4.3 Integration of ISO 9001, ISO 14001 and OHSAS 18001-Quality, Environmental, and Safety (QES) Management Systems

As we mentioned in the previous section, the ISO 9001, ISO 14001 and OHSAS 18001 standards are all integrated by the management system of Quality, Environment and Safety Management one to one because of their parallel structures; approaches to managements, customer focus, requirements; aspects to

^{1*} It is a ranking system in Singapore, that G1 indicates that the smallest and G8 the largest.

the global market and competitiveness; employees working conditions and the latest product. Because of these similar features, these standards and management system belong to have tended to be existed in integration as Quality-Environmental, Quality- Safety or all of three as Quality- Environmental-Safety (QES) Management System or Integrated Management System

4.3.1 Evolution of QES

Quality, environmental, and safety (QES) Management systems -a three in one approach- are generally proposed that integrates ISO 9000, ISO 14000, and OHSAS 18000 regulations. This integrated management system is defined by Griffith (1999) as; *the organizational structure, resources and procedures used to plan, monitor and control project quality, safety, and environment*. Another definition, comprising the construction industry, belonging to Moore (1999) is that; *the planning, monitoring and control of all aspects of a construction project that are necessary to ensure that all those involved are aware of their responsibilities and perform them safely, to required quality and with due regard for the environment*. It is an approach to doing business which tries to maximize the competitiveness of an organization through the continual improvement of its product, services, people, and environment by emphasizing customer focus (internal as well as external), long-term commitment, and teamwork (Koehn & Datta, 2003).

Also this kind of integration ensures standards to have a useful impact on one to another. For example occupational health and safety issues cannot be resolved in isolation, but will have an impact on environmental and quality issues. An integrated system will allow for comprehensive solutions to problems and let the three-in-one system adapt to the changing environment of the organization.

As it is mentioned before, the main target of these standards separately is the continual improvement which will ensure the sustainability of the companies, products and projects in the long term position. So, it is unavoidable that a QES Management System is related with “*continual improvement*” and it subscribes to the principles illustrated in Figure 4.1 as shown, management and staff commitment, education and training, and measurement/evaluation are connected with the QES process.

Quality management system (QMS), Environmental Management System (EMS) and Occupational Health and Safety Management System OH&SMS help organizations to come to terms with changing markets and the assessment of business risk. Important characteristics of organizational development follow from

these systems, for example: corporate focus; credibility in the marketplace; reduced liability; and greater efficiency and effectiveness. Both the management systems and the organization provide to shape each other symbiotically. Although quality, environmental and safety management have developed separately, as highlighted previously, they are characterized by common key elements. These are influenced mainly, by the respective national and international system specification standards, ISO 9000, ISO 14001 and OHSAS 18001. These elements are:

1. policy;
2. aims and objectives;
3. organization;
4. documentation;
5. plans (programmes);
6. procedures;
7. records;
8. audit; and
9. review.

These elements form the system and establish the whole-organization philosophy. Elements 1 to 4 are developed at company level and are translated into elements 5, 6 and 7 for implementation at the project level. Elements 8 and 9 close the system loop between project and corporate activities. The key challenge for an IMS is to translate the various company policies, aims and objectives for quality, safety and environment into a single management plan for project application (Griffith, 2000).

4.3.2 Benefits of Integration

Like other integration systems, this three to one integration system has many advantages which can show a great deal of differences according the structure of the organization. For Instance, for a small construction company implementation of a QES management system may be a slight burden sometimes. But for medium to large organizations, application of QES should bring about an improvement in cost and productivity factors along with improved quality and a safer working environment. Since materials, processing, and operations are brought under single control, the production rate will also increase.

The intent of the IMS is to provide the focus vehicle for implementing project risk assessment while capitalizing on the available benefits of a single system solution for project control. These benefits include:

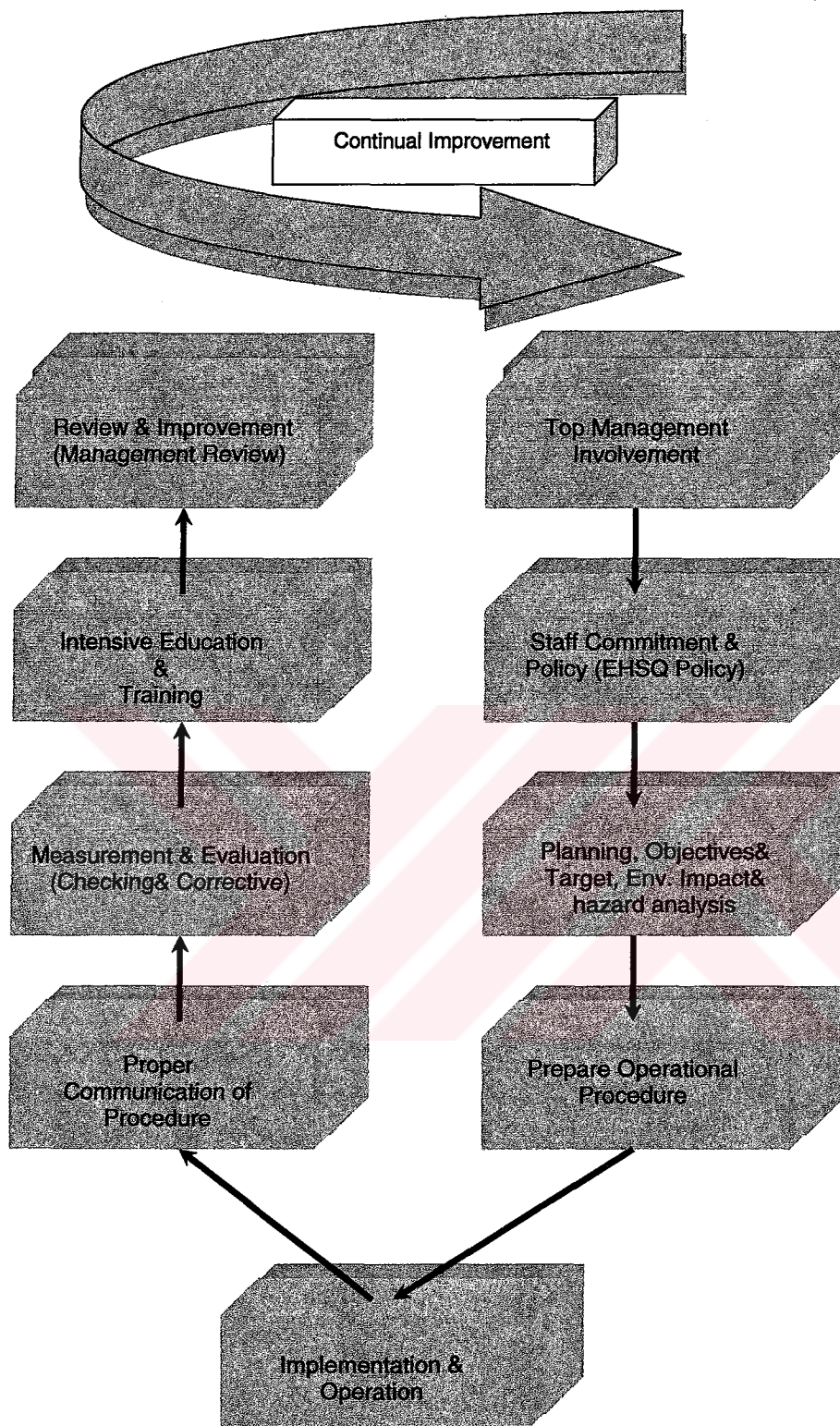


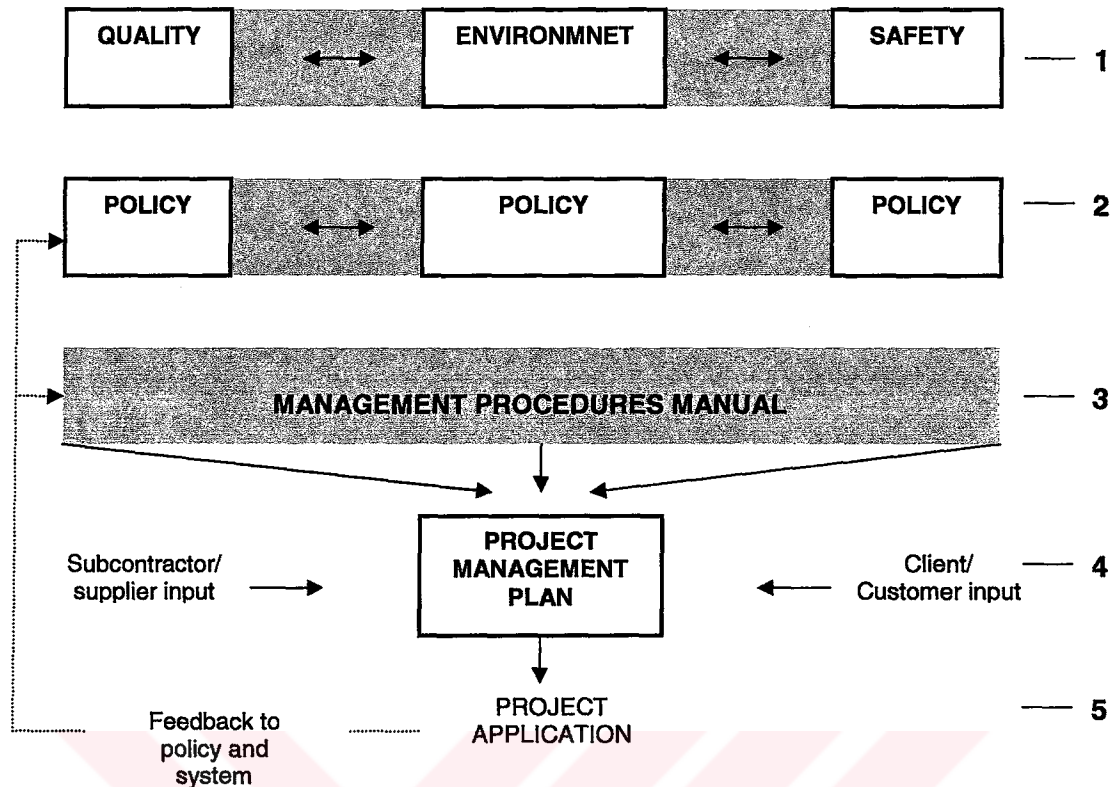
Figure 4.1 (QES) Continual Improvement *

(*) This figure is taken from Koehn & Datta 2003, pp.563

- avoidance of duplication from multiple individual systems;
- eliminating the overlap of effort;
- reduction in the fuzzy management boundaries between individual systems;
- broadening the horizon beyond the functional level of any individual system;
- sharing information across traditional organizational boundaries; and
- Streamlining paperwork and communications.
- Reducing costs, and enhances productivity
- Providing the foundation for detailed project risk assessment within the system and can encourage reducing the fuzziness between management boundaries and general bureaucracy.
- Versus to vertical separate management system, it ensures a cross functional management system which helps in sharing information and coordinating practices between departments and projects

Horizontal cross-Functional Management System

An IMS presents an opportunity to establish a cross functional horizontal management structure as illustrated in figure 4.2. In this approach, the management functions become integrated at the strategic level within the corporate organization. A distinct policy is developed for quality, environment and safety to give clarity and focus and to ensure that external influences such as specific legislation, system assessment and market influences are met. These policies are strongly linked in the mission, vision and culture of the company such that each, both singularly and in combination, remains focused not only on its respective activity but towards holistic business success. It should be sufficiently flexible to accommodate the specific orientation of each support service, bringing these together to capitalize on the synergy derived from their integration. This forms the basis for developing a dedicated Project Management Plan (PMP) which assists with the compilation of method statements, activity programmes and working instructions for a particular project. With this, management procedures, working instructions and task routines become clearer and easier to follow. Plans also provide the opportunity of accommodating closer collaboration with and useful inputs from clients, subcontractors and suppliers (Griffith, 2000).



- 1- common elements of standards brought together in considering legislation and management standards (ISO 9001:2000; ISO 140001:1996; OHSAS 18001:1999)
- 2- separate policies for clarity and focus in meeting external influences, integrated internally for meeting holistic needs of the core business
- 3- best practice guidance brought together in multi-functional manual facilitating shared information and practices
- 4- project specific management plan, allowing inputs from other project participants, can focus on real risk assessment, planning and control.
- 5- Clear feedback routes to policy and procedures manual facilitates auditing and review.

Figure 4.2 A horizontal cross-functional management system for quality, environment, health and safety *

(*) This figure is taken from Griffith 2000, pp.236

Vertical Separate Management systems

Conventionally, the management of quality, environment and safety is structured vertically within both the corporate and the project organizations as indicated in the figure 4.3. In this approach, each function is separate and operates in parallel. Each function has its set management boundaries and there is little, if any, sharing of tasks or information.

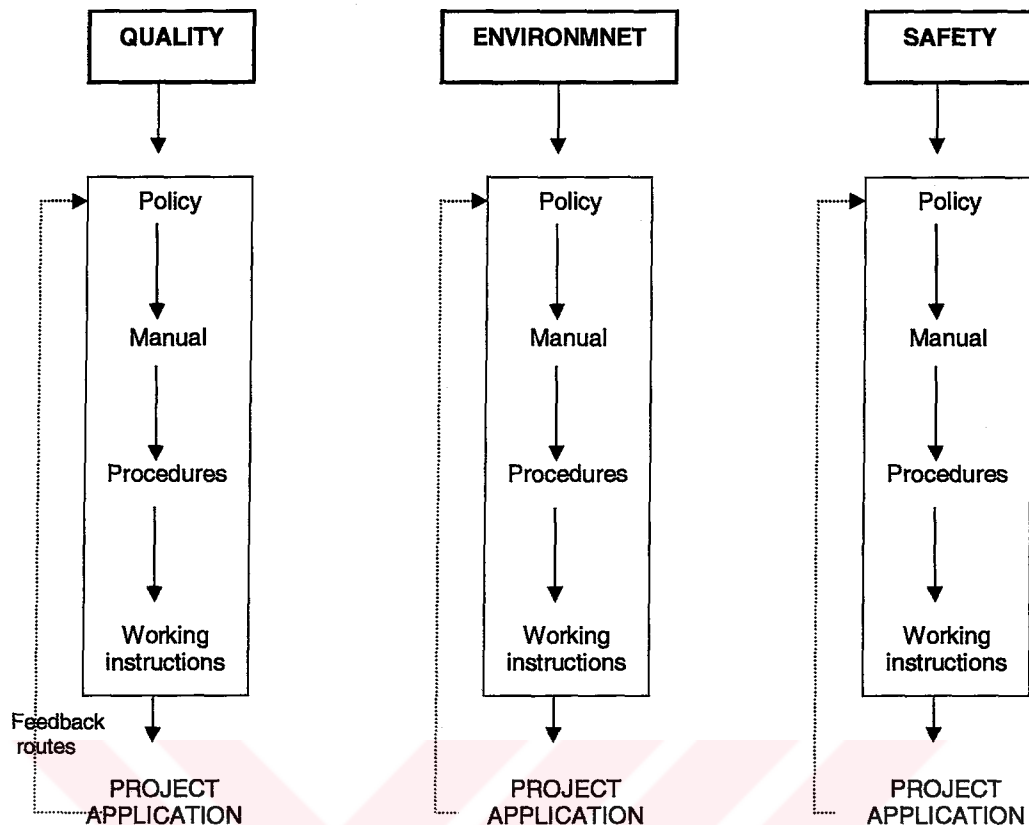


Figure 4.3 Vertical separate management systems for quality, environment, health and safety *

(*) This figure is taken from Griffith 2000, pp.236

IMS and Interaction of Cost and Productivity

An effective IMS or QES program not only ensures the product a quality, but also reduces costs, and enhances productivity. It is a top down process, i.e., top management together with line management and other employees develop the program and motivate all personnel to accept the process.

Important functions that must be given a great deal of are;

1. Explain and clarify the quality, environmental, and safety performance expected;
2. Concern with employees in decision-making and problem solving;
3. Describe the consequences of poor quality and unsafe/unhealthy work conditions;
4. Establish QES goals and provide feedback on performance;
5. Provide a self-monitoring system; and

6. Recognize and reinforce good performance and develop a reward system

In addition, appreciation of specifications and tolerances will reduce the waste of basic materials such as steel and concrete. Due to a safer working environment, personnel may increase their sense of belonging, which may also increase productivity and quality as shown in Figure 4.4.

Lower cost of production and decreased pollution are also important attributes of a QES system. It is generally known that accidents can incur high direct and indirect costs. Management can control these expenses through proper implementation of a QES management system. Direct expenses may include medical costs, increased workers' compensation insurance charges, as well as liability and property-damage premiums. Indirect or hidden costs may be a much larger part of the economic burden imposed on a firm with a poor accident record. According to Koehn and Regmi (1990), reduced productivity, job schedule delays, added administrative time, damage to equipment and facilities, and costs of administering and handling workers' compensation insurance are some of the indirect costs associated with accidents (Koehn & Datta, 2003). On the other hand, for construction companies with very poor safety records, insurance premiums for worker's compensation can be costly enough to render a company noncompetitive compared to safer firms.

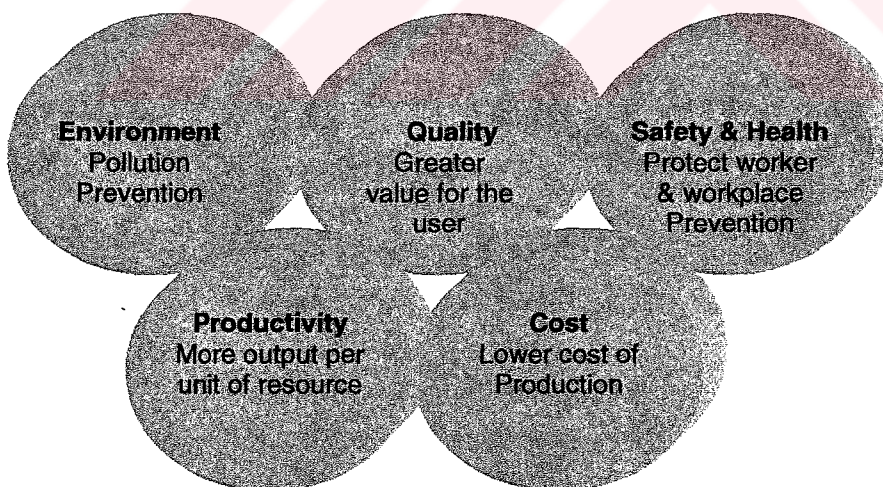


Figure 4.4 QES and interaction of cost and productivity
(*) This figure is taken from Koehn & Datta 2003, pp.563

In addition, except for these benefits, there are several long-term benefits such as;

- internal integration to meet external, or project team, integration (Department for Environment, Transport and the Regions (DETR) 1998);
- meeting the requirements of one-system certification (Griffith, 2000).

In conclusion, An Integrated management system or QES management system is concerned with actions that can create an organizational setting in which workers can be trained and motivated to perform safe, healthy, and productive construction work which satisfies customer needs and presents a maintaining stage with a high quality to the users by ensuring the users' and environmental safety. It is a plan-do-check action process. To be successful, management must continually remind employees to engage in comprehensive planning, checking, and review to ensure that quality, safety, and concern for the environment are achieved. Specifically, the researches and practices suggest and encourage that it is so possible for a construction company to develop a system that is effective in ensuring quality, environmental protection, health, and safety. Similar measures could also be taken by other organizations to eradicate poor quality, unsafe and unhealthy working conditions, and lack of environmental control.



5. EXAMINING THE QUALITY, ENVIRONMENT AND SAFETY CONCEPTS WITHIN THE BUILDING DESIGN MANAGEMENT PROCESS

Construction is a complex occupational process that includes many kinds of work process beginning with inspection to maintenance, and also comprises many types of activities such as development and management.

In the building construction industry, the important factors in the construction phases are the product and the process quality which are moving toward higher levels. Traditional quality assurance and quality control procedures are being implemented in the industry. As mentioned at the previous chapters, emerging process-centered quality improvement techniques (e.g., total quality management, etc.) that became popular in the manufacturing industry are now also being used successfully in the building construction industry. More emphasis is given to process quality to increase product quality and to satisfy all stakeholders in the industry. One should differentiate between “product quality” (i.e., the quality of elements directly related to the physical product itself) and “process quality” (i.e., the quality of the process that causes the product to be either acceptable or not) (Nagasaku & Oda, 1965). For example, product quality in the construction industry refers to achieving quality in the materials, equipment, and technology that go into the building of a structure (Arditi & Gunaydin, 1999).

On the other hand, process quality refers to achieving quality in the way the project is organized and managed in some core phases. It is important to mention that all activities can, but need not, occur in each phases. In general, these project processes are summarized into four main groups as design, procurement, construction and maintain; and project activities listed in table 5.1 are integrated to these project phases. In this chapter, the design phase of the project stages will be taken into hand and the effects of the quality, environmental, and safety management activities of project activities to the design phase will be discusses. In conclusion, the impacts of the design phase quality with the integration of the

environmental and safety concepts to the construction and maintain phases will be mentioned (Arditi & Günaydın, 1999)

Table 5.1 List of project stages and project activities

Project Stages	Project Activities
A: Inspection	1: Development Activities
B: Feasibility	2: Evaluation and Approval
C: Concept Design	3: Design Management
D: Coordinated Design	4: Cost Management
E: Production Information	5: Quality Management
F: Procurement	6: Procurement Management
G: Preconstruction	7: Healthy and Safety
H: Construction	8: Implementation and Control
	9: Commision and Handover
	10: Environmental Management

5.1 Building Design Process and Building Design Management

Design process is the second main stage of the construction phases and needs to be paid attention to the activities and procedures become fact during this stage and affect the other stages. The building design is formed by eight main sections such as;

- *Inception*: which mean is meeting the client.
- *Feasibility*: which may be described as the formulating the design brief, considering basic options.
- *Outline Proposals*: which mean is establishing a practical proposal in principle.
- *Scheme design*: which mean is developing an agreed idea into a coherent working proposition.
- *Detailed design*: which mean is finalizing the scheme.
- *Measurement*: which mean is bills of quantities (BQ).
- *Tender action*: which mean is obtaining competitive prices.
- *Project planning*: which mean is tender analysis, appointment of contractor, confirmation of construction methodology, CDM consideration, construction programming.

During these periods, the feasibility of the required specifications and relating standards such as ISO 9001, ISO 14001 and ISO 18001 are so important in order to

ensure the maximum process, project and output quality during even design and construction stages.

5.1.1 Building Design

Design is primarily a personal task with the whole project's design becoming a combination of the motivation and expressions of many individuals. It is also viewed by the separate members of the project teams from many different directions and, in particular, with regard to how well it will accommodate their own needs and wishes (Gray & Hughes, 2001).

Some writers have been interested in design at a contextual level, as a process that requires specific inputs to produce a set of agreed outputs, and define building design as 'a process which maps an explicit set of client and end-user requirements to produce, based on knowledge and experience, a set of documents that describe and justify a project which would satisfy these requirements plus other statutory and implicit requirements imposed by the domain and/or the environment' (Baldwin, Austin, Hassan & Thorpe, 1999)

5.1.2 The Elements of Building Design

The principle elements of any product are materials, processes, forms and appearance, each influenced by the response of clients, designers, manufacturers, and users to a wide range of factors. Their perception or evaluations of the importance of any particular factor will of course not necessarily be the same. The product design wheel (figure 5.1) gives some indication of the complexity of possible combinations as each band in the wheel rotated around the others (Tunstall, 2000).

In principle, the elements of building design are the same as the elements of any product. Although a building could be regarded as one product, it is in fact, an assembly of many individual products, some of which are purpose designed to suit special requirements but many of which are obtained from suppliers, chosen from ranges of pre-designed alternatives. Many of the raw materials and components already exist and it is the way that they are put together that creates the new building, influenced by all the issues based on understanding of the purpose of the building and the needs of its users. Buildings serve a practical function as enclosed shelters, capable of maintaining a reasonable level of quality, environmental comfort and safety in order to sustain human activity (Tunstall, 2000).

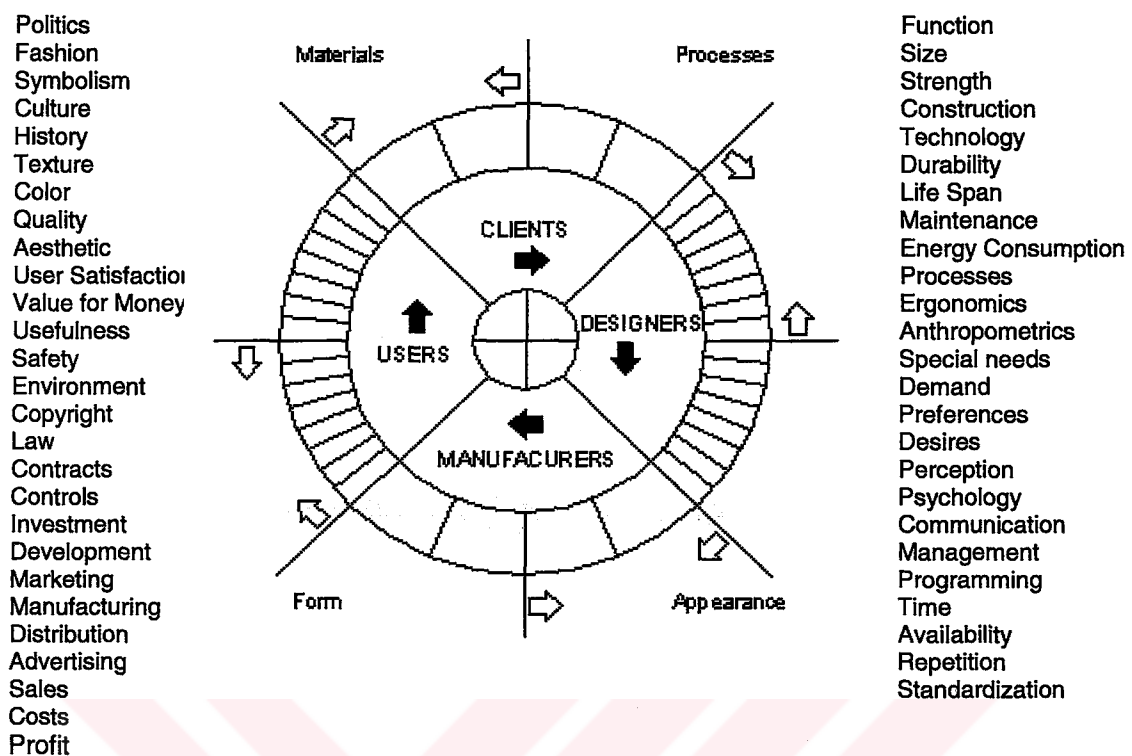


Figure 5.1 Product design wheel *

(*) This figure is taken from Tunstall 2000, pp.17

5.1.3 Building Design Process

Designing is a continual process of selecting and organizing elements, establishing which are the most important and how they all play their part in the creation of the new product and inevitably ideas change as possibilities are added or discounted.

The aims of design can be summarized as follows;

- To identify all the relevant elements pertinent to the project,
- To discover or understand how the elements interact with one another,
- To plan or arrange the elements so that they fit together in an appropriate or meaningful way to create a competent product (Tunstall, 2000).

The design development process involves the analysis, synthesis, appraisal and feedback actions which are displayed in figure 5.2

For all but the simplest of design tasks, the process will not be in the progressive linear form of start, analysis, synthesis, appraisal, feedback, finish, completing each stage before moving on to the next one. It cannot be categorically stated which comes first, as ideas and decisions are influenced by each action and there is a constant need to go back and test solutions against requirements.

All the factors identified on the product wheel can be rotated around the spiral, increasing awareness and understanding of their significance.

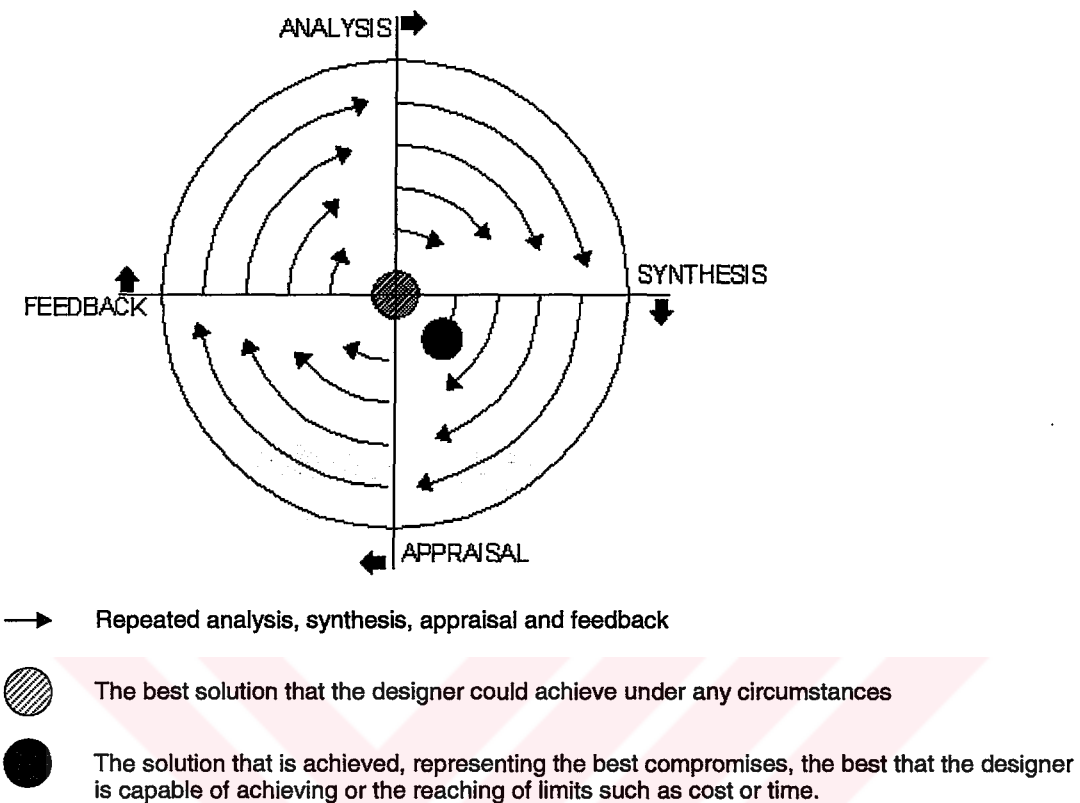


Figure 5.2 The Design Spiral *

(*) This figure is taken from Tunstall 2000, pp.23

The building design process in a construction environment is extremely dynamic and complex. Invariably, it consists of multiple interacting feedback processes, and nonlinear relationships. Moreover, it is a specialized and highly demanding form of problem solving. Although the creative vision of the design may be separated from the partial imperative of converting it into a working model of a project, there is an intimate and continuing link between the creative and documentation process. (Love, Mandal & Smith, 2000) The design process relies upon construction project feedback for its effective management.

The building design process is a multi-disciplinary process, performed in a series of iterative steps to conceive, describe and justify increasingly detailed solutions to meet the needs of the client. This may be considered to commence with the initial inception of the development and to end when construction is complete (Baldwin, Austin, Hassan & Thorpe, 1999)

The Development Team

The nature of the design process is complex; it involves thousands of decisions, sometimes, over a period of years, with numerous interdependencies, and under a highly uncertain environment (Freire & Alarcon, 2002) Creating a new building involves contributions from many individuals, exchanging ideas and instructions as the project is developed. They can be grouped as Clients, consultants, authorities and builders.

Clients: The client is responsible for commissioning the new building and must approve design decisions as work proceeds. In the highly competitive construction market, designers and contractors must respond swiftly and efficiently to clients' requirements and provide a building that meets agreed standards and satisfies cost and time constraints. Efficient management of the design process is imperative to ensure that the client's requirements will be met before starting construction. Interference in the construction process resulting from design changes or the late supply of information to the construction team is costly (Baldwin, Austin, Hassan & Thorpe, 1999).

Different types of clients including the following:

- *Owners:* Ownership may rest with individuals, partners or shareholders who have the personal power to make decision
- *Representatives:* Directors, managers or in-house specialist responsible for day to day activity that may have the power to make decisions, but may also be required to seek the approval of the owners.
- *Committees:* Ownership can take the form of a professional or lay management committee, making decisions collectively.
- *Users:* Prospective purchasers or tenants may fill the role of clients, making decisions based on their specific preferences.

Consultant: The consultant supply design and management expertise and can include the following;

- *Measurement surveyors and investigators:* Land surveyors for the measurement and production of information about site; sub-soil exploration sub-contractors and laboratory testing consultants; ground contamination experts; photographers of underground pipework aerial views; building surveyors for the preparation of reports on the condition of existing buildings.

- *Quantity surveyors:* For estimating, cost planning, advising on economy, measuring materials and labors, valuing completed work for payment.
- *Designers:* Architect; architectural technologist; space planners; interior designers; landscape designers; planting specialist; graphic designers and artists.
- *Engineers:* For structures; space heating and hot water; gas and solid fuel installations; ventilation; air-conditioning; plumbing; electrics for power and lighting; acoustics; vibration control; specialist machinery and equipment; computers; drainage; highways; lifts; escalators and moving pavements; fire protection and fire fighting; ground preparation; refuse/waste disposal; internal and external communications; audio systems; water supply and storage for processes and cooling; pumping; security systems; detectors and alarms; spray painting and specialist environments such as clean rooms.

It should be noted that any of these engineers could also be described as designers, who may play a significant role in the creation of the new building.

- *Valuers:* Estate agents for advice about land and buildings; specialist for commercial undertakings.
- *Managers:* Project managers; clerks of work; construction regulation (CDM) supervisors; and process management consultants.
- *Other specialist:* Planning consultants; building control and commercial development consultants.

Authorities: The authorities advise on design and construction, and have statutory duties to exert control with respect to their individual responsibility. The authorities involved in building development;

- *Local Authorities:* County, District, Borough, City and Parish Councils who have interests in planning, building, control, rating and licenses, grants, domestic drainage, environmental health, waste disposal, highways and transport, highways drainage, street lighting and street naming
- *The fire Office*
- *The Environment Agency:* for resolution of issues affecting existing watercourses and potential effects on ground water

- *Health and Safety Executive*
- *Police*
- *Service Providers*
- *Home office and other governmental agencies*
- *Insurance Companies:* for advice about protection of buildings and their contents, particularly from theft and fire damage.

Builders: The builders' personnel may include;

- *Managers:* Directors, contract or project managers, site agents
- *Finance and administration:* Estimators, programme planners, buyers and valuation surveyors.
- *Site engineers:* For setting out and dimensional co-ordination
- *Operatives:* Tradespeople (bricklayers, carpenters, joiners, plumbers, etc,)
- *Subcontractors:* Independent companies employed for the duration of their work on the specific project for specialist trades such as roofing, steel frames, cladding (Tunstall,2000).

Each category of professionals has a different background, culture, and learning style. Trade-offs between multiple, competing design criteria must be made throughout the design process, often with inadequate information and under intense budget and schedule pressure. Early design stages are notoriously hard to evaluate and control against progress milestones; lacking physical deliverables such as drawings, it is difficult to measure the amount of work completed and remaining on any given task, and consequently in the project as a whole. Moreover, feedback from the production and building operation stage takes a long time to be obtained, and tends to be ineffective. To make matters worse, projects are increasingly subject to uncertainty because of the pace of technological change, the rapid shifting of market opportunities, and the inability to keep pace with relentless pressure to reduce time and cost (Freire & Alarcon, 2002)

Building Project Development Process

Building projects, irrespective of type, sizes, and complexity, go through a typical development life cycle that can be divided into two stages: planning and design, and construction and implementation. During the planning and design stage, the owner's concept of a project is converted into a finished design. This conversion process includes planning, design, and possibly the preconstruction procurement. The term project planning is used here to represent both the planning and design of a project.

The construction and implementation phase includes the following subphases: bidding (tendering), construction and procurement, startup commissioning, operation, and final disposal of the project. The subphases may be sequential where completion of one subphase is followed by the start of the succeeding subphases, or there may be some overlapping between subphases. Also, some of the subphases may be combined with others, or not performed at all on a given project. (Ahmed, Sang & Torbica, 2003)

Four development phases for civil engineering capital project planning can be identified as follows:

1. project requirement,
2. feasibility study,
3. preliminary design, and
4. detailed design.

Each of these four successive phases identified in figure 5.3 involves transactions between a customer and a supplier and produces a distinct deliverable.

1. **Project Requirement Phase:** The objective of the project requirement phase is to develop a clear definition of the end product a client is looking for. It starts with a client who faces a problem and needs a solution.
2. **Feasibility Study Phase:** Like the project requirement phase, the feasibility study may be, and usually is, carried out internally. The phase deliverable for this phase is the preliminary project feasibility study report.

During the first two phases, the customer needs and wants are initiated (project requirement phase) and then subjected to validation (feasibility phase). Up to this point, it is the business or policy side of the client that speaks. The value-adding actions in the following phases (preliminary and detailed design) are engineering in nature and customer and supplier roles are fulfilled by engineering entities, either by the owner's in-house design/ engineering team or by an outside consultant.

3. **Preliminary Design Phase:** After the project is determined to be feasible for meeting the client's business objectives, the client will give a green light to proceed with a preliminary design. The preliminary engineering design deliverables are quite substantial and will undergo a series of partial submittals, reviews, and further refinements in collaboration with the customer. When approval by the customer (the client) is obtained and funding is available, the project scope is considered finalized. Health and

safety issues and the requirements of CDM legislation are discussed with the planning supervisor and the client and the design consider the preparation of the Tender Health and Safety Plan. It is at this stage that the important elements of the design brief must be formally agreed and that projected costs are fully understood (Tunstall, 2000). The detailed design then proceeds, and the approved deliverables of the preliminary design phase will constitute the basis for the detailed design phase.

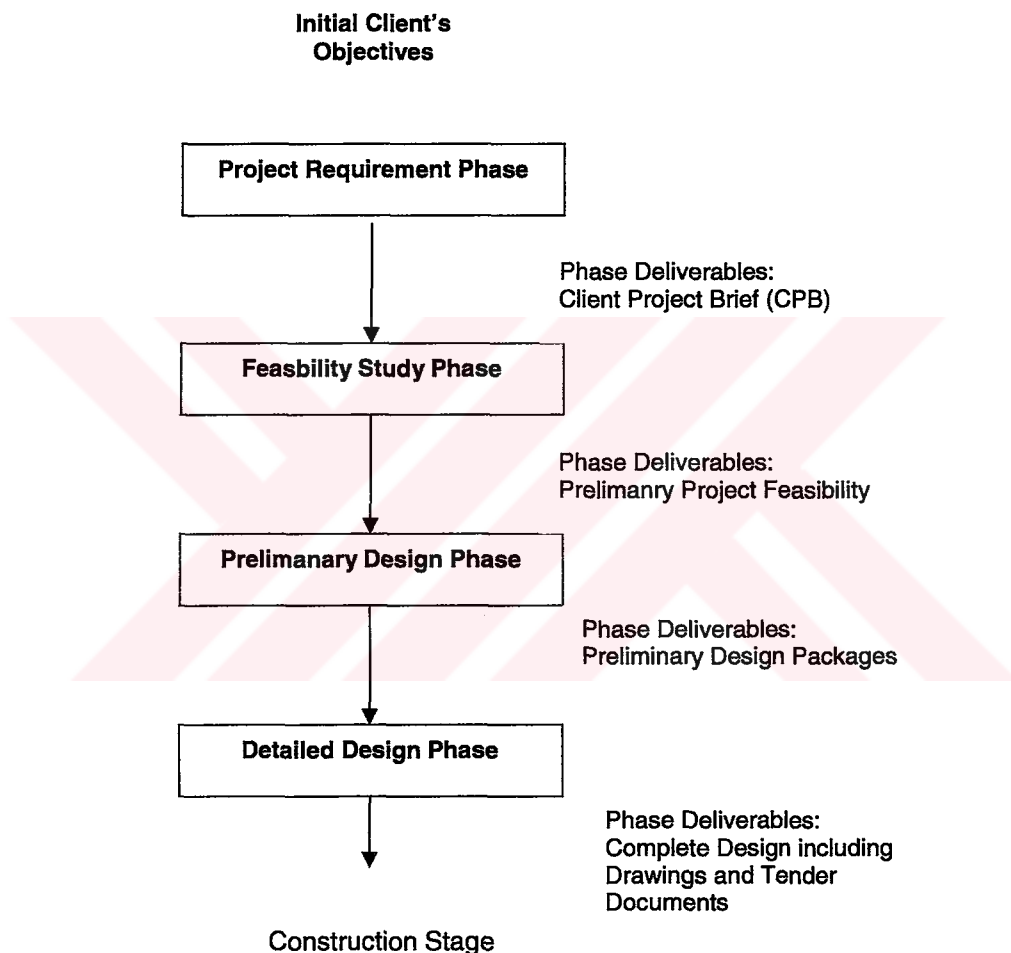


Figure 5.3 Model of project planning process *

(*) This figure is taken from Ahmed, Sang & Torbica (2003), pp.361

4. **Detailed Design Phase:** The detailed design stage leads to a full understanding of all parameters relating to the site layout and the building. The design team begins to prepare working drawings to illustrate the arrangements and assembly of the detailed parts of the new building which detailed specifications describing requirements for materials and construction (Tunstall, 2000). The main objective of the detailed design is to produce a set of contract documents for the

contractor to follow during construction of the project. At the completion of the preliminary design phase, the design of a project may be 40% or so complete. The preliminary-to-detailed design interface involves only the further refinement of the same design work performed in the preceding phase. Up to this stage, the results of all related studies, such as the environmental impact assessment, traffic impact assessment and drainage impact assessment, are obtained. Statutory approvals will be obtained as well. The detailed design will finalize the project design close to 100%, and the remainder, if any, would be items that require initial construction to commence before they can be finalized. Such items are not usually planned, but simply happen. It must be noted that the consultant involved in the preliminary design phase may not be the same one used in the detailed design phase, but the phase customer and phase supplier relationship remains the same as that in the preliminary design phase. By completing the detailed design phase, the planning and design phase in the development of a civil engineering capital project ends (Ahmed, Sang & Torbica, 2003).

Constraints and Problems on the Design Process:

At any point in the process the designer is working within a set of constraints, both internal and external:

1. **Internal Constraints:** The internal constraints are imposed through wanting to work in a particular way, or with particular materials or technologies. These constraints may limit the range of solutions or may present the client with an appealing consistency. Therefore certain designers develop a particular style of design or approach to the design problem and their reputation is based on this. Many of the constraints are self-imposed through self-criticism, which, if taken to the extreme, can mean that a solution that satisfies the designer can never be achieved.
2. **External Constraints:** External constraints come from many sources, but essentially fall into four categories;
 - 1) client's needs,
 - 2) the technology,
 - 3) the construction process,
 - 4) statutory control

The requirements of the building itself will place constraints on the designer because of the need to satisfy the demands of the clients. The nature and locations of the site will also play an important part, as will any environmental conditions. Further

constraints are imposed by the methods of assembly of the materials and products. There are also practical limitations in terms of spans, weight and sizes of components that make certain options less desirable. Finally, designers of building do not enjoy complete freedom; various laws impose constraints on what they do, through planning, building quality control, and health and safety legislation (Gray & Hughes, 2001)

The influence of the design stage on the outcome of construction projects both technically and economically is extremely important. It is precisely in this phase when the customer's ideas and speculations are conceptualized into a physical model, defining his/her needs and requirements into procedures, drawings, and technical specifications. However, the administration and engineering of design have been barely explored and exemplified. In fact, numerous authors as Cornick (1991) and Koskela (1997) indicate that planning and control are substituted by;

- chaos and improvising in design,
- causing poor communication,
- lack of adequate documentation,
- deficient or missing input information,
- unbalanced resource allocation,
- lack of coordination between disciplines, and
- Erratic decision making.

The design process fails to minimize the effects of complexity and uncertainty, to ensure that the information available to complete design tasks is sufficient, and to reduce inconsistencies within construction documents. Even if the nature of the design process justifies some of these problems, this reality cannot be viewed as satisfactory (Freire & Alarcon, 2002)

5.1.4 Building Design Management

Building design management concept can be defined as the integration of the design and management functions under one umbrella. In construction, when using general contracting, the phenomenon is clearly visible in the separation of responsibility for designing from the responsibility for construction. It is given further focus because, in the past, the designer has supervised the construction of the work. In practical design and management of design are the two sides of the same coin. However, there is a great deal of evidence to support the idea that while it is important for designers to be the managers of the construction process, the

management of design process is something inherently different from the act of design. (Gray & Huges, 2001).

Management Problems

Many of the building design management problems are identified by previous construction relate design researches. The professionals, who included architects, structural engineers, and building services and other design staff, identified some of their main problems in design management as being due to;

1. The inherent nature of design in particularly, its iterative nature,
2. Acquiring technical information,
3. Client changes
4. Difficulties in managing information (such as the problem of missing information)
5. Difficulties in planning and scheduling design work. “(Baldwin, Austin, Hassan & Thorpe, 1999).

The last two categories are directly linked and related with the lack of communication and documentation of project team. Creating new buildings is a process in which individuals and groups frequently exchange information with one another, asking questions, providing answers, confirming requirements or issuing instructions. The transfer of information takes place *by speech (talking to people face to face, or on telephone), in writing (through letters, reports, meeting notes and specifications) and by using images (by preparing drawings, models and photographs).*

Individuals in the project team exchange information with one another; the outcome is likely to have an effect on the others who were not directly involved in the exchange. Consequently many of the discussions and agreements made between individuals must be made available to others, or even to everyone. Therefore, from the beginning of the project, it is useful to have an understood and agreed strategy for:

- Collecting relevant information and confirming its accuracy,
- Presenting ideas to one another in order to explain what may be possible and to secure necessary approvals,
- Establishing a reliable system for the management and distribution of information so that agreed ideas are understood as a common basis for proceeding.

To be successful, communication must be understood by recipients and design team. Communication skills influence the way that decisions are taken and how the work of others is coordinated, monitored and approved. Good communication creates confidence which is an essential ingredient in any team activity.

Past research has shown that management of the design phase is particularly important, because decisions made in this phase of a project often have the greatest impact on the eventual total project cost (Paulson 1976). The design of a commercial, industrial or other complex building is a multi-disciplinary task requiring input from architects, civil and structural engineers, and building service engineers. To manage the design process effectively;

- Information inputs must be scheduled to meet the requirements of each member of the design team.
- Deliverables must do so within a time scale and at a cost acceptable to the client and all related parties.
- Information needs to be exchanged in a timely and effective manner

These are the efficient and effective management of this information flow and the resources required to produce the design deliverables, (drawings, specifications, calculations reports...etc.) that we consider essential to improved design management: in particular the interfaces between members of the design team. (Baldwin, Austin, Hassan & Thorpe, 1999).

Design management has attempted several methods to solve the problems mentioned above, like project management, concurrent engineering, process models, value management, new organizational forms, and information technology support (Ballard and Koskela 1998).

The importance improved design management is now widely recognized. A report by NEDC (1987) showed that more than 50% of problems on building sites which directly impact the quality, safety and environmental factors of the project were related to poor design information. The British Standard, BS7000: Guide to Managing Design in Construction (BSI 1994), recognizes both the importance of the task and the procedures involved (Baldwin, Austin, Hassan & Thorpe, 1999).

Design management has attempted several methods to solve the problems mentioned above, like project management, concurrent engineering, process models, value management, new organizational forms, and information technology support. Even though these "state-of-the-art" design management approaches contain many interesting and seemingly effective new features, they are fragmented

and lack a solid conceptual foundation, thus becoming a barrier for progress. Huovila (1997) proposed a conceptual framework for managing the design process, in which three different views of this process are considered (Freire & Alarcon, 2002);

1. design as a conversion of inputs to outputs;
2. design as a flow of information; and
3. design as a value generation process for the clients.

This set of perspectives allows a more solid conceptual foundation of design and engineering, which can be comprehended as the simultaneous juncture of the three views.

5.2 Quality in Design

5.2.1 The Definitions of Quality through Design

In many ways the problem of defining 'quality' is more acute the building process than in any other production field. This is essential because the total responsibility for the creation of a building project is divided between many different people and organizations (which may only work together once on any particular project) and for major works, extends over a comparatively long period of time. Therefore, there is a danger that the meaning of quality for any specific aspect of the project can easily become changed over time and distance and between different methods of working.

The fact that the client has an implicit expectation of quality for building, the designers have their own professional view of quality depending on architectural and engineering tradition, and the management and the specialist contractors and component manufacturers have to make commercial judgments about quality related to price – all this serves to create confusion over concepts of quality. The result of this confusion over what is meant by 'quality' is so often a dissatisfied client, disillusioned and sometimes sued designers, commercially embarrassed contractors and distrusted component manufacturers at the end of the design and construction phases of the building. For this reason the meaning of 'quality' has to be agreed for the sake of all participants who take part in a project if they are all to be successful, especially designers, who play the key role of being the translators of "need" into "physical reality" of a building.

According to the Cornick (1991), standard definitions of 'quality' can be derived of three definitions which are;

1. **Level of excellence**, a definition which in technical performance can be subjective, as individual people react differently, both emotionally and physically, to the same environment. General expectations (and the codes and the standards that reflects those) are constantly changing as a result of social and economic development. Therefore this definition is unacceptable if common agreement is to be reached by all participants for the management of a building project's design and construction.
2. **Fitness for purposes**, a definition which can be create a problem in building design, where many spaces and elements are multi-purposed and a greater fitness for one purpose can only be achieved at a lesser fitness for another, given the cost and time available.
3. **Conformance to requirements**, a definition which can be accepted as the management definition of 'quality'. This is because requirements are capable of;

- Clearly defined by number, text, drawing or example,
- Communicated by a variety of media to suit the recipient, and
- Reasonably objectively assessed for conformance

regardless of whatever product or service is being offered in any field of human activity. This definition may seem unacceptable to the ultimate customer in the process- the building client- because he would prefer 'fitness for purpose' which he would rightly expect in his finished building (Cornick, 1991)

5.2.2 Quality by Design

Quality by design is the practice of using a multidisciplinary team to conduct conceptual thinking, product-project design and planning all at one time. It is also known as concurrent engineering, simultaneous engineering, or parallel engineering. The team is composed of specialist from business, engineering, production and customer base. Quality by design, or concurrent engineering, requires the major functions to be performed at the same time. This system provides immediate feedback, which prevents problems with quality and productivity from occurring. Also, quality by design has recently encouraged changes in management structures. A board definition of quality by design is a team of specialists who simultaneously design and develop a product or project to ensure ease of producibility and customer satisfaction (Besterfield, 2003).

Within the increasing of the lead times and higher costs because of the design changes, quality by design has been helping control these design changes by shifting all the design to the beginning of the project rather than throughout its whole life cycle. The shifting of all design to the beginning of the project increases the time required for initial design; however, the future benefits outweigh this increase (Besterfield, 2003).

By using quality by design, the project is designed within design capabilities in order for statistical process control to be effective. Designing projects within process capabilities will cause a chain reaction of customer satisfaction. Customer returns and rework costs will decrease. As a result, profit margins become larger because the time that was previously used to rework nonconformities can be used to produce new projects (Besterfield, 2003).

The benefits of quality by design are;

- significant decrease in time to market
- faster product development
- less work in progress
- fewer engineering change orders
- increased productivity

As mentioned in the first chapter, quality is defined by CII as conformance to established requirements and it is a critical factor in determining project acceptance and resultant contractual payment levels. Based on relationships between material / construction characteristics (e.g., layer thickness, density, and compaction) and performance (Chamberlin 1995), deviations from design and construction requirements can adversely impact the service life of the finished project in which distresses can occur (cracking). During construction, nonconformance occurs when the finished state of a project and/or its parts deviates from established requirements and necessitates decisions to be made regarding their acceptance and rectification. Nonconformance stands in the project time frame between antecedent anomalies (poor compaction) and

future distresses of the finished work (i.e., performance problems). To the contractor, nonconformance can yield penalties, cost, and time burdens for rework and can result in productivity loss (Battikha 2000b). To the owner and/or user, nonconformance can translate into problems related to safety (structural failure), service (functional underperformance), and economy (maintenance costs) (Battika, 2002)

5.2.3 Improving Quality of Design Projects

For improving the quality of design projects, there are some important subjects that have to be done before design or during design, fundamentally. These can be summarized as follows;

- Plans and specifications should be carefully reviewed because of not adding time and costs to design. According to TQPM (Total Quality Project Management) *quality is improved not by more checking but by eliminating the source of these errors. By the time the design gets to the review stage, it has fewer errors so that less time (and money) is required for reviews and corrections. Also, fewer errors go undetected during the reviews.*
- The requirements must be clearly defined at the beginning of the project and must be agreed to by both the client and the design team.
- Designing requirements on a design project must be viewed not to ask a task for the owner to the while preparing a request for proposal nor as an agenda item for a one-hour kick-off meeting. It should be an evolution that results from a dialog between the owner and the designer.
- For most of the projects, a '*design report*' should be prepared for internal interview and subsequently to the client for review and approval. This report should include design criteria for each discipline such as civil, mechanical, architectural, electrical, instrumentation, etc. These should reflect all criteria, requirements, material selection, specialty design techniques, codes and all other related items necessary to guide the designer.
- Just as the '*design report*' can be used to document the technical aspects of the design, the '*project management*' plan can document the project management approach. Some particularly important elements of the plan are;
 - *Organizing the team for quality.* to overcome the probable quality problems often associated with a less-than-ideal project team, the project manager should review the project team and identify the strengths and weakness of each individual. This result of these evaluations can be tabulated in the form of a project team profile which will enable the project manager to make the most effective use of each person's strengths while mitigating the quality impacts of their weaknesses.

- *Anticipating problem:* the list of the responses given to the question of “What can go wrong that will hurt the quality of the project?” and ideas that can prevent the problem or mitigate its impact, is then incorporated into the project management plan and distributed to everyone on team so that that can prevent these problems or solve them before they become severe.
 - *Preparing a quality control (QC) plan:* every design project will be plagued with errors and omissions. The purpose of control is to find and correct these errors before the design goes to the field. A good QC plan should define which documents should be viewed; who should review them; when they should be reviewed; what kind of errors will be sought; the budget allotted for review; the schedule and budget allotted for corrections.
- To have a natural sequence of activities which lead to the most efficiently produced product, work process of design project should be sequenced. Deviations from this natural sequence introduce rework and errors, which cost time and money to correct. This natural sequence can be determined by preparing a task precedence diagram for each project (Stasiowski, 1996).
 - The other core subject of improving the quality concept in design is conformance to the related standards as ISO 9001. As remembered from the definitions of the ISO standards and related management system (quality management system), all these subjects, which are listed as the improving factors of the quality in design are the fundamentals of the ISO 9001 and Quality management systems as customer satisfaction, documentation, management responsibility, resource management, product and/or service realization, measurement, analysis and improvement.

5.2.4 Impacts of the Cost to the Building Quality

Project management is well established as a means to improve cost, schedule, and quality performance of design and construction. Past research has shown that management of the design phase is particularly important, because decisions made in this phase of a project often have the greatest impact on the eventual total project cost.

The Quality Management Task Force (QMFT) of the Construction Industry Institute (CII) has developed a Quality Performance Management System (QPMS) that is based on the premise that quality costs can be adequately tracked (Measuring

1989). The QMTF conducted research to identify and quantify the rework costs (including repair and replacement) of correcting quality deviations a design and construction. The study found that the average cost of rework on industrial projects exceeded 12%. Design deviations accounted for roughly 80% of the increased costs, while construction deviations accounted for about 20%. According the researches done United Kingdom, the cost of quality was estimated to be at least one-fourth the total of the project cost (Abdel-Razek, 1998).

5.2.5 The Requirements of the ISO 9001 Standards during Design Stage

As it is mentioned previous chapter, the essential requirements of ISO provide the fundamental mechanisms to support the philosophy of quality. In broad terms the four basic mechanisms of a quality in management system are organization, *auditing*, *reviewing* and *feedback*. These mechanisms can be considered not only as fundamental to the setting up and maintaining of a quality management system itself, but also as the additional formal actions to be carried out in the design process for a building project. That is, a quality management system needs to be constantly reviewed, but formal reviews need to be carried out from time to time throughout the design process of a project (Cornick, 1991)

The reasons that general standard for a quality management system should be applied to building design are as follows:

- The design of building as a process is fundamentally no different from that of any other artifact which has technological implications
- The Standard views design as an integral part of production and will therefore, by definition, impose on the building design process the appropriate discipline to ensure that what is designed can, in fact, be constructed.
- The various process involved in a building project (briefing, scheme designing, detail designing, specifying, etc) have very distinct products, and therefore only a very general standard can apply to the building process as a whole (Cornick, 1991).

Properly implemented, formal quality systems provide a vehicle for achieving conformance to established requirements. ISO 9000 series standards furnish conceptual guidelines with which to structure and implement the elements of a quality system (Arnold 1994). Achieving conformance to established requirements consists of a series of quality management activities during the various phases of a project. In the design phase, quality requirements for the end products and/or their

performance are specified to meet the user's needs. Depending on whether the specifications are method-type, end-result, or performance-related, construction methods and materials are specified by the owner's agent or defined later by the contractor to permit achievement of these requirements. In addition, quality management procedures are developed to ensure compliance with the specifications. During construction, nonconformance in terms of end products (the finished state of the constructed product), output products of activities (the states through which the end product passes during its construction), and/or in-process characteristics may be detected. Appropriate actions must then be taken to rectify nonconforming situations and, if possible, diagnosis of the reasons causing nonconformance, followed by the elimination of the causes to prevent recurrence during the remainder of the projects and on future projects. These activities require the analysis of vast amounts of data, and fast, expert-based decisions about actions to be taken (Battikha, 2002).

5.3 Quality through Environment

In this century, we are already witnessing a tremendous growth in global construction industry parallel with the increasing of the population and there is increasing concern that the environmental loadings resulting from these high levels of construction activities may endanger the natural ecosystem. So, it is imperative that organizations and companies around the world model their industrial activities on good environmental management principles and make a serious commitment effectively manage these activities so we can bring them in harmony with the natural environmental system. However, to develop such a system and apply its requirements in construction industry, the nature and complexity of the problems have to be understood completely. Some definitions of key words associated with the EMS and taken from the draft international standard ISO 1400:1996 are implemented below.

Environment; Surroundings in which an organization operates, including air, water, land, natural resources, flora, fauna, humans, and their interrelation. The environment in this context extends from within an organization to the global system.

Environmental Aspect; Elements of an organization's activities, or services which can interact with the environment

Environmental Impact; Any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organization's activities, products, or services.

Environmental Management System; Organizational structure, responsibilities, practices, procedures, processes, and resources for implementing and maintaining environmental management. (Puri, 1996)

Environment is one of the elements of TQM process (and also ISO 9001). Establishment of a receptive environment throughout the project organization is critical to the success of TQM. The main elements that are necessary for establishing such an environment are *commitment*, *awareness* and *recognition*. Management's commitment towards quality is not only essential; it must also be clearly communicated. Every member of the team should be aware of this commitment and be concerned about quality. For this to work effectively, management must introduce motivational activities, such as recognizing and rewarding team members for their contribution and extra work for the success of the TQM process (Ahmad & Sein, 1997). The quality of the environment is dramatically affected by the way we utilize materials, products, and energy, and by our construction processes. Most products, processes, and services follow a life-cycle pattern, depending on their nature and complexity, each stage of their life-cycle has some impact on the environment. This interaction also directly, affects the design of the building because of the fact that buildings design is planned according the internal and external environmental factors.

5.3.1 Environmental Characteristics;

As indicated in figure 5.5, the major environmental characteristics which may potentially be affected by development actions, which could place significant constraints on a proposed development is outlined. All of these entities and their environmental aspects must be carefully evaluated during the development or design phase of a new project proposal.

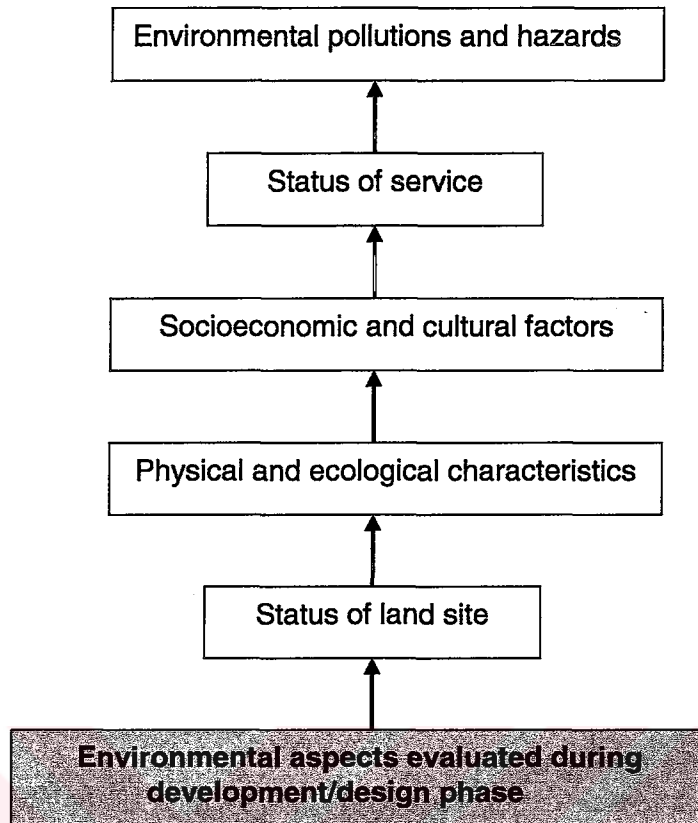


Figure 5.4 New site proposal- Environmental Consideration *

(*) This figure is taken from Puri (1996), pp.36

Below is a generic checklist of these major environmental characteristics.

1. *Status of Land Site;*

- *General characteristic of site*
- *Residential areas*
- *Commercial areas*
- *Industrial Areas*
- *Agricultural Areas*

2. *Physical and Ecological Characteristics*

- *Physical Characteristics of the land*
- *Climatic Conditions of the area*
- *Conditions relating to vegetation, animals, marine, and freshwater system*

3. *Socioeconomic and cultural factors*

- *Demographic aspects*
- *Economic base*
- *Cultural and religious aspects*

4. Status of service

5. Environmental Pollutions and Hazards

- *Air, water, and noise pollution*
- *Solid or liquid waste and by-product disposal*
- *Hazards to public*
- *Worker's safety and risk aspects*
- *Health and safety aspects*
- *Various cumulative and synergistic effects.*

5.3.2 Environmental Impacts of Commonly Used Building Products, Processes and Services and Related Design Issues

Buildings have a large impact upon the environment in a number of ways. They are responsible (with other forms of construction) for half of the total energy, all raw material use and as consequence for nearly the same proportion of carbon emissions to the atmosphere, thereby fuelling global warming. For example in Europe, 50 percent of all water is to serve the sanitation and drinking needs of people in building and half of all ozone depleting gases are used in the construction industry and 40 percent of all plastics.

Taken together, buildings have a major impact upon environmental wellbeing and the attainment of sustainable development. The materials and products which are used during construction are also large users of energy in manufacture, energy in transportation, and land to derive the raw materials. Decisions affecting the design, layout, density, methods of heating and lighting, the employment of different materials, etc have a great potential impact upon the environment both directly and indirectly. Architects, therefore, need to understand that the impacts, risks and consequences of the decisions they make can affect the well-being of both local and global environment, the health and safety of the people, the resources available to future generations, and the realization of balanced, sustainable communities (Edwards, 2000).

5.3.3 Environmental Impact Assessment (EIA)

Environmental Impact Assessment (EIA) is the term applied to the systematic examination of the likely impacts of development proposals on the environment prior to the beginning of any activity. In principle, EIA should apply to all actions likely to have a significant environmental effect. The potential scope of a comprehensive EIA system is considerable and could include the appraisal of policies, plans, programmes and specific projects. The result of an EIA is assembled in a document

known as an Environmental Impact Statement (EIS) which looks at all the positive and negative effects of a particular project on the environment. This report is just one component of the information required to aid decision makers in making their ultimate choices about a project (<http://www.ncte.ie/envirion/welcome.htm>).

In project planning and design process, a large amount of information will need to be compiled to satisfy EIS procedure. Although this may be viewed by the developer as an unnecessary additional burden, an astute professional adviser will use the information systematically gathered to help ensure the project proposals are compatible with sensible environmental management. An architect needs to ask what information he or she requires to gather together at the early stages of the project. Specifically, there may be a need to collect information on potential environmental impacts under the following headings;

- Visual aspects of the design
- Effects on health and safety
- Pollution
- Land take and its agricultural capacity
- Impact management and public relations.

By the application of the ES, the developer can improve the proposals by instructing the architect to reduce the adverse environmental impacts by;

- Better design,
- Improved energy management,
- Using cleaner technologies,
- Building on a different site,
- Reducing the scale of development (Edwards, 1999)

5.3.4 Designing for Environment;

One of the greatest challenges facing building designers at the present time is the creation of buildings which not only fulfill all of the customary social, aesthetic and functional requirements but also minimize their impact upon the environment and use the environment resources into their design effectively. Linked to this, the term “design for environment” captures the essence of the new movement in environmental protection. It takes the old reliable, well-proven environmental control methods and concepts and combines them with new ideas that concentrate on the design phase of a product.

Because of the fact that the environmental impact of the construction sector is manifold and complex, designers have a crucial role in specifying the materials to be

used and the technical performance standards required for the operation of buildings. In their key position, they have also the possibility to influence clients. Therefore, it is important to increase knowledge in energy efficiency and environmentally sound construction among architects and engineers. For designers it is important to have a holistic approach and not to focus on an isolated issue. To consider only the initial embodied energy in buildings might be wrong, since the operation of buildings sometimes is much more energy consuming over a building's lifetime. A life-cycle approach is therefore recommended. Recommendations aimed at designers such as architects and engineers can be mentioned in three main headings;

- *Selection of building materials;* For this matter the necessities can mentioned as:
 - Materials, systems and designs that require less non-renewable resources and that have low embodied energy is preferable.
 - Locally available building materials should be specified in order to reduce transportation.
 - To decide the appropriate strategy depending on the local and regional circumstances and priorities and on economic factors for choosing the materials. For example; a low energy material might be less appropriate if it implies high energy use during the building's lifetime, e.g. if the material has low durability and has to be replaced often, or if it causes high operational energy.
- *Design for recycling:* Reuse and recycling of building materials and wastes can drastically reduce the embodied energy in buildings. Furthermore, recycling has proved to be effective as a principle of material and energy conservation and employment generation in most developing countries. To apply this matter;
 - Architects and engineers should design buildings to enable recycling of materials when a building is to be demolished.
 - Structures with joints should be designed easy to disassemble
 - Choosing weaker mortars such as lime or lime/cement mortars, which are strong enough for most applications; greatly increase the possibilities to recycle building bricks and tiles.
 - Because of to be preceded of Construction of new buildings by demolition of old buildings on the construction site, the possibility of

reusing building materials from the existing buildings should be carefully studied.

- *Low-energy building design:* To ensure the low-energy building design;
 - Buildings should be passively adapted to the climate as much as possible;
 - The building should provide a reasonable indoor climate with little or no energy input.
 - To make best use of solar energy and other natural characteristics, such as topography and trees, and to control wind and shade, the placement and orientation of buildings should be taken into consideration seriously.
 - Solar heat gains are generally the main problem in hot regions. Shading of windows from direct sun is essential, especially on the east and west facades. Protection from diffuse solar radiation and reflected sunlight is also important.
 - In temperate or cold climates, the building design should allow passive heating from solar radiation during the cold season.
 - To limit heat losses the building envelope should have sufficient thermal insulation and windows and doors should be sealed. Energy conscious design is extremely important in actively cooled and/or heated buildings.
 - In hot climates, heat reflecting glass should be considered if shading devices cannot be used. In cold climates double-glazing or coated windowpanes with low-emissive may be beneficial.
 - To reduce the energy required for lighting, buildings should be designed for adequate daylight, although improved day lighting can increase energy demand for cooling and/or heating.
 - Heating domestic water requires a considerable amount of energy, and where the climate is suitable it is recommended to install solar collectors. In temperate and cold climates with sunny winters, solar collectors can even contribute to the heating of buildings during the cold season. (Der-Petrossian; & Johansson, 2000)

In general meaning, products, processes and services of an organization exert environmental burdens at all stages of their life-cycle. If the activities that impinge on the environment can be designed properly in the first place, there can be significant source reduction of the environmental impact of these activities. A well designed

environmental management system would have a high probability of success and sustainability (Puri, 1996).

Many useful benefits can accrue from designing for environment. Obviously the greatest benefit of the environment is the reduced impact to the environment (Kuhre, 1995). The organization or the company can anticipate regulatory compliance requirements and incorporate them into the design of activities, products, processes or services. It can properly design projects that will yield efficiency and cost-effectiveness as well as reduce risk and liabilities. The organization can also achieve competitive advantages through better designs and enhance its capability. (Puri, 1996).

5.4 Safety through Design

Safety is a general concept that has a great deal of importance in many industries, like quality concept, from chemistry to automotive, textile to construction. Although the sectors apply this concept to their industries with different principles and management techniques, the main permanent basis is the human safety.

Generally, safety management principles are developed for the construction site employees' safety and they are prepared to protect them from the construction site hazardous accidents. Nowadays, there is a trade in the construction industry to enhance safety by design. The theory behind this concept is that designers clearly can and do influence construction worker and user safety through their design decisions (Wilson, & Koehn, 2000). Therefore, if the design process takes the safety of the workers and users into consideration, the overall safety of the project can be impacted in a positive manner. Implementation of this type of program requires the cooperation of both architects and engineers.

On the other hand it is important to mention that the owner has the main responsibility for ensuring the implementation of these design criteria from project initiation, and for making safety a priority for the duration of the project. It is argued that thus, by taking into consideration the safety problem in the early stages as pre-design or design of the project, many injuries and a great amount of extra expenses will have been prevented. In fact, there may be a decrease in cost due to reduced insurance rates, which in turn will lower the contractors' expenses.

5.4.1 Definitions of Safety through Design:

Before defining and applying the safety through design concept, some fundamental definitions should be done to understand the core concept healthier. In fact, the terms of safety, hazard and risk, which come to mind at the first stage, are defined as follows;

- *Safety*, is defined as that state for which the risks are judged to be acceptable
- *Hazards*; are defined as the potential for harm: hazards include the characteristics of things and the actions or inactions of people. Hazards encompass any aspect of technology or activity that produces risk. Hazards are most effectively and economically avoided, eliminated, or controlled if they are considered early in the design process, and where necessary as the design progresses.
- *Risk*; is defined as a measure of the probability of a hazards-related incident occurring and of the severity of harm or damage that could result (Christensen & Manuele, 1999). Minimum risk is sought with respect to new technology, facilities, materials, and designs; in designing new production methods; in the design of products for human use; and in all redesign endeavors. In determining minimum risk, the decision factors will be the design objectives, the practicality of risk-reduction measures and their costs, and their probable acceptance by users.

Safety through design is defined as the integration of hazard analysis and risk assessment methods early in the design and engineering stages and the taking of the actions necessary so that the risk of injury or damage are at an acceptable level. Its theme is that the following benefits will derive if decisions affecting safety, healthy, quality, and environment are integrated into the early stages of the design processes:

- Significant reductions will be achieved in injuries, illnesses, damage to the environment, and their attendant costs.
- Productivity will be improved
- Operating costs will be reduced
- Expensive retrofitting to correct design short-comings will be avoided (Christensen & Manuele, 1999).

5.4.2 Safety through Design Model

Moving safety from an afterthought to forethought in the design of facilities, processes, and products is emphasized in the figure 5.4. Thus, consideration of hazards and risks would be moved as far “upstream” as possible in the design process. Upstream includes all aspects of the origination of business concepts, the relative decision making, and the design process, during which the greatest effectiveness can be achieved in hazard avoidance, elimination and control. As the figure 5.4 indicates, integrating consideration of hazards and risks early in the concept and design stages results in easier and less costly retrofitting in the build, operation, maintenance, and decommissioning periods (Christensen & Manuele, 1999).

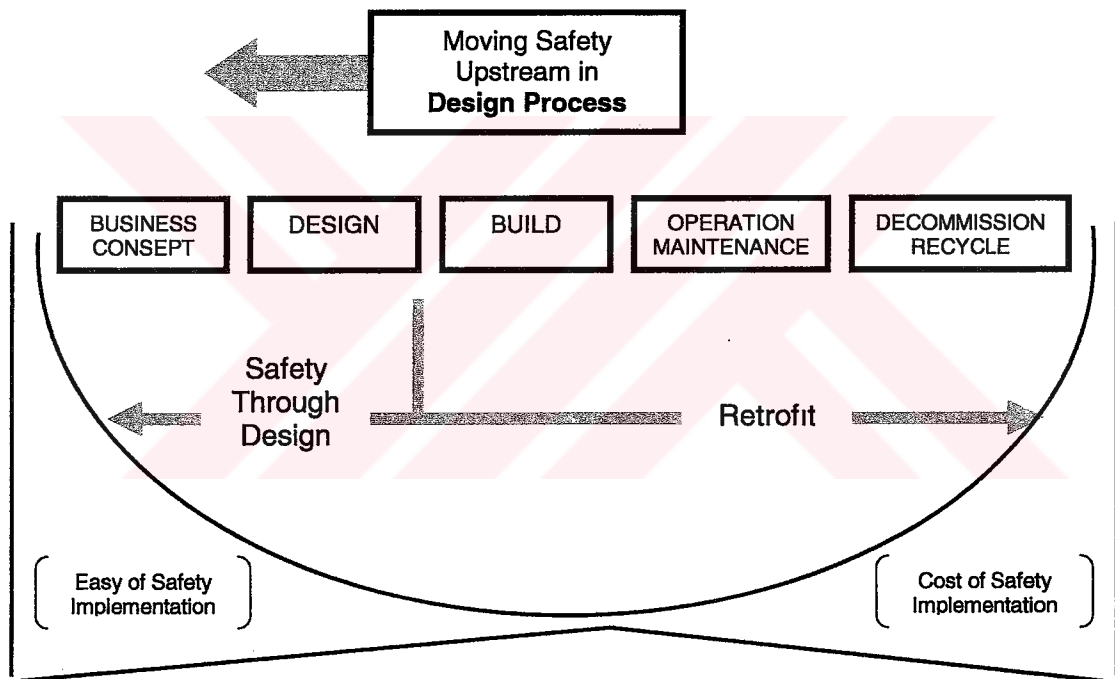


Figure: 5.5 The Model for Safety Through Design *

(*) This figure is taken from Christensen & Manuele (1999), pp.4

5.4.3 Relating Safety through Design to Designing for Quality

How does one have a quality project if it is not safe? Being safe is no accident—it is training, planning, quality control, quality assurance, redundancy, etc. Safety must be the number one priority for the construction team (owner, architect/engineer, general constructor, construction manager, subcontractors and suppliers work). It is the construction team's responsibility to ensure that the project is completed safely with quality and economy. A safe project requires a specific safety plan to address

the individual issues for a specific site, and the hazards that each site poses to construction. A typical listing of items for which safe operations must be planned includes: traffic pedestrian and vehicular, utilities, trenching, hazardous materials, overhead obstructions, and material delivery; limited site access/storage; infection control, indoor air quality, confined space, limited hoisting access, swing radius limitations/air rights, and fall protection for the type of structural frame construction (steel and concrete); and fall protection for the building envelope/facade type (concrete, curtain wall, masonry, windows, precast, metal panel, stone, stucco, and roofing). The listing of hazardous exposures on a project changes daily as no day in the life of the construction site presents the identical permutations of risk, which consists of individual exposure, weather, crew composition, experience of the workers, and specific site conditions. Construction site and building safety demands vigilance and attention to detail (Chini & Valdez, 2003).

There is a remarkable kinship between sound quality management principles and sound hazards management principle. Deming agrees that "Process must be designed to achieve superior quality if that is the quality level desired, and that superior quality can not be attained otherwise." And the same principle can be applied to safety by quoting the Deming's 14 points of management to the safety management principles.

If the superior quality and superior safety are the unavoidable subjects, they must be designed into new system and also a continuous improvement program, which encompassed the entirety of productivity, cost efficiency, quality and safety, for the redesign of existing workplaces and work methods must be maintained.

5.5 Integrated Concepts (Standards and Systems) in Construction Design Stage

As determined by Ahmad & Sein, (1997) construction is the process whereby designers' plans and specifications are converted into physical structures and facilities. It involves the organization and coordination of all the resources for the project, labor, construction equipment, permanent and temporary materials, supplies and utilities, money technology and methods, and time- to complete the project on schedule, within the budget, and according to the standards of quality and performance specified by the designer. To accomplish all these activities in a great success, some principles and requirements are anticipated beginning through the design stage of the construction.

In previous chapters, it is stated that the three systems such as quality management, environmental management and safety management and the standards of these systems such as ISO 9001:2000, ISO 14001: 1996 and OHSAS 18001 have a significance importance separately in the whole construction and particularly in the design stage of the construction. Also it is mentioned that if these three systems and standards are taken into hand as an integrated system, it will provide the organization many benefits and advantages; and ensure to raise the level of high quality buildings with an efficient use of environmental and safety factors that are indicated through standards. But first of all, to apply these systems and standards in construction industry efficiently, basic concepts of quality, environment and safety, which are the fundamentals of the systems and standards, have to be understood and agreed by all participants, deeply, within the all its principles in the design stage. Besides all these subjects affects directly to the design stage and also construction stage of the building. It first impacts the design of the building in the preliminary design phase and then affects the planning or organization of the construction site and materials that will be used in construction.

Although all these concepts and systems are generally taken up separately in construction, actually they are thought together because of the relationship between them except the similarities of the principles of the standards. The standards are the main tool of these three quality, environment and safety basic concepts to reach the required targets of the company or organization. By this point of view, standards actually enforced the organizations for using the environmental factors to reach the high quality by preventing the safety issues of the employees and the users. Also in last decade, in order to make the procedures easier, shorten the process of preparation and thus, to encourage the companies to produce high quality products, associations responsible from these systems and standards have started to renew the standards and systems suitable to the integration.

In conclusion, the core point of the application of the integrated systems efficiently and reaching the sustainable quality in construction without any loss, is concerned with the assuming the quality, environmental and quality concepts together; and by the help of the related standards, to apply the systems into the organizations beginning from the design stage to maintain.

6. CASE STUDY: Examining the Existence of the Integrated System through Turkish Construction Companies and the Effects of These Integrated Standards to the Building Design Phase

In this study, it is aimed to learn the quality, environment and safety concepts; their management systems; and related standards together in the design stage of construction. Beginning from the basic concepts, firstly the management systems and their standards are examined involving the general industries and specifically the construction industry; and then the concepts which form the fundamentals of these systems and their impacts to the design stage of construction are widely explained in the previous chapters. In this chapter, a case study is going to be taken up in the view of the quality, environment and safety concepts to learn the effects of related standards to the design process of the construction in the context of Turkish construction companies.

6.1 The Purposes, Methodology, Scope and Limits of the Case Study

In this research, there are some questions that shape this study and thought to be turned into hypotheses. These questions are asked below:

- How far do you agree with the following statements concerning the benefits of an integrated ISO 9001: 2000, ISO 14001:1996 and OHSAS 18001: 1999 and systems?
- Do you think that you can apply the standards you have in both your company and the design process or your design department efficiently, properly and regularly?
- How far do you agree with the reflections and effects of the Integrated System (*ISO 9001:2000 Quality Management System, ISO 14001:1996 Environmental Management System and OHSAS 18001:1999 Occupational Health and Safety Management System*) to the design phase?

- How far do you agree with the opinion that the decisions which taken in the view of these integrated standards during the design or pre-design phase effect the design team creativity and the whole construction site activities?

Apart from these questions, hypothesis of this study are;

- To use these standards as an integrated management system among the whole organizations has been beneficial.
- Integrated systems have had positive impacts and reflections to the design stage.
- Applying the integrated systems during the design stage or in the design department has increased the quality of the project and

To test these hypotheses, we can state the purposes of the case studies as the followings;

- To learn the proportion of the Turkish construction companies which have minimum one standard through ISO 9001:2000, ISO 14001:1996 and OHSAS 18001:1999.
- To determine the proportion of the Turkish construction companies which have all tree standards of ISO 9001:2000, ISO 14001:1996 and OHSAS 18001:1999.
- To learn that these companies took these standards whether integrated or stand alone.
- To examine the benefits of the integrated systems in the construction industry in a general view.
- To learn whether or not these systems affect any of the design activates; and if there is an effect, what the way and amount of this influence is.

Relating to these purposes, a questionnaire has been done with a group of Turkish construction companies which are selected according to both firms' size and situations that they have or do not have all the three standards of ISO 9001:2000, ISO 14001:1996 and OHSAS 18001:1999. The selection of these companies were done from the list of ISO certified Members of Turkish Contractors Association (TCA). The 23 companies of 97 recorded company, which have achieved minimum one standard around the Turkey, was determined from this list appropriate to the conditions of having all three standards. The 7 headquarters of companies of 23 companies are located in Istanbul and 16 of them in Ankara. So there is no limitation about the location of the companies.

The questionnaire was applied to 10 companies of these 23 companies, 6 of which are large scale and 4 of which are middle scale companies; and half of which are located in Ankara and other half in Istanbul. At the beginning of the survey, it was purposed to do interviews one to one with quality system managers by giving a questionnaire. This method has been applied to 8 of these selected 10 companies successfully. But because of the audit dates of the 2 companies, and the work intensity of the quality managers, the questionnaire was applied by the method of e-mailing to these two companies. These interviews and mailings were done by the managers who are responsible for the quality system. During the questionnaire, according to the flow of the interview, some questions were asked to the system managers and were gotten answers under the scope of the questionnaire questions but independent from them. The findings of these independent questions has been explained occasionally both in the parts of findings and conclusion.

In this study, it is purposed to have general information about the present situation of the standardization in the Turkish Construction firms and then aimed to learn how and in what proportion these standards and systems have been applied and used in the design phase of the construction projects. For this reason, the questionnaire consists of two parts. In the first part, there are 2 main questions and 23 subtitles (sub-questions), which measure the approaches of the companies to the integrated standards' benefits through the system management and cost mentioned in the literature. The other part consists of 4 questions and 36 subtitles (sub-questions), which help to understand the impacts of the applying standards to the design phase in practical. The questionnaire is given in the appendix.

The research evaluation can be divided into two phases as shown in table 6.1. In the first phase, the general characteristics and policies of the companies are explained. In the second phase, firstly, the responses of the companies to the questions are mentioned by a Likert scale of 1 to 5, which ensures to do the general evaluations of the responses statistically and to illustrate the results by histograms. Then the evaluation of the questionnaire is stated. The evaluation of the questionnaire is done in two ways. In the first evaluation, the values (1 to 5) of each statement determined in the questions are added and the average of these totals is calculated. The result gives the percentage of the agreement or significance level generally. By this method, it is aimed to learn what the levels of the companies' general opinions about the statements (benefits, reflections, impacts, etc.). These results are shown in the percentage figures by the help of histograms. The second

Table 6.1 Research Evaluation Methodology

PHASE I	Finding 1: Characteristics of the Turkish Construction Companies	
	Finding 2: Quality, Environment; and Occupational Health and Safety Policies of the Companies	

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PHASE II	Finding 3: Questionnaire responses and evaluations	First Stage Findings about the Benefits of Integrated Standards:
		Question 1: General Benefits of Integrated Systems
		Responses
		First evaluation of the benefits (%)
		Second evaluation of the benefits:
		Question 2: Cost Benefits of Integrated Systems
		Responses
		First evaluation of costs benefits (%)
		Second evaluation of costs benefits:
		Second Stage Findings about the Effects of Integrated Systems to the Design Phase:
		Question 1: Effects of Integrated Systems to design phase quality
		Responses
		First evaluation of affects of integrated systems (%)
		Second evaluation of affects of integrated systems
		Question 2: Reflections of Integrated Systems
		Responses
		First evaluation of reflections of integrated systems (%)
		Second evaluation of reflections of integrated systems
		Question 3: Problems arising during design stage
		Responses
		First evaluation of problems (%)
		Second evaluation of problems
		Question 4: Application level of the standards in organizations

evaluation has been done by multiplying the numbers of the responses that the system managers mentioned with the levels of the Likert scale values 1 to 5, for each statement listed in the tables. Thus, the significance and agreement levels of each heading can be learned.

6.2 Finding 1: *Characteristics of the Turkish Construction Companies that took place in the Case Study*

This questionnaire application has been done with the quality system managers of 10 construction companies which have all three standards of ISO 9001:2000, ISO 14001:1996 and OHSAS 18001. All of the firms are the members of the Turkish Contractors Association.

The basic properties of the companies are as follows;

- *Company 1:* This Company is an incorporated company which was established in 1954 and started to activate in the construction industry in 1976. Being incorporated, the company is active in the fields of contracting, land development, industry and trade, tourism, energy, seafood and real estate investment, housing projects & public service buildings. Company has numerous branch offices around the world such as Moscow, Berlin, Almaty, Tashkent, Istanbul (headquarter), Ankara, Oran, Baghdad, Ashgabat and Sakhalin.

The mission of the company is "to lead in construction of the new world and to satisfy our customers, shareholders and employees by both creating a unity of technology, information and human resources within a creative organization and giving environment-friendly, reliable contracting services with high quality." And the vision of the company "to be an international contracting firm displaying the first preference of the customers, employees, shareholders and the society in order to rebuild the globalizing world. The path we follow to achieve our mission and vision respectively starts with our organizational and human resources."

Company has been possessed to ISO 9001:2000, OHSAS 18001:1999 Certificates received from TÜV since 2003 and ISO 14001:1996 since 2002.

- *Company 2:* It is one of the largest groups of Turkey, founded in 1976 as an affiliate of its group, and active in the fields of banking, insurance and financial services, shipping, transportation, telecommunications; steel, paper, chemicals and textile industries and construction. The construction works some of which belong to the private sector and some belong to the public sector can be mainly classified as

infrastructural works, coast reclamation, housing, turn-key plant construction, industrial structures, and vast amounts of recreation works. The company that has successfully completed infrastructural, irrigation and land reclamation, housing, high-technology and industrial plant, hotel and health center projects, has many branch offices in Turkey, Libya, Iraq, Saudi Arabia and the former U.S.S.R. (today Commonwealth of Independent States C.I.S.);

Company is the first construction firm in Turkey, which possesses ISO - 9001 Certificate received from British Standards Institute (BSI) in 1997. After the revision of the ISO 9001 standards in 2000, company has been possessed to all three standards as integrated since 2003.

- *Company 3:* It is the group company which was found in 1972 as the first company of the Group. Its primary specialty is the construction of dams, irrigation networks and water related major infrastructure projects. It has extensive construction experience in a wide range of areas, including: dams (concrete, rockfill and earthfill) and HEPP; irrigation, drainage, water supply and sewer networks; roads and bridges (CIP, post-tension, precast, steel); natural gas and petroleum pipelines; harbors, dredging and land reclamation projects; large scale sports facilities; underground structures; piles, retaining systems, foundations and ground improvement; military structures. Although its operations are mainly based in Turkey, the company has branch offices in the Arabian Gulf and Greater Russia.

Company possesses ISO - 9001 Certificate received from TÜV in 2002 with having the possibility of taking other standards. In 2003 it took both ISO 14001:1996 and OHSAS 18001 as an integrate system.

- *Company 4:* The Company, having the headquarter in Istanbul, was found in 1950. The group of company has numerous activities one of which is construction. The company started its activities of construction in 1954 in the domestic market and in 1980 in the international market. Its field of activity can be divided into two company groups such as one company responsible for Infrastructural Works (dam; road; motorway; tunnel; power plant; port; agricultural projects; water reservoir; railway; industrial plant) and the other company whose major area is building construction (institutional; commercial; industrial; cultural; educational; public; residential; recreational; buildings; tourism facilities).

Company possesses ISO 9001 Certificate received from DNV in 2000 with having the possibility of taking other standards. In 2003 it took the both ISO 14001:1996

and OHSAS 18001 as an integrate system. Now only the company responsible for Infrastructure work has all three standards systems.

- *Company 5:* The Company was registered in Istanbul as a limited liability company in 1957. In 1967, the partnership was transformed into a joint stock company and is now one of the leading construction companies in Turkey and one of the largest in the world, comprising 24 subsidiaries engaged in different fields of activities. The company has been involved in the construction industry for 47. The major field of activities of the company is Power Plants ; Motorways Bridges and Tunnels; Petrochemical Plants ; Pipelines ; Business and Cultural Center ;New Towns and Housing Complexes , Shopping Malls ; Hospitals ; Airports Harbors and Offshore Works , Industrial Plants. It has own design department; but in some situations, it works with design firms from the outside.

The mission of the Company is stated by quality group manager as, “to continuously increase our contribution to the economies of the countries where we work while preserving our feature of being an enterprise which implements the tasks it undertakes with outstanding success in quality and execution time; to be a company whose involvement is desired by clients; which retains a reasonable profit from its undertakings and whose employees are proud to be associated with.”

Company possesses ISO 9001 and ISO 14001 Certificate received from BSI in 2002 for 3 years period. In 2003 it took the both OHSAS 18001 as an integrate system. Now, only the company responsible for Infrastructure work has all three standards systems.

- *Company 6:* It was established in 1959 as a civil contractor. Headquarter of the firm is located in Ankara. The company’s business abroad is developed, enhanced and backed up by a network of branch offices, liaison offices and associate companies established in key locations throughout the Middle East, Europe, the Russian Federation and the Central Asian Countries. As the size its technical staff grows, so does the level of expertise and specialization in related activities. The field of activity of the firm diversified as industrial projects (Cement Plants; Refineries; Petrochemical and Natural Gas Facilities; Chemical & Met. Facilities ; Pipeline & Transport Systems; Heating Centers ; Water Treatment) and Civil projects (Metro Subway Systems; Factories; Office Buildings; Hotels-Hospitals-Houses; Business & Shopping Centers; Cultural)

It took ISO - 9001 Certificate received from BVQI in 1997. After the revision of the ISO 9001 standards in 2000, company has been possessed to ISO 9001 standard in 2001 and other ISO 14001 and OHSAS 18001 as integrated system in 2002.

- *Company 7:* It was founded as a corporation in 1977 in Elazığ, Turkey by seven partners. Now headquarter of the Company is located in Ankara. Over the next 27 years, the Company gained an unblemished reputation as a first-class constructor of large scale public and private developmental projects. The main activity field of the Company is hydraulic projects (dams; irrigation systems; flood control; water conveyance System) transport project (roads, highways and motorways; railways; bridges and tunnels; ports; airports; pipelines), industrial projects (repair and maintenance workshops; factories and industrial facilities), residential projects (houses-mass houses; business centers), touristic facilities (hotels, motel and restaurants); power and communication projects; military projects (administration buildings; c/b protected blast resistant buildings; recreational facilities; communication and power), environment oriented projects (solid waste landfills; sewage treatment; water treatment)

The mission of the company is “completing the contracts within the shortest possible period, with the lowest cost and highest quality, and create lasting works; while meeting the demand of our country as to powerful contracting sector, proving that the profitableness depend on quality in the long run contribute in production in all conditions, produce quality works, and obtain confidence in every aspect; and undertaking tough and delicate works of special character, provide every work that we do to be of more good quality than the previous one, and add additional values to the investments reaching the standards of the contemporary world.”

The mission is “by doing its next work in much more good quality, expanding the scale of specialization in its sector constantly, and taking its level to the international arena, it has deserved to be within the first 3 construction firms of Turkey, and within the first 100 construction firms of the world.”

Company has been possessed to ISO 9001:2000, ISO 14001:1996 and OHSAS 18001:1999 Certificates received from TÜV as integrated system in 2002.

- *Company 8:* The Company was founded in 1969 to meet the demand for quality housing within enhanced living environments. It has extended and diversified its business into various new members and now is a group. Today, the Company group, , is comprised of 11 companies, and 4 plants, 2 touristic facilities, 2 shopping

centers, 1 sports center and 3 partnerships in numerous fields. Construction-Investment Group is comprised of 1 domestic and 2 overseas companies. It is responsible for constructing all kinds of building types and infrastructure plants. 1 Investment Company and 2 joint ventures have directed their resources into new opportunities provided through the union of forces under the Company. Industrial Group is comprised of 1 company and 5 plants. This Group is responsible for producing primarily tunnel forms together with all kinds of molding steel, wire mesh; wood, PVC and aluminum joinery; all kinds of standard and special building components of reinforced concrete and facade elements. It has a 30 years background that earned respect and success in the housing sector through its commitment to retained experience in design, construction and management. It operates as both an entrepreneur and contractor, constructing—both in Turkey and abroad—large-scale housing projects, every sort of housing (many-storied, few-storied, luxury, social, etc.), technical and social facilities for housing projects, and the necessary infrastructure that goes with them. It carries out environmental arrangement and landscaping, and constructs large-scale office buildings and shopping centers, tourism and sports facilities, health and cultural centers, schools, city parks, mosques, industrial plant and the like.

Company has been possessed to ISO 9001:2000, ISO 14001:1996 and OHSAS 18001:1999 Certificates received from BVQI as integrated system in 2003.

- *Company 9:* It is a member of Group of Companies established in 1969 by the foundation of one of the universities in Ankara. The company started activity in 1988 by reorganizing in 1986 as part of a Holding, owned by a private university, also established in Ankara by the same foundation. It provides turnkey contracting services of projects in Turkey and abroad from project design to construction, including interior design. It has completed housing complexes of thousands of units, University campuses, concert halls, hospitals and polyclinics, hotels and holiday villages, cultural and commercial centers, sport complexes and pipelines.

Company possesses ISO - 9001 Certificate received from BVQI in 2000. After the revision of the ISO 9001 standards in 2000, company has been possessed to all three standards as integrated systems since 2003.

- *Company 10:* The Company was founded in 1965 and has been undertaking construction projects abroad for more than 20 years. Since its foundation in 1965, starting as a "research and design" firm during its initial years, it completed design works for important engineering projects. In the following periods it started

undertaking general contracting projects and gained its first contracting experience in building industrial facilities and complexes especially using prefabrication technologies. After 1980 it started to perform also international design and construction projects specifically in Algeria, Kuwait, Russia and Turk. The company activities diversified in several related fields which are industrial construction (Industrial Estates; Factories; Workshops), public service buildings (Touristic Complexes; Trade Centers; Multi-Storey Car parks; Sport Halls; Housing; Education Complexes; Shopping Centers, transportation (metros; light rapid transit systems; tramlines), energy and irrigation (dams; energy); heavy construction (railway stations; tunnels, viaducts and bridges); strengthen and restoration, environmental projects. Company's mission has been "to create and to realize construction projects that will serve humanity by creating happiness environments". Company aims to increase the quality of life of humanity, in particular that of its customers, shareholders and employees. Company possesses ISO - 9001 Certificate received from DQS BVQI in 2001. After the revision of the ISO 9001 standards in 2000, company has been possessed to all three standards as integrated systems since 2003.

6.3 Finding 2: Quality, Environment; and Occupational Health and Safety Policies of the Companies

- ***Company 1***

Quality Policy: The Company Group has a strong tradition of basing its activities and operations on well defined procedures in written form. These procedures are regularly rewied on the basis of both the criteria set forth by the international quality management standards, namely ISO 9001 and also internal standards of the group. The Quality System and its procedures are defined in the Quality Manuel of the company. Monitoring of the management system and the procedures is carried out through systematic surveys and controls. It employs efficient, consistent and regular control mechanisms in order to reach its quality targets.

The objective of the management of the Company is to provide services in strict compliance with the needs and requirements of its customers. The members of the Group attribute utmost importance to experience, expertise, skills, quality and reliability and this is the very heart of our services. On every project Company is committed to applying the Contracting Quality Control System that the company has

developed and in this manner operates in conformance with both the conditions of its contracts and with legal procedures.

Environment Policy: One of the basic principles of Company, a company which operates in the construction sector in and out of Turkey, is to protect the environment, keeping it free from damage and even developing it in all of its offices and all kinds of activities, based on the principle of "Emphasizing natural balance in all of our activities". It does not produce products or engage in activities that may directly or indirectly damage the environment. It reviews all of its activities systematically and within the frame of documented procedures in terms of potential damage to the environment and organizes the activities by taking measures in advance. It provides related information and training to the employees and ensures that all employees have environmental awareness. It takes as an obligation to obey the effective laws, regulations and decrees related with environmental protection.

In all of its activities, it takes and makes others take the necessary actions to protect the natural assets and historical works, to avoid causing adverse effects on living organisms, to prevent all kinds of pollution, to keep the environment intact and even to develop it positively. It puts into effect methods and modes of work which decreases the consumption of natural resources such as energy, water, paper. It aims to decrease the volume of waste and to accumulate waste separately for recycling purposes. It evaluates all kinds of related suggestions and complaints, takes necessary actions and informs the public.

Health and Safety Policy: Company is actively engaged in General Contracting Services and handles Occupational Health & Safety as a corporate value and a basic human right. The Group gives top priority to protection of health and safety in all fields of its activities. It assesses all risks, hazards and attitudes challenging work health and safety in a systematic way and aims to avoid potential hazards at their source; the Group tries to mitigate risks through determining and implementing effective risk control methods. Company Group acknowledges compliance with relevant national and international regulations and other special requirements applicable to its activities and the pursuit of technological developments as a minimum obligation in this respect. The Group ensures the provision of material and moral resources for the development of healthy and safe working conditions.

It strives to establish a corporate culture of "preventive action" among employers, subcontractors and related parties;

- In the line of communication, training and encouragement programs, the mutual exchange of information
- In the implementation of occupational health and safety procedures
- On the basis of having responsibility sharing that shall be realized among employers, subcontractors and related parties.

All personnel, who work as a team under the coordination of the management, ensure that the production is realized within the OHS rules in a timely manner of the highest quality. Company executes reviews and develops its operations for Occupational Health and Safety through teamwork using performance monitoring and measurement methods; it aims to improve its management system on a regular and consistent basis.

- **Company 2**

Quality Policy: Company has adopted the following as the Company's Objectives with no exceptions in any country or project:

- Timely and complete fulfillment of the requirements of the employer, as specified under the relevant contract.
- Conducting operations in due regard with the legal practices that prevail in the country and region where the company operates.
- Completion of any work under any project that the Company has undertaken, without any discrepancy, in compliance with the specifications, the budget and the work schedule

Environment Policy: Could not be reached

Health and Safety Policy: Could not be reached

- **Company 3**

Quality Policy: Could not be reached

Environment Policy: Could not be reached

Health and Safety Policy: Could not be reached

- **Company 4**

Quality Policy: The quality policy of the Company is listed as follows;

- Directing customer requests and conforming to these requests at maximum level.

- Maintaining the communication between customers and sub-contractors without any mistake by defining the communication canals between them.
- Completing and delivering the projects on schedule and in conformity with the work program and with the technical specifications.
- Increasing the efficiency and decreasing the costs by maintaining the losses in site processes at optimum level.
- Using the modern, required and valid techniques, technology, knowledge and management systems, and for this purpose not to escape from necessary researches and investments.
- Conforming to the legislation and obligatory standards of the country worked in.
- To maintain that the personnel feel happy and proud to be working in the Company.
- To make the improvement studies which are the results of work processes analysis natural behavior of the employees.
- To be a director as to develop sub contractors while establishing and applying control and follow up systems for maintaining occupational health and safety and environmental management criteria.
- To contribute the growth of earned dignity which is gathered within long years by taking all actions with the responsibility of being the Company's employee?

Health, Safety and Environment Policy: Health and safety policy of the Company has been stated as follows;

- Compliance with the current occupational health and security and environmental management legislation and regulations of the country worked in.
- Recognition of continual improvement as the basic principle in all operations.
- Paying attention to the views and expectations of all interested parties including Employers, in implementation of occupational health and security and environmental management systems.
- Attributing significance to the re-cycling of waste and thus providing for the in source processing and evaluation of waste.
- Avoiding over-consumption of energy and natural resources.
- Developing and submission to employers the projects with optimum use of natural resources and minimum adverse impacts to the environment during execution and commissioning.

- Prevention of hazardous event which can lead to accidents and elimination of the existing hazardous surroundings.
- Be prepared for emergency situations.
- Ensuring the subcontractor's observance of legislation and the procedures and principles of Company HSE programme.

• **Company 5**

Quality Policy: Company's quality policy is based on their quality principles. So, the below stated principals which Company has adhered to since their foundation and which they will adhere to in the future in order to be able to fulfill their mission:

- Not to compromise general and professional ethics,
- Always to adopt a constructive attitude towards their clients, customers and partners, beyond the mere fulfillment of our contractual duties,
- To be receptive to innovations, to implement state of art technologies and always to seek the better,
- To be sensitive and cautious in matters of work safety and environmental protection,
- To train their young employees in accordance with their culture to be creative, industrious and honest and to take care that our employees work as individuals who are self confident, communicative, ready to exercise powers vested in them and assume responsibility,
- To seek their competitive advantage and profit in perfection of their own management and technical skills.

Environment Policy: Company is committed to maintain a conscientious and responsible attitude to the environment by using all available and relevant knowledge to identify and minimise pollution risks that could impact construction activities in the countries of operation.

Starting from business development stage, through the tendering, engineering, mobilisation, construction, including demobilisation, all activities shall be performed with due consideration given to the environmental aspects and impacts. Company Senior Management shall provide all necessary resources to operate Environmental Management System as required by assigning responsibilities and authorising respective persons and fostering environmental awareness to all personnel. Company aims to create an environmental awareness which will continue increasing the attention of all its employees to the environment and the economic usage of

natural resources. To realise this aim, the environmental management system is based on continuously corrective and preventive activities which are to become natural behaviour of all personnel and this philosophy constitutes the basis of the environmental policy. To this aim;

- Meeting or exceeding the environmental regulations of the countries of operation,
- Using natural resources economically,
- Mitigating environmental aspects/impacts by controlling waste,
- Reducing the risks of emergency,
- Fostering environmental awareness of all employees,
- Meeting the requirements of ISO 14001 Environmental Management System and providing the necessary resources,

are the main deliverables.

All Company's employees are responsible to support and assist in establishing, implementation and continuous improvement of Environmental Management System.

Occupational Health and Safety Policy: The Management of the Company believes that all accidents are preventable. This is achievable through their desire for continuous improvement and our dedication to *Safety Excellence* and *Zero Accident Philosophy*. The ESH Management Team shall set the standard for accountability for every action of each employee. By this, all employees shall conduct themselves and execute their work in safe and healthy manner and protect client property. The standard is communicated to all people involved in the projects whether they are Company's Joint Venture Partners' employees, subcontractors or suppliers. It has always been the Company's policy to provide a safe environment for subcontractors and workers in all projects. They expect every employee to uphold the standards of applicable Occupational Safety and Health Act and safety requirements in the countries of operation. Preventive measures and the elimination of any potential hazard are of the utmost importance for the safety of all employees, visitors and the public in general.

The Company commit to meet or exceed the requirements of applicable Occupational Safety and Health regulations of the countries of operation. The protection of health and safety is given the highest priority throughout all phases of the projects from front end engineering through construction, ending with final demobilisation. Company's Project Management Teams shall put into place an effective and understandable Project ESH program. The vision that supports the

objective includes the following key result areas: The creation of a workforce and supervision;

- Well informed, motivated who strive to achieve the *Zero Accident Target*,
- That embraces the philosophy that there is no job or task so important that they can not take the time necessary to do it safely,
- That upholds the virtue that the environment shall be left as how it was found, or better.
- That is sensitive to hazards and conscience to responsible.

Safety personnel and the rest of the employees have the responsibility to immediately report to one level up or the Site Manager of any potential hazardous conditions. The Authorised people are responsible for immediate actions in order to eliminate the potential hazard. It is the responsibility of every employee to support and assist in establishing and implementing Safety & Health requirements.

- **Company 6**

All three policies of Quality, Environment, and Occupational Health and Safety of Company 6 have been stated in one heading.

Quality, Environment, Occupational Health and Safety Policy: Company Management is committed to establishing a management system that will lead to;

- Execute all activities in full compliance with legal regulations, Company principles, customer requirements and expectations,
- Ensure continuity of the customer satisfaction established by the quality of products and services, and achieve all quality, environment and occupational health and safety objectives,
- Take all precautions to ensure the occupational health and safety of employees,
- Protect the environment and utilize resources in the most efficient manner in continual improvement basis having the understanding that quality is the key for success. Company has agreed to provide the required resources and ensures compliance with this system by all Company employees.

- **Company 7**

Quality Policy: Could not be reached.

Environment, Occupational Health and Safety Policy: Two policies of the Company are listed together as follows;

- In all the services that Company produce they obey all the laws and regulations as to the environment, working health and safety, and always spend effort to improve these aspects,
- They determine their effects on the environment during our activities and reduce the negative effects to minimum, if there are any,
- During our activities, they use their energy and resources effectively and constantly take measures in order to save,
- When they are carrying out their operations, they control their wastes, and minimize the pollution of air, water and soil by means of appropriate techniques.
- Company carry out all the works of announcement and educational courses required for all the employees to carry on the conscious of environment, working health and safety.
- During all the services that they give, they protect their employees and the people to be effected from Company's activities against the injuries and illnesses.
- In order not to damage their properties and goods of theirs and of other persons, Company control the danger at the beginning, they constantly watch it, fulfill the necessary arrangements and provide every possible protection at the application phase.
- They announce the effects of the services that they give on the environment to the public, and share the information they have with it.

• **Company 8**

Quality Policy: In the production of infrastructure, superstructure and construction components, Company adheres to the requirements of design, related standards, technical specifications, regulations governing management and current law, and all the requisites of the technique and art of construction. In doing so, it makes sure to take advantage of innovations in information and communications technologies.

The Company's guiding principle is, with the active participation of all its personnel, to take account of the customer's needs and means in order to ensure his or her continued satisfaction by using resources economically, effectively and efficiently while delivering products on time.

In accomplishing these goals, the company strives constantly to be a leader in its field, innovative and open to development, while ensuring that the Company brand name remains competitive in the domestic and international markets.

Environment Policy: Company follows existing environmental guidelines as well as those to which it would be subject on its own initiative, constructing super- and infrastructure, as well as construction elements, in a manner that uses necessary resources so as to prevent the pollution of air, water and soil.

By employing personnel who are aware of these issues, both in design and production, the company contributes to sustainability and the preservation of the environment while continuing to develop and progress.

They have the environment on loan from future generations, and Company makes every effort to take the lead in Turkey in preserving it, contributing to whatever steps it can in this direction.

Occupational Health and Safety Policy: The Company observes current OHSM law as well as the regulations put forward by organizations of which it is a member, taking all necessary precautions to ensure occupational health and safety. The company ensures that personnel are aware of their individual OHSM responsibilities, and that continual improvements are made in activities related to occupational health and safety.

Concern not just for products and the customer, but also for the satisfaction of personnel, along with their health and safety, is an important sign of the “people first” approach of which Mesa Housing Industries Inc. is so proud.

- **Company 9**

Quality Policy: The quality policy of Company 9 is listed as follows;

- To provide university resources to maintain and develop its presence ;
- With trust to their most significant internal sources, their employees;
- To reach *Modern Quality Values* and *Customer Satisfaction* in every stage of their production ,
- To provide quality of product concerning competition, productivity and profitability ,
- With respect to our social and environmental ethic values; their institution will carry on its activities.

Environment, and Health and Safety Policy: While working on top quality projects fulfilling the expectations of our customers, they provide health services, safety on the job to the staff and reduce the factors damaging the environment by applying current rules and regulations that are effective by law. Their staff regularly receives

on the job training in order to develop their skills as well as on the procedures; so that they understand the system and they are aware of their responsibilities and duties. Their objective is to reach to a point together with all staff to have '*Zero Work Hazard*' by eliminating the risk factors. Starting from the design phase, throughout their projects, at all phases of the project, they work in co-operation with their subcontractors and other companies and meanwhile take the applicable measures to protect the environment.

- **Company 10**

Quality Policies The quality policy of Company is;

- Focusing on predetermined markets and technologies to seek competition on advantage of knowledge and system capabilities.
- To be innovative and leading company in the sector and proposing advanced technologies to acquire cost, speed and quality advantage in favor of its customers.
- To establish awareness of quality in all employees and develop company procedures continuously.
- By analyzing customer expectations and requirements and available techniques and technologies with all aspects in order to prepare well documented, easy understanding and complete tenders.
- To plan as to finish the works earlier and within its budget and properly allocate necessary resources.
- While specifying materials and methods of construction, to consider durability as one of the key factors.

Environment Policy: Minimizing the consumption of natural resources and waste produced, proving continuous improvement of these safeguarding activities, and conforming legal mandates are the main principles that environment Policies of Company based on.

- To control and manage of our activities for minimizing the harmful impacts that could affect to the environment and society that we live in and to comply with the legal requirements of local countries, related to the issues defined in Environmental management system of Company.
- To consider the environmental approach of the subcontractors, and suppliers when selecting and evaluating them.

- To support all activities for an efficient energy consumption, prevent contamination, and for minimizing natural resource consumptions.
- To ensure all personnel including subcontractors to be aware for environmental issues.

Occupational Health & Safety Policies: Occupational Health and Safety policies of the Company are based on zero accident philosophy.

- To have necessary knowledge and motivation for accomplishing zero accident objective.
- To comply with the legal requirements of local countries, related to the issues defined in Occupational Health and Safety management system of Company.
- To ensure all personnel including subcontractors to be sensitive and aware for Health & Safety issues.
- To consider the health and safety approach of the subcontractors, and suppliers when selecting and evaluating them.

6.4 Findings 3: Questionnaire responses and evaluations

In this part, the responses of the companies' quality system managers to the questionnaire will be stated and evaluated in two sections. In the first stage, the first part of the questionnaire's answers will be explained and in the second stage, the second part of the questionnaire's responses will be appraised.

6.4.1 First Stage Findings about the Benefits of Integrated Standards

At the first part of the questionnaire, there are two main questions by which it is aimed to learn the Turkish construction companies' thoughts about the benefits of the integrated ISO 9001:2000, ISO 14001: 1996 and ISO 18001:1999 standards and their related management systems which are mentioned in the literature through last several years. For this aim, existing benefits of standards which are examined in the literature is listed and the agreement levels of each 10 Turkish construction companies are shown in a table. After that, the evaluation of the responses will be calculated by the means of their mean and standard deviation and will be illustrated by bar chart diagrams. The purposes of this part of the study are:

- Understanding the present *general benefits* of integrated standards in the organization of the Turkish construction companies.

- Learning the main benefits of the integrated standards in the view of the *cost effectiveness* through the companies.

The responses and the evaluations of the management system managers of the companies for the first part of the questionnaire related to the main purposes are as follows:

(QUESTION 1) The management systems managers of the companies were asked to how far they agree with the statements concerning the *benefits of an integrated ISO 9001:2000, ISO 14001: 1996 and OHSAS 18001:1999 standards and systems.*

Responses: The responses of the managers are seen below at the Table 6.2. (The numbers show the agreement level of the factors for the directors. e.g. 1: strongly disagree, ..., 5: strongly agree)

Table 6.2 The 10 Turkish construction companies' responses involved the benefits of integrated standards

Benefits	Companies									
	1	2	3	4	5	6	7	8	9	10
1- Towards establishing an integrated and optimal performance management system	4	5	5	5	4	5	5	4	3	5
2- Adopting the integration exercise as the foundation for integration other systems such as buildability, just-in-time and quality function deployment	4	5	4	3	4	4	5	4	3	4
3- More comprehensive involvement of all interested parties. Each party will have to be aware of the larger scope of their work, i.e. how all quality, environmental and safety issues affect the management efficiency of the company as a whole	4	5	4	4	4	5	5	4	4	4
4- Common resources result in better utilization, efficiency and no duplication of efforts	5	2	5	5	5	4	5	4	4	5
5- Achieve synergy from the development of the integrated system where the achievement of a combined system is more than the sum of the achievement of each system implemented individually	4	5	4	5	5	4	5	4	5	4
6- Harmonization and unified problem solving	5	5	4	5	4	4	5	3	4	3
7- Encourage technology development and transfer	3	5	2	4	4	3	5	4	2	4
8- Improve joint operational (quality, safety and environmental) performance in which all three systems are improved together	4	5	4	5	5	4	5	4	-	3
9- Improve international management methods and cross functional team work	4	5	3	5	5	3	5	4	2	4
10- Higher staff motivation and lower interfunctional conflicts and injuries	3	5	4	5	5	4	5	3	4	4

Benefits (continue)	Companies									
	1	2	3	4	5	6	7	8	9	100
11- Higher employee adoption with the help of the safety and environmental management system	4	5	4	5	5	4	5	3	4	2
12- Multiple audits reduced and streamlined	5	5	5	5	5	5	5	2	5	1
13- Ensure employee involvement and education	3	5	5	5	5	4	5	4	4	4
14- Enhance confidence of customers for a commitment to the environment and positive market/commodity image	3	5	5	4	5	5	5	3	3	4
15-Improve industry/ government relations	3	4	5	4	5	4	5	4	4	1
16- Potential impact on world trade to allow competition on an equal basis	3	5	4	4	5	5	5	4	4	4
17- Savings in consumption of energy and materials	4	5	5	5	5	3	5	3	5	4
18- Controlling the stages as procurement, building processes and application in one hand	3	5	5	5	5	4	5	4	3	3
19- Decreasing/ being removed of the poor quality and unsafety work and environment conditions	4	5	5	5	5	5	5	4	4	5

First evaluation of the benefits: According to the information given in the table 6.2, the percentages of the benefits, which are calculated by the method that has been described in the methodology part, are shown in table 6.3. From this table, the agreement levels of the managers to the benefits of integrated system may be understood.

Table 6.3 The evaluation of the benefits of the integrated systems.

Benefits	Percent of Responses					No reply
	1	2	3	4	5	
1- Towards establishing an integrated and optimal performance management system	0	0	1	3	6	0
2- Adopting the integration exercise as the foundation for integration other systems such as buildability, just-in-time and quality function deployment	0	0	2	6	2	0
3- More comprehensive involvement of all interested parties. Each party will have to be aware of the larger scope of their work, i.e. how all quality, environmental and safety issues affect the management efficiency of the company as a whole	0	0	0	7	3	0
4- Common resources result in better utilization, efficiency and no duplication of efforts	0	1	0	3	6	0
5- Achieve synergy from the development of the integrated system where the achievement of a combined system is more than the sum of the achievement of each system implemented individually	0	0	0	5	5	0

Benefits	Percent of Responses					No reply
	1	2	3	4	5	
6- Harmonization and unified problem solving	0	0	2	4	4	0
7- Encourage technology development and transfer	0	2	2	4	2	0
8- Improve joint operational (quality, safety and environmental) performance in which all three systems are improved together	0	0	1	4	4	1
9- Improve international management methods and cross functional team work	0	1	3	3	5	0
10- Higher staff motivation and lower interfunctional conflicts and injuries	0	0	2	4	4	0
11- Higher employee adoption with the help of the safety and environmental management system	0	1	1	4	4	0
12- Multiple audits reduced and streamlined	1	1	0	0	8	0
13- Ensure employee involvement and education	0	0	1	4	5	0
14- Enhance confidence of customers for a commitment to the environment and positive market/commodity image	0	0	3	2	5	0
15-Improve industry/ government relations	1	0	1	5	3	0
16- Potential impact on world trade to allow competition on an equal basis	0	0	1	5	4	0
17- Savings in consumption of energy and materials	0	0	2	2	6	0
18- Controlling the stages as procurement, building processes and application in one hand	0	0	3	2	5	0
19- Decreasing/ being removed of the poor quality and unsafety work and environment conditions	0	0	0	3	7	0
Mean	0.10	0.31	1.21	3.68	4.63	0.05
Percentage	%1	%3.1	%12.1	%36.8	%46.3	%0.5

The agreement levels of the factors concerning the benefits of integrated system shown in the table 6.3, is seen below in relation at the Figure 6.1 by histogram diagram.

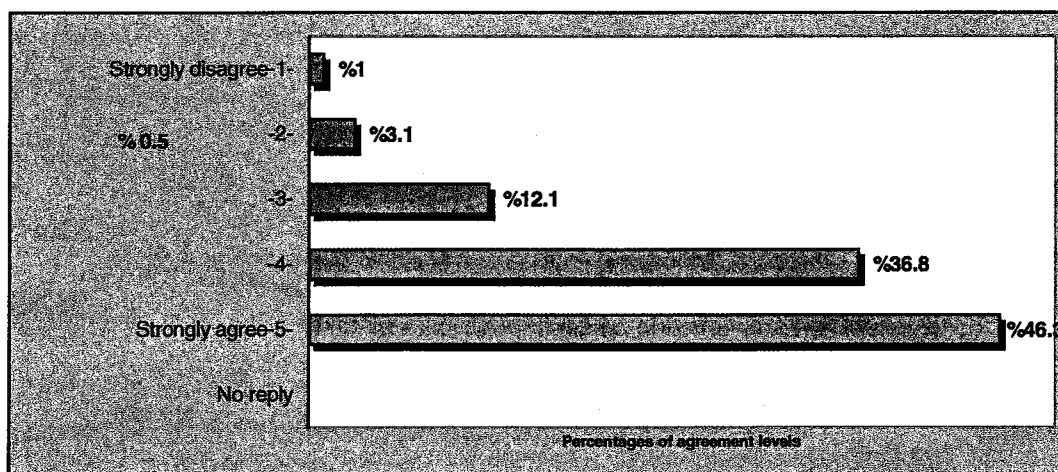


Figure 6.1 Percentage of agreement levels of integrated systems benefits

A statistical analysis of Table 6.3 shows that;

1. On a Likert scale of 1, on average, 1.0% of the respondents indicated strong disagreement with the benefits of an integrated system
2. On a Likert scale of 2, on average, 3.1% of the respondents indicated strong disagreement with the benefits of an integrated system
3. On a Likert scale of 3, on average, 12.1% of the respondents were neutral concerning the benefits of an integrated system
4. On a Likert scale of 4, on average, 36.8% of the respondents indicated strong agreement with the benefits of an integrated system
5. On a Likert scale of 5, on average, 46.3% of the respondents indicated strong agreement with the benefits of an integrated system

The overall results from table 6.3 appear to suggest that a majority of the respondents agreed with the benefits of an integrated system and the results supporting this view are statically significant. As seen from the percentages, the "5" level of the Likert Scale has approximately half of the responses.

Second evaluation of the benefits: With the second evaluation, it is aimed to understand the importance levels of each benefit separately. According to this evaluation, that is seen in figure 6. 2, the values of each heading are so high and all of them are up to average value of 3.0/5.0. Headings of improve international management methods and cross functional team work; and decreasing of the poor quality and unsafety work and environment conditions, have chosen the most important benefits of the integrated systems and have a very high value of 4.8 and 4.7/5.0. Also opposite of this, some companies don't have the same opinion related to the statement of improve international management methods and cross functional team work. Versus to the diagram results, it is mentioned that within the application of the integrated standards, some existing methods or communication types have gained a name such as management methods.

The secondly agreed and beneficial headings through the integrated standards are;

- o Towards establishing an integrated and optimal performance management system;
- o Achieve synergy from the development of the integrated system where the achievement of a combined system is more than the sum of the achievement of each system implemented individually;
- o Common resources result in better utilization, efficiency and no duplication of efforts;

- o Ensure employee involvement and education; and saving in consumption of energy and materials

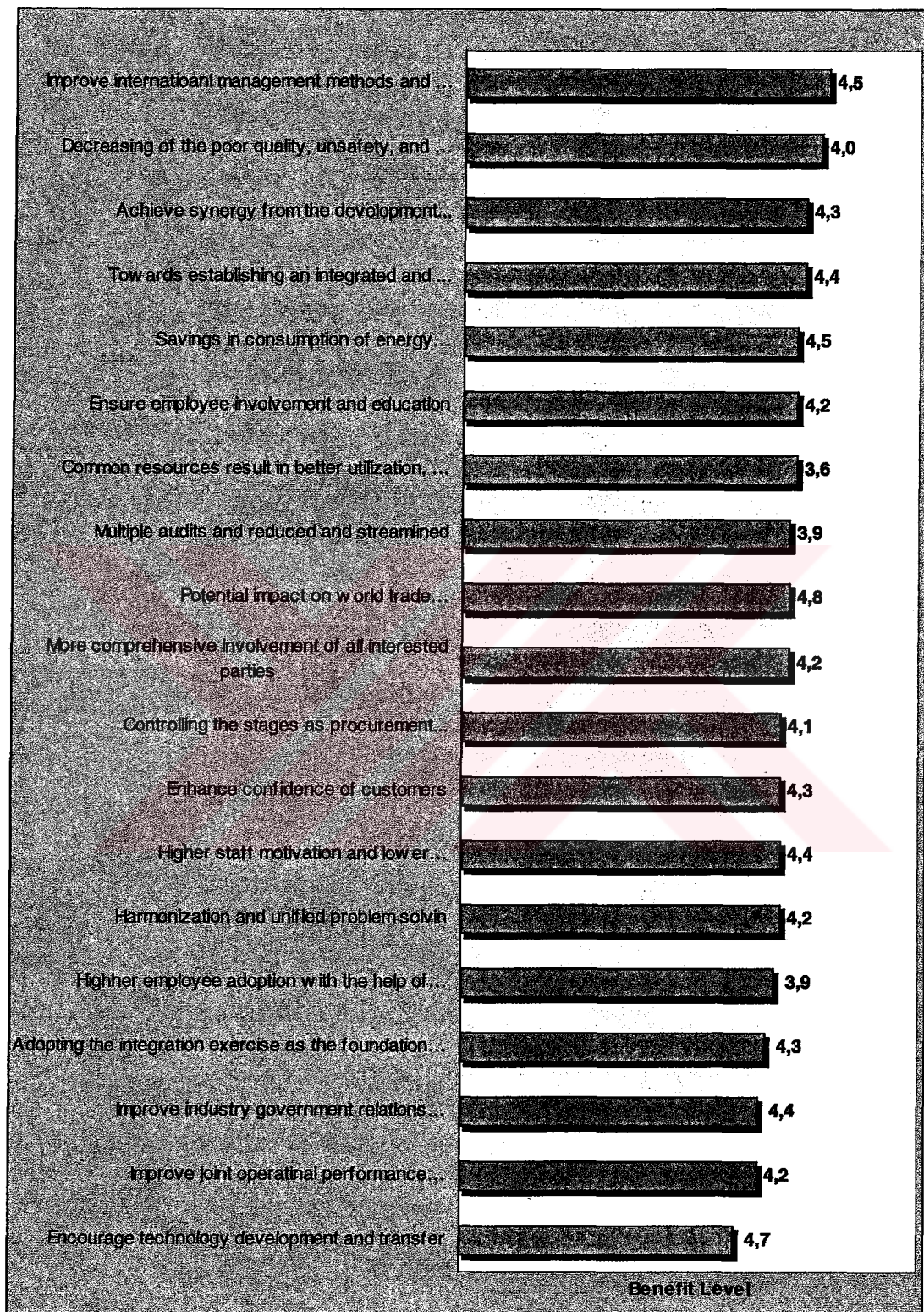


Figure 6.2 Evaluation of the benefits of the integrated systems

The statements of higher staff motivation and lower interfunctional conflicts and injuries; and higher employee adoption with the help of the safety and environmental

management system are the largest values of the Likert scale with a degree of 4.1 and 4.3/5.0. But generally, it is thought by the system managers that many problems have arisen during the trainings especially with the uneducated staffs. But also it is mentioned that when the benefits of the standards started to be understood, the ratio of the problems and complaints have decreased, in the long term period.

Moreover the heading of the multiple audits reduce and streamlined is one of the other strongly agreed statement about the benefits of the integration with a degree of 4.3/5.0. About this benefit, some system managers have emphasized that the number of the audits go down from 2 to 1 although there is no decrease in the period of internal audits in a year. Also it is stated for one of the company that the multiple audits only lengthen the audit time, for instance 1 day to 2 days. Another Company has stated that multiple audits ensure a great deal of utility in the view of management plans and programs. Furthermore, one of the Companies has determined that the multiple audits ensure their companies a great deal of easiness, because of their organization chart. In this Company, there isn't a vertical or a horizontal organization chart. Instead of this traditional system, there are support groups consist; of bid preparation, project design, machinery, investment, account& finance, human resources, quality assurance, environmental health & safety assurance, information systems and legal department; and project execution groups which have own general manager, project manager, accountant, engineers, etc. separately; in an elliptical order. Each project individuals are responsible with their own project group and each project has been inspected separately. System Manager of this Company has stated that they have three audits in a year and ten project groups. Then he has added that if they have not integrated standards in their organization, it is so difficult to inspect all the groups separately for each standard. So the integration of the standards is more important than other companies in order to save time.

Technology development and transfer has been chosen by the system managers as the least important factor with the value of 3.6/5.00, in spite of having a degree up to the average level of 3.0/5.0. The main reason of this result has been stated by different companies with two different response one of which is that the application of the integrated systems in construction industry does not have the mission of encouraging high technologies directly despite of helping the development. It is also mentioned that there is no so important changes in the technologic opportunities after or before applying the systems. This may be result from the fact that the history of this integrated systems are so new in Turkey. The other response is concerning

with the Turkey's economic conditions. Parallel to this, it is stated by one of the companies that because of the economic crises, the investments have to be stopped for a while and in this period there could not be so many progresses by the means of the technologic development. Also the statement of improve industry/government relations is the secondly less agreement benefit. However, this statement has been evaluated in two ways. One of the companies emphasized that this 1 to 5 scale evaluation is changed according the standards in such a way that the value is 4 if ISO 9001:2001 evaluated alone, and the value is 2 if the other two standards are evaluated separately. This means that the government has not assumed the integrated standards, yet. For other company, it is indicated that there is no ministry sanction about the safety and environment standards and management system. Moreover one of the Companies' system managers has determined that in the international market, sometimes the companies which do not have these standards do not have chance to participate the biddings. But generally because of the fact that the integration of these standards in construction industry is new, standards are evaluated separately not as integrated. Besides, he has stated that firstly occupational health and safety standard take into consideration, after that the quality standard is demanded from the organizations because of the risky activities of construction industry.

Also in some companies, it is emphasized that adopting the integration exercise ensures the stakeholder to widen for the environment and work safety. Generally in companies, the statement of the harmonization and the unified problem solving has a great deal of strongly agreed level. Related to this statement, it is mentioned that it is possible and easy to see the reasons of the problems and the previous general solutions of these problems by the help of record principle of the standards and management systems.

(QUESTION 2) It is asked to the system managers that how far they agree with the statements concerning *costs of an integrated ISO 9001:2000, ISO 14001: 1996 and OHSAS 18001:1999 standards and systems.*

Responses: This again requires the respondents to indicate their thoughts about the costs of integrated system on a scale of 1 to 5, which denote "strongly disagree" and "strongly agree," respectively. The answers of the managers are seen below at the Table 6.4.

Table 6.4 The 10 Turkish construction companies' answers of the cost benefits of integrated standards

Costs	Companies									
	1	2	3	4	5	6	7	8	9	10
1- Higher costs in all management training	3	1	5	3	1	3	2	4	4	3
2- Reduced costs and more efficient reengineering	4	5	5	4	5	4	4	2	3	3
3- More time and resources to develop this integrated system	2	2	5	3	1	5	3	4	4	4
4- Costlier as greater expertise and higher level of competency in quality management systems are required	2	1	3	3	1	4	3	3	3	3
5- Less certification, staff and consulting costs	4	3	1	5	5	3	3	3	3	3

First evaluation of costs of integrated systems: According to the information given in the table 6.4, the percentages of the statements about costs, which are calculated by the method that has been described in the methodology part, are shown in table 6.5. From this table, the agreement levels of the managers to the costs of integrated system can be understood.

Table 6.5 The evaluation of the cost of the integrated system.

Costs	Percent of Responses					No reply
	1	2	3	4	5	
1- Higher costs in all management training	2	1	4	2	1	0
2-Reduced costs and more efficient reengineering	0	1	3	4	2	0
3-More time and resources to develop this integrated system	1	2	2	3	2	0
4-Costlier as greater expertise and higher level of competency in quality management systems are required	2	1	6	1	0	0
5-Less certification, staff and consulting costs	1	0	6	1	2	0
Mean	1.2	1.0	4.2	2.2	1.4	0.0
Percentage	%12	%10	%42	%22	%14	%0

The percentages of agreement levels of the factors concerning the costs of integrated system, is seen below in relation at the Figure 6.3 by bar chart diagram.

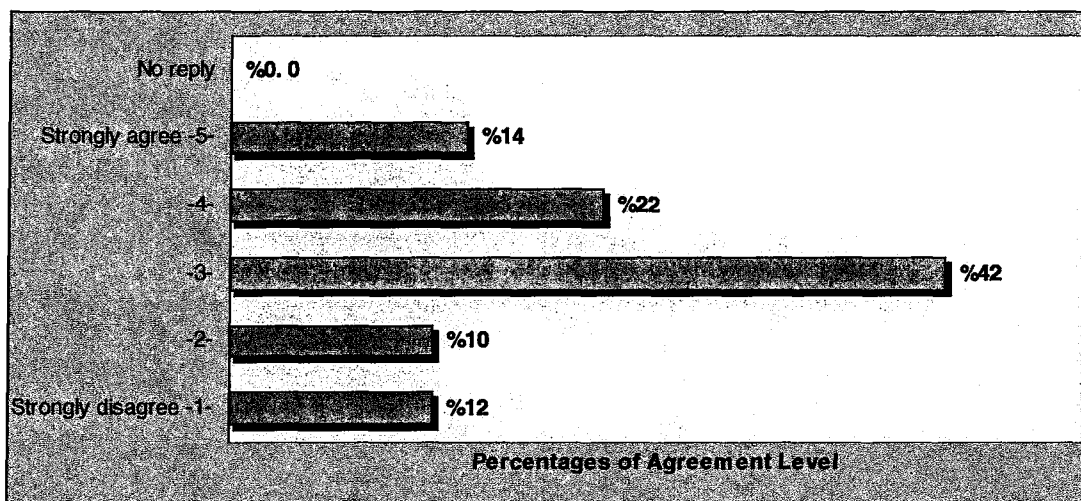


Figure.6.3 Percentage of agreement levels of integrated systems costs

A statistical analysis of table 6.5 and shows that;

1. On a Likert scale of 1, on average, 12% of the respondents indicated strong disagreement with the benefits of an integrated system,
2. On a Likert scale of 2, on average, 10% of the respondents indicated strong disagreement with the benefits of an integrated system,
3. On a Likert scale of 3, on average, 42% of the respondents were neutral concerning the benefits of an integrated system,
4. On a Likert scale of 4, on average, 22% of the respondents indicated strong agreement with the benefits of an integrated system,
5. On a Likert scale of 5, on average, 14% of the respondents indicated strong agreement with the benefits of an integrated system

Moreover;

- On the issue of costs, when the 30% of the respondents have agreed with the statement of “higher cost is required in both management and training, the others have been neutral by the percentage of 40 and have disagreed by the percentage of 30.
- Secondly, when the 60% of the respondents have agreed with the statements of “reduced costs and more efficient reengineering are required”, the 40% of them have been neutral and the 30% of respondents have disagreed.
- Moreover, the percentage of 30 have disagreed and the percentage of 20 have been neutral, while the %50 of the respondents have agreed with the statement of “more time and resources are required to develop this integrated system”.

- On the other hand, when the 10% of the respondents have agreed with the statement of “higher cost for greater expertise and a higher level of competency in quality management system is required”, the 60% of them have been neutral and the 30% of them have been disagreed.
- Finally, on the issue of costs, when the 30% of the respondents have agreed with the statement of “Lower certification, staff, and consulting costs are required”, the others have been neutral by the percentage of 60 and have disagreed by the percentage of 10.

Second evaluation of costs of integrated systems: The results of the second evaluation of the cost issues show the value of each cost factor according to 10 Turkish construction companies. According to this evaluation, that is seen in figure 6. 4, the values of each heading are not so high and many of them are in average value of 3.0/5.0. In these results, heading of reduced cost and more efficient reengineering has chosen the most agreed cost benefit of the integrated systems and have a value of 3.7/5.0. However, some companies have indicated that there are no so big cost responsibilities in the whole organization, despite of the obligation that the system causes.

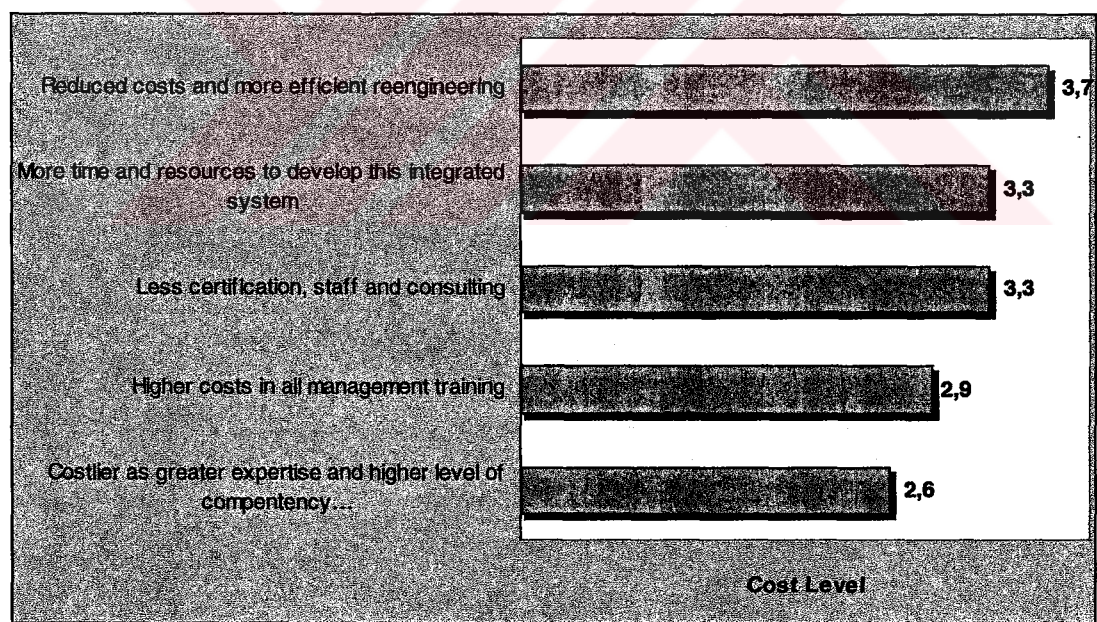


Figure.6.4 Evaluation of the cost related benefits of the integrated systems

Less certification, staff and consulting costs; and more time and resources to develop this integrated system is the secondly important and beneficial headings through the costs of integrated standards with the value of 3.3/5.0.

The heading of higher costs in all management training; and costlier as greater expertise and higher level of competency in quality management systems have been chosen by the system managers as the least agreed statements with the value of 2.9 and 2.6 which are under the average value. The main reason of this result has been stated as that in the long term period this higher costs are neutralized by other possession arised from the use of integrated system although the training of the employee may be cost so much at the beginning. Moreover, because of the deficiency of the expertise about these subjects in Turkey, it is mentioned that the companies have preferred to train their employees regularly after they start to work. Also related to this subject some companies mentioned that the increasing the training costs may be efficient in some organizations where the staffs always change. But because of the fact that many of the companies in the survey are the biggest and the oldest group companies, and their most of the staffs are permanent, there is no problem with the higher costs of the staff training.

Lastly, one of the company system managers has determined that the system contributes to the companies to be an institutional organization by being independent from the individuals.

6.4.2 Second Stage Findings about the Effects of Integrated Systems to the Design Phase

At the second part of the questionnaire, the questions were prepared to take the consideration to the design stage of the construction process and it is aimed to learn the impacts of the integrated standards of ISO 9001:2000, ISO 14001: 1996 and OHSAS 18001:1999 and management systems to the design phase of the construction. For this aim, 4 questions were asked to the construction companies' management system managers and also the architects from the project design departments of some companies. The purposes of this part of the study are:

- To learn the effects of the integrated systems to the design phase quality.
- To identify the reflections or benefits of the integrated systems to the design phase
- Having a view of the present general reflections or benefits of integrated standards to the design stage; design stage decisions; and the organization's design department of the construction companies.
- To learn the level of the application of these standards in both design phase or design department; and in the whole organization.

- To identify the problems of these systems during the application to the organization.

The responses and evaluations of the management system managers of the companies for the second part of the questionnaire related to the main purposes are as follows;

(QUESTION 1) It was asked to the management systems managers of the companies that what the degrees of factors that affect the quality of the design phase in the view of ISO 9001:2000, ISO 14001: 1996 and OHSAS 18001:1999 standards.

Responses: The responses of the managers are seen below at the Table 6.6. (The numbers show the significance level of the factors for the system directors. e.g. 1: not important, ... , 5:very important)

Table 6.6 The 10 Turkish construction companies' responses to the affects of integrated standards to the design phase quality.

	Companies									
	1	2	3	4	5	6	7	8	9	10
DEVELOPMENT TEAM										
1- Level of cooperation of design professionals	4	5	4	5	4	4	5	4	4	4
2- Extent of teamwork of parties participating in the design phase (<i>Structural, mechanical, electrical, environmental, civil engineers, architects, owners</i>)	5	5	4	5	3	4	5	4	4	4
3- Educational background of designers	4	3	5	4	5	5	5	5	4	4
4- Extent of designers training (<i>In-house training courses, apprenticeship programs, continuing education courses, seminars, etc</i>)	3	4	3	4	4	5	4	5	3	4
5- Personalities of the participants	3	3	5	3	4	4	4	4	4	2
MANAGEMENT										
6- Level of management leadership in promoting quality	5	5	4	4	5	5	5	4	5	5
7- Level of management commitment to continuous quality improvement	5	5	5	5	5	5	5	4	5	4
8- ISO 9001:2000, ISO 14001:1996 and OHSAS 18001 Management Programs/ Plans	4	5	3	5	5	4	5	5	4	5
PROCESS										
9- Selection of appropriate design firm (<i>Experience skills, capabilities, workload, appropriateness of the standards, etc</i>)	5	5	4	5	4	5	5	4	3	4
10- Existence of feedback system (<i>Information system used to transfer data between old and new projects</i>)	5	5	5	5	4	4	5	4	2	4

	Companies									
	1	2	3	4	5	6	7	8	9	10
11- Constructability of the design (Constructability reviews)	4	5	4	5	4	5	5	4	4	5
STANDARDS AND SPECIFICATIONS										
12- Appropriateness of project specifications	4	5	5	5	4	5	5	4	4	4
13- Quality of codes and standards (Federal, state and local codes, generally accepted standards)	4	5	5	5	4	4	5	3	5	5
14- Characteristics of drafting practices (Drafting standards, drafting procedure, etc.)	4	5	4	5	3	4	5	3	2	4
BUDGET										
15- Budget allocated for design	4	5	4	5	2	3	5	4	4	2
OTHERS										
16- Characteristics of office practices (Physical environment, organizational structure, personnel policy, ethical environment, etc.)	3	3	3	4	4	3	5	4	4	4

First evaluation of affects of integrated systems to design phase quality:

According to the information given in the table 6.6, the percentages of significance level of the factors that affects the design phase quality in the light of integrated system are shown in table 6.7. From this table, the agreement levels of the managers about the effects of integrated system to the design phase can be understood.

Table 6.7 The evaluation of the factors that affect the quality in the design phase in the view of ISO 9001:2000, ISO 14001:1999 and OHSAS 18001:1999.

	Percent of Responses					Not reply
	1	2	3	4	5	
DEVELOPMENT TEAM						
1- Level of cooperation of design professionals	0	0	0	7	3	0
2- Extent of teamwork of parties participating in the design phase (<i>Structural, mechanical, electrical, environmental, civil engineers, architects, owners</i>)	0	0	1	5	4	0
3- Educational background of designers	0	0	1	4	5	0
4- Extent of designers training (<i>In-house training courses, apprenticeship programs, continuing education courses, seminars, etc</i>)	0	0	1	4	5	0
5- Personalities of the participants	0	1	3	5	1	0

	Percent of Responses					Not reply
	1	2	3	4	5	
MANAGEMENT						
6- Level of management leadership in promoting quality	0	0	0	3	7	0
7- Level of management commitment to continuous quality improvement	0	0	0	2	8	0
8- ISO 9001:2000, ISO 14001:1996 and OHSAS 18001 Management Programs/ Plans	0	0	1	3	6	0
PROCESS						
9- Selection of appropriate design firm (<i>Experience skills, capabilities, workload, appropriateness of the standards, etc</i>)	0	0	1	4	5	0
10- Existence of feedback system (<i>Information system used to transfer data between old and new projects</i>)	0	1	0	4	5	0
11- Constructability of the design (<i>Constructability reviews</i>)	0	0	0	5	5	0
STANDARDS AND SPECIFICATIONS						
12- Appropriateness of project specifications	0	0	0	5	5	0
13- Quality of codes and standards (<i>Federal, state and local codes, generally accepted standards</i>)	0	0	1	3	6	0
14- Characteristics of drafting practices (<i>Drafting standards, drafting procedure, etc.</i>)	0	1	2	4	3	0
BUDGET						
15- Budget allocated for design	0	2	1	4	3	0
OTHERS						
16- Characteristics of office practices (<i>Physical environment, organizational structure, personnel policy, ethical environment, etc.</i>)	0	0	4	5	1	0
Mean	0.0	0.31	1.0	4.18	4.75	0.0
Percent	%0.0	%3.1	%10	%41.8	%47.5	%0.0

These percentages are illustrated in the figure 6.5 by the means of the significance level of the factors that affect the design phase quality. It is seen from this figure that the selected Turkish construction companies' management systems managers that the listed factors that may be affect the design phase quality is so important.

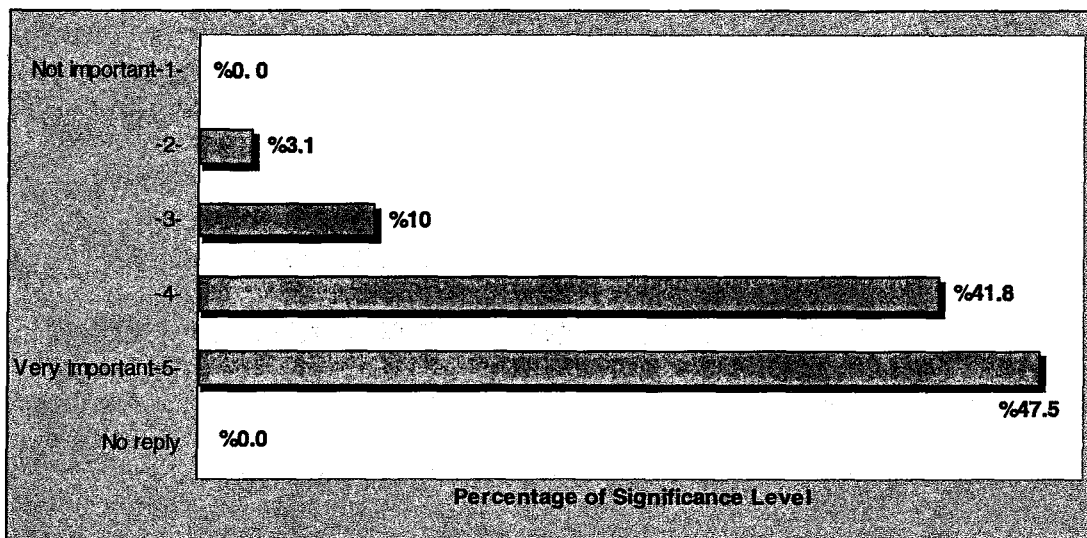


Figure 6.5 Percentage of significance level

A statistical analysis of Table 6.7 shows that;

1. On a Likert scale of 1, the respondents don't indicate any unimportance.
2. On a Likert scale of 2, on average, 3.1% of the respondents indicated strong unimportance with the factors that affect the quality the design phase of an integrated system.
3. On a Likert scale of 3, on average, 10 % of the respondents were neutral concerning the importance of an integrated system in design phase.
4. On a Likert scale of 4, on average, 41.8 % of the respondents indicated strong importance with the factors that affect the quality the design phase of an integrated system.
5. On a Likert scale of 5, on average, 47.5 % of the respondents indicated strong importance with the factors that affect the quality the design phase of an integrated system

Second evaluation of affects of integrated systems to design phase quality:

The second evaluation results show the value of each effect according to 10 Turkish construction companies. According to this evaluation, that is seen in figure 6. 6, the values of each heading are so high and all of them are up to average value of 3.0/5.0 and so near to the very important level.

Headings of Level of management leadership in promoting quality; and level of management commitment to continuous quality improvement, have chosen the most important effects of the integrated systems to the design phase quality and have a very high value of 4.8 and 4.7/5.0. This shows the significant and the necessity of

the management systems and principles of the standards in the design phase as it is in the whole construction stages.

The other result of this question is that ISO 9001:2000, ISO 14001:1996 and OHSAS 18001 Management programs/ plans; constructability of the design; appropriateness of project specifications; and quality of codes and standards are the secondly important factors according to the companies' system managers with the scale value of 4.4/5.0. It is mentioned by system managers about the statement of the quality of codes and standards that the legal standards can be much harder than ISO standards in some countries such as Russia, Saudi Arabia, etc., so, the quality concept gains another importance in this view.

The statements about the educational background of the designers; and extent of designers training are secondly the highest important factors with a value of 4.4 / 5.0. Regarding to this subject one of the manager has indicated that they generally need trainings in some periods about these systems because of the insufficiency of the personnel. So they have attached importance to the in house trainings such as seminars, apprenticeship programs.

Thirdly, with a scale value of 4.3/5.0, the other important effects of the in the view of standards and management systems are the headings of;

- educational background of designers;
- extent of designers training selection of appropriate design firm;
- level of cooperation of design professionals;
- extent of teamwork of parties participating in the design phase;
- existence of feedback system;
- characteristics of drafting practices.

Here, it is realized that the system managers of the selected companies have a common opinion about the significance of the education and the communication of the design participants among themselves and between other stages participants.

Although the other highest statement is seen as the budget of the design, some companies have mentioned that there is no strongly relation between the standards and budget, and have stated that there is no change regarding to this factor after starting to apply the standards and systems. This may be because of the fact that they have a design department in their organization.

The less important statement is chose as the personalities of the participants and the characteristics of the drafting practices with the value of 3.6 and 3.7/ 5.0 although these factors have a great importance for some companies. For instance

some companies' system managers have stated that the application of the standards and systems efficiently depends on the personnel's personalities directly. Unless they are open to the renewals and they accept these systems, it is too difficult to establish and apply the system and to see the results in a short period.

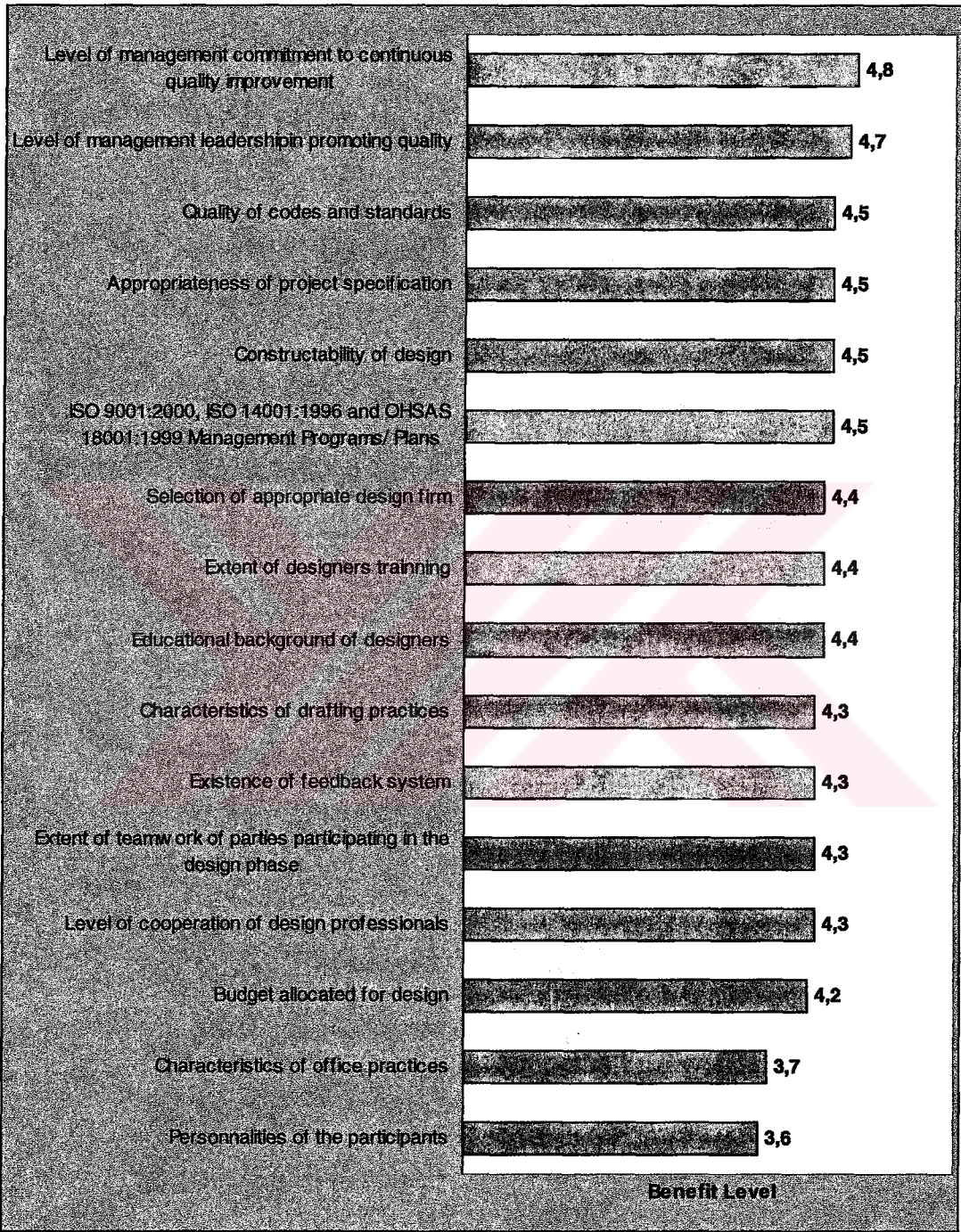


Figure 6.6 Evaluation of the factor that affects the quality of the design phase

(QUESTION 2) As a second question, the system managers were asked that how far they agree with the reflections of the integrated ISO 9001:2000, ISO 14001: 1996 and OHSAS 18001:1999 standards and systems to the design phase.

Responses: The responses of the managers are seen below at the Table 6.8. (The numbers show the significance level of the factors for the system directors. e.g. 1: strongly disagree, ... , 5: strongly agree)

Table 6.8 The 10 Turkish construction companies' responses to the reflections of the integrated ISO 9001:2000, ISO 14001: 1996 and ISO 18001:1999 standards and systems to the design phase.

	Companies									
	1	2	3	4	5	6	7	8	9	10
1- Prevent design process internal constraints	4	5	4	2	2	4	4	4	3	4
2- Prevent design management problems	4	5	3	4	4	4	5	5	5	4
3- Reduce the design changes and revisions	2	5	4	5	4	2	4	4	2	3
4- Plans and specifications should be carefully reviewed because of not adding time and costs to design	3	5	4	4	4	4	4	4	3	2
5- Increase productivity	4	5	4	5	4	4	4	3	3	4
6- Choosing and using the appropriate materials, project and construction system, convenient to the environmental conditions	3	5	4	5	4	4	5	4	3	4
7- Appropriate use of the environment	4	5	4	5	4	5	5	4	4	4
8- Designing of a project or site and using the convenient materials, equipment, and systems in terms of ensuring the employee and user safety	4	5	-	5	4	5	5	4	4	4
9- Faster product development	3	5	-	5	4	4	4	3	3	3
10-Increase the motivation of the employees	4	5	2	5	4	3	4	3	3	3
11-Decrease the conflicts of transferring the data and communication problems	4	5	4	5	4	4	5	5	4	4
12-Utilize materials, products, sources and energy completely	4	5	5	5	4	4	5	4	3	4
13-Increase the customer satisfaction in the maintain phase	4	5	5	4	5	5	5	-	5	5
14-Others		-	-	-	-	-	-	-	-	-

First evaluation of reflections of integrated standards and systems to design phase: According to the information given in the table 6.8, the percentages of agreement level related with the reflections of the integrated systems to the design phase are shown in table 6.9. From this table, it can be learned that how the

companies system managers and architects evaluate the integrated systems during design phase.

Table 6.9 The evaluation of the reflection of the integrated systems to the design stage.

	Percent of Responses					Not reply
	1	2	3	4	5	
1-Prevent design process internal constraints	0	2	1	6	1	0
2-Prevent design management problems	0	0	1	5	4	0
3-Reduce the design changes and revisions	0	3	1	4	2	0
4-Plans and specifications should be carefully reviewed because of not adding time and costs to design	0	1	2	6	1	0
5-Increase productivity	0	0	2	6	2	0
6-Choosing and using the appropriate materials, project and construction system, convenient to the environmental conditions	0	0	2	5	3	0
7-Appropriate use of the environment	0	0	0	6	4	0
8-Designing of a project or site and using the convenient materials, equipment, and systems in terms of ensuring the employee and user safety	0	0	0	5	4	1
9-Faster product development	0	0	4	3	2	1
10-Increase the motivation of the employees	0	1	4	3	2	0
11-Decrease the conflicts of transferring the data and communication problems	0	0	0	6	4	0
12-Utilize materials, products, sources and energy completely	0	0	1	5	4	0
13-Increase the customer satisfaction in the maintain phase	0	0	0	2	7	1
Mean	0.0	0.46	1.38	4.76	3.07	0.23
Percent	%0.0	%4.6	%13.8	%47.6	%30.7	%2.3

The results of this question are illustrated in the figure 6.7 by the means of the percentage of agreement levels.

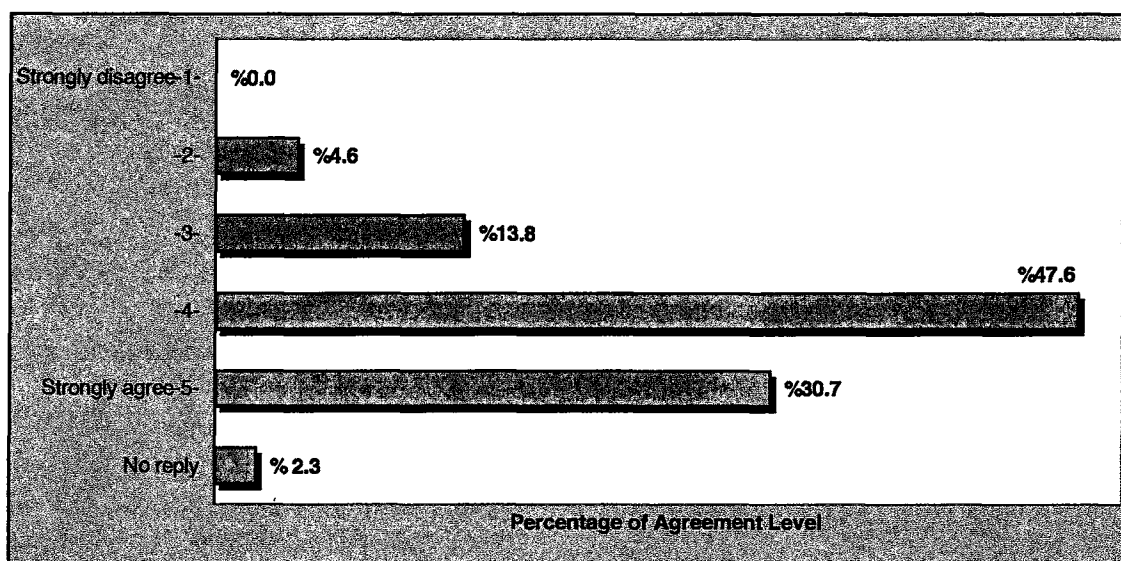


Figure 6.7 Percentages of the reflections of the integrated systems through design stage

A statistical analysis of table 6.9 shows that;

1. On a Likert scale of 1, there is no responds of the strongly disagree level about the reflections of the integrated system to the design stage,
2. On a Likert scale of 2, on average, 4.6 % of the respondents indicated strong disagreement with the reflections of the integrated system to the design stage,
3. On a Likert scale of 3, on average, 13.8 % of the respondents were neutral concerning the reflections of the integrated system to the design stage,
4. On a Likert scale of 4, on average, 47.6 % of the respondents indicated strong agreement with the reflections of the integrated system to the design stage,
5. On a Likert scale of 5, on average, 30.7 % of the respondents indicated strong agreement with reflections of the integrated system to the design stage,

Second evaluation of reflections of integrated standards and systems to design phase: In the second evaluation, the results are one more time up to the average of 3.0/5.0 and the statements of appropriate use of the environment; and decrease the conflicts of transferring the data and communication problems are chosen as the factors that have the highest grade of the Likert scale levels with the value of 4.4/5.0.

Prevent design management problems; utilize materials, products, sources, and energy completely; and increase the customer satisfaction in the maintain phase

are stated as the factors which are secondly strongly agreed with the value of 4.3/5.0. With the value of up to 4.0/5.0, the other higher statements are arised as;

- The headings of increase productivity;
- choosing and using the appropriate materials, project and construction system,
- convenient to the environmental conditions;
- designing of a project or site and using the convenient materials, equipment, and systems in terms of ensuring the employee and user safety

Although these factors have high values, at the same time the system managers and architects have been indicated that all of these activities have applied for years successfully, not only after standards. But with the (integrated) standards, the assiduities to some subjects' controls in general meaning have increased.

In this diagram it is seen that the statement which has the lower level is the factors of the faster product development. The result of this stated as that the integrated standards ensure the perfect regularity in the work flow because of the principles such as documentation and recording. So it is thought that the integration of the systems do not directly reflects the faster product development in the design stages. The other factor that has a low degree is the statement of prevent design process internal constraints and external constraints with a value of 3.6/5.00. This is because, the clients demands these systems by one and force the companies to apply these standards and systems. So there are no big demands coinciding with the standards requirements.

Also, the other less agreed factor is the statement of reducing the design changes and revisions. About this statement, there are various aspects. For instance one of the company's system managers has mentioned that the revisions do not depend on the standards. On the other hand, one manager has strongly argued this idea and has been mentioned that if one of the requirements is made wrong, the revision is unavoidable activity.

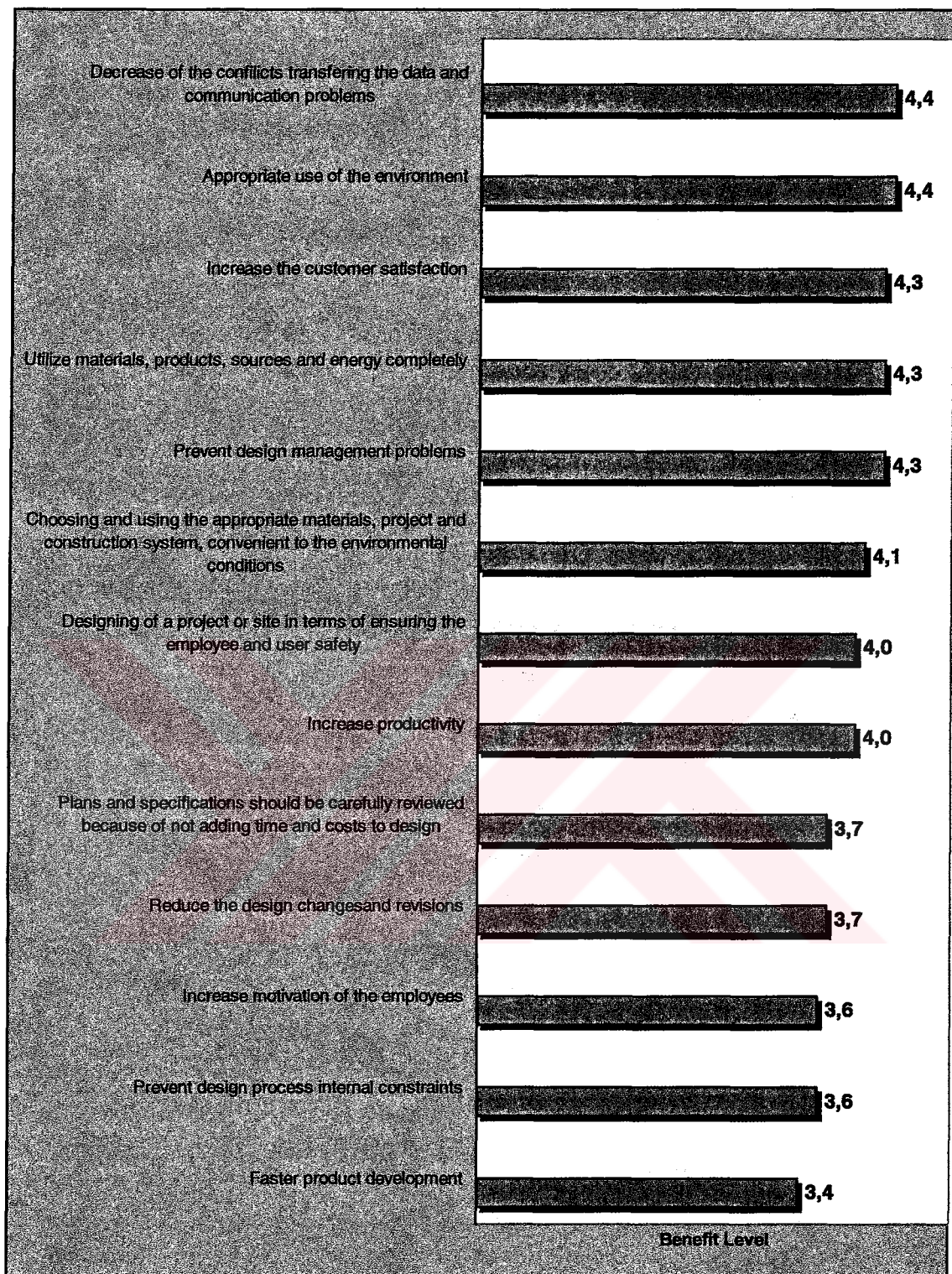


Figure 6.8 The evaluation of the reflections of the integrated systems in design stage

(QUESTION 3) Thirdly, it was asked to the system managers that how far they agree with the statements concerning the problems which can arise during the application of these systems to their whole organization, especially the design department.

Responses: The responses of the managers are seen below at the Table 6.10. (The numbers show the agreement level of the factors for the system directors. e.g. 1: strongly disagree, ... , 5: strongly agree)

Table 6.10 The 10 Turkish construction companies' responses to the problems which can arise during the application of these systems to their whole organization, especially the design department.

	Companies									
	1	2	3	4	5	6	7	8	9	10
1- Management problems	4	1	1	3	2	1	1	2	2	4
2- Problems in documentation phase	2	1	5	2	4	2	1	3	4	2
3- Problems that can arise during the employee training	3	1	3	2	2	2	3	4	3	1
4- Problems which occur during the reflection of the standards to the design phase	5	1	3	2	2	1	3	3	2	3
5- Customer problems	3	1	4	4	5	1	4	1	2	1

First evaluation of problems: According to the information given in the table 6.10, the percentages of agreement level problems that can arise during the design phase are shown in table 6.11. From this table, it can be understood whether the companies has had any problems while applying the integrated systems to their whole organization and during the design phase or not. Also the levels of these problems can be learned.

Table 6.11 The evaluations of the problems which may be occur during the application of the standards

	Percent of Responses					Not reply
	1	2	3	4	5	
1- Management problems	4	3	1	2	0	0
2- Problems in documentation phase	2	4	1	2	1	0
3- Problems that can arise during the employee training	2	3	4	1	0	0
4- Problems which occur during the reflection of the standards to the design phase	2	3	4	0	1	0
5- Customer problems	4	1	1	3	1	0
Mean	2.4	2.8	2.2	1.6	0.6	0.0
Percent	%24	%28	%22	%16	%6.0	%0.0

The results of the table 11 are illustrated by bar chart diagrams in the figure 6.9.

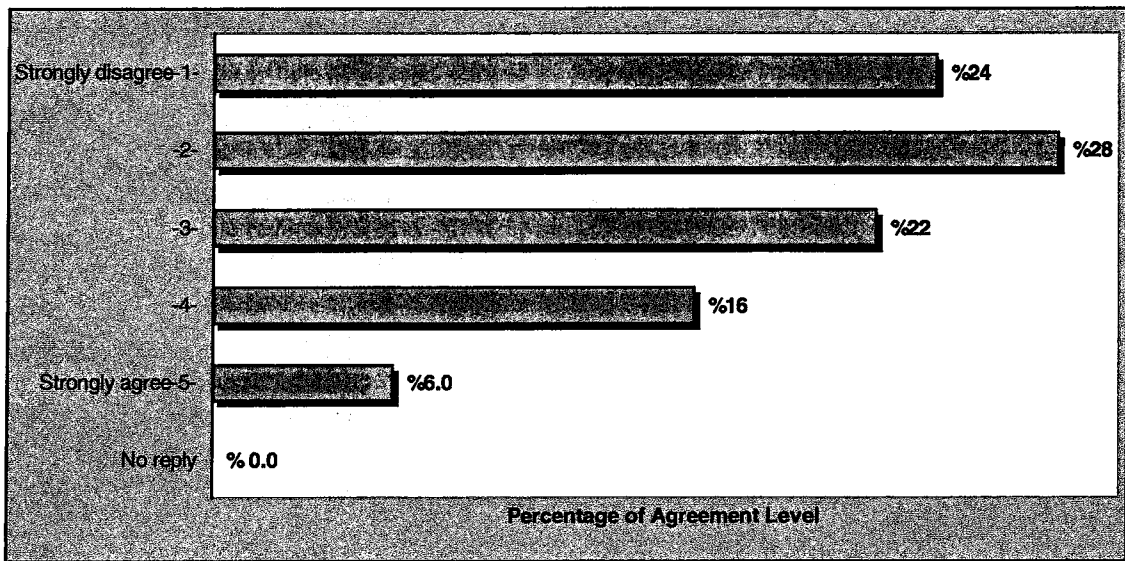


Figure 6.9 Percentages of the problems that occur during the application of the integrate standards

A statistical analysis of table 6.11 shows that;

1. On a Likert scale of 1, on average, 24 % of the respondents indicated strong disagreement with the problems occurred during the application of the integrated systems.
2. On a Likert scale of 2, on average, 28 % of the respondents indicated strong disagreement with the problems, which have occurred during the application of the integrated systems.
3. On a Likert scale of 3, on average, 22% of the respondents were neutral concerning the problems, which have occurred during the application of the integrated systems.
4. On a Likert scale of 4, on average, 16 % of the respondents indicated strong agreement with the problems, which have occurred during the application of the integrated systems.
5. On a Likert scale of 5, on average, 6.0 % of the respondents indicated strong agreement with the problems, which have occurred during the application of the integrated systems.

Second evaluation of problems: As the second evaluation of the questionnaire's last question, seen in the figure 6.10, the values of the each problem are calculated.

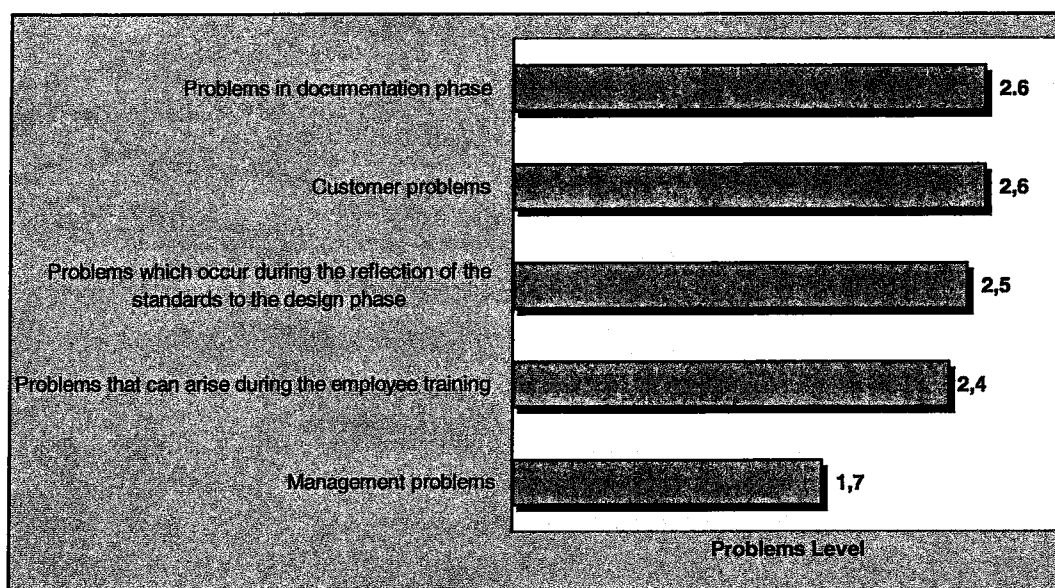


Figure 6.10 The evaluation of the problems that occur during the application of the integrate standard

The findings are spread more equal to each Likert scale level than the other questions' responses but all of them are under the average level. According to these results, the statement of management problems has a great amount of value in spite of the fact that it is the less agreed problem. The other problems such as management problems; problems in documentation phase; problems that can arise during the employee training; and customer problems all have approximately same level values such as 2.4 and 2.5/5.0, under the average level of 3.0/5.0. This result shows that the companies don't have had so serious or unsolved problems at the period of the integrated standards both in the whole stage of the construction and the design alone.

(QUESTION 4) The system management managers were asked that if they think that they could apply the standards in the design phase or the design department efficiently, properly and regularly.

Responses: The responses of the managers are seen below at the Table 6.12. (The numbers show the application level of the factors for the system directors. e.g. 1:exactly not applied, ... , 5: exactly applied)

Table 6.12 The 10 Turkish construction companies' responses about the application level of the standards in the design phase or the design department

Companies	Exactly not applied				Exactly applied
	1	2	3	4	5
Company 1			✓		
Company 2					✓
Company 3		✓			
Company 4			✓		
Company 5				✓	
Company 6					✓
Company 7			✓		
Company 8			✓		
Company 9				✓	
Company 10				✓	

Evaluation of application level: According to the information given in the table 6.12, the percentages of agreement level problems that can arise during the design phase are shown in table 6.13. From this table, it can be understood hat is the level of the application of these standards during the design stages and among the whole organization.

Table 6.13 The evaluations of the application of the standards

	Percent of Responses					Not reply
	1	2	3	4	5	
Application of the standards efficiently	0	1	4	3	2	0
Mean	0	1	4	3	2	0
Percent	%0	%10	%40	%30	%20	%0.0

The results of the table 6.13 are illustrated by histograms in the figure 6.11.

A statistical analysis of table 6.13 shows that;

1. On a Likert scale of 1, there is no response of the 'exactly not applied' level about the application of the integrated system,
2. On a Likert scale of 2, on average, 10 % of the respondents indicated strong disagreement about the application of he standards,
3. On a Likert scale of 3, on average, 40% of the respondents were neutral

4. On a Likert scale of 4, on average, 30% of the respondents indicated strong agreement about the application of he standards,
5. On a Likert scale of 5, on average, 20% of the respondents indicated strong agreement about the application of he standards,

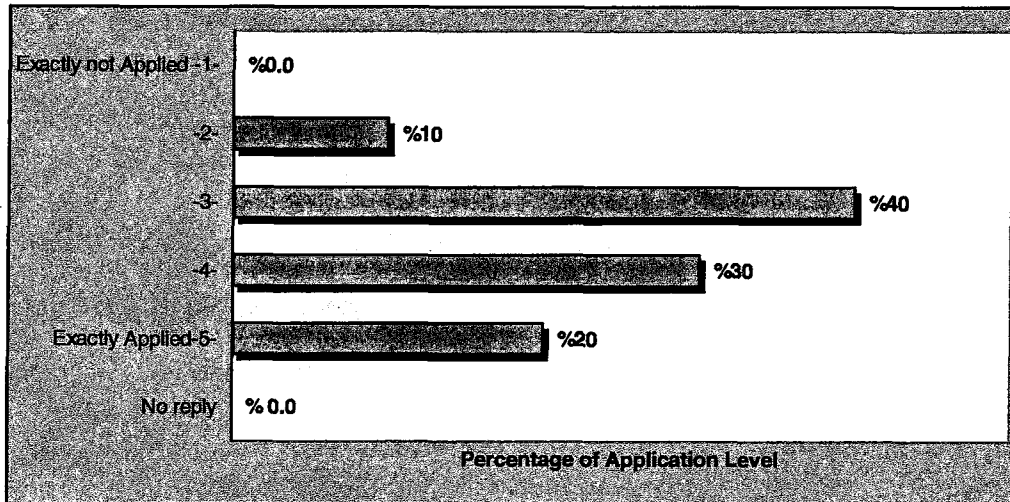


Figure 6.11 The percentages of the application levels of the systems

From these results, generally, it is understood that application of the standards are no effective and proper in Turkish construction companies. Some of the companies apply these systems more proper than others. The result of this has been explained by the managers as, that the system they used before the standards are so similar with the standards requirements and systems structure. The only fundamental change is having a more regular record and documentation system and also a name. So they have mentioned that they use the system at the levels of 4 according to the Likert Scale. Another reason of these low values of application of the systems is based on the newness of the systems. For example some companies indicated that because of the fact that the systems are so new, they have not taken the results of the systems clearly, yet. But at the same time, they have mentioned that with they will reach the desired solutions in a short time with patience, ambitions and the continued education of the personnel. So the average level (neutral) of 3.0/ 5.0 has the maximum value. In conclusion, it should be mentioned that the results shown in the diagrams give the average and general aspects of the 10 Turkish construction firms. But the explanations of the figures and tables belong to the system managers and so neutral. In addition, the evaluations of the questionnaire display the general ideas about the integration of the standards and systems in design phase and in the whole organization.

7. CONCLUSION AND DISCUSSION

This study shows that the quality concept beginning with the “inspection” has had many revisions and progresses since 1900’s by the developing of the competitiveness of the new era of borderless trade, changing the environmental factors, arising new technological possibilities and increasing the human demands day by day. Today, there is an unpreventable improvement of the industries to reach the basic quality concept by using both advanced technological and management methods in the view of the international standards. Also mainly in this study, the other important and required concepts of environment, safety and health and their international standards of management systems display us that in today’s world, quality concept is not alone in the international market and have to be integrated with other concepts of environment, and safety to preserve the sustainability in all sectors.

As mentioned in the previous chapters, construction is one of the biggest and important industries around the world, in which quality, environment and safety have to take part, and all standards have to be used efficiently. But it is known that the construction industry has a complex structure and is a short term activity that enforced the implication of some systems regularly. However it should not be forgotten that at the same time it is one of the most considerable industry whose fundamentals are based on the two living factors of human’s and environment’s safety and health. So, in today’s world international standards gain a meaning of crucial elements of success for construction enabling them to sustain credibility, competitiveness and profitability.

In this study, serving to these thoughts, the most used international standards of ISO 9001:2000, ISO 14001:1996 and OHSAS 18001:1999, which are generally preferred to be used as integrated three in one or two in one approach in construction industry and have a mission of continual improvement, and their management systems were explained. During the literature research, it was seen

that the application of these systems and concepts in the design phase are generally superficial, because of the fact that the integration of these systems is too new in the world market. Also the investigations are generally tended to the construction phase and construction phase improvement. So, the main problem of the study is mentioned as researching the impacts and reflections of these integrated systems in the design phase of the construction and evaluating the problems in the view of the integrated standards.

In addition, safety, environment and quality concepts are the three factors which are directly or indirectly affected from each other beginning with the design stage to maintenance. Quality, safety and environmental management systems and standards are tools of these concepts to reach the perfect continual improvement, success, quality and sustainability.

To identify the implementation of integrated standards and management systems in Turkish construction companies, during both design phase and the whole project process, a questionnaire was applied to the top 10 construction companies which have all three standards in their organizations. The purposes of this case study were;

- To learn the proportion of the Turkish construction companies which have minimum one standard through ISO 9001:2000, ISO 14001:1996 and OHSAS 18001:1999.
- To determine the proportion of the Turkish construction companies which have all three standards of ISO 9001:2000, ISO 14001:1996 and OHSAS 18001:1999.
- To learn that these companies took these standards whether integrated or stand alone.
- To examine the benefits of the integrated systems in the construction industry in a general view.
- To learn whether or not these systems affect any of the design activities; and if there is an effect, what the way and amount of this influence is.

Parallel to this purpose, questionnaire was divided into two parts, one of which evaluated the benefits of the integrated standards in a general manner including the whole organization and one of which inclined the implication of the integrated standards and systems during the design stage of the construction.

The findings of the case study, done with a group of 10 Turkish construction companies having integrated standards in their organization, were widely examined

in the previous section of the study. In the light of these findings, the study has reached to some consequences.

1. *The first stage findings*; through benefits of integrated systems in general.
2. *Second stage findings*; through the effects of integrated systems during the design phase

7.1 First Stage Findings in General

As mentioned before, the first stage of the questionnaire includes the statement concerning the benefits of integrated standards of ISO 9001:2001, ISO 14001:1996 and OHSAS 18001:1999 and management systems. According to the findings,

- Comprehension of the integrated systems is too new in Turkish construction industry although many of the companies have applied the ISO 9001 Quality management for several years regularly.
- Many of the construction firms have applied the integration systems including the all three standard since 2002 and 2003. Some of them had first applied the integrated system of ISO 9001:2000 and ISO14001 as a beginning. Because of the fact that the integrated systems are new in construction industry, some benefits couldn't be efficiently applied; but they are intended and expected to rise the level of implementation in the following years.
- The main reason of the companies for applying these standards in their organizations are seem as that they have a serious market place in the international construction industry. So the acceptance of these systems is unavoidable for these firms to exist in the competitive market.
- Benefits of the integrated systems were evaluated with a great concern. The 46.3% of the respondents indicated strong agreement with the benefits of an integrated system such as establishing an integrated and optimal performance management system; utilizing the common resources in better way, efficiency and no duplication of efforts; achieving synergy from the development of the integrated system where the achievement of a combined system is more than the sum of the achievement of each system implemented individually; providing higher staff motivation and lower interfunctional conflicts and injuries; ensuring employee involvement and education; and enhancing confidence of customers for a commitment to the

environment and positive market/commodity image. There is no contradiction about the answers of the questions among the companies. Approximately many of the system managers have same opinions about the benefits.

- Also from the findings of the study, is seen that majority of the construction companies had a similar procedures and management system in their organizations before the standards. Within theses standards, the system they had, gained a regular document system and the obligatory of implementation for all staffs in all stages of the construction.
- Lastly in this part the costs of the integrated systems are not a big problem or restrictive impact for companies. It is generally thought that in the long term period the costs are neutralized by other inputs of the systems, although it gives some extra costs to the companies at the beginning.

7.2 Second Stage Findings Concerning the Design Phase

The second stage includes the questions that evaluate the impacts of the integrated standards and management systems to the design phase. According to the findings;

- The factors affect the design phase quality in the view of the standards and the environment and safety concepts have great importance for the companies. The companies which work with a design firm from outside indicated that they pay a great deal of attention while selecting the appropriate design firms. For this selection they use a grading system which is proposed by the principles of the standards. By the help of this grading system, they select the most appropriate firm which has the potential of designing according to the environment and safety principles to reach the high quality.
- According to the findings, the record and feedback system of the design departments of the companies are very important for ensuring the efficient communication between other departments and other construction stages.
- Although 47.6 % of the respondents indicated strong agreement with the reflections of the integrated system to the design stage, it is seen that the main reflection of the “reducing the design changes and revisions” has a low value on average. This can be interpreted that companies do not efficiently apply some principles of the standards in the design phase. For instance,

one of the companies indicated that because of working by focusing on the customer satisfaction so much, many revisions are fitted in the as built drawings and this can take a great amount of time.

- According to the findings it is understood that the importance of choosing and using the appropriate materials, project and construction system, convenient to the environmental and safety conditions; and utilizing materials, products, sources and energy have increased the attention to mandatory design concerns since the date of the companies started to adapt the systems. For example; after this period the environmental impact assessment have started to be mandatory for each project. So this ensures to designers as an obligatory of thinking for some factors in the view of the quality, environment and safety concepts.
- From the answers of the question, "Do you think that you can apply the standards you have in the design process or your design department efficiently, properly and regularly?", it is understood that the companies have some deficiencies concerning with the implementation of the integrated standards in the departments of the whole organization or during design stage of the whole construction period. It seems much clearer through the construction period as it is mentioned in the literature review. But if it is evaluated within the design stage, there are some serious deficiencies especially with the implementation of the concept of safety design. It is determined that safety principles are mostly implemented for the safety and health of the employees in the construction site and design through the safety management standards is dealt with related to this thought. However, safety in construction should be implemented in two directions; one is safety of employee and the other is the safety of users. These two factors take place in different stages of the building, construction and maintenance. But, common point of these factors is that both of the safety concepts must be thought in the design and early design stages. So, safety should not only be thought as severity for site workers, but also should be taken the attention of the people who will use those buildings. Last stage of the building process, the maintenance, is the most important phase that the quality and safety of the buildings can be conceived.
- The main finding about the implementation of the standards in design phase is related with the concept of the design team creativity. According to the findings and thoughts of both system managers and architects of some companies, there is no negative impact of the standards to the creativity or

the development of the project' concept design. On the contrary, the standards have ensured to maximum use of the resources and conditions as design inputs of the project and also help for applying the specifications efficiently. Moreover it has been mentioned by some of the companies' system managers that one of the benefits of ISO 14001 is ensuring the mandatory of the environmental impact assessment during the design phase. Thus, each step of the projects can be under control in the view of environment and related standard and environment concept is considered important.

- Furthermore, from the literature search and questionnaire interviews, it has been seen that the main target of the standards is the *continual improvement*, which is one of the management systems' elements. If these standards apply among the organizations and in each processes effectively, the sustainability of the projects and also the *sustainability* of environment, safety and quality through the design process can be fulfilled successfully. Namely, there can be a connection between the systems' element of *continual improvement* and *sustainability*
- Finally, from the question of "How far do you agree with the statements concerning the problems which can arise during the application of these systems to your firm (especially to your design department)?" shows that the values of each problem listed in the survey are so low, under the average level. This means that the companies do not have been forced so much although the system is so new. It is expected that in a short period of time this problems will disappeared and many other construction companies will participate in the list of Turkish Contracting Association.

7.3 General Proposals

According to all these conclusions and findings regarding to the literature search and case study, some general proposals have arised. For example, at the beginning of the case study, it is decided by author to apply the questionnaire in Turkish to facilitate the interview and to dominate the subject effectively. But the companies' system directors demanded to realize the questionnaire in English, because of the fact that the insufficiency of the Turkish vocabulary regarding to the standards and management systems. They indicated that there can be meaning defects during translation. So, as a proposal, the vocabulary should broaden for evaluating these systems in Turkish. Secondly, many companies has emphasized that there is not educated personnel about these systems; for this reason, they have had many

adaptation problems. So, related to this subject another proposal can be that, for the next generation of the construction sector, the subjects of international standards; integrated systems; quality, environment and safety concepts should be taken up widely in the related departments of universities to gain experts to the sector about these subjects. Finally, in this research, benefits, impacts and reflections of the standards and integrated standards through the building processes and the design process have been investigated. However, as a proposal, in the future studies, it can be researched that what can be done in the view of standards during the design phase; which design precautions should be thought relating to environment, safety and quality separately; and which design subjects are related to these standards. Also as it is mentioned in the study, these standards and management systems have very similar structures and procedures for the companies from the preparing stage to using stage. Because of this, it is foreseen to integrate these systems. But especially for construction companies, it can be difficult and take time to prepare for all three systems in the same time and apply these systems to their companies. So, in the future studies, standard parameters for the application of these systems to construction sector can be found between these systems. And then, a model can be developed, which use these standard parameters to prevent the losses (such as time, information, cost..etc.) through the whole company and during the design stage; to compare the common elements and factors of these three standards and management systems one to one; by the help of specific matrixes.

In conclusion, from this study, it is learned that the integrated standards and also the standards as a stand alone system are new and the numbers of the companies having these systems in Turkey are not enough in the conditions of the today's world market and technology. This aspect will be changed within a few years and importance of the standards in the design stage will be understood by producing high quality and safety buildings in a safety environment.

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APPENDIX

**ISTANBUL TECHNICAL UNIVERSITY,
DEPARTMENT OF ARCHITECTURAL,
PROGRAM OF PROJECT AND CONSTRUCTION MANAGEMENT**

Subject: "Integrated Systems for Quality in Building Design Process: ISO 9001:2000 Quality-ISO 14001:1996 Environment- OHSAS 18001:1999 Occupational Health and Safety Management"

Definition:
This questionnaire is prepared to investigate the latest position of the Turkish Construction firm which have minimum one standard from the three international standards of ISO 9001:2000, ISO 14001:1996 and OHSAS 18001:1999; and to learn the effects of the standards to the design process of the construction. This questionnaire has been done under control of Prof. Dr. Nur ESİN and at the scope the thesis which is prepared by Architect Burcu YILMAZ. All of the firm data will be kept secret.

QUESTIONNAIRE

Firm Name
:.....

Filled in by :.....Major
:.....

Part I

Please tick the relevant boxes for the following questions.

Question 1- Are ISO 9001, ISO 14001 and OHSAS 18001 implemented as one integrated system or a stand-alone system?

	Date		
	ISO 9001	ISO 14001	OHSAS 18001
Stand-alone system			
Integrated			

Question 2- How far do you agree with the following statements concerning the benefits of an integrated ISO 9001: 2000, ISO 14001:1996 and OHSAS 18001: 1999 and systems?

Benefits	Strongly disagree 1	2	3	4	Strongly agree 5
1- Towards establishing an integrated and optimal performance management system					
2- Adopting the integration exercise as the foundation for integration other systems such as buildability, just-in-time and quality function deployment					
3- More comprehensive involvement of all interested parties. Each party will have to be aware of the larger scope of their work, i.e. how all quality, environmental and safety issues affect the management efficiency of the company as a whole					
4- Common resources result in better utilization, efficiency and no duplication of efforts					
5- Achieve synergy from the development of the integrated system where the achievement of a combined system is more than the sum of the achievement of each system implemented individually					
6- Harmonization and unified problem solving					

	Strongly disagree 1	2	3	4	Strongly agree 5
7- Encourage technology development and transfer					
8- Improve joint operational (quality, safety and environmental) performance in which all three systems are improved together					
9- Improve international management methods and cross functional team work					
10- Higher staff motivation and lower interfunctional conflicts and injuries					
11- Higher employee adoption with the help of the safety and environmental management system					
12- Multiple audits reduced and streamlined					
13- Ensure employee involvement and education					
14- Enhance confidence of customers for a commitment to the environment and positive market/commodity image					
15-Improve industry/ government relations					
16- Potential impact on world trade to allow competition on an equal basis					
17- Savings in consumption of energy and materials					
18- Controlling the stages as procurement, building processes and application in one hand					
19- Decreasing/ being removed of the poor quality and unsafety work and environment conditions					

Question 3- How far do you agree with the following statements concerning costs of an integrated ISO 9001: 2000, ISO 14001:1996 and OHSAS 18001: 1999 systems?

Costs	Strongly disagree 1	2	3	4	Strongly agree 5
1- Higher costs in all management training					
2- Reduced costs and more efficient reengineering					
3- More time and resources to develop					

this integrated system					
4- Costlier as greater expertise and higher level of competency in quality management systems are required					
5- Less certification, staff and consulting costs					

Part II

Please tick the relevant boxes for the following questions.

Question 1- What are the degrees of factors that affect the quality in the design phase in the view of ISO 9001:2000, ISO 14001:1996 and OHSAS 18001:1999?

	Not Important 1	2	3	4	Very Important 5
DEVELOPMENT TEAM					
1- Level of cooperation of design professionals					
2- Extent of teamwork of parties participating in the design phase (Structural, mechanical, electrical, environmental, civil engineers, architects, owners)					
3- Educational background of designers					
4- Extent of designers training (In-house training courses, apprenticeship programs, continuing education courses, seminars, etc)					
5- Personalities of the participants					
MANAGEMENT					
6- Level of management leadership in promoting quality					
7- Level of management commitment to continuous quality improvement					
8- ISO 9001:2000, ISO 14001:1996 and OHSAS 18001 Management Programs/ Plans					
PROCESS					
9- Selection of appropriate design firm (Experience skills, capabilities, workload, appropriateness of the standards, etc)					

	Not Important 1	2	3	4	Very Important 5
10- Existence of feedback system (<i>Information system used to transfer data between old and new projects</i>)					
11- Constructability of the design (<i>Constructability reviews</i>)					
STANDARDS AND SPECIFICATIONS					
12- Appropriateness of project specifications					
13-Quality of codes and standards (<i>Federal, state and local codes, generally accepted standards</i>)					
14- Characteristics of drafting practices (<i>Drafting standards, drafting procedure, etc.</i>)					
BUDGET					
15- Budget allocated for design					
OTHERS					
16- Characteristics of office practices (<i>Physical environment, organizational structure, personnel policy, ethical environment, etc.</i>)					

Question 2- How far do you agree with the following reflections of the Integrated System (*ISO 9001:2000 Quality Management System, ISO 14001:1996 Environmental Management System and OHSAS 18001:1999 Occupational Health and Safety Management System*) to the design phase?

	Strongly disagree 1	2	3	4	Strongly agree 5
1- Prevent design process internal constraints (<i>which are imposed through wanting to work in a particular way, or with particular materials or technologies</i>) and external constraints (<i>such as client's needs, the technology, the construction process, statutory control, ..</i>)					
2- Prevent design management problems (<i>client changes, difficulties in managing information, difficulties in planning and scheduling design work</i>)					

	Strongly disagree 1	2	3	4	Strongly agree 5
3- Reduce the design changes and revisions					
4- Plans and specifications should be carefully reviewed because of not adding time and costs to design					
5- Increase productivity					
6- Choosing and using the appropriate materials, project and construction system, convenient to the environmental conditions					
7- Appropriate use of the environment					
8- Designing of a project or site and using the convenient materials, equipment, and systems in terms of ensuring the employee and user safety					
9- Faster product development					
10-Increase the motivation of the employees					
11-Decrease the conflicts of transferring the data and communication problems					
12-Utilize materials, products, sources and energy completely					
13-Increase the customer satisfaction in the maintain phase					
14-Others					

Question 3- How far do you agree with the following statements concerning the problems which can arise during the application of these systems to your firm (especially to your design department)?

	Strongly Disagree 1	2	3	4	Strongly Agree 5
1- Management problems					
2- Problems in documentation phase					
3- Problems that can arise during the employee training					
4- Problems which occur during the reflection of the standards to the design phase					
5- Customer problems					

Question 4- Do you think that you can apply the standards you have in the design process or your design department efficiently, properly and regularly?

Exactly Not Applied 1	2	3	4	Exactly Applied 5



CURRICULUM VITAE

Burcu YILMAZ was born in 1980 in Turgutlu/ MANİSA. After completing her primary education at Cumhuriyet Primary School, and graduating from Turgutlu Anatolian High School in 1998 with a school rank of 1st, she attended to Architecture Faculty of Izmir Dokuz Eylül University. After completing undergraduate study at the Department of Architecture in 2002 with a department rank of 1st, she attended to the graduate program of Project and Construction Management at Department of Architecture at Istanbul technical University.

