The Grenfell-Baines School of Architecture, Construction and Environment

Improving Quality of Delivery of Public Construction Projects in Saudi Arabia

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Abstract

In construction industry, quality of construction projects on delivery is essential for the companies seeking competitive advantage. In Saudi Arabia, different factors affect the quality of delivery of public construction projects. These factors are of major concern for the government and for the construction professionals. Therefore, the aim of this study is to investigate these parameters in Riyadh city, Saudi Arabia. Accordingly, opinions of 50 Saudi construction professionals are collected using questionnaire of response rate 37%. The research sample is randomly selected to include contractors, consultants and site engineers of different age, jobs, education and experience.

The results show that the companies of 60% of the sample adopt clear definition of quality. This finding was reported by 88% of the older participants. Similar opinions were reported by 70% of consultants, 65% of contractors and 52% of site engineers. Same finding was reported by 71% of high school, 67% of high education and 55% of university educated participants along with 80% of the experience participants. The results show significant relationship between age, and education level, and the adoption of clear quality definition. The results also show that 52% of participants' companies have quality development plans. In addition, 29 participants (58%) reported that top management in their companies support quality development plans.

The results also show that the most important main factor affecting the quality of construction projects on delivery is the labour followed by site staff. Meanwhile, the lowest important main factors are the project, design of the project, and materials. Insignificant difference between age and the importance of these factors is found with significant relationships with job, education and experience were established. The most important sub-factors related to the project is the project location, related to materials is the relations with material suppliers, related to labour is the use of experienced labours, and related to sub-contractors is the evaluation of sub-contractors performance.

Based on the results, recommendations are proposed. These include improvement of the tender prices to encourage contractors to hire skilled labour and to improve the harmonisation between the main contractors and the sub-contractors. It is also include collection of data from other cities for wider understanding of the quality issues.

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Chapter 1: Introduction

1.1 Background of the Research

Quality has turned to be very widespread issue in recent years because of the conceptual variations and differences in technologies and industries. Quality was defined in the past as the compliance to standards. This definition is found to be insufficient and has been changed into present definition as customer satisfaction (Aatsalo-Sallinen, 2006).

The roadmap towards quality, according to Oakland (2005), has started by the quality control (QC) then the quality management (QM) followed by the quality assurance (QA) to finally reach the Total Quality Management (TQM). Rungtusanatham *et al.* (2005) reported that in developed countries, the goal of quality has become to ensure quality rather than to control the final product. This is mainly because the quality systems have been well-established in these countries long ago. It is not the case in the developing countries including Saudi Arabia in which quality receives less attention. The new viewpoints of quality are to bring benefits to the customers and to benefit the manufacturer by decreasing the quality costs aiming at decreasing the total costs. The adoption of these viewpoints has resulted in decreasing the unit cost at better quality which improves the market share and increases profits (Mohanty and Lakhe, 2003).

In construction industry all over the world, the quality is usually of remarkable costs. Therefore, the measures of quality control and/or quality assurance are adopted only according to the contractual constraints. In construction sector, the production processes are remarkably different from the production processes implemented in factories or production plants. So, quality considerations related to the construction industry require special attentions. These considerations are significant for the various production processes in which the expenses of remedial activities can be exceedingly high in the absence of quality assurance (Agus *et al.*, 2009).

In Saudi construction industry, which is featured by vigorous competition, quality has remarkable effects on the majority of construction companies (Abdelsalam and Gad, 2009). Quality is significantly becoming an essential success factor especially with the remarkable reduction of quality costs. In Saudi Arabia, quality is of significant effects on competitive advantage of construction companies (Al-Tmeemy *et al.*, 2012). Special

attention is needed towards the quality of construction projects especially in the public sector. This is mainly because the public projects are executed under the supervision of the government as owner. Therefore, the factors affecting the quality of delivery of public projects in Saudi Arabia are significant for both the government and construction professionals. Identification of these factors may enable Saudi government and construction professionals to improve the quality of the delivered public projects.

1.2 Scope and Significance of the Research

1.2.1 Scope of the Research

The scope of this study is to explore opinions of constriction professionals, of concerns with the quality at delivery of public construction projects, in the city of Riyadh in Saudi Arabia. The participants of this research include consultants, contractors, and site engineers of different Saudi construction companies.

1.2.2 Significance of the Research

The procedures and criteria utilised to award contracts of the public construction project to contractors are of considerable significance on the successful completion of these projects, especially regarding the quality of delivery. Accordingly, utilisation of quality assurance methods during the planning and execution of public projects can positively contribute to realising increased chances of success in the delivery of public projects, especially in Saudi Arabia. Although the costs of monitoring the quality of delivering the construction projects are high, the use of low levels of quality monitoring of the projects at the delivery can cause severe damage to the structures and loss of lives of end users. Accordingly, it is essential to consider adopting higher standards of quality assurance measures at the delivery of construction projects, especially in public sector in Saudi Arabia. Therefore, the significance of this study is that it is an opportunity to add to the present knowledge on the factors affecting quality at delivery of the public construction projects in Saudi Arabia. Also, the significance of this research is to offer recommendations to support solving problems caused by the non-compliance to quality measures during the execution and delivery of Saudi public construction projects.

1.3 Aim and Objectives of the Research

1.3.1 Aim of the Research

The aim of this research is to investigate the factors affecting quality of delivery of public construction projects in Riyadh city, Saudi Arabia.

1.3.2 Objectives of the Research

The objectives of this research are:

- To present and discuss definitions, concepts and costs of quality and the philosophies of quality management
- To discuss the application of quality management in construction industry
- To investigate and analyse the factors affecting the quality of delivery of construction projects in Saudi Arabia

1.4 Research Questions

The research question of this study is:

Q1) What are the parameters affecting the delivery of public construction projects in Riyadh city, Saudi Arabia?

1.5 Brief Description of Research Methodology

1.5.1 Research Method

The proper selection of research methodology has significant effects on answering the research questions (Kothari, 2009). There are two research methods that can be adopted in this study, which are qualitative and quantitative methods (Dawson, 2009). In most research work, qualitative method is used to explore attitudes, opinions and viewpoints of little number of participants on specific phenomenon (Walliman, 2010). Meanwhile, quantitative method is used to explore the opinions of participants numerically. It is also used to present these opinions using frequencies and percentages of responses to certain questions and evaluate agreement with specific statements (Dawson, 2009). Each of these methods has advantages and disadvantages. Sometimes, researchers use mixed approach of the two methods based on data collection requirements for their study. In this research, quantitative research method is used so that quantitative data are collected using questionnaire survey research tool.

1.5.2 Research Design

Descriptive analysis method is used in this research in order to analyse and discuss the data collected using questionnaire. This approach is adopted because it enables the classification and categorisation of the research parameters based on the collected responses of the participants. Moreover, descriptive approach is adopted because it helps to reach at relationships between the research variables using counts (frequency of occurrence) and percentages (Walliman, 2010).

1.5.3 Data Collection Method

In this research, the primary data is collected using questionnaire survey. The research sample includes Saudi construction professionals such as contractors, consultants, and site engineers of experience with public construction projects. The research sample includes participants involved in planning, execution and delivery of public construction projects in which the quality measures have remarkable impacts on the success of projects' delivery. The research sample in this study is randomly selected in Riyadh, Saudi Arabia. Therefore, questionnaire papers are completed using questionnaire survey. Each participant is informed about the research objectives and the rights to withdraw from the research at any time before completing the questionnaire. Questionnaire is used in this study because it ensures higher rates of response. In this research, 50 participants out of 135 correctly completed the questionnaire papers, with response rate 37%. The secondary data needed for this research are collected using review of literature including journal articles, textbooks, and reports.

1.5.4 Data Analysis Method

The primary data of this research is statistically analysed using Microsoft Excel software. In these analyses, descriptive data are presented as counts and percentages of opinions and responses. In addition, relationships between research parameters are obtained. The results are presented using pivot tables and charts. Also, Chi-square and ANOVA tests are used to study significance between research parameters.

1.6 Plan of the Research

1.6.1 Phases of the Research

This research study comprises four different phases. These phases are:

Phase (1): Literature review on quality of construction projects

Phase (2): Design and distribution of questionnaire

Phase (3): Analysis and discussion of the results

Phase (4): Writing up and submission of the report

1.6.2 Tasks of the Research

The tasks of this research study are:

Task-1: Preparation of the research topic

Task-2: Completion of the research proposal and ethics forms

Task-3: Review of literature and preparation of the presentation

Task-4: Preparation of report on the research method

Task-5: Design and distribution of questionnaire

Task-6: Analysis and discussion of the results

Task-7: Writing up and submission of the report

1.6.3 Time Table of the Research

The time table of this research is shown in Table 1.1.

Table 1.1 Time table of the research

Month	Oct 2014		Nov 2014		Dec 2014		Jan 2015		Feb 2015		Mar 2015		Apr 2015		May 2015		Jun 2015		Jul 2015		Aug 2015		Sep 2015	
Task-1																								
Task-2																								
Task-3																								
Task-4																								
Task-5																								
Task-6																								
Task-7																								

1.7 Layout of the Research Report

The report of this research comprises five chapters. The contents of each chapter are:

Chapter One: This chapter is used to present background information on the research topic. It also includes description of the scope and significance of this research. This chapter also presents the aim and objectives of the research along with the research questions. It also includes brief description of the research methodology. This chapter includes also description of the plan of this research including the phases, tasks and the time table of the research. In addition, this chapter includes overview of the contents of the research report.

Chapter Two: This chapter is used to present the information collected using the secondary data collection method i.e. the literature review. It includes information on the concepts of quality in construction projects. It includes definitions of quality and description of the various methods and techniques available to manage the quality of construction projects, especially at the delivery to ensure successful execution. It also includes discussion and analysis of the factors affecting the quality of delivering public construction projects, especially in the developing countries such as Saudi Arabia.

Chapter Three: This chapter includes discussion of the selected research methodology. It includes description of the data and information collection tools as part of the research method adopted in this research. This chapter also includes discussion of data collection

and analysis techniques. Furthermore, it includes description of the method used to decide upon the sample size along with the presentation of the different research ethics related to this study.

Chapter Four: This chapter includes discussion and analysis of the collected data. It presents distributions of the research participants such as education level and previous experience. It also includes analysis of the factors affecting the successful delivery of construction projects in terms of quality measures.

Chapter Five: This chapter is used to present the different conclusions drawn from the results of this research. It also includes proposing recommendations for construction professionals in Saudi Arabia to ensure higher quality at the delivery of the public construction projects executed in the country. It also includes recommendations for further research efforts that can be considered for future studies.

Chapter 2: Literature Review

2.1 Introduction

This chapter includes discussion and presentation of the different definitions, concepts and costs of quality. It also includes discussion and analysis of the various quality management philosophies. This chapter also includes discussion of the concepts of the term Total Quality Management (TQM) and the applications of total quality measures in the field of construction projects. Overview of quality in construction projects is presented. Factors and parameters of effects on quality of construction projects are discussed. The last part of this section includes discussion on using quality measures in Saudi construction projects.

2.2 Definitions, Concepts and Costs of Quality

2.2.1 Definitions of Quality

There are several definitions of quality. For several years there have been efforts to describe the importance of quality, which usually are presented using broad expressions. Nevertheless, in current times, there are several expressions adopted to express the meaning of quality by means of quality assurance (QA) techniques. In general, part of quality definitions is resulted from recognised and trusted documents whereas others definitions resulted from previous experiences, viewpoints, opinions, and assumptions. In fact, there are recognised inconsistencies amongst quality definitions but there are clear shared basics and principles in the different definitions (Gould and Joyce, 2013).

Quality is defined by the British Standard Institution as the full characteristics and features of a specific output (i.e. product or service) that affects its capability to fulfil the reported and actual requirements (Dale, 2009). Based on this definition, there is a necessity to recognise and identify the various features and different characteristics of the product and/or the services that have direct effects on the quality. These features and characteristics are considered as fundamentals and basis for the needed measurement and future control. In general, the capability of a product and/or service to fulfil the actual requirements is a direct reflection of its value to customers such as the price (i.e. economic value), safety in use, reliability and life and maintainability (Juran, 2004).

According to Evans and Lindsay (2002), another definition of quality based on product is reported. This definition considers the quality of a specific product as the accurate and quantifiable variable. Accordingly, the differences in quality of products can be adopted to reflect selected attributes of these products. But, this definition imperfectly considers the existence of a relationship between the quality and the cost. In other words, it considers that the increase of the cost is always accompanied by higher quality, which is not always true. Accordingly, the cheap products and/or the services must not to be considered as lower quality types (Yusof and Aspinwall, 2000).

Quality of a product or a service can also be defined according to the customer needs and his/her ability and willing to pay for the product or the service. In this context and because people are of changeable needs, there are several and diverse standards of quality. Elghamrawy and Shibayama (2008) reported the customer-based definition of quality as the fitness for purpose and/or use. The authors demonstrated the importance of the quality definition reported in ISO 8402, which considers the quality as the tool that can be used to relate the evaluation of a specific product and/or service to the capability of this product/service to fulfil a specific requirement. Accordingly, the quality definition as the fitness for use is generally motivated by the customer pleasure. This definition is the main quality definition that is widely implemented by most of the manufacturing and service delivery companies (Ramezani and Gharleghi, 2013).

To clarify the former quality definition, the word customer needs more understanding. In general, the customer is any person that can be affected by the product, service and/or the process, who can be classified as external or internal customer (Palaneeswaran *et al.*, 2006). Category of external customers comprises the end users along with the close processors and traders. In construction industry, finished facility represents the product for which the external customer is the end user of this facility. Meanwhile, the internal customers comprise all the performance functions that can be affected by the finished product at managerial and operation levels (Aziz and Hafez, 2013). In most cases, the internal customers obtain products and data from other groups of people inside their organisations. Therefore, the satisfaction of the different needs of all internal customers represents significant function of the process of providing the end user i.e. the external customer with product of remarkable quality (Palaneeswaran *et al.*, 2006). For instance, the carpenter of duties to prepare the formwork needed for the concrete placement can considers the owner as the end user (external) customer; meanwhile, the operators using the forms for concrete placement represent the internal customers to this carpenter. In

this example, the carpenter has to ensure the satisfaction of both needs and expectations of the concrete placement operators about the forms (Gryna *et al.*, 2006).

Quality can also be defined using a manufacturing-based type. In this regard, quality can be defined as the result of specific engineering and/or manufacturing operation. In this regard, quality can be defined as the full compliance with the agreed, identified, recognised and understood requirements. In this context, quality cannot be seen as a relative meaning so that there is complete absence of high or low quality. In other words, the products and/or the services are in compliance to the requirements or not (Thorpe and Sumner, 2004).

Quality can also have a value-based definition. In this case, quality can be defined as of direct relation to both costs and prices. Therefore, quality is defined by Dale *et al.* (2007) as "Uniformity of the product characteristics or delivery of a service around a nominal or target value" (p.7). This definition is focused on the identification of the features and characteristics of the product along with the operational parameters according to the design terms and/or restrictions (Yang *et al.*, 2009).

In general, there is a necessity to have several and different quality definitions. This is mainly because the perspectives and perceptions are usually modified and changed at different organisational levels (Sulivan, 2010). Accordingly, the dependence on the use of single quality definition can result in frequent occurrences of several troubles and problems. In other words, it is significantly required to have the ability to change quality perspective and perception with the movement of products from design stage to the delivery in the market. In this regard, it is essential to consider the different opinions and viewpoints, which also must be matching with the overall organisational beliefs in order to develop such a higher quality product. The variety of quality definitions may be clarified by inspecting the eight basic dimensions of quality reported by Evans and Lindsay (2002), which are shown in Figure 2.1.

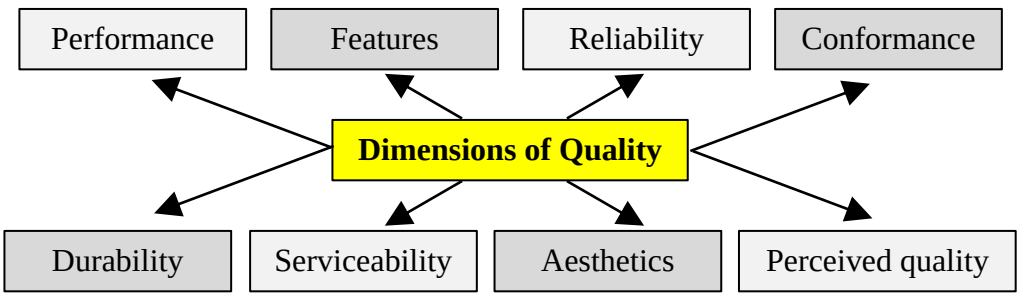

Figure 2.1 Basic dimensions of quality (adapted from: Evans and Lindsay, 2002)

As shown in Figure 2.1, the performance dimension is related to the main operational features of the product. Meanwhile, the features dimension is related to the required and needed properties of the product. The reliability dimension means the possibility of the product to survive for an identified lifetime when subjected to specific conditions of usage. The conformance dimension denotes the closeness of the different physical and performance features of the product to reputable and usable standards. The durability dimension describes the number of usage periods of the product before its physical failure and/or the need to be replaced. The serviceability dimension is related to the rapidity, gentility, capability and or restoration. The aesthetics dimension is related to the product in terms of the appearances, feeds, noises, flavours and/or odours. Finally, the perceived quality dimension represents the personal valuation and recognition of specific product that can be caused by the image of this product, resulted by the success of advertisement and/or affected by the brand power (Evans and Lindsay, 2002). In general, the most relevant quality definitions are the fitness for use (design view) and the compliance to specifications (manufacturing view) (Low and Toe, 2014).

2.2.2 Concepts of Quality

There are several concepts to be clearly identified in studying quality issues. For example, the term quality policy is seen as the overall organisational objectives and guidelines in all aspects regarding quality, which can be devised by the top management (McCabe, 1998). Meanwhile, the quality management is the term used to describe the approach to quality. In this regard, it is defined by Davies (2004, p.4) as:

> "All activities of the overall management function that determine the quality policy, objectives and responsibilities, and implement them by means such as quality planning, quality control, quality assurance and quality improvement within the quality system".

In projects, management of quality is considered as a division or a part of the project management process. According to PMI (2013), management of quality deals with all processes needed to guarantee that the project, upon completion, will fulfil the requirements for which it was planned. Therefore, management of quality comprises several processes such as planning, assurance and quality control. Davies (2004, p.4) defined the quality control as "the operational techniques and activities that are used to fulfil requirements for quality". In order to control quality, it is essential to consider the suitable quality system that can be adopted. Davies (2004, p.4) defined the quality system as "Organisational structures, procedures, processes and resources for implementing quality management".

In construction industry, the quality system needs to be inclusive which means including other items along with the inspection and control. Harris and McCaffer (2013) reported that the quality system in construction application, in addition to the inspection and control, has to include nine items as shown in Figure 2.2.

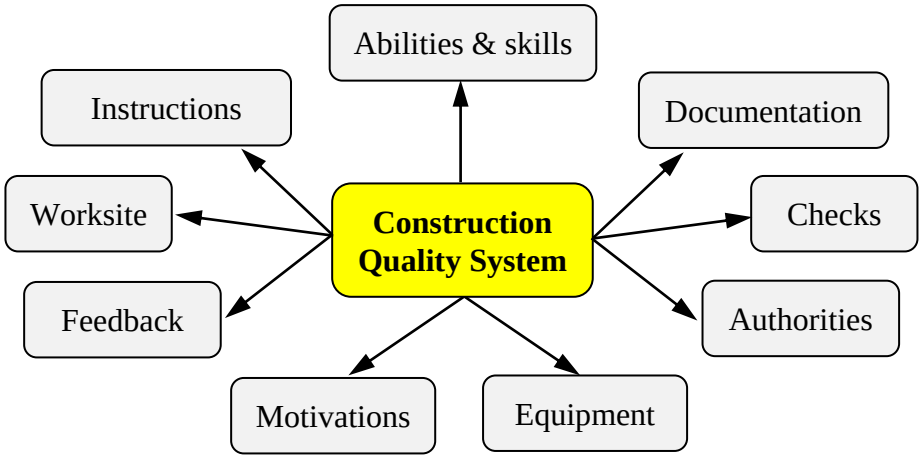

Figure 2.2 Construction quality systems (adapted from: Harris and McCaffer, 2013)

As shown in Figure 2.2, the quality system for construction industry requires clearly communicated instructions. It also requires abilities and skills which can be devised through organised training systems. The equipment needs should be effective in operation and suitable for the purpose along with increased levels of safety. In addition, the quality system should include suitable worksite conditions with constant inspection. It also requires the use of tests and checks to ensure proper recording of the completed tasks and activities. In addition, this system needs clear identification of responsibilities and allocation of authorities for successful decision making to correct faults. It also includes methods to motivate the workers to ensure higher quality results. The system should have organised and easy access documentation system so that feedback can be used to confirm remediation of the faults (Harris and McCaffer, 2013).

The management of quality should consider all the organisational activities required to accomplish the planned quality policy and to ensure quality assurance. Davies (2004, p.3) defined the quality assurance as:

> "All the planned activities implemented within the quality system, and demonstrated as needed, to provide adequate confidence that an entity will fulfil requirements for quality".

Therefore, part of the activities needed to assure quality can be unplanned and random, but the majority of these activities are to follow prepared procedures planned in advance. These activities in general are the main constituents of the quality system. This

system need to include several elements, which require identification and description in the standards of the system. Part of the elements can be used to make quality control by reducing the non-compliance. Other elements can be used to provide confirmations, or management assurance, to the end user and to the authorities (Griffith, 2010).

2.2.3 Costs of Quality

The evaluations of the costs related to quality works are usually include the costs needed only for the inspection and testing. Meanwhile, the other costs and expenses are usually added to the overhead expenses. However, there are different facts appeared with the consideration of full costs of quality. The first fact is the increase of the actual quality costs compared with the usually reported so that it can reach about 20 to 40% of the overall organisational revenues (Griffith, 2010). The second fact is that the costs related to quality are not solely related to manufacturing processes but to the additional required services including the purchasing and customer service activities. In addition, most of the costs are caused by the decreased levels of quality so that these extra costs can be avoided (Griffith, 2010). The different categories of quality costs are reported by Evans and Lindsay (2002) as shown in Figure 2.3.

Figure 2.3 Categories of quality costs (adapted from: Evans and Lindsay, 2002)

As shown in Figure 2.3, the overall costs of quality comprise four different categories of costs. The first category is the prevention costs, which are the costs needed to avoid the happening of non-compliance of the products in the future. The second category is the appraisal costs, which are the costs needed to measure and control the prevailing methods and process of production to ensure compliance of the end products with the customer or end user requirements. The third category is the internal failure costs, which are the costs experienced due to the non-compliance of the product with the requirements, just prior to the shipping of the product. The fourth and last category is the external failure costs, which are the costs experienced due to the non-compliance of the product with the requirements, just after the shipping of the product (Wood, 2013).

Evaluating the costs of quality is significant to properly direct the management actions and activities. It is also significant for the management team to follow the progress of

the quality enhancement efforts. In an ideal world, the total costs of quality can be decreased over time; however, only 10% annual reduction can be achieved as reported by Pyzdek and Keller (2003).

The main solution to improve the quality and increase the organisational profit is to adopt the concept of prevention. An essential method to ensure increased levels of quality assurance is the increase of the prevention budget, which can result in significant savings in all previously mentioned categories of quality costs. In general, the adequate prevention of having products of poor quality can significantly decrease the internal failure costs because it can remarkably minimise the number of defective products. In addition, the external failure costs can be decreased for the same reason. Meanwhile, decreased appraisal costs will be needed because the products are to be correctly manufactured and prepared from the beginning. Figures 2.4 through 2.7 show the various elements of costs that can be encountered in each category of the main four categories of total quality costs.

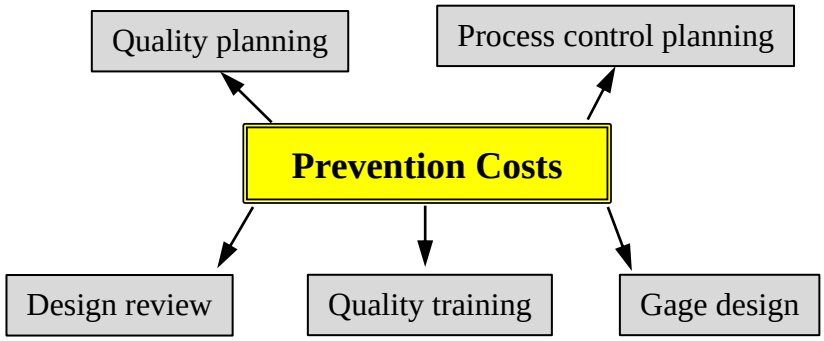

Figure 2.4 Elements of prevention costs (from: Evans and Lindsay, 2002)

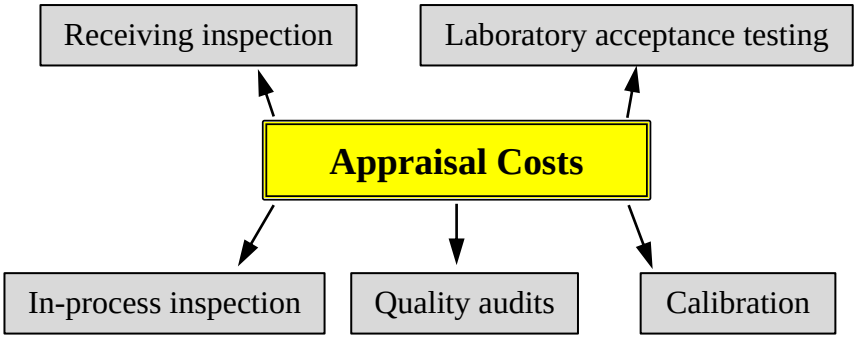

Figure 2.5 Elements of appraisal costs (from: Evans and Lindsay, 2002)

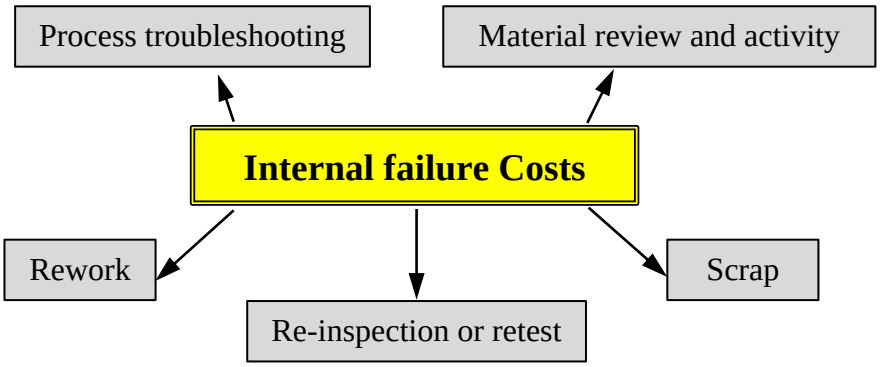

Figure 2.6 Elements of internal failure costs (from: Evans and Lindsay, 2002)

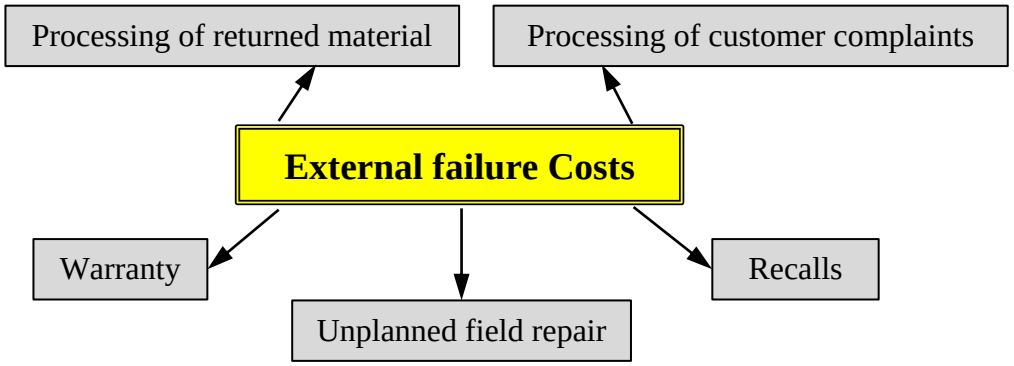

Figure 2.7 Elements of external failure costs (from: Evans and Lindsay, 2002)

2.3 Philosophies of Quality Management

Three main philosophies on the best methods to measure, manage and improve quality have been developed and internationally recognised. These philosophies have been developed by Deming (quality management systems), Juran (quality assurance) and Crospy (quality control) (McCabe, 1998). The following sections are devoted to explain these philosophies and to discuss their importance in understanding the principles and basics needed for quality management.

2.3.1 Deming's Philosophy

W. Edwards Deming (1900-1993) concentrated on improving products and services to comply with predefined features and specifications by decreasing the uncertainty and inconsistency in the design and manufacturing operations (Kumar and Suresh, 2008). In Deming's opinion, changes are the main responsible for poor quality. Therefore, the achievement of decrease in these changes, Deming proposed the use of a repeated cycle of processes related to the product. These processes include the design, manufacturing, testing, and selling along with market surveying to be able to redesign, and so on (Tam *et al.*, 2000). Based on the Deming's claims, there is a significant relationship between

the increased levels of quality and the increase of production volumes, which in turn results in recognised organisational competitive advantage (Kumar and Suresh, 2008).

Deming succeeded to identify two routes with which any process can be improved as reported by McCabe (2002). These routes are: a) the reduction of the "common causes" of changes encountered in the manufacturing system; and b) the elimination of the hidden "special causes" recognisable with a certain worker, equipment, or group of materials. Therefore, it has been suggested by Deming that the use of statistical methods can offer the appropriate method to identify the special causes and to acknowledge the common causes (Kumar and Suresh, 2008). In general, the statistical methodologies are only part of the contemporary Deming's philosophy. Deming categorically verified that the successful managerial practices must adopt some sort of major renovation. In this regard, he proposed the "14 points system" as the basics for the program required to achieve quality superiority. According to McCabe (2002), the Deming's philosophy is the scheme in which all the 14 points are to be considered and organisations cannot just select few of them to implement. The 14 points system is shown in Figure 2.8.

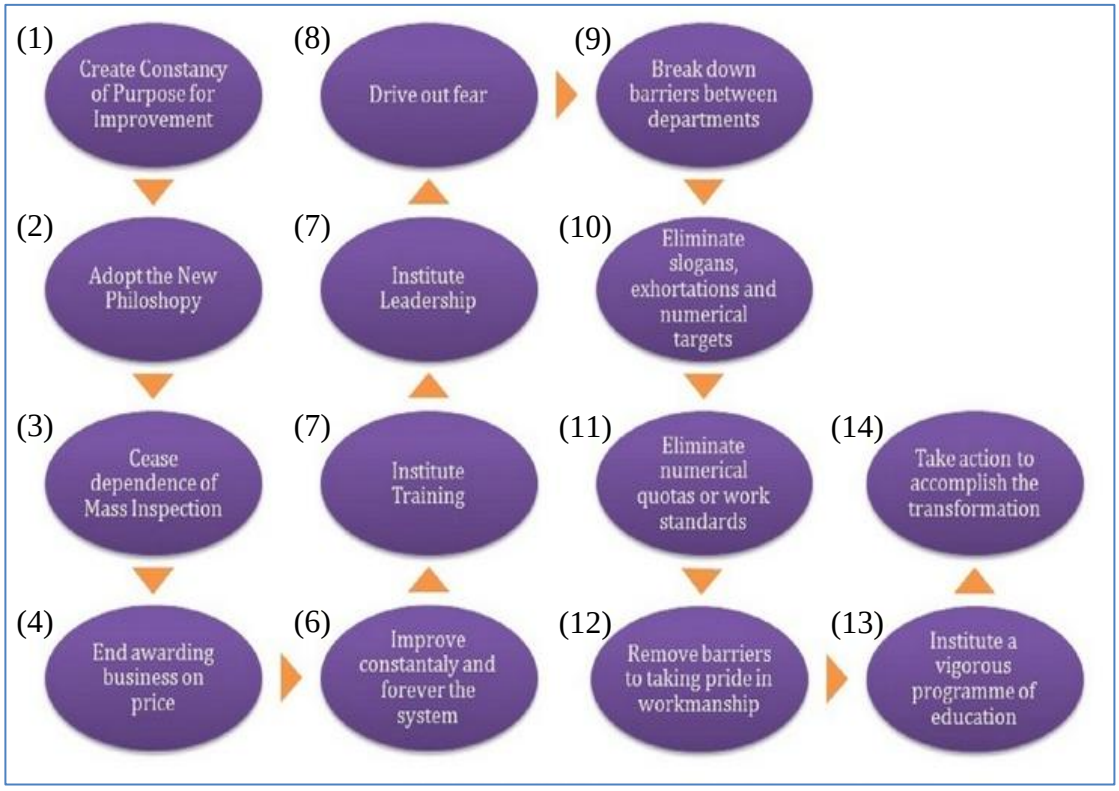

Figure 2.8 Deming's 14 points system (https://www.pinterest.com/pin/330739969988757 8/)

2.3.2 Juran's Philosophy

Quality is defined by Juran (1904-2004) as "fitness for use". McCabe (2002) reported that this definition of quality can be further clarified by recognising four additional categories. These categories include quality of design, quality of compliance, and availability along with the field service, as shown in Figure 2.9.

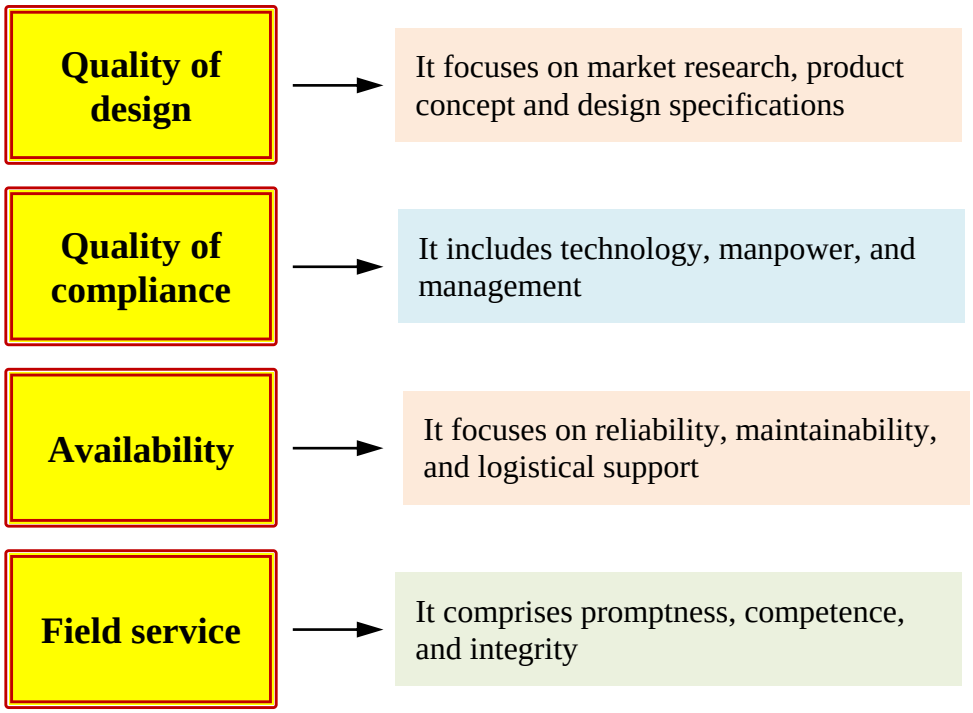

Figure 2.9 Categories of quality (adapted from: Juran, 2004)

Juran (2004) demonstrated the significance and importance of total quality management (TQM). In this regard, he reported that TQM starts at the top organisational level and moves down to other levels. Therefore, he developed ten essential steps to improve quality of products. These steps (Juran, 2004) are:

Step 1: Awareness creation regarding the need and the chances to improve quality

Step 2: Setting of goals needed for nonstop quality improvement

Step 3: Building an organisation to achieve these goals

Step 4: Giving training to every body

Step 5: Carrying out projects to be able to solve problems

Step 6: Reporting of the projects' progress

Step 7: Showing recognition

Step 8: Communicating the results

Step 9: Keeping records of successes

Step 10: Adopting improvements of systems and processes to maintain momentum

The former ten steps can be further merged into three main areas of management, which is termed as Juran Trilogy, as shown in Figure 2.10.

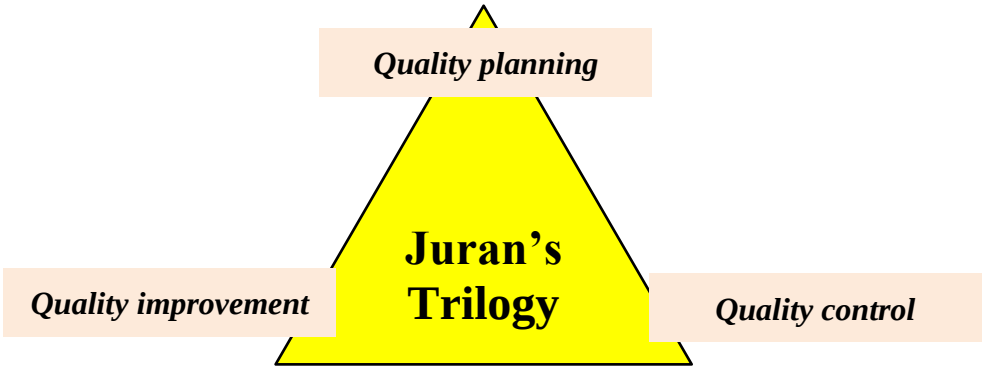

Figure 2.10 Schematic presentation of Juran's Trilogy (Juran, 2004)

2.3.3 Crosby's Philosophy

The principle of Crosby's philosophy regarding quality is represented as the compliance to the requirements. Basically, Crosby's philosophy adopts the principle of prevention not inspection. McCabe (2002) reported that the philosophy of Crosby can be explained in the next elements needed for quality management:

Element 1: Quality is truly the conformance to the requirements not to the elegance

Element 2: Quality problems must be identified by the bodies causing them

Element 3: In terms of economics, it is cheaper to perform the job right the first time

Element 4: Quality costs are the sole performance measurement

Element 5: "Zero Defects" is the single performance standard

In order to ensure adopting these elements, there are fourteen steps to follow. These steps (Crosby, 2005) are shown in Table 2.1.

Table 2.1 Steps of Crosby's philosophy of quality

Step	Title of step	Step	Title of step
(1)	Management Commitment	**(8)**	Supervisor Training
(2)	Quality Improvement Team	**(9)**	Zero Defects Day
(3)	Quality Measurement	**(10)**	Goal Setting
(4)	Cost of Quality Evaluation	**(11)**	Error Cause Removal
(5)	Quality Awareness	**(12)**	Recognition
(6)	Corrective Action	**(13)**	Quality Councils
(7)	Zero Defects Planning	**(14)**	Do It Over Again

2.4 Quality Management in Construction Industry

2.4.1 Features of Construction Quality Management

Quality management is an integrated approach for quality improvement of products and services by involving all organisational employees (Fewings, 2012). In other words, quality management is the process to ensure higher quality of products and services from the start and to make quality the main interest and obligation of each member of the company. The success of quality management relies on their sincere commitment to quality (Evans and Lindsay, 2002), especially in construction industry in developing countries.

There are several features required for the successful quality management. These features are (Bernold and AbouRizk, 2010):

- Sincerer organisational leadership commitment to highest standards
- Using planned training programmes for managers and employees
- Adopting teamwork culture so that each member participates in the improvement
- Adopting prevention measures by searching for the potential problems and not just waiting for the failure to occur then start treatment
- Consistent targeting of the actual root causes of troubles and problems through the use of constant prevention efforts
- Improving communication channels to ensure that significant data and information are available to the authorised managers, at the right time, and with full details
- Clear identification of organisational vision, mission and goals as main requirements for the constant success of quality management

2.4.2 Components of Construction Quality Management System

In general, construction industry is characterised by remarkably differentiated and uneven structure. The abilities, commitment and coordination of specialists and experts of construction industry have established in an environment of speciality, divergent backgrounds and often contrasting interests in integration. Therefore, it is essential to establish suitable quality system that can be implemented in construction Industry. Example of quality system, which can be used to improve the quality in construction industry (ASCE, 2011) is shown in Figure 2.11. The main components of this system are the policy, organisation, Procedures, Processes, Training, and Manuals. Description of each component is given in the next sections.

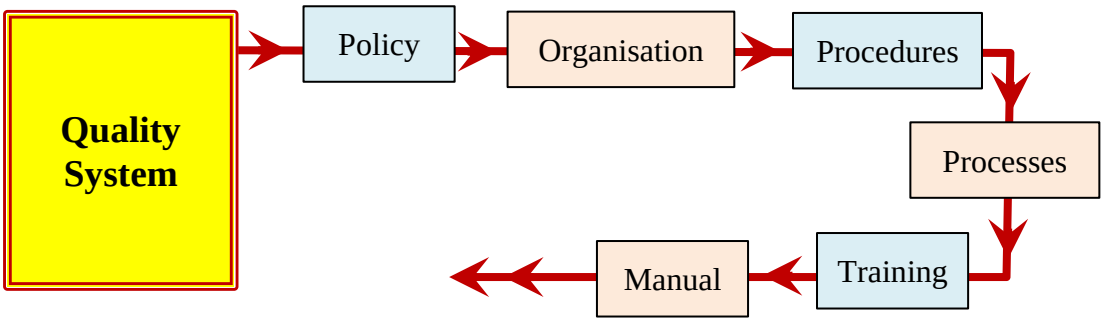

Figure 2.11 Quality system components (adapted from: Nee, 1996)

2.4.3 Policy of Construction Quality System

The first component of construction quality system is the establishment of policy. The policy has to be prepared in relation to the organisational goals and to the needs and expectations of the targeted customers. In addition, the policy is to be devised to include measurable objectives, which must be relevant to the organisational plans and related to the customers' needs. Therefore, in construction projects, it is expected from the quality system to include the targets and objectives of the quality policy (Bubshait and Al-Atiq, 1999; Yung, and Yip, 2010).

2.4.4 Organisation of Construction Quality System

The main target and the key objective in establishing quality system in construction projects are to fulfil the organisational internal requirements. Therefore, this system needs to be cost-effective, well-suited with known best practices within the construction industry, and to have clear organisational benefits. Nee (1996) and Wood (2013) reported that centralised and decentralise types of quality systems that can be utilised to manage quality of construction projects.

In centralised systems, special attention is to be given to the activities of quality control and/or the operational methods and actions that are utilised to achieve the needed quality. Therefore, in the typical centralised quality system, the different operations and processes related to the quality are to be the direct responsibility of a specialised quality control team. This quality control team characterises by having special management authorities with no direct relationships with the management of the production teams. Meanwhile, the main difference between the centralised and the de-centralised quality systems is in the allocation of responsibility. In the de-centralised systems, the quality control responsibility is given to the operating teams with actual roles in the production processes. This concept is in consistency with the principle of commitment. According to this principle, the management of the production team must have the commitment to

produce in appropriate compliance with the specifications. In this case, the control activities are not allowed to be given to and/or to be shared with others (Ashford, 2002).

2.4.5 Procedures of Construction Quality System

The implementation of quality system in construction industry needs to be effective by using organised and documented procedures. The complication of these procedures is determined by the level of complexity of activities, methods utilised, abilities of control team, and training programmes required for successful execution of the activities. David and Gunaydin, (1997) and Dale *et al.* (2007) reported the significance of developing suitable and appropriate operational procedures that can support the coordination of the various activities needed for successful quality system. According to Dale *et al.* (2007), the documented procedures needs to be simply formulated, easy to understand, clear, and include the methods to be utilised and the criteria to be matched.

2.4.6 Processes of Construction Quality System

In construction industry, the organisations (e.g. Construction Companies) are required to identify and decide upon the various construction and servicing processes that are usually of direct impacts on the quality of the delivered projects. Also, construction companies are required to make sure that all of the identified processes are performed under specific operational conditions. These conditions (Nee, 1996) include:

- Utilisation of the proper and suitable equipment needed for the various activities of construction, building, and servicing in a safe work environment
- Compliance in all activities with the construction codes, requirements of the quality plans and the planned procedures
- Monitoring and governing processes' factors and products' features
- Approving various processes and equipment if needed
- Defining clear workmanship criteria in terms of standards and examples
- Using planned equipment maintenance to ensure continues operations

2.4.7 Training of Construction Quality System

In construction industry, it is essential for any organisation to create and retain clear planned procedures to identify the training requirements of all workers performing tasks of effects on the final quality of the delivered projects. The needed training sessions are to be delivered at the workplace in which workers are performing their activities (Chung, 1999). The qualifications to be awarded are to be related to the awareness and education resulting from these sessions. Also, Nee (1996) reported the significance of

maintaining clear detailed records of the delivered training sessions including delivered materials, training periods, and the methods of assessments.

2.4.8 Manuals of Construction Quality System

The main purpose to consider using quality manual is to offer a suitable and sufficient representation of the used quality management system. In general, this manual is a long-term reference needed for successful implementation of the system and for the future maintenance and modifications (Jha and Iyer, 2006). Usually, the form of construction quality manual, which must be original in nature, varies from an organisation to another. In this context, Evans and Lindsay (2002) suggested that the typical quality manual can comprise five different sections, as shown in Figure 2.12.

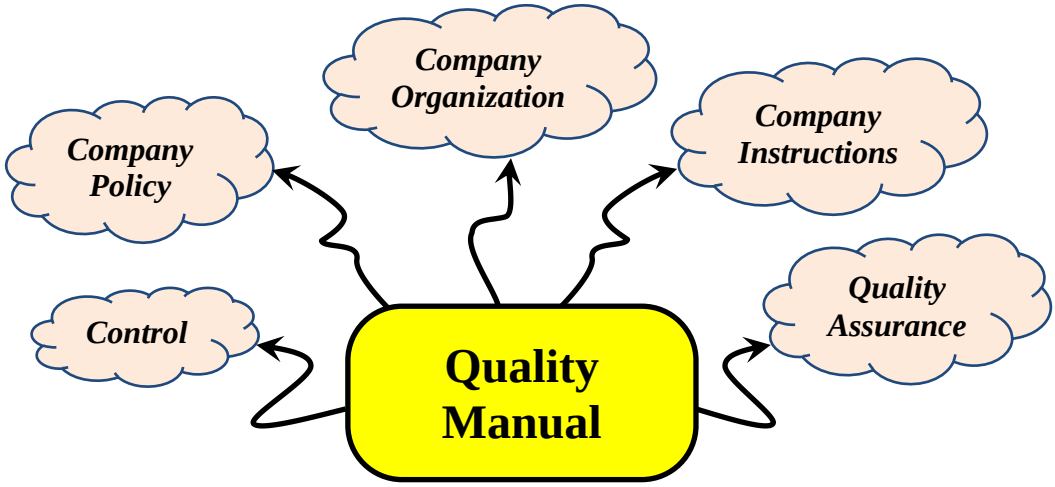

Figure 2.12 Proposed components of quality manual (Evans and Lindsay, 2002)

As shown in Figure 2.12, quality manual starts with control section. This section is used to describe the manual contents to the readers and to explain the manual's authorities. It also used to explain the method utilised to ensure that the manual is up to date and to notify the readers with the changes and amendments that have been made to the manual. The second section is the section related to the company policy. This section is used to present and clarify the organisational objectives and to demonstrate the values and codes with which the quality system is expected to conform. The third section is related to the company organisation. This section is used to define and explain the various organisational activities and to describe the organisational management system. In addition, this section is used to clarify the responsibilities allocated to top management and to report the position, functions and responsibilities of the organisational quality assurance (QA) manager. The fourth section is related to the company instruction. This section is used to list and explain the various organisational instructions, which are of direct relationships with the quality management. This section is also used to describe

the relationships between these instructions and the related standards. The quality manual is to finish with the section related to the quality assurance. This section is used to present and discuss the procedures needed to assign quality assurance (QA) engineers to specific activities and explain their liabilities. This section is also used to describe the procedures needed to prepare the quality plans (Evans and Lindsay, 2002).

2.5 Factors and Elements Affecting Quality of Construction Projects

2.5.1 Overview of the Factors

Usually, construction process comprises inputs, processing and outputs (Abdel-Razeq *et al.*, 2001; 2006). The inputs include the resources needed for the construction. The processing i.e. execution includes utilisation of inputs to perform the construction activities. The output is the project. The players affecting construction activities are: the owner, the designer, the contractor, the suppliers of construction materials, the site team of the owner, and the site team of the contractor (Abdel-Razeq *et al.*, 2001). Various researches (Tam *et al.*, 2000; Pheng, 2004; Jha and Iyer, 2006; Yung and Yip, 2010; Omran *et al.*, 2012) have been performed to identify the factors affecting quality of construction projects. These factors are related to: clients, project environment, abilities and skills of team leaders, project procedures and effectiveness of project management. In addition, several studies have been conducted to investigate the critical success factors of construction projects (Chan and Tam, 2000; Tam *et al*., 2000; Yang *et al*., 2009; Peter *et al*., 2010; Sulivan, 2010). These studies proposed lists of variables affecting the quality of construction project. There are specific variables of effects and mentioned in different lists, which shows the absence of agreement on the variables (Sulivan, 2010). Chan and Tam (2000) reported several factors affecting the quality of construction projects. These factors form five groups as shown in Figure 2.13.

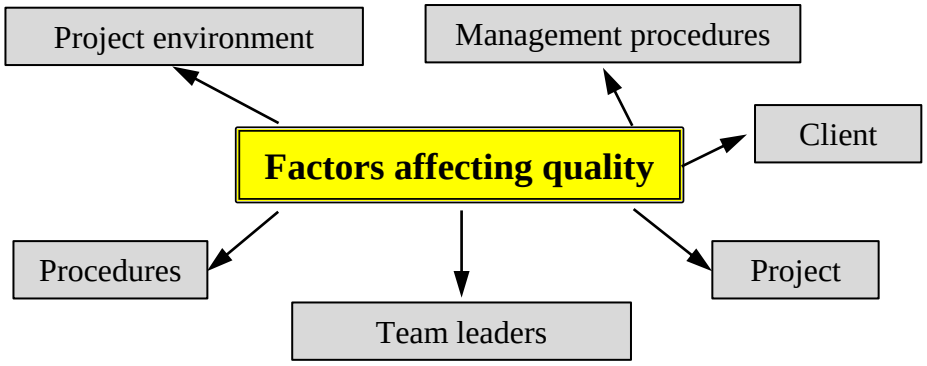

Figure 2.13 Factors affecting construction project's quality (Chan and Tam, 2000)

2.5.2 Factors Related to Client

There are several aspects related to the effects of clients on the success of construction projects. One of these aspects is the type of client. In this context, Chan and Tam (2000) reported that clients can be of complicated type, which are characterised by having previous experience of building projects before. Chan and Tam (2000) also reported that clients can be of specialised type, which are characterised by their participation on repeated similar construction projects. The authors demonstrated that the client of these types is always of increased success chances with construction projects than beginners. In addition, Chan and Tam (2000) considered other aspects of project's client including the client's nature, which means either public or private construction project. Other aspects include personal abilities of the client such as understanding the project's mission, capability to make decisions and to describe roles. These personal features of the clients are of effects on the quality of construction projects (Omran *et al.*, 2012.

2.5.3 Factors Related to Project's Features

The features and characteristics of the construction project are of remarkable effects on the quality performance. Therefore, it is significant to define the different features and characteristics of project using scope, nature and complexity of this project. Generally, the scope of the construction project describes the project's type, the construction activities and the difficulties of the project. Meanwhile, the nature of the project identifies whether the project is related to new construction or just a refurbishment of present project. According to Chan and Tam (2000), some of the construction projects are more costly to construct than others and the refurbishment activities can experience increased unit cost compared with the new projects. In addition, the project's complexity can be evaluated in terms of ease to have construction site access, having design easy to build, having difficult worksite conditions, and strict system of quality management (Yang *et al*., 2009; Hoonakker *et al*., 2010).

2.5.4 Factors Related to Project's Environment

The environment of any construction project includes all the external parameters of effects on the progress and quality of construction activities. In general, these external parameters can be categorised into physical, economic, social, political, and industrial relations. These parameters are of various effects nationally and/or locally. These parameters are also of effects in different manners according to the project's type i.e. public or private construction projects. Chan and Tam (2000) reported dramatic changes in approaches to the project's environment during the last three decades. These changes

resulted in obvious uncertainty regarding the costs and regarding the organisational investment in project's activities, which have significant effects on the quality.

2.5.5 Factors Related to Project's Team Leaders

In construction industry, the project's team comprises specialists and workforces from different organisations. The duties of this team are to perform the required design and construction activities needed to complete the project. Meanwhile, the management team of these projects includes client, project's designer, material suppliers, principle contractors, in addition to the sub-contractors. Generally, the project's management team and the client's consultants are responsible to advice on the advancement of the projects and to monitor the compromise between execution time, costs and the quality. In reality, the performance of the project's team relies considerably on the abilities, skills and previous work experience of the main team leaders of the project. According to Chan and Tam (2000), the project's team leaders include the client's representative, the team leader of the design duties, and the team leader of the construction activities. The authors also reported that the performance of the project's team members may be evaluated based on the practical and managerial skills of the members, work environment in terms of work relationship and workers' behaviour, and also on the help and support offered by the parent organisations (Thorpe *et al*., 1996).

2.5.6 Factors Related to Project's Procedure

Quality of the construction project at the delivery stage is dependent on the procedures utilised during the execution of the construction activities. These procedures mainly include the methods of procurement and the system of tendering to be adopted. The fragmental feature of construction processes, the dissimilarities between construction projects and the transient nature of the project's organisation significantly affect the role of project's team in preparing the construction activities and leading the project to the required completion at the higher quality. According to Chan and Tam (2000), proper selection of experienced companies for project's design and then for the construction are of significant role in increasing the chances to achieve higher quality of completed construction projects (Pakseresht and Asgari, 2012).

2.5.7 Factors Related to Project's Management Actions

The managerial system is mainly responsible to make the required decisions related to the planning and monitoring organisational activities. The managerial system of the organisation is also responsible for bridging the gaps between the organisation and the

surrounding environment, formulating the organisational objectives, evolving strategic and operating plans, and launching the required control processes. An essential role of the diverse managerial duties is the devising of the general strategy, selecting employees, allocating responsibilities, assessing the outcomes and leading the required changes. The project's management actions are significant in selecting the suitable control mechanisms needed to solve specific problems (Ng, 2005). In reality, there is a significantly lower control conditions in the absence of specialised design team, inadequate drawings, improperly identified specifications, poor quality documentation and lack of standard to follow (Love and Smith, 2003). However, the higher control conditions are prevailing and dominant with the administration of comprehensive clear documentation by means of consistent team meetings, planned monitoring and continuous inspections (Chan and Tam, 2000).

2.5.8 Elements Affecting Quality of Construction Projects

There are several elements of significant effects on the quality of construction activities and processes. These elements include several inputs and processing components. In other words, these elements include: design, contract, materials, labour, and equipment. These elements also include: sub-contractors, planning of the project site layout, other systems, site staff related to management concepts, and execution of the project's activities, as shown in Figure 2.14.

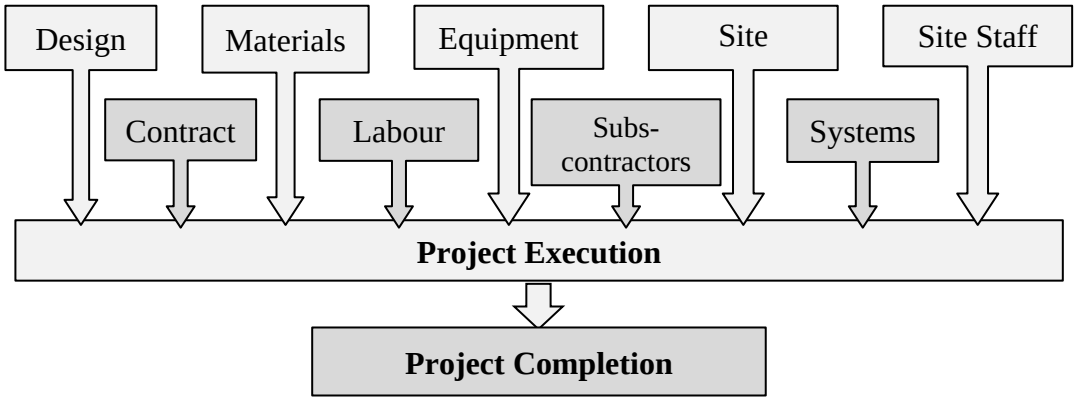

Figure 2.14 Concept of construction process (from Abdel-Razeq et al., 2001)

The design elements include all aspects related to design process of the project. The contract represents the contractual agreement between the owner and the contractor. The materials elements include all aspects related to suppliers of materials. The labour elements include all aspect related to workforce participated in project's activities. The equipment elements include all aspects related to the equipment needed for the activities. The sub-contractors elements include all aspects related to subcontractors.

Site layout elements include the issues related to the planning of the site area. The system elements include all other systems which are not included in the previously mentioned factors. The site staff elements include all aspects related to the methods of management and the issues related to the shared and common tasks of the management teams. Finally, the execution elements include all aspects related to execution. The issues of significant effects on construction projects quality are classified by Tan and Lu (1995) into eight groups. Each group includes different factors as shown in Table 2.2.

Table 2.2 Elements affecting construction project quality (from: Tan and Lu, 1995)

Quality group	Factors of effects
Qualifications of workforce	– Ability and skills of project manager – Ability and skills of design staff – Ability and skills of supporting staff
Conformity with codes and standards	– Willing of owner to accept the agreed rules and standards – Adoption of proper editions and articles – Uniformity of the rules and standards.
Conformity with owner's needs	– Accuracy of owner's specified needs – Clarity of owner's specified needs – Changes of owner's needs
Conformity with design procedures	– Totality of design manuals, and guidelines – Efficiency of quality control program – Adopting engineering change controls
Conformity with schedule needs	– Observing and controlling schedule and performance – Number of design changes – Rationality of the schedule
Conformity to cost needs	– Number of changes – Clarity of work scope and work statement – Rationality of cost estimates and budget
Fullness of and conformity to the output standards	– Sufficiency of data and information – Clearness of diagrams and groupings – Precision of the data and methods
Constructability	– Adequacy of equipment and materials supply – Utilisation of standardised approaches and materials – Review of designs for constructability

2.6 Quality Management in Saudi Construction Industry

In Saudi construction industry, quality management systems are needed to improve levels of quality and to keep this high level of quality during the life time of the project. Ramanathan *et al.* (2012) reported that the project's quality can be affected by cultural and behavioural characteristics, which are related to the customer's needs. At present, the construction industry in Saudi Arabia is encountering significant challenges in implementing quality management systems. This is mainly because the increased competitiveness in this industry amongst national and international companies. For example, Mohamed *et al*. (2014) demonstrated that Saudi construction industry is experiencing remarkable developments and growth in various cities of the Saudi Arabia. This development necessitates adoption established quality standards for the construction projects. The required high quality levels can be achieved by utilising planned processes, team members training, continuous monitoring and performance evaluation. It can be achieved also through improvements of the organisational operation systems to adopt the use of higher quality standards (Mazher *et al*., 2015).

The utilisation of quality management systems in Saudi construction industry is targeting several benefits. These include the increase of productivity of operating teams, the increase of organisational profitability and to improve the organisational reputation (Al-Kharashi and Skitmore, 2009). In reality, the latter benefit is most significant for the companies to reach the quality characteristics defined by the Saudi Arabian Standard Organisation (SASO). However, during implementing quality management systems, Saudi construction companies are encountering several barriers and obstacles. These barriers and obstacles appeared because of the lack of experience, weakness of control and using inappropriate techniques for assessment and evaluation (Al-Sedairy, 2001; Albert, 2012). Taking into account the outcomes of quality inspection processes of construction projects, Mazher *et al.* (2015) reported the significance and importance of restrictions of Saudi Construction Standard, which necessitate the implementation of effective quality management systems and techniques.

Saudi Arabia is one of the largest countries in the Middle East and the richest countries in the region. Because of the increased country's income from the oil revenues, considerable investments in Saudi Arabia are directed towards construction projects. Therefore, it is essential for the organisations operating within the construction industry in Saudi Arabia to adopt quality management systems in all projects to survive in this environment of vigorous competition (Monghasemi *et al.*, 2015). However, the

implementation of the quality systems in Saudi construction projects is facing different challenges. These challenges include the remarkable lower willingness to use novel materials and to utilise effective construction techniques to cope with the fast developments in majority of construction processes (Zhou *et al*., 2013). Therefore, it is essential and significant for Saudi construction professionals to consider the nature of the market of economic liberalisation. This nature results in limited product life cycles, especially with the daily introduction of new innovations in construction industry. Therefore, it is important to pay attention to the decreased product life cycle; abilities of workers; matching the final products with customer's needs to ensure their satisfaction; and the costs needed for improving the product's quality (Mazher *et al*., 2015).

In Saudi Arabian construction industry, Mohamed *et al.* (2014) reported the significance of improving the operation systems of the industry's organisations. This can take place by adopting and utilising higher standards for the products and/or the services. In addition, it is important for the Saudi construction companies to pay more attention to the management systems specialised in dealing with environment and health and safety issues. This can support Saudi construction companies to meet the quality requirements needed to offer their employees the suitable materials, equipment and construction techniques (Heravi *et al*., 2015). In general, Saudi construction companies need to work hard towards improving quality of construction projects to be able to increase their productivity, market share, customer satisfaction and customer loyalty. This quality improvement can be ensured by utilisation of effective quality management systems such as Six Sigma or ISO 9001 (Din *et al.*, 2010). In addition, Olawale and Sun (2015) reported the importance of offering adequate training programmes to the employees in order to increase their awareness with the quality systems and novel construction materials and techniques. Therefore, implementation of quality management systems by Saudi construction companies necessitates studying the parameters affecting quality of delivery of public construction projects in Saudi Arabia, which is aim of this research.

2.7 Summary

This chapter is used to present review of literature on quality especially in the field of construction projects. The first section of this chapter includes definitions, concepts and costs of quality. In terms of concepts, it includes discussion of quality policy, quality management, project quality management, quality control, quality system, and quality assurance. The second section includes review of the different philosophies of quality management including philosophies of Deming, Juran, and Crosby. The third section is

devoted to discuss the total quality management in construction industry. It includes discussion of the quality system policy and quality system organisation including centralised and de-centralised systems. It also includes discussion of the quality system procedures, quality system processes, quality system training, and quality system manuals. The fourth section includes discussion of quality of construction projects. It includes discussion about the different factors affecting quality of construction projects such as the effects on the client, project features, project environment, project team leaders, project procedure and project management actions. In addition, it includes discussion of the elements affecting quality of construction projects. The final section is devoted to discuss the quality measures and total quality management methods adopted by Saudi construction professionals.

Chapter 3: **Research Methodology**

3.1 Introduction

This chapter is used to discuss the research methodology utilised in this research. It includes analysis and discussion of the research method and the method employed to collect the data from Saudi professionals in construction industry. This chapter also includes discussion of the key research philosophies to be used for the research, which are related to ontology and epistemology. In addition, the features of the qualitative and quantitative methods of research are explained. Thereafter, it includes description of the research design utilised in this study with clarified justification for the selection process of the research method. It also includes description of design of the questionnaire survey used for data collection and description of the sampling method, data analysis techniques, and the research ethics of the research.

3.2 Philosophy of Research Design

3.2.1 Overview

The connection between quality of data and the method used to collect this data is an issue of continuous debate amongst researchers. This is because the significant effects of data collection methods on the quality of data collected for any investigation. In this regard, Walliman (2010) demonstrated the importance of appropriate preparation of research design. Dawson (2009) discussed three reasons explaining the significance of philosophical issues examination, especially the issues of direct relations to the study. These reasons are explained in details the next sections.

First reason, the availability of different philosophical stances helps the researcher to refine and specify the research methods to be utilised. This help includes clarification of the kind of evidences-collection and its causes, the method in which these evidences are inferred, and the method with which these evidences can support answering research questions (Dawson, 2009). Second reason, knowing research philosophy is significant in enabling the researcher to assess the available research methodologies, and helps to avoid using unsuitable research techniques. It also helps to avoid performing unwanted research activities after recognising the limitations of certain methods at early stages of the research. This saves the time and reduces the costs (Dawson, 2009). Third reason,

the appreciation of philosophical conditions helps the researcher to increase creativity and innovation in selecting research method, which might be outside consideration (Dawson, 2009).

The majority of research designs involve philosophical conditions. However, Johnson *et al.* (2007) reported that these conditions can be affected by the practical concerns of the research. They reported that the differences in research directions offer wide range of ontological and epistemological selections. Hence, it is essential to decide upon the method that suits the research nature. The next section presents discussion of these philosophical conditions.

3.2.2 Ontology and Epistemology

The term ontology focuses on the assumptions that can be made about the nature of social reality (de Gialdino, 2009). It is proposed to express the titles and assumptions that can be made about what exists, what it looks like, what units make it up and how these units interact with each other (Babbie, 2008). In this context, Grix (2001, p 26) stated that: "ontological assumptions are concerned with what we believe constitutes social reality". Meanwhile, epistemology is the nature of human understanding that can be attained through various sorts of inquiry and other methods of examination (Cohen, 2007). Coughlan and Coghlan (2011, p.166) described epistemology as "a general set of assumptions about the best way of inquiring into the nature of the world". In other words, epistemology is concerned with whether what is assumed to exist, can be known to exist. Therefore, ontology is about what knowledge it is possible to have whereas epistemology is about how that knowledge becomes known (de Gialdino, 2009).

Amongst the ontological terms, objectivism and constructionism are commonly used. Constructionism is linked to subjectivism as it is related to the subjective meanings that require investigation, and from which the investigator constructs meaning (Young and Collin, 2004). Constructionism requires social behaviour explanation using subjective measures based on the researcher experience. Saunders *et al.* (2009) see constructionism as the method of exploring the details of a situation to understand the reality behind it. Constructionist researchers perform studies based on their subjective experiences and clarify the phenomena under study using their own social reality. However, objectivism focuses on the social entities that can be understood in the absence of the personal interpretive context of the researcher. Thus, objectivism means that social phenomena do exist even if they are not considered for investigation (Saunders *et al.*, 2009).

Amongst the epistemological terms, positivism and constructionism are the commonly used. Positivists believe in the existence of social world. They believe that events within this world can be, and sometimes must be, measured using objective methods rather than inferring these events subjectively through feelings, reflections and/or perceptions (Blaikie, 2009). Therefore, positivism considers independent objective realities which cannot be created by human mind (Saunders *et al.*, 2009). Therefore, positivism needs quantitative methods to study specific phenomenon. Meanwhile, constructionism needs provides qualitative description of the phenomena as it allows in-depth examination (Dawson, 2009). Based on the comparison between both terms, the positivism approach is adopted in this study, which needs the use of quantitative method of data collection. However, it is significant to compare the quantitative with the qualitative as discussed in the next section.

3.3 Qualitative and Quantitative Approaches

3.3.1 Qualitative (Induction) Approach

Qualitative approaches are used to collect personal attitudes, motivations and behaviour related to the research subject. It allows collecting valuable descriptive explanations of personal perceptions, attitudes, beliefs, feelings, and behaviour. It also helps to reveal the personal meanings and interpretations related to specific events (Hakim, 2000).

Qualitative approach depends on basics related to the social rather than natural science. Becker *et al.* (2012) reported four key concerns of qualitative researches. These issues focus on: a) actor's explanation; b) context; c) process; and d) flexibility. Becker *et al.* (2012) reported two features distinguishing qualitative from quantitative research. First, qualitative research includes an inductive approach, which is used to relate theory to research. Second, qualitative research utilises constructionist situation related to the research nature. So, social phenomena and reality can be interpreted as outcomes of personal social interactions. Also, qualitative approach enables in depth interviewing of persons and provides data that can be accurately validated by the collected details. This is one of the merits of qualitative studies. However, the direct communication and sharing ideas with persons is disadvantage of qualitative research because it can cause bias in explanation (Gray, 2009).

3.3.2 Quantitative (Deduction) Approach

Quantitative approach is originated from scientific methods usually adopted in most of the natural sciences (Gray, 2009). It characterises by its objectivity and formality as it is

the systematic method in which numerical data are used to measure phenomena and generate results. Quantitative method is used for deductive testing of a specific theory to evolve relationships needed to discuss the results. Becker *et al.* (2012) reported that quantitative studies usually start with an idea (normally expressed as a hypothesis) and use measurement data (generated by deduction) to draw conclusions.

Becker *et al.* (2012) reported four key concerns of quantitative studies. These concerns are: a) measurement; b) causality; c) generalisation; and d) replication. Becker *et al.* (2012) reported two features distinguishing quantitative from qualitative methods. First, quantitative studies use deductive approach to reach at relationships between the theory and the results. Second, they use objective situation to reach at relationships between the phenomena and reality. Creswell (2009) reported that quantitative research uses random sampling of participants, which must be representative of the whole population. Therefore, it enables generalisation of the results to the population. Creswell (2009) recognises that quantitative approach is reliable in exploring the relationships between the study variables and in facilitating predictions and control of the results. Therefore, the quantitative approach is adopted in this study as it enables the use of random sampling of participants.

3.4 Research Design

Research design is the programme that directs the researcher throughout collection, analysis, and interpretation of the observations (Creswell, 2009). It is considered the action plan needed to get the researcher from start to end of the research (Yin, 2013). In order to formulate the research action plan, there are several design alternatives. In case of single design, it is possible to find several suitable data collection methods. Walliman (2010) reported different research methods that can be used for various aspects of same study. Each of these methods allows different routes for the investigation and analysis of the research problem. Therefore, in the present research, considering the aim and objectives, several alternatives have been reviewed to decide upon the suitable research design and data collection techniques. The next sections include discussion of the design details of the research method.

3.4.1 Research Method

This research aims to investigate the parameters affecting quality of delivery of public construction projects in Riyadh city, Saudi Arabia. In order to do so, this research is designed to include two stages.

The first stage is devoted to collect research data. This stage is termed as the induction stage, which is designed to target theory generation. The tasks in this stage are designed to review the literature on several quality issues related to construction industry, especially in Saudi Arabia. It includes establishment of the factors and element affecting quality of construction projects in Saudi Arabia. Also, this stage includes discussion and analysis of several project's quality management techniques. The activities of this stage include formulation of the research questions and review of literature.

The second stage includes design and distribution of questionnaire papers to collect primary data. It also includes discussion and analysis of the results, drawing conclusions and proposing recommendations. The stages of the research are shown in Figure 3.1.

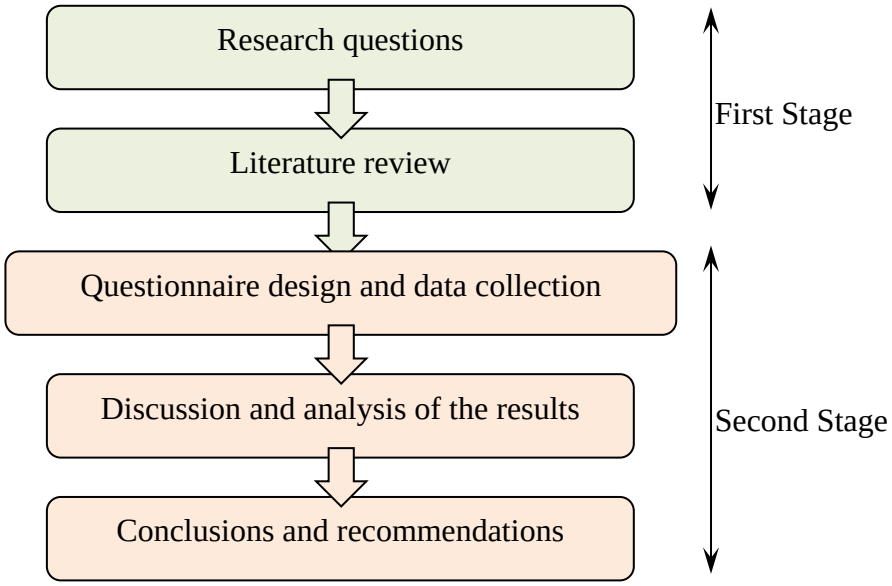

Figure 3.1 Description of the research design

3.4.2 Data Collection Method

Quantitative research method is used in this research. The use of quantitative approach is adopted because it allows recognition, consideration and collection of different opinions of large sample of participants. Also, the use of quantitative method enables performing inclusive evaluation instead of only assessing attitudes and behaviour of limited number of individuals. More details about the suitability of quantities method for this research is discussed in Section 3.3. In this regard, the data collection in this research is selected to obtain primary data in a quantitative form. This type of data is needed to investigate the parameters affecting quality of delivery of public construction projects in Riyadh city in Saudi Arabia. Description of the data collection process, for primary and secondary data, used in this study is shown in Figure 3.2.

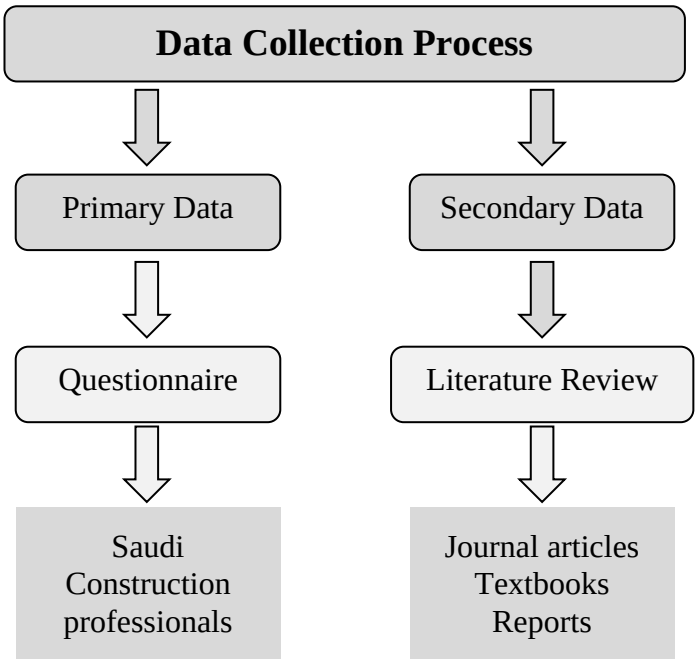

Figure 3.2 Description of data collection method

As shown in Figure 3.2, questionnaire is used in this study as the tool of primary data collection. Questionnaire is selected because it is easy to design, distribute and enables collecting data easy for analysis. Moreover, the selection of questionnaire is justified by the nature of data needed, which is quantitative. Accordingly, questionnaire papers are designed, piloted and then distributed amongst the research participants. Explanatory statement was also designed and distributed along with the questionnaire papers. In the explanatory statement, the aim and objectives of the research are explained and each participant is informed with the right to skip any question of the questionnaire without giving reasons. Before filling in the questionnaire papers, each participant is informed through the explanatory statement with the right to withdraw from the research at any time. Also, the security measures and the confidentiality procedures adopted to save the personal information participants were made clear to each participant. The explanatory statement form is shown in Appendix A.

3.4.3 Data Analysis Method

In this research, Microsoft Excel software is adopted for the statistical analysis of the research data. The first step for the analysis is the coding process, which make it easy to perform the analysis after preparing the required excel spreadsheets. Descriptive method of analysis is adopted in this research to describe the the collected quantitative data. This method of analysis is selected because it enables the researcher to reach at the trends of the results. It also helps to produce expressive presentations of the opinions of participants using counts and percentages of opinions of the total sample. The count of

participants' opinions and the percentages enables the researcher to assess the overall viewpoints of the research sample about each section of the questionnaire paper. Therefore, cross-tabulations (pivot tables) were used to present the data in the form of counts and percentages. The descriptive method of analysis is suitable also in producing results easy to present using tables and graphs. In addition, the significances between the research variables are investigated using Chi-square and ANOVA tests.

3.5 Selection of Research Sample

Selection of study sample is helps to collect different opinions of individuals from Saudi construction industry. These individuals are to have experience in different construction projects types. The selection of sample for this study is affected by several parameters. First, it is affected by the needs to evaluate the awareness of Saudi construction professionals about the factors affecting quality of construction projects at the delivery stage. Second; it is affected by the higher population size of professionals of concerns with the quality of the Saudi construction projects after the execution phases. Third, it is remarkably affected by the limited time period available to collect data and the possibility to have agreement of Saudi construction professionals to join the study.

The sample in this study is randomly selected to comprise various Saudi construction professionals. Different companies are contacted and contractors, consultants, and site engineers are selected to participate in this research. The sample includes participants of experience in planning, execution and delivery of public construction projects, in which the quality standards are of significant effects on the projects' delivery. The research sample is selected, as stated earlier, randomly in the city of Riyadh, capital of Saudi Arabia. Total number of 50 participants from different Saudi construction companies responded and correctly filled in the questionnaire papers. In summary, the sample comprises participants of different age, job titles, education levels and previous work experience.

3.6 Design of the Questionnaire Paper

In this research, questionnaire is the primary data collection tool. Balnaves and Caputi (2001) reported that questionnaire is preferred because it is easy to design, distribute and analyse. In addition, questionnaire need less time and require less costs to perform. The participants completed the questionnaire papers in Riyadh (Saudi Arabia) during months of June and July 2015. The limited time for data collection had remarkable effects on the design of questionnaire. In this study, questionnaire is designed using

closed-ended and open-ended questions, as shown in Appendix B. The use of closed-ended questions makes it easy for the participants to understand the questions and reduces the time needed to filling in the questionnaire paper. Also, closed-ended questions are easier to code and to analyse. Meanwhile, these questions provide limited selections to the participant to choose from. Therefore, using the open-ended questions enabled the participants to express their opinions using their own words and to demonstrate their own thoughts.

As shown in Appendix B, the questionnaire paper consists of two pages. It comprises five main sections. Section I is designed to collect personal information about the study participants. It is designed to collect data about the participants' age so that three categories are given to select from. These are: a) less than 30 years; b) between 30 and 50 years; and c) more than 50 years. Section I is also designed to collect data about the job titles of the research participants so that three categories are given: a) contractors; b) consultants; and c) site engineers. In addition, section I is designed to collect data about the education level of participants so that three education categories are given to the participants to select from including: a) High school; b) University degree; and c) High degree (MSc, PhD). Moreover, section I is designed to collect data about the previous experience of participants so that three categories are given including: a) less than10 years; b) between 10 and 25 years; and c) more than 25 years.

Section II includes three closed ended questions designed to collect data about the adoption of quality measures by Saudi construction companies. The first question in this section is designed to explore the existence and use of clear quality definition by Saudi construction companies. The second question is designed to investigate the use of quality development plans by these companies. The third question is used to collect data about top management support to the quality development plans in Saudi construction companies. For each of these questions, participants are asked to select only one answer from: a) Yes; b) No; and c) No idea.

Section III is designed to collect the participants' opinions about the different factors affecting quality at delivery of public construction projects. So, each participant is asked to rate the importance of each parameter by selecting number on Likert scale of range 1 to 5 with selection 1 is lower important, 2 is low important, 3 is moderate important, 4 is important, and 5 is very important. This question includes ten factors: 1) The project; 2) Design of the project; 3) Contractual agreements; 4) Materials; 5) Labour; 6)

Equipment; 7) Sub-contractors; 8) Site staff; 9) Financial issues; and 10) Project's environment.

Section IV is designed to collect the participants' opinions about the different sub-factors related to the main factors of effect considered in section III. Each participant is asked to rate the importance as mentioned before. Question 5 is designed to collect opinions about the importance of sub-factors related to construction project itself. This question includes four sub-factors: 1) Nature of the project; 2) Location of the project; 3) Access to the project's site; and 4) Execution time of the project. Meanwhile, question 6 is designed to collect opinions about the importance of sub-factors related to materials needed for the project. This question includes four sub-factors: 1) Using material management system; 2) Relations with material suppliers; 3) Availability of good quality materials; and 4) Good storage and handling system. Question 7 is designed to collect opinions about the importance of sub-factors related to labour. This question includes four sub-factors: 1) Using Labour management system; 2) Using experienced labours; 3) Using motivation system; and 4) Training for labours. Question 8 is designed to collect opinions about the importance of quality sub-factors related to sub-contractors of the project. This question includes four sub-factors: 1) Methods of selecting sub-contractors; 2) Sub-contractual terms and conditions; 3) Relations between sub-contractors and main contractor; and 4) Evaluation of sub-contractors performance.

Section V is designed to collect opinions and thoughts of participants using two open ended questions. Question 9 is designed to enable each participant to express his/her understanding of the term project's quality. Meanwhile, question 10 is designed to enable the participants to describe the methods, procedures and techniques with which delivering construction projects of high quality can be achieved.

After finishing the design, the questionnaire is piloted so that three colleagues read and filled in the questionnaire papers. Based on their responses in completing questionnaire paper, they were asked to report the difficulties they encounter during the filling in process and their comments on the clarity of the questions. Their comments were considered in doing the required modifications to the research questions. The final form of the questionnaire paper is shown in Appendix B.

3.7 Research Ethics

This study necessitates collecting information and data from individuals, which means clear conditions and guidelines are required to correctly deal with each individual sharing in this research. These guidelines are needed during the data collection face to face meetings and after collecting the data. During each meeting and before asking to fill in the questionnaire papers, it is essential to:

- demonstrate the objectives of study to the participants
- inform each participant about his/her rights to skip any question or part of the questionnaire paper and the right to cancel their responses, without giving reasons
- avoid interfering or guiding participants to specific selections while they are filling in the papers

After data collection, it is essential to:

- have the collected opinions (i.e. the questionnaire papers) in secure place
- protect the identity of each participant in any publications related to the research
- honestly treating the collected information and reporting the findings

3.8 Summary

This chapter includes description of the research method used in this research. It includes discussion of the research method and data collection tool. This chapter also includes discussion of the research philosophies related to ontology and epistemology. It includes comparison of objectivism versus constructionism and positivism versus constructionism. Also, qualitative and quantitative methods of research are discussed and compared. Thereafter, it presents description of the research design used in this study with giving reasons for the selection of the research method, data collection, and data analysis methods. This chapter also includes description of the questionnaire design used to collect data, the sampling method, and data analysis method. Regarding the questionnaire design, it includes five different sections used to collect personal data and opinions of participants through mixing of closed-end and open-ended questions.

Chapter 4: Results and Discussion

4.1 Introduction

This chapter is used to analyse and discuss the data collected using questionnaire. The first part of this chapter is used to present demographic analysis of the study sample. It comprises analysis of the sample based on age, job title, level of education and previous experience. The second part is used to present discussion and analysis of adoption of clear quality definition by Saudi construction companies, use of quality improvement plans, and support of top management to quality enhancement activities. The third part of this chapter is used to present discussion and analysis of opinions of participants about the importance of the main factors affecting the quality of public construction projects at delivery. It is also used to present analysis and discussion of the importance of sub-factors of the main factors. The last part of this chapter is used to present analysis and discussion of opinions about the understanding of the term project's quality and their thoughts about the methods to be used to ensure delivering public construction projects of high quality in Saudi Arabia.

4.2 Analysis of the Research Sample

In this research, opinions of participants are collected using questionnaire. In total, 135 professionals of Saudi construction industry are contacted to fill in the questionnaire. Some of them are contacted using direct face-to-face meetings, some through phone calls, some using e-mail and others are contacted through friends as third parties. In total, 50 individuals are properly completed the questionnaire papers. This results in having questionnaire response rate of about 37%. Distributions of participants based on age, job title, education level and previous experience are in the next sections.

4.2.1 Analysis of Research Sample by Age

The participants of this study are distributed based on their ages. Based on the results of this study, there are 14 participants (28% of the sample) of age <30 years. There are 28 participants (56% of the sample) of age 30-50 years. Meanwhile, the age group of >50 years includes 8 participants (16% of the sample). The distribution of participants by age is shown in Figure 4.1. Each age group is then analysed using job title, education, and experience, as shown in Table 4.1.

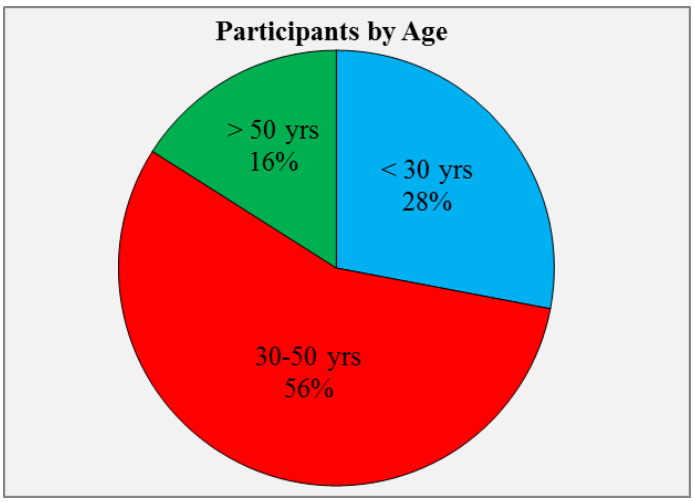

Figure 4.1 Distribution of research sample by age

Table 4.1 Description of age groups by job, education and experience

Other groups		Age groups			Chi-square P-value
		<30 years	**30-50 years**	**>50 years**	
Job	Contractor	5 (36%)	10 (36%)	2 (25%)	0.949
	Consultant	2 (14%)	6 (21%)	2 (25%)	
	Site Eng.	7 (50%)	12 (43%)	4 (50%)	
Edu.	High school	3 (21%)	4 (14%)	------	0.311
	University degree	9 (64%)	18 (64%)	4 (50%)	
	High degree	2 (14%)	6 (21%)	4 (50%)	
Exp.	<10 years	5 (36%)	11 (39%)	2 (25%)	0.636
	10-25 years	8 (57%)	15 (54%)	4 (50%)	
	>25 years	1 (7%)	2 (7%)	2 (25%)	
	Total	**14 (100%)**	**28 (100%)**	**8 (100%)**	

As shown in Table 4.1, the group of age <30 years includes 5 contractors (36% of the group), 2 consultants (14%) and 7 (50%) site engineers. This group includes 3 (21% of the group) of high school, 9 (64%) of university and 2 (14%) of high education. Also, this group includes 5 (36% of the group) of <10 years of experience, 8 (57%) of 10-25 years and 1 (7%) of >25 years.

As shown in Table 4.1, the group of age 30-50 years includes 10 (36% of the group) contractors, 6 (21%) consultants and 12 (43%) site engineers. This group includes 4 (14% of the group) of high school, 18 (64%) of university and 6 (21%) of high

education. This group includes 2 (25% of the group) of <10 years of experience, 4 (50%) of experience 10-25 years and 2 (25%) of experience >25 years.

As shown in Table 4.1, the group of age >50 years includes 2 (25% of the group) contractors, 2 (25%) consultants and 4 (50%) site engineers. This group includes none of high school, 4 (50% of the group) of university and 4 (50%) of high education. This group also includes 2 (25% of the group) of <10 years of experience, 5 (50%) of 10-25 years and 2 (25%) of experience >25 years.

Based on Chi-square results, there is no significant relationship between age and job title ($P = 0.949$). Also, there is no significant relationship between age and education ($P = 0.311$) and no significant relationship between age and experience ($P = 0.636$).

4.2.2 Analysis of Research Sample by Job Title

The participants are distributed according to their job into three groups: a) contractors; b) consultants; and c) site engineers. Based on the results, 17 participants (34% of the sample) are contractors, 10 (20% of the sample) are consultants and 23 (46% of the sample) are site engineers. Each job group is described using age, education, and experience in Table 4.2. Also, sample distribution based on job is shown in Figure 4.2.

Table 4.2 Description of job title groups by age, education and experience

Other groups		Job title groups			Chi-square P-value
		Contractor	**Consultant**	**Site Eng.**	
Age	<30 years	5 (29%)	2 (20%)	7 (30%)	0.949
	30-50 years	10 (59%)	6 (60%)	12 (52%)	
	>50 years	2 (12%)	2 (20%)	4 (17%)	
Edu.	High school	5 (29%)	------	2 (9%)	0.165
	University degree	10 (59%)	7 (70%)	14 (61%)	
	High degree	2 (12%)	3 (30%)	7 (30%)	
Exp.	<10 years	5 (29%)	3 (30%)	10 (43%)	0.637
	10-25 years	11 (65%)	5 (50%)	11 (48%)	
	>25 years	1 (6%)	2 (20%)	2 (9%)	
	Total	**17 (100%)**	**10 (100%)**	**23 (100%)**	

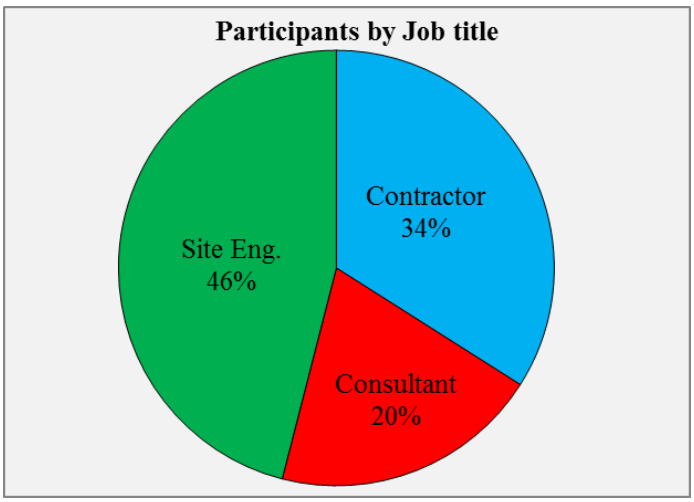

Figure 4.2 Distribution of research sample by job title

As shown in Table 4.2, the group of contractors includes 5 (36% of the group) of age less than 30 years, 10 (59%) of age between 30 and 50 years and 2 (12%) of age more than 50 years. This group includes 5 (29% of the group) of high school, 10 (59%) of university and 2 (12%) of high education. This group includes 5 (29% of the group) of experience <10 years of, 11 (65%) of 10-25 years and 1 (6%) of experience >25 years.

As also shown in Table 4.2, the group of consultants includes 2 (20% of the group) of age <30 years, 6 (60%) of age 30-50 years of age and 2 (20%) of age >50 years. This group includes none of high school, 7 (70% of the group) of university and 3 (30%) of high education. This group also includes 3 (30% of the group) of <10 years of experience, 5 (50%) of 10-25 years and 2 (20%) of experience >25 years.

The results in Table 4.2 show that the group of site engineers includes 7 (30% of the group) of age <30 years, 12 (52%) of age 30-50 years and 4 (17%) of age >50 years. This group includes 2 (9% of the group) of high school, 14 (61%) of university and 7 (30%) of high education. This group also includes 10 (43% of the group) of <10 years of experience, 11 (48%) of 10-25 years and 2 (9%) of experience >25 years.

Based on the Chi-square results, there is no significant relationship between job title and education level ($P = 0.165$). Also, there is no significant relationship between job title and previous experience ($P = 0.637$).

4.2.3 Analysis of Research Sample by Education Level

The participants in this study are distributed based on their education into three groups: a) high school; b) university degree; and c) high degree (i.e. master and PhD). Based on

the results, there are 7 participants (14% of the sample) are of high school education. There are 31 (62% of the sample) are of university degree and 12 (24% of the sample) are of high degree. Each education level group is described using age, job title, and previous experience, as shown in Table 4.3. Also, the overall distribution of participants based on their education is shown in Figure 4.3.

Table 4.3 Participants of each education group by age, job and experience

Other groups		Education groups			Chi-square P-value
		High school	**University degree**	**High degree**	
Age	<30 years	3 (43%)	9 (29%)	2 (17%)	0.311
	30-50 years	4 (57%)	18 (58%)	6 (50%)	
	>50 years	------	4 (13%)	4 (33%)	
Job	Contractor	5 (71%)	10 (32%)	2 (17%)	0.165
	Consultant	------	7 (23%)	3 (25%)	
	Site Eng.	2 (29%)	14 (45%)	7 (58%)	
Exp.	<10 years	1 (14%)	14 (45%)	3 (25%)	0.149
	10-25 years	5 (71%)	16 (52%)	6 (50%)	
	>25 years	1 (14%)	1 (3%)	3 (25%)	
	Total	**7 (100%)**	**31 (100%)**	**12 (100%)**	

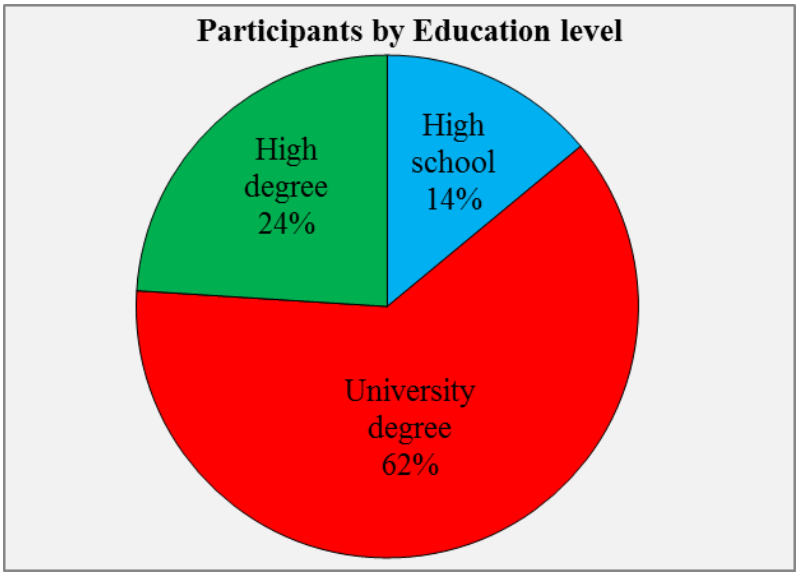

Figure 4.3 Distribution of research sample by education level

As shown in Table 4.3, the high school education group includes 3 (43% of the group) of age <30 years, 4 (57%) of age 30-50 years and none of age >50 years. This group

includes 5 (71% of the group) contractors, no consultants, and 2 (29%) site engineers. This group also includes 1 (14% of the group) of <10 years of experience, 5 (71%) of 10-25 years and one (14%) of experience >25 years.

As also shown in Table 4.3, the group of university degree education includes 9 (29% of the group) of age <30 years, 18 (58%) of age 30-50 years of age and 4 (13%) of age >50 years. This group includes 10 (32% of the group) contractors, 7 (23%) consultants, and 14 (45%) site engineers. This group also includes 14 (45% of the group) of experience <10 years of, 16 (52%) of 10-25 years and 1 (3%) of experience >25 years.

The results in Table 4.3 also show that the group of high degree includes 2 (17% of the group) of age <30 years, 6 (50%) of age 30-50 years and 4 (33%) of age >50 years. This group includes 2 (17% of the group) contractors, 3 (25%) consultants, and 7 (58%) site engineers. This group also includes 3 (25% of the group) of experience <10 years, 6 (50%) of 10-25 years and 3 (25%) of >25 years. Based on Chi-square results, there is no significant relationship between education and experience ($P = 0.149$).

4.2.4 Analysis of Research Sample by Experience

The participants are distributed based on experience into three groups: a) <10 years; b) 10-25 years; and c) >25 years. Based on the results, there are 18 participants (36% of the sample) are of experience <10 years. Also, 27 (54% of the sample) are of experience 10-25 years and 5 (10% of the sample) are of experience >25 years. The distribution of participants based on experience is shown in Figure 4.4. Also, each experience group is described using age, job title, and education level, as shown in Table 4.4.

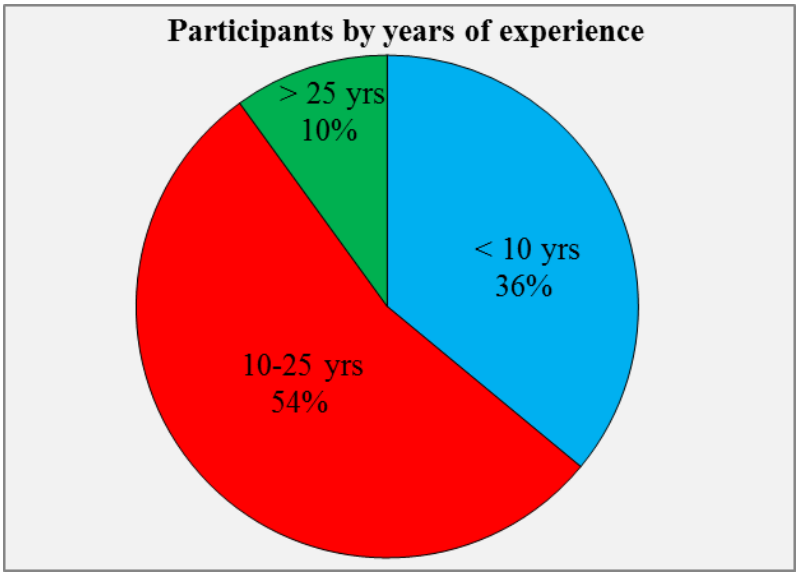

Figure 4.4 Distribution of research sample by experience

Table 4.4 Description of experience groups by age, job and education

Other groups		Experience groups			Chi-square P-value
		<10 years	**10-25 years**	**>25 years**	
Age	<30 years	5 (28%)	8 (30%)	1 (20%)	0.636
	30-50 years	11 (61%)	15 (56%)	2 (40%)	
	>50 years	2 (11%)	4 (15%)	2 (40%)	
Job	Contractor	5 (28%)	11 (41%)	1 (20%)	0.637
	Consultant	3 (17%)	5 (19%)	2 (40%)	
	Site Eng.	10 (56%)	11 (41%)	2 (40%)	
Edu.	High school	1 (6%)	5 (19%)	1 (20%)	0.149
	University degree	14 (78%)	16 (59%)	1 (20%)	
	High degree	3 (17%)	6 (22%)	3 (60%)	
	Total	**18 (100%)**	**27 (100%)**	**5 (100%)**	

As shown in Table 4.4, the group of experience <10 years of includes 5 (28% of the group) of age <30 years, 11 (61%) of age 30-50 years and 2 (11%) of age >50 years. This group includes 5 (28% of the group) contractors, 3 (17%) consultants, and 10 (56%) site engineers. This group also includes 1 (6% of the group) of high school, 14 (78%) of university and 3 (17%) of high education.

As shown in Table 4.4, the group of experience 10-25 years includes 8 (30% of the group) of age <30 years, 15 (56%) of age 30-50 years and 4 (15%) of age >50 years. This group includes 11 (41% of the group) contractors, 5 (19%) consultants, and 11 (41%) site engineers. This group also includes 5 (19% of the group) of high school, 16 (59%) of university and 6 (22%) of high education.

The results in Table 4.4 show that the group of experience >25 years includes 1 (20% of the group) of age <30 years, 2 (40%) of age 30-50 years and 2 (40%) of age >50 years. This group includes 1 (20% of the group) contractor, 2 (40%) consultants, and 2 (40%) site engineers. This group also includes 1 (20% of the group) of high school, 1 (20%) of university and 3 (60%) of high education.

4.3 Quality Measures in Saudi Construction Companies

4.3.1 Adoption of Clear Quality Definitions

The participants are asked if their companies adopt clear definition of quality. They were given the statement: *My Company adopts clear definition of quality* and three answers to select from: Yes, No, and No idea. The responses are in Figure 4.5.

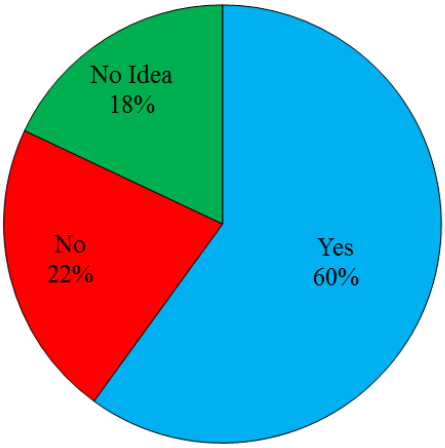

Figure 4.5 Adoption of clear definition of quality

As shown in Figure 4.5, the majority of participants (30 i.e. 60% of the sample) reported that their companies adopt clear definition of quality. However, 11 (22%) reported no adoption and 9 (18%) reported no idea. This reflects the increased awareness of Saudi construction companies towards the significance of delivering higher quality projects. Responses of each group are shown in Table 4.5.

Table 4.5 Opinions of groups to adoption of clear quality definition

Other groups		Count (% of other group)			Total	ANOVA P-value
		Yes	No	No idea		
Age	<30 years	8 (57%)	3 (21%)	3 (21%)	14 (100%)	0.004
	30-50 years	15 (54%)	7 (25%)	6 (21%)	28 (100%)	
	>50 years	7 (88%)	1 (13%)	-------	8 (100%)	
Job	Contractor	11 (65%)	2 (12%)	4 (24%)	17 (100%)	0.136
	Consultant	7 (70%)	1 (10%)	2 (20%)	10 (100%)	
	Site Eng.	12 (52%)	8 (35%)	3 (13%)	23 (100%)	
Edu.	High school	5 (71%)	1 (14%)	1 (14%)	7 (100%)	0.013
	University	17 (55%)	8 (26%)	6 (19%)	31 (100%)	
	High degree	8 (67%)	2 (17%)	2 (17%)	12 (100%)	
Exp.	<10 years	9 (50%)	7 (39%)	2 (11%)	18 (100%)	0.120
	10-25 years	17 (63%)	4 (15%)	6 (22%)	27 (100%)	
	>25 years	4 (80%)	-------	1 (20%)	5 (100%)	
	Total counts	**30**	**11**	**9**	**50 (100%)**	

As shown in Table 4.5, the highest adoption of clear quality definition is reported by 88% of the group of >50 years and slightly more than half of other age groups. Highest adoption is also reported by 70% of consultants, 65% of contractors and 52% of site engineers. Also, highest adoption is reported by 71% of high school education, 67% of high level of education and 55% of university educated. In addition, highest adoption is reported by 80% of those of experience >25 years, 63% of those of experience 10-25 years and 50% of those of experience <10 years.

Analysis of variance (ANOVA) test is performed and the level of significance is evaluated using P-value. As shown in Table 4.5, there is a significant relationship between age and the adoption of clear definition of quality ($P = 0.004$) and significant relationship between education level and the adoption of clear definition of quality ($P = 0.013$). However, there is insignificant relationship between job and the adoption of clear definition of quality ($P = 0.136$) and insignificant relationship between work experience and the adoption of clear definition of quality ($P = 0.120$).

4.3.2 The use of Quality Development Plan

The participants are asked if their companies have quality development plan. They were given the statement: *My company have a quality improvement plan* and three answers to select from: Yes, No, and No idea. The responses are in Figure 4.6.

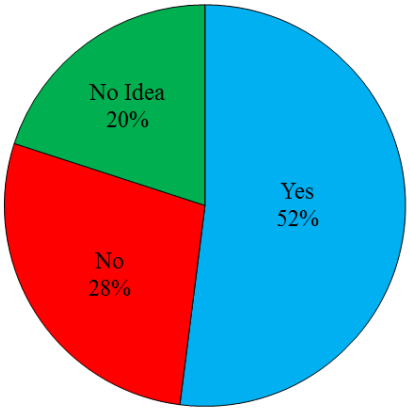

Figure 4.6 Responses to companies have quality development plan

As shown in Figure 4.6, slightly more than half of participants (26 i.e. 52% of the sample) reported that their companies have quality development plans. However, 14 (28%) reported no use and 10 (20%) reported no idea. This shows the appreciation of Saudi construction companies to develop the quality of their projects. Responses of each group are shown in Table 4.6.

Table 4.6 Opinions of groups on having quality development plans

Other groups		Count (% of other group)			Total	ANOVA P-value
		Yes	No	No idea		
Age	<30 years	8 (57%)	3 (21%)	3 (21%)	14 (100%)	0.003
	30-50 years	13 (46%)	9 (32%)	6 (21%)	28 (100%)	
	>50 years	5 (63%)	2 (25%)	1 (13%)	8 (100%)	
Job	Contractor	8 (47%)	7 (41%)	2 (12%)	17 (100%)	0.297
	Consultant	6 (60%)	4 (40%)	-------	10 (100%)	
	Site Eng.	12 (52%)	3 (13%)	8 (35%)	23 (100%)	
Edu.	High school	3 (43%)	3 (43%)	1 (14%)	7 (100%)	0.051
	University	17 (55%)	8 (26%)	6 (19%)	31 (100%)	
	High degree	6 (50%)	3 (25%)	3 (25%)	12 (100%)	
Exp.	<10 years	10 (56%)	4 (22%)	4 (22%)	18 (100%)	0.040
	10-25 years	14 (52%)	7 (26%)	6 (22%)	27 (100%)	
	>25 years	2 (40%)	3 (60%)	-------	5 (100%)	
	Total counts	**26**	**14**	**10**	**50 (100%)**	

As shown in Table 4.6, 63% of the group of >50 years and about half of other age groups reported that their companies have quality development plans. Meanwhile, 60% of consultants, 52% of site engineers, and 47% of contractors reported the same. Also, 55% of university education, 50% of high education and 43% of high school educated reported similar responses. In addition, 56% of those of <10 years of experience and 52% of those of experience 10-25 years reported that their companies have quality development plans. However, 60% of those of experience >25 years reported not having quality development plans in their companies.

As shown in Table 4.6, ANOVA test results demonstrated that there is a significant relationship between age and possession of quality development plans ($P = 0.003$) and significant relationship between work experience and possession of quality development plans ($P = 0.040$). However, there is insignificant relationship between job and the possession of quality development plans ($P = 0.297$) and insignificant relationship between education level and possession of quality development plans ($P = 0.051$).

4.3.3 Top Management Support Quality Development Plan

The participants are asked if the top management in their companies support the quality development plan. They were given the statement: *In my company, quality improvement plans are supported by top management* and three answers to select from: Yes, No, and No idea. The responses are in Figure 4.7.

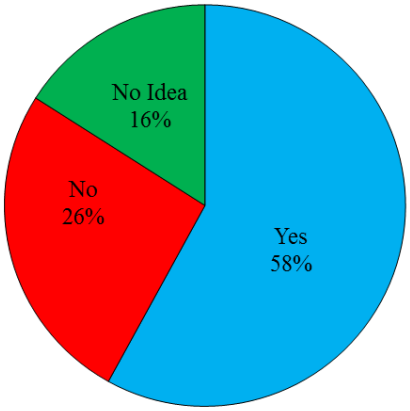

Figure 4.7 Top management support quality development plan

As shown in Figure 4.7, 29 participants (58% of the research sample) reported that their top management in their companies support quality development plans. However, 14 (28%) reported no support and 8 (16%) reported no idea. This shows the willingness of top management of Saudi construction companies to support quality development plans in their companies. Responses for each group are shown in Table 4.7.

Table 4.7 Opinions of groups on support of quality development plans

Other groups		Count (% of other group)			Total	ANOVA P-value
		Yes	No	No idea		
Age	<30 years	9 (64%)	4 (29%)	1 (7%)	14 (100%)	0.021
	30-50 years	14 (50%)	9 (32%)	5 (18%)	28 (100%)	
	>50 years	6 (75%)	--------	2 (25%)	8 (100%)	
Job	Contractor	9 (53%)	7 (41%)	1 (6%)	17 (100%)	0.169
	Consultant	7 (70%)	2 (20%)	1 (10%)	10 (100%)	
	Site Eng.	13 (57%)	4 (17%)	6 (26%)	23 (100%)	
Edu.	High school	3 (43%)	3 (43%)	1 (14%)	7 (100%)	0.061
	University	17 (55%)	9 (29%)	5 (16%)	31 (100%)	
	High degree	9 (75%)	1 (8%)	2 (17%)	12 (100%)	
Exp.	<10 years	7 (39%)	8 (44%)	3 (17%)	18 (100%)	0.132
	10-25 years	17 (63%)	5 (19%)	5 (19%)	27 (100%)	
	>25 years	5 (100%)	--------	--------	5 (100%)	
	Total counts	**29**	**13**	**8**	**50 (100%)**	

As shown in Table 4.7, 75% of the group of >50 years, half of the age group 30-50 years and 64% of age group <30 years reported that top management in their companies support quality development plans. Similar support is reported by 70% of consultants, 57% of site engineers, and 52% of contractors. Also, 75% of high level education, 55% of university education and 43% of high school educated reported similar support. In

addition, only 43% of those of <10 years of experience, 63% of those of experience 10-25 years and all group of >50 years of experience reported management support.

As shown in Table 4.7, ANOVA test results demonstrated significant relationship between age and management support of quality development plans ($P = 0.021$). There is insignificant relationship between job and management support ($P = 0.169$), between education and management support ($P = 0.061$) and between experience and support of top management to quality development plans ($P = 0.132$).

4.4 Main Factors Affecting Quality of Construction Projects

The participants were given factors of effects on the quality of construction projects at delivery and were asked to rank them based on importance using scale (1 is lowest and 5 is highest). For each factor, the mean importance score is calculated from:

$$Mean = \frac{1}{n}\sum_{i=1}^{i=5}(Count\ of\ i * i) \quad (4.1)$$

where n is 50. For example, the score of the main factor "*The project*" is calculated as:

$Mean = \frac{1}{50}[(5 * 1) + (16 * 2) + (6 * 3) + (11 * 4) + (12 * 5)] = \frac{159}{50} = 3.18$

The main factors are ranked based as shown in Table 4.8.

Table 4.8 Ranks of main factors affecting quality

Main factors	Importance: count (% of sample)					Mean
	[1]	[2]	[3]	[4]	[5]	
Labour	3 (6%)	7 (14%)	14 (28%)	11 (22%)	15 (30%)	**3.56**
Site staff	2 (4%)	9 (18%)	14 (28%)	11 (22%)	14 (28%)	**3.52**
Financial issues	2 (4%)	12 (24%)	13 (26%)	8 (16%)	15 (30%)	**3.44**
Equipment	3(6%)	6 (12%)	18 (36%)	16 (32%)	7 (14%)	**3.36**
Contractual agreements	2 (4%)	12 (24%)	12 (24%)	15 (30%)	9 (18%)	**3.34**
Project's environment	3 (6%)	13 (26%)	12 (24%)	10 (20%)	12 (24%)	**3.30**
Sub-contractors	3 (6%)	8 (16%)	20 (40%)	10 (20%)	9 (18%)	**3.28**
The project	5 (10%)	16 (32%)	6 (12%)	11 (22%)	12 (24%)	**3.18**
Design of the project	2 (4%)	17 (34%)	8 (16%)	16 (32%)	7 (14%)	**3.18**
Materials	2 (4%)	15 (30%)	12 (24%)	14 (28%)	7 (14%)	**3.18**

The results in Table 4.8 show that the most important factor of effects on the quality of Saudi construction projects at delivery is labour ($mean = 3.56$) followed by site staff ($mean = 3.52$). This result is in good agreement with literature Omran *et al.* (2012) who demonstrated the effects of labour and workers at project site on the quality of delivery of construction projects. The skilled labour and well trained workforce can positively affect the quality. Meanwhile, the results show that the factors of lowest

importance ($mean = 3.18$) are the project, design of the project, and materials. This finding is supported by the findings of Pheng (2004) who reported that the nature of project and its features should have minimised effects on the quality at delivery. However, it is surprising to find lowest importance of materials because the use of high quality materials considerably affects the quality of the final form of the construction. Financial problems appeared as shown in Table 4.8 in the third place of importance because the availability of budgets enables to hire skilled labour and to use higher quality materials needed for increased overall quality of the project at delivery. This is mainly critical in the public projects because the government officials are very strict when accepting the final executed construction projects. This finding agreed well with the results of Abdel-Razeq *et al.* (2001), who reported the importance of solving financial problems to avoid their negative impacts on the quality of construction projects, especially owned by the government i.e. the public projects. The contractual agreements was found, see Table 4.8, amongst the first five important factors because it presents the reference between the contractor and the owner at the end of the project. Therefore, quality standards should be included in the contracts to ensure delivering public construction projects at higher quality. The ANOVA test results show insignificant difference between age groups ($P = 0.716$) and the importance of factors affecting quality. However, there are significant differences between groups of job title, education and experience about the importance of these factors ($P < 0.001$).

4.5 Sub-Factors Affecting Quality of Construction Projects

4.5.1 Sub-Factors related to the Project

The participants were given 4 sub-factors related to the project and were asked to rank them based on importance. The ranks are shown in Table 4.9.

Table 4.9 Ranks of sub-factors related to the project affecting quality

Sub-factors	Importance: count (% of sample)					Mean
	[1]	[2]	[3]	[4]	[5]	
Location of the project	8 (16%)	16 (32%)	9 (18%)	6 (12%)	11 (22%)	**2.92**
Access to the project's site	9 (18%)	17 (34%)	7 (14%)	5 (10%)	12 (24%)	**2.88**
Nature of the project	8 (16%)	17 (34%)	8 (16%)	7 (14%)	10 (20%)	**2.88**
Execution time of the project	9 (18%)	16 (32%)	9 (18%)	6 (12%)	10 (20%)	**2.84**

The results in Table 4.9 show that the most important sub-factor related to the project is the project location ($mean = 2.92$). This can attributed to the effect of location on the performance of the labour and also the closeness to the good quality materials. The

access to the project site is in the second place because it enables fast access to the work area and therefore suitable time for performing the tasks at higher quality. The least important sub-factor is the execution time of the project ($mean = 2.48$). This result is contradicting the findings of Jha and Iyer (2006) who reported the importance of execution time to the quality of delivered work. In general, if the tasks are executed at the planned time, they are expected to be performed at higher quality. ANOVA results show insignificant difference between groups of age ($P = 0.747$), job ($P = 0.627$), education ($P = 0.321$) and years of experience ($P = 0.915$) and the importance of sub-factors related to the project.

4.5.2 Sub-Factors related to Materials

The participants were given 4 sub-factors related to materials and were asked to rank them based on importance. The ranks are shown in Table 4.10.

Table 4.10 Ranks of sub-factors related to materials affecting quality

Sub-factors	Importance: count (% of sample)					Mean
	[1]	[2]	[3]	[4]	[5]	
Relations with material suppliers	8 (16%)	16 (32%)	7 (14%)	7 (14%)	12 (24%)	**2.98**
Good storage and handling system	7 (14%)	16 (32%)	10 (20%)	6 (12%)	11 (22%)	**2.96**
Using material management system	13 (26%)	15 (30%)	5 (10%)	8 (16%)	13 (26%)	**2.78**
Availability of good quality materials	14 (28%)	13 (26%)	4 (8%)	8 (16%)	11 (22%)	**2.78**

The results in Table 4.10 show that the most important sub-factor related to materials is the relations with material suppliers ($mean = 2.98$). This is mainly because it can affect the quantity and quality of the materials needed to produce higher quality products. The second important parameter is the good storage and handling of the materials because it affects the material quality, especially used for finishing, on the overall quality of the project. The lowest important sub-factor is the availability of good quality materials ($mean = 2.78$). This can be true because materials of good quality in the absence of skilled labour can have negative effects on the quality of delivery of the public projects in Saudi Arabia because of the severe weather conditions. For example, the temperature in summer can exceeds 50 degree Celsius. ANOVA results show that there is insignificant difference between different groups of age ($P = 0.235$), job title ($P = 0.957$), education level ($P = 0.829$) and experience ($P = 0.899$) and importance of the sub-factors related to materials.

4.5.3 Sub-Factors related to Labour

The participants were given 4 sub-factors related to labour and were asked to rank theses sub-factor based on importance. The ranks are shown in Table 4.11.

Table 4.11 Ranks of sub-factors related to labour affecting quality

Sub-factors	Importance: count (% of sample)					Mean
	[1]	[2]	[3]	[4]	[5]	
Using experienced labours	6 (12%)	17 (34%)	5 (10%)	11 (22%)	11 (22%)	**3.08**
Using motivation system	7 (14%)	14 (28%)	8 (16%)	10 (20%)	11 (22%)	**3.08**
Using labour management system	7 (14%)	17 (34%)	9 (18%)	7 (14%)	10 (20%)	**2.92**
Training for labours	10 (20%)	15 (30%)	7 (14%)	8 (16%)	10 (20%)	**2.86**

The results in Table 4.11 show that the most important sub-factor related to labour is the use of experienced labours ($mean = 3.08$). The higher experience of labours enables them to benefit from the available material in performing higher quality jobs. This factor is reported of higher importance for delivering higher quality construction projects by Jha and Iyer (2006). Other factor of importance is the existence of motivation system so that the labour performing higher quality jobs can be rewarded. This spread the culture of quality performance amongst the labour force of the project. The lowest important sub-factor is the training for labours ($mean = 2.78$). ANOVA results show insignificant difference between different groups of age ($P = 0.267$), job title ($P = 0.304$), education level ($P = 0.762$) and experience ($P = 0.811$) and the importance of the sub-factors related to labour.

4.5.4 Sub-Factors related to Sub-contractors

The participants were given 4 sub-factors related to sub-contractors and were asked to rank them based on importance. The ranks are shown in Table 4.12.

Table 4.12 Ranks of sub-factors related to sub-contractors affecting quality

Sub-factors	Importance: count (% of sample)					Mean
	[1]	[2]	[3]	[4]	[5]	
Evaluation of sub-contractors performance	7 (14%)	15 (30%)	8 (16%)	10 (20%)	10 (20%)	**3.02**
Sub-contractual terms and conditions	7 (14%)	17 (34%)	7 (14%)	9 (18%)	10 (20%)	**2.96**
Methods of selecting sub-contractors	13 (26%)	14 (28%)	5 (10%)	7 (14%)	11 (22%)	**2.78**
Relations between sub-contractors and main contractor	14 (28%)	13 (26%)	5 (10%)	7 (14%)	22%	**2.76**

The results in Table 4.12 show that the most important sub-factor, related to sub-contractors, is the evaluation of sub-contractors performance ($mean = 3.02$). the evaluation of subcontractor performance force them to deliver high quality tasks in order to extend their subcontracts with big companies. Also, the terms and conditions are important because they represent reference to refer to at the end of the project to assess the quality of delivery of the project. The lowest important sub-factor is the relations between sub-contractors and main contractor ($mean = 2.76$). ANOVA results show that there is insignificant difference between different groups of age ($P = 0.213$), job title ($P = 0.138$), education level ($P = 0.770$) and experience ($P = 0.439$) and the importance of the sub-factors related to sub-contractors.

4.6 Opinions on Understanding of Project's Quality

Few number of participants (12 i.e. 24%) expressed their understanding of the term quality of construction project. These participants see the quality of construction project as the pleasing look of the final product and the freedom from defects on delivery. Other opinions consider this quality as the project delivery on time in a condition of good compliance with the project purpose. Quality of construction projects was also related to having reasonable running costs over the lifetime of the project by means of satisfactory durability. Opinions of respondents also show that quality of construction project can be understood by the client in a way different from the constructors. For example, clients consider the project of high quality as the one of higher value for money and match the project purpose. Meanwhile, constructors evaluate the quality of the project in terms of client satisfaction so that the project of higher quality is the project receives more satisfaction of client and users.

4.7 Opinions on Delivering High Quality Construction Projects

Few number of participants (12 i.e. 24%) expressed their opinions about the methods with which construction projects of high quality can be delivered. This can be ensured by continuous development and enhancement of the quality assurance to provide effective quality control systems. This can also be achieved through accurate estimation of the costs of every process and the right selection of contractors and consultants. Also, quality can be ensured through arrangement of training sessions for contractors, labour and consultants and by adopting quality systems such as ISO 9000. Quality can also be ensured through good utilisation of the resources and considering the importance of specialisation in construction activities. High quality construction projects can also be

delivered by the strong co-operation between the industry and the scientific and research centres. Also, clear definition of the responsibilities of each project's parties is very important for the delivery of increased quality projects.

4.8 Summary

Saudi construction professionals including contractors, consultants and site engineers completed the questionnaire. The participants are distributed based on their ages, job titles, level of education, and their previous experience. Each category includes three different groups.

The results show that the majority of participants reported that their companies adopt clear definition of quality. The results also show significant relationship between age and the adoption of clear quality definition and between education level and the adoption of clear quality definition. However, the relationships between job and experience and the adoption of clear quality definition were insignificant.

Considerable number of opinions shows that Saudi construction companies have quality development plans. The statistical analysis show significant relationships between age and experience and possession of quality development plans. Meanwhile, insignificant relationships were found between job and education level and having quality plans.

In addition, several participants of this study reported that top management in their companies support quality development plans. The results show significant relationship between age and top management support. However, insignificant relationships were found between job, education, and experience and the support of top management.

The main factors of effects on the quality of construction projects at delivery are ranked based on their importance. The most important factors are the labour and site staff whereas the lowest important are the project, design of the project, and materials. There are significant differences only between groups of job, education and experience and the importance of these factors.

Importance of sub-factors related to project, materials, labour and sub-contractors are ranked based on their importance. The most important sub-factor related to the project is the project location and the lowest important is the execution time of the project. The most important sub-factor related to materials is the relations with material suppliers and the lowest important is the availability of good quality materials. The most

important sub-factor related to labour is the use of experienced labours and the lowest important is the training for labours. The most important sub-factor related to sub-contractors is the evaluation of sub-contractors performance and the lowest important is the relations between sub-contractors and main contractor.

Chapter 5: Conclusions and Recommendations

5.1 Conclusions

In construction market, featured by vigorous competition, quality is essential in the majority of construction projects. Quality is an essential success factor especially with the reduction of quality costs and its effects on competitive advantage of construction companies. The factors affecting the quality of delivery of public construction projects in Saudi Arabia are significant for the government and construction professionals. Therefore, the aim of this research is to investigate these parameters in Riyadh city, Saudi Arabia. Based on the results of this study, several conclusions can be drawn. These conclusions are:

- There are several and different definitions of quality because the perspectives and perceptions are changeable at various organisational levels. So, it is difficult to rely on single quality definition to avoid performance problems. (Section 2.2)
- The change of quality definitions is related to the different quality dimensions, which include performance, features, reliability, conformance, durability, serviceability, aesthetics, and the perceived quality dimension. (Section 2.2)
- It is important to use suitable quality system for construction industry. Such system is effective with higher abilities and skills which can be ensured by training. The quality system in construction industry needs healthier worksite conditions with constant inspection. It also requires identification of responsibilities along with methods to motivate workers to produce higher quality work. (Section 2.2)
- The overall quality costs comprise four categories. These are prevention costs, appraisal costs, internal failure costs, and external failure costs. Quality costs have significant effects on the management decisions. (Section 2.2)
- There are three main philosophies on the best methods to measure, manage and improve quality. These philosophies have been developed by Deming (quality management systems), Juran (quality assurance) and Crospy (quality control). (Section 2.3).
- It is essential to establish a quality system to improve the quality in construction industry. The first step is to establish quality policy followed by organising the system needs. The second step is to design the procedures and processes of the

system. The third step is to keep the system alive through training and to prepare the required quality manual suitable for the construction company. (Section 2.4)

- The factors affecting the quality of construction projects are classified into five groups related to client, project, team leader, procedure, project environment, and management procedures.

In order to assess the factors affecting the quality of delivery of public construction projects in Saudi Arabia, 135 Saudi construction professionals are contacted to fill in the questionnaire. The correctly completed questionnaire papers are obtained from 50 participants (37% response rate). The participants are distributed based on their ages into three groups. There are 14 participants (28% of the sample) in the age group of <30 years. There are 28 (56%) in the group 30-50 years and 8 (16%) in the group of >50 years. According to their job titles, the study sample includes 17 (34%) contractors, 10 (20%) consultants and 23 (46%) site engineers. Based on the level of education, there are 7 participants (14%) of high school, 31 (62%) of university degree and 12 (24%) are of high degree education. According to their previous experience, the research sample includes 18 participants (36%) of experience <10 years, 27 (54%) of experience 10-25 years and 5 (10%) of experience >25 years. Based on the analysis of questionnaire results the following conclusions can be drawn:

- The majority of participants (60% of the sample) reported that their companies adopt clear definition of quality. However, 22% of them reported no adoption and 18% reported no idea, which show that Saudi construction companies are keen to deliver high quality construction projects. (Section 4.3.1)
- The majority of older age participants reported adoption of clear quality definition. Similar responses were reported by 70% of consultants, 65% of contractors and 52% of site engineers. Meanwhile, 71% of high school, 67% of high level education and 55% of university educated participants reported the same. In total, 80% of the experience participants reported that their companies adopt clear quality definition. (Section 4.3.1)
- There is a significant relationship between age and the adoption of clear definition of quality and between education level and the adoption of clear quality definition. However, insignificant relationship between job and the adoption of clear quality definition was found. (Section 4.3.1)

- More than half of participants (52%) reported that their companies have quality development plans, which shows the appreciation of Saudi construction companies to enhance the quality on delivery of their projects. (Section 4.3.2)
- About two thirds of older age group reported having quality development plans in their companies. Similar responses are given by 60% of consultants, 52% of site engineers, and 47% of contractors. In addition, 55% of university level, 50% of high level and 43% of participants of high school education reported the same. However, 60% of participants of highest experience reported having no plans. (Section 4.3.2)
- There is significant relationship between age and having quality development plans and between experience and having these plans. However, insignificant relationship was found between job and having quality plans and insignificant relationship between education level and having plans to develop quality. (Section 4.3.2)
- More than half of participants (58%) reported that top management in their companies support quality development plans. However, 14 (28%) reported no support and 8 (16%) reported no idea. This shows the preparedness of top management to adopt effective quality development plans in their companies. (Section 4.3.3)
- The support of top management is reported by 75% of the older age and more than half of other age groups. Also, top management support is reported by 70% of consultants, 57% of site engineers, and 52% of contractors. The support is reported also by 75% of high level education and 55% of university education. Similar responses are given by all high experience participants. (Section 4.3.3)
- There is significant relationship between age and top management support. However, insignificant relationship was found between job and support, between education and support and between experience and top management support. (Section 4.3.3)

Main Factors Affecting Quality of Projects

Ten main factors of effects on the quality of construction projects at delivery are evaluated by participants of this study. These factors are ranked according to their importance for the quality of public construction projects at delivery. The first five factors are: labour, site staff, financial issues, equipment and contractual agreements. The last five are project's environment, sub-contractors, the project, design of the project, and materials. Based on the results of this study, the most important factor is the labour followed by the site staff. Meanwhile, the factors of lowest importance are the

project, design of the project, and materials. The statistical results show insignificant difference between age groups and the importance of these factors. However, there are significant differences between groups of job title, education and experience and the importance of these factors. (Section 4.4)

Sub-Factors Affecting Quality of Projects

Importance of four sub-factors related to project is evaluated. These sub-factors are: location of the project, access to the project's site, nature of the project, and the execution time of the project. The most important sub-factor related to the project is the project location and the lowest important is the execution time of the project. There is insignificant difference between any group of participants and the importance of project related sub-factors. (Section 4.5.1)

Importance of four sub-factors related to materials is evaluated. These sub-factors are: relations with material suppliers, good storage and handling system, using material management system, and availability of good quality materials. The most important sub-factor related to materials is the relations with material suppliers and the lowest important is the availability of good quality materials. There is insignificant difference between any group of participants and the importance of the materials related sub-factors. (Section 4.5.2)

Importance of four sub-factors related to labour is evaluated. These sub-factors are: using experienced labours, using motivation system, using labour management system, and training for labours. The most important sub-factor related to labour is the use of experienced labours and the lowest important is the training for labours. There is insignificant difference between any group of participants and the importance of the labour related sub-factors. (Section 4.5.3)

Importance of four sub-factors related to sub-contractors is evaluated. These sub-factors are: evaluation of sub-contractors performance, sub-contractual terms and conditions, methods of selecting sub-contractors, and relations between sub-contractors and main contractor. The most important sub-factor related to sub-contractors is the evaluation of performance and the lowest important is the relations between sub-contractors and main contractor. There is insignificant difference between any group of participants and the importance of the sub-contractors related sub-factors. (Section 4.5.4)

Participants of this study understand the quality of construction project as the pleasing look of the final product and the freedom from defects on delivery. Others understand quality as delivering the project on time in good compliance with the purpose. Others assess the quality by the reasonable running costs of the project and its durability. Moreover, clients understand quality in terms of value for money whereas constructors understand it in terms of client satisfaction. (Section 4.6)

There are several methods with which construction projects of high quality can be delivered. These include continuous development of quality assurance, using accurate cost estimation and good selection of contractors and consultants. These methods also include training of contractors, labour and consultants and by adopting quality systems such as ISO 9000. Other methods include good utilisation of resources and considering specialisation in activities along with the co-operation between industry and research centres. (Section 4.7)

5.2 Recommendations

Based on the results of this study, several recommendations can be proposed to improve the quality of Saudi construction public projects on delivery. Part of the proposed recommendations is to the construction professionals and the other part is for the researchers. The construction professionals in Saudi Arabia are recommended to:

- Improve the tender prices in order to encourage and help the contractors to hire skilled labour forces
- Enhance the cooperation between governmental officials, designers, consultants and contractors to deliver public projects
- Consider the importance of completing the projects' activities on time and controlling the costs to become within the budget while monitoring the quality at all times.
- Improve the harmonisation between the main contractors and the sub-contractors
- Train the contractors to equip them with the skills needed to properly understand the design drawings to deliver outcomes of higher quality and specifications
- Arrange workshops for the contractors to improve their abilities in adopting quality system needed to improve their works
- Review the property of selected materials to match the Saudi standards

For the researcher, the recommendations are:

- Increase the sample size of the questionnaire to match the opinions of population and to improve the quality of research results
- Collect data from other cities to build wider understanding of the issues of quality all over the country
- Consider the opinions of clients and users on the quality of public projects

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Appendix A: Explanatory Statement

Research Title:

Involving End Users in Managing Water Resources Projects in KSA

The data and opinions required for this research is collected using questionnaire. This questionnaire is implemented in Riyadh city, Saudi Arabia. The questionnaire is used because of its suitability and ease to complete by the Saudi construction professionals. The participants in this study are contractors, consultants and site engineers of different age, job titles, level of education, and work experience.

The questionnaire paper comprises two pages and includes different sections. The first section is used to collect personal information about research participants. These data and information are needed to make categories required for data analysis purposes. These data are to be stored in safe and secure place and can only be accessed by the researcher. The other sections are designed to collect the participants' opinions about issues related to quality of delivery of public construction projects.

The participants of this research have the right to skip any question or any part of the questionnaire paper. They also have the right to withdraw from the research at any time at any stage without giving any reason for their withdrawal.

Thank you for agreeing to participate in this research.

Appendix B (Questionnaire)

Section I: Personal Information

Age (years): □ less than 30 □ 30 to 50 □ more than 50

Job title: □ Contractor □ Consultant □ Site engineer

Education level: □ High school □ University degree □ High degree (MSc, PhD)

Experience (years): □ less than10 □ 10 to 25 □ more than 25

Section II: Quality measures in your company

(1) My company adopts clear definition of quality

□ Yes □ No □ No idea

(2) My company have a quality improvement plan?

□ Yes □ No □ No idea

(3) In my company, quality improvement plans are supported by top management?

□ Yes □ No □ No idea

Please tick your selection (✓) so that 5 is more important on the scale

Section III: Factors affecting Quality of delivery of construction projects

(4) Rate the importance of the following elements on project's quality?

No.	Quality Element	1	2	3	4	5
4.1	The project					
4.2	Design of the project					
4.3	Contractual agreements					
4.4	Materials					
4.5	Labour					
4.6	Equipment					
4.7	Sub-contractors					
4.8	Site staff					
4.9	Financial issues					
4.10	Project's environment					

Section IV: Sub-Factors affecting Quality of delivery of construction projects

(5) Rate the importance of the sub-factors related to project on project's quality?

No.	Sub-factor	1	2	3	4	5
5.1	Nature of the project					
5.2	Location of the project					
5.3	Access to the project's site					
5.4	Execution time of the project					

(6) Rate the importance of the sub-factors related to materials on project's quality?

No.	Sub-factor	1	2	3	4	5
6.1	Using material management system					
6.2	Relations with material suppliers					
6.3	Availability of good quality materials					
6.4	Good storage and handling system					

(7) Rate the importance of the sub-factors related to labour on project's quality?

No.	Sub-factor	1	2	3	4	5
7.1	Using Labour management system					
7.2	Using experienced labours					
7.3	Using motivation system					
7.4	Training for labours					

(8) Rate the importance of the sub-factors related to sub-contractors on project's quality?

No.	Sub-factor	1	2	3	4	5
8.1	Methods of selecting sub-contractors					
8.2	Sub-contractual terms and conditions					
8.3	Relations between sub-contractors and main contractor					
8.4	Evaluation of sub-contractors performance					

Section V: Opinions and viewpoints

(9) Express your understanding of the term project's quality?

---

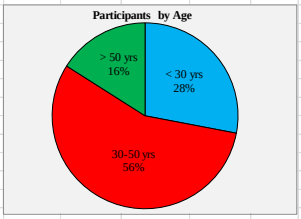
(10) How to ensure delivering construction projects of high quality?

Thank you for your time

Appendix C: Statistical Results

Row Labels	Count of Age
<30	14
30-50	28
>50	8
Grand Total	**50**

Age	n
< 30 yrs	14
30-50 yrs	28
> 50 yrs	8
Total	50



% of total	
< 30 yrs	28%
30-50 yrs	56%
> 50 yrs	16%
Total	100%

Count of Job	Column Labels			
Row Labels	**Contractor**	**Consultant**	**Site Eng.**	**Grand Total**
<30	5	2	7	14
30-50	10	6	12	28
>50	2	2	4	8
Grand Total	**17**	**10**	**23**	**50**

	Contractor	Consultant	Site Eng.	Total
< 30 yrs	5	2	7	**14**
30-50 yrs	10	6	12	**28**
> 50 yrs	2	2	4	**8**

% of age by Job				
	Contractor	Consultant	Site Eng	**Total**
< 30 yrs	36%	14%	50%	100%
30-50 yrs	36%	21%	43%	100%
> 50 yrs	25%	25%	50%	100%

< 30 yrs	30-50 yrs	> 50 yrs
5	10	2
2	6	2
7	12	4

% of total			
	< 30 yrs	30-50 yrs	> 50 yrs
Total	36%	36%	25%
< 30 yrs	14%	21%	25%
30-50 yrs	50%	43%	50%

Count of Edu	Column Labels			
Row Labels	**High school**	**University degree**	**High degree**	**Grand Total**
<30	3	9	2	14
30-50	4	18	6	28
>50		4	4	8
Grand Total	**7**	**31**	**12**	**50**

	High school	University degre	High degree	Total
< 30 yrs	3	9	2	**14**
30-50 yrs	4	18	6	**28**
> 50 yrs	0	4	4	**8**

% of age by Edu				
	High school	University degre	High degree	**Total**
< 30 yrs	21%	64%	14%	**100%**
30-50 yrs	14%	64%	21%	**100%**
> 50 yrs	0%	50%	50%	**100%**

< 30 yrs	30-50 yrs	> 50 yrs
3	4	0
9	18	4
2	6	4

% of total			
	< 30 yrs	30-50 yrs	> 50 yrs
Total	21%	14%	0%
< 30 yrs	64%	64%	50%
30-50 yrs	14%	21%	50%

Count of Exper	Column Labels			
Row Labels	**<10**	**10-25**	**>25**	**Grand Total**
<30	5	8	1	14
30-50	11	15	2	28
>50	2	4	2	8
Grand Total	**18**	**27**	**5**	**50**

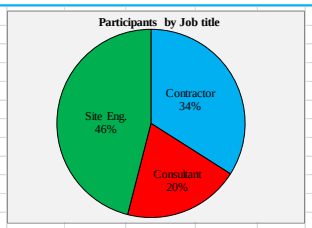
	< 10 yrs	10-25 yrs	> 25 yrs	Total
< 30 yrs	5	8	1	**14**
30-50 yrs	11	15	2	**28**
> 50 yrs	2	4	2	**8**

% of age by Edu				
	< 10 yrs	10-25 yrs	> 25 yrs	**Total**
< 30 yrs	36%	57%	7%	**100%**
30-50 yrs	39%	54%	7%	**100%**
> 50 yrs	25%	50%	25%	**100%**

< 30 yrs	30-50 yrs	> 50 yrs
5	11	2
8	15	4
1	2	2

% of total			
	< 30 yrs	30-50 yrs	> 50 yrs
Total	36%	39%	25%
< 30 yrs	57%	54%	50%
30-50 yrs	7%	7%	25%

Job	n
Contractor	17
Consultant	10
Site Eng.	23
Total	**50**



Row Labels	Count of Job
Contractor	17
Consultant	10
Site Eng.	23
Grand Total	**50**

% of total	
Contractor	34%
Consultant	20%
Site Eng.	46%
Total	100%

Count of Age	Column Labe			
Row Labels	**<30**	**30-50**	**>50**	**Grand Total**
Contractor	5	10	2	17
Consultant	2	6	2	10
Site Eng.	7	12	4	23
Grand Total	**14**	**28**	**8**	**50**

	< 30 yrs	30-50 yrs	> 50 yrs	Total
Contractor	5	10	2	**17**
Consultant	2	6	2	**10**
Site Eng.	7	12	4	**23**

	Contractor	Consultant	Site Eng.
	29%	20%	30%
	59%	60%	52%
	12%	20%	17%
	5	2	7
	10	6	12
	2	2	4

% of age by Job

	< 30 yrs	30-50 yrs	> 50 yrs	Total
Contractor	29%	59%	12%	100%
Consultant	20%	60%	20%	100%
Site Eng.	30%	52%	17%	100%

Count of Edu	Column Labe			
Row Labels	**High school**	**University degree**	**High degree**	**Grand Total**
Contractor	5	10	2	17
Consultant		7	3	10
Site Eng.	2	14	7	23
Grand Total	**7**	**31**	**12**	**50**

	High school	University degre	High degree	Total
Contractor	5	10	2	**17**
Consultant	0	7	3	**10**
Site Eng.	2	14	7	**23**

	Contractor	Consultant	Site Eng.
	29%	0%	9%
	59%	70%	61%
	12%	30%	30%
	5	0	2
	10	7	14
	2	3	7

% of age by Edu

	High school	University degre	High degree	Total
Contractor	29%	59%	12%	**100%**
Consultant	0%	70%	30%	**100%**
Site Eng.	9%	61%	30%	**100%**

Count of Exper	Column Labe			
Row Labels	**<10**	**10-25**	**>25**	**Grand Total**
Contractor	5	11	1	17
Consultant	3	5	2	10
Site Eng.	10	11	2	23
Grand Total	**18**	**27**	**5**	**50**

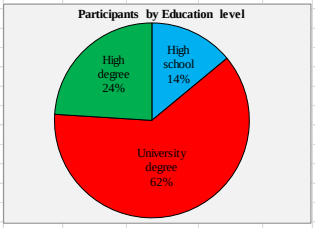
	< 10 yrs	10-25 yrs	> 25 yrs	Total
Contractor	5	11	1	**17**
Consultant	3	5	2	**10**
Site Eng.	10	11	2	**23**

	Contractor	Consultant	Site Eng.
	29%	30%	43%
	65%	50%	48%
	6%	20%	9%
	5	3	10
	11	5	11
	1	2	2

% of age by Edu

	< 10 yrs	10-25 yrs	> 25 yrs	Total
Contractor	29%	65%	6%	**100%**
Consultant	30%	50%	20%	**100%**
Site Eng.	43%	48%	9%	**100%**

Education	n
High schoo	7
University	31
High degre	12
Total	**50**



Row Labels	Count of Edu
High school	7
University degree	31
High degree	12
Grand Total	**50**

% of total	
High school	14%
University degree	62%
High degree	24%
Total	100%

Count of Age	Column Labels			
Row Labels	**<30**	**30-50**	**>50**	**Grand Total**
High school	3	4		7
University degree	9	18	4	31
High degree	2	6	4	12
Grand Total	**14**	**28**	**8**	**50**

	< 30 yrs	30-50 yrs	> 50 yrs	Total
High school	3	4	0	**7**
University de	9	18	4	**31**
High degree	2	6	4	**12**

High schoo	versity deg	high degree
43%	29%	17%
57%	58%	50%
0%	13%	33%
3	9	2
4	18	6
0	4	4

% of age by Job

	< 30 yrs	30-50 yrs	> 50 yrs	Total
High school	43%	57%	0%	100%
University degree	29%	58%	13%	100%
High degree	17%	50%	33%	100%

Count of Job	Column Labels			
Row Labels	**Contractor**	**Consultant**	**Site Eng.**	**Grand Total**
High school	5		2	7
University degree	10	7	14	31
High degree	2	3	7	12
Grand Total	**17**	**10**	**23**	**50**

	Contractor	Consultant	Site Eng.	Total
High school	5	0	2	**7**
University degree	10	7	14	**31**
High degree	2	3	7	**12**

71%	32%	17%
0%	23%	25%
29%	45%	58%
5	10	2
0	7	3
2	14	7

% of age by Edu

	Contractor	Consultant	Site Eng.	Total
High school	71%	0%	29%	**100%**
University degree	32%	23%	45%	**100%**
High degree	17%	25%	58%	**100%**

Count of Exper	Column Labels			
Row Labels	**<10**	**10-25**	**>25**	**Grand Total**
High school	1	5	1	7
University degree	14	16	1	31
High degree	3	6	3	12
Grand Total	**18**	**27**	**5**	**50**

	< 10 yrs	10-25 yrs	> 25 yrs	Total
High school	1	5	1	**7**
University degree	14	16	1	**31**
High degree	3	6	3	**12**

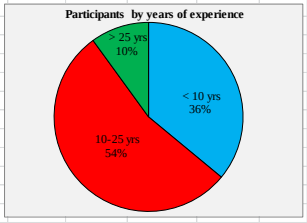
14%	45%	25%
71%	52%	50%
14%	3%	25%
1	14	3
5	16	6
1	1	3

% of age by Edu

	< 10 yrs	10-25 yrs	> 25 yrs	Total
High school	14%	71%	14%	**100%**
University degree	45%	52%	3%	**100%**
High degree	25%	50%	25%	**100%**

Row Labels	Count of Exper
< 10 yrs	18
10-25 yrs	27
> 25 yrs	5
Grand Total	**50**

Education	n
< 10 yrs	18
10-25 yrs	27
> 25 yrs	5
Total	**50**



% of total		
< 10 yrs	36%	
10-25 yrs	54%	
> 25 yrs	10%	
Total	100%	

Count of Age	Column Labe			
Row Labels	<30	30-50	>50	Grand Total
< 10 yrs	5	11	2	18
10-25 yrs	8	15	4	27
> 25 yrs	1	2	2	5
Grand Total	**14**	**28**	**8**	**50**

	< 30 yrs	30-50 yrs	> 50 yrs	Total
< 10 yrs	5	11	2	**18**
10-25 yrs	8	15	4	**27**
> 25 yrs	1	2	2	**5**

% of age by Job				
	< 30 yrs	30-50 yrs	> 50 yrs	Total
< 10 yrs	28%	61%	11%	100%
10-25 yrs	30%	56%	15%	100%
> 25 yrs	20%	40%	40%	100%

5	8	1	
11	15	2	
2	4	2	

Count of Job	Column Labe			
Row Labels	Contractor	Consultant	Site Eng.	Grand Total
< 10 yrs	5	3	10	18
10-25 yrs	11	5	11	27
> 25 yrs	1	2	2	5
Grand Total	**17**	**10**	**23**	**50**

	Contractor	Consultant	Site Eng.	Total
< 10 yrs	5	3	10	**18**
10-25 yrs	11	5	11	**27**
> 25 yrs	1	2	2	**5**

% of age by Edu				
	Contractor	Consultant	Site Eng.	Total
< 10 yrs	28%	17%	56%	**100%**
10-25 yrs	41%	19%	41%	**100%**
> 25 yrs	20%	40%	40%	**100%**

5	11	1	
3	5	2	
10	11	2	

Count of Edu	Column Labe			
Row Labels	High school	University degree	High degree	Grand Total
<10	1	14	3	18
10-25	5	16	6	27
>25	1	1	3	5
Grand Total	**7**	**31**	**12**	**50**

	High school	niversity degree	High degree	Total
< 10 yrs	1	14	3	**18**
10-25 yrs	5	16	6	**27**
> 25 yrs	1	1	3	**5**

% of age by Edu				
	High school	Jniversity degre	High degree	Total
< 10 yrs	6%	78%	17%	**100%**
10-25 yrs	19%	59%	22%	**100%**
> 25 yrs	20%	20%	60%	**100%**

1	5	1	
14	16	1	
3	6	3	

< 10 yrs	10-25 yrs	> 25 yrs
36%	54%	10%
28%	30%	20%
61%	56%	40%
11%	15%	40%
28%	41%	20%
17%	19%	40%
56%	41%	40%
6%	19%	20%
78%	59%	20%
17%	22%	60%

Chi-Square Test

Count of Job	Column Labels			
Row Labels	Contractor	Consultan	Site Eng.	Grand Total
<30	5	2	7	14
30-50	10	6	12	28
>50	2	2	4	8
Grand Total	17	10	23	50

ACTUAL	Contractor	Consultant	Site Eng.	Total
< 10 yrs	5	2	7	14
10-25 yrs	10	6	12	28
> 25 yrs	2	2	4	8
Total	17	10	23	50

EXPECTED	Contractor	Consultant	Site Eng.
< 10 yrs	4.76	2.8	6.44
10-25 yrs	9.52	5.6	12.88
> 25 yrs	2.72	1.6	3.68

AGE AND JOB

P-Value 0.949

Count of Edu	Column Labels			
Row Labels	High school	University	High deg	Grand Total
<30	3	9	2	14
30-50	4	18	6	28
>50		4	4	8
Grand Total	7	31	12	50

ACTUAL	High school	Jniversity degree	High degree	Total
< 10 yrs	3	9	2	14
10-25 yrs	4	18	6	28
> 25 yrs	0	4	4	8
Total	7	31	12	50

EXPECTED	High school	Jniversity degree	High degree
< 10 yrs	1.96	8.68	3.36
10-25 yrs	3.92	17.36	6.72
> 25 yrs	1.12	4.96	1.92

AGE AND EDUCATION

P-Value 0.311

Count of Exper	Column Labels			
Row Labels	< 10 yrs	10-25 yrs	> 25 yrs	Grand Total
<30	5	8	1	14
30-50	11	15	2	28
>50	2	4	2	8
Grand Total	18	27	5	50

ACTUAL	< 10 yrs	10-25 yrs	> 25 yrs	Total
< 10 yrs	5	8	1	14
10-25 yrs	11	15	2	28
> 25 yrs	2	4	2	8
Total	18	27	5	50

EXPECTED	< 10 yrs	10-25 yrs	> 25 yrs
< 10 yrs	5.04	7.56	1.4
10-25 yrs	10.08	15.12	2.8
> 25 yrs	2.88	4.32	0.8

AGE AND EXPERIENCE

P-Value 0.636

Count of Edu	Column Labels			
Row Labels	High school	University	High deg	Grand Total
Contractor	5	10	2	17
Consultant		7	3	10
Site Eng.	2	14	7	23
Grand Total	7	31	12	50

ACTUAL	High school	Jniversity degree	High degree	Total
Contractor	5	10	2	17
Consultant	0	7	3	10
Site Eng.	2	14	7	23
Total	7	31	12	50

EXPECTED	High school	Jniversity degree	High degree
Contractor	2.38	10.54	4.08
Consultant	1.4	6.2	2.4
Site Eng.	3.22	14.26	5.52

JOB AND EDUCATION

P-Value 0.165

Count of Exper	Column Labels			
Row Labels	< 10 yrs	10-25 yrs	> 25 yrs	Grand Total
Contractor	5	11	1	17
Consultant	3	5	2	10
Site Eng.	10	11	2	23
Grand Total	18	27	5	50

ACTUAL	< 10 yrs	10-25 yrs	> 25 yrs	Total
Contractor	5	11	1	17
Consultant	3	5	2	10
Site Eng.	10	11	2	23
Total	18	27	5	50

EXPECTED	< 10 yrs	10-25 yrs	> 25 yrs
Contractor	6.12	9.18	1.7
Consultant	3.6	5.4	1
Site Eng.	8.28	12.42	2.3

JOB AND EXPERIENCE

P-Value 0.637

Count of Exper	Column Labels			
Row Labels	< 10 yrs	10-25 yrs	> 25 yrs	Grand Total
High school	1	5	1	7
University degree	14	16	1	31
High degree	3	6	3	12
Grand Total	18	27	5	50

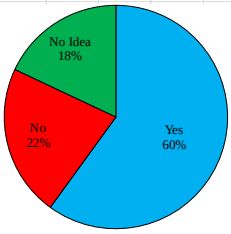
ACTUAL	< 10 yrs	10-25 yrs	> 25 yrs	Total
High school	1	5	1	7
University de	14	16	1	31
High degree	3	6	3	12
Total	18	27	5	50

EXPECTED	< 10 yrs	10-25 yrs	> 25 yrs
High school	2.52	3.78	0.7
University degr	11.16	16.74	3.1
High degree	4.32	6.48	1.2

EDUCATION AND EXPERIENCE

P-Value 0.149

Q-01 Results



Row Labels	Count of Q1
Yes	30
No	11
No Idea	9
Grand Total	**50**

	Q1
Yes	30
No	11
No Idea	9

Age & Q1

Count of Q1	Column Labels			
Row Labels	**Yes**	**No**	**No Idea**	**Grand Total**
< 30 yrs	8	3	3	14
30-50 yrs	15	7	6	28
> 50 yrs	7	1		8
Grand Total	**30**	**11**	**9**	**50**

	Yes	No	No Idea	Total
< 30 yrs	8	3	3	14
30-50 yrs	15	7	6	28
> 50 yrs	7	1	0	8

	Yes	No	No Idea	Total
< 30 years	57%	21%	21%	100%
30 - 50 years	54%	25%	21%	100%
> 50 years	88%	13%	0%	100%

Anova: Two-Factor Without Replication

SUMMARY	*Count*	*Sum*	*Average*	*Variance*
< 30 yrs	3	14	4.666667	8.333333
30-50 yrs	3	28	9.333333	24.33333
> 50 yrs	3	8	2.666667	14.33333
Yes	3	30	10	19
No	3	11	3.666667	9.333333
No Idea	3	9	3	9

ANOVA

Source of Varia	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	70.22222	2	35.11111	31.6	0.003543	6.944272
Columns	89.55556	2	44.77778	40.3	0.002236	6.944272
Error	4.444444	4	1.111111			
Total	164.2222	8				

Job & Q1

Count of Q1	Column Labels			
Row Labels	**1**	**2**	**3**	**Grand Total**
Contractor	11	2	4	17
Consultant	7	1	2	10
Site Eng.	12	8	3	23
Grand Total	**30**	**11**	**9**	**50**

	Yes	No	No Idea	Total
Contractor	11	2	4	**17**
Consultant	7	1	2	**10**
Site Eng.	12	8	3	**23**

	Yes	No	No Idea	Total
Contractor	65%	12%	24%	100%
Consultant	70%	10%	20%	100%
Site Eng	52%	35%	13%	100%

Anova: Two-Factor Without Replication

SUMMARY	*Count*	*Sum*	*Average*	*Variance*
Contracto	3	17	5.666667	22.33333
Consultan	3	10	3.333333	10.33333
Site Eng.	3	23	7.666667	20.33333
Yes	3	30	10	7
No	3	11	3.666667	14.33333
No Idea	3	9	3	1

ANOVA

Source of Varia	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	28.22222	2	14.11111	3.432432	0.135541	6.944272
Columns	89.55556	2	44.77778	10.89189	0.024067	6.944272
Error	16.44444	4	4.111111			
Total	134.2222	8				

Educ & Q1

Count of Q1	Column Labels			
Row Labels	**1**	**2**	**3**	**Grand Total**
High school	5	1	1	7
University degree	17	8	6	31
High degree	8	2	2	12
Grand Total	**30**	**11**	**9**	**50**

	Yes	No	No Idea	Total
High school	5	1	1	7
University degree	17	8	6	31
High degree	8	2	2	12

	Yes	No	No Idea	Total
High school	71%	14%	14%	100%
University	55%	26%	19%	100%
Higher	67%	17%	17%	100%

Anova: Two-Factor Without Replication

SUMMARY	*Count*	*Sum*	*Average*	*Variance*
High schoo	3	7	2.333333	5.333333
University	3	31	10.33333	34.33333
High degre	3	12	4	12
Yes	3	30	10	39
No	3	11	3.666667	14.33333
No Idea	3	9	3	7

ANOVA

Source of Varia	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	106.8889	2	53.44444	15.51613	0.013037	6.944272
Columns	89.55556	2	44.77778	13	0.017778	6.944272
Error	13.77778	4	3.444444			
Total	210.2222	8				

Experience & Q1

Count of Q1	Column Labels			
Row Labels	**1**	**2**	**3**	**Grand Total**
<10 yrs	9	7	2	18
10-25 yrs	17	4	6	27
>25 yrs	4		1	5
Grand Total	**30**	**11**	**9**	**50**

	Yes	No	No Idea	Total
<10 yrs	9	7	2	18
10-25 yrs	17	4	6	27
>25 yrs	4	0	1	5

	Yes	No	No Idea	Total
<10 yrs	50%	39%	11%	100%
10-25 yrs	63%	15%	22%	100%
>25 yrs	80%	0%	20%	100%

Anova: Two-Factor Without Replication

SUMMARY	*Count*	*Sum*	*Average*	*Variance*
<10 yrs	3	18	6	13
10-25 yrs	3	27	9	49
>25 yrs	3	5	1.666667	4.333333
Yes	3	30	10	43
No	3	11	3.666667	12.33333
No Idea	3	9	3	7

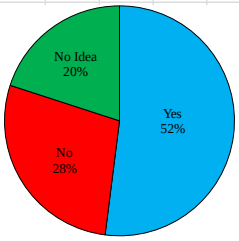
ANOVA

Source of Varia	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	81.55556	2	40.77778	3.783505	0.119585	6.944272
Columns	89.55556	2	44.77778	4.154639	0.105598	6.944272
Error	43.11111	4	10.77778			
Total	214.2222	8				

Q-02 Results

Row Labels	Count of Q2
1	26
2	14
3	10
Grand Total	**50**

	Q2
Yes	26
No	14
No Idea	10



Age & Q2

Count of Q2	Column Labels			
Row Labels	**1**	**2**	**3**	**Grand Total**
< 30 yrs	8	3	3	14
30-50 yrs	13	9	6	28
> 50 yrs	5	2	1	8
Grand Total	**26**	**14**	**10**	**50**

	Yes	No	No Idea	Total
< 30 yrs	8	3	3	14
30-50 yrs	13	9	6	28
> 50 yrs	5	2	1	8

	Yes	No	No Idea	Total
< 30 years	57%	21%	21%	100%
30 - 50 years	46%	32%	21%	100%
> 50 years	63%	25%	13%	100%

Anova: Two-Factor Without Replication

SUMMARY	*Count*	*Sum*	*Average*	*Variance*
< 30 yrs	3	14	4.666667	8.333333
30-50 yrs	3	28	9.333333	12.33333
> 50 yrs	3	8	2.666667	4.333333
Yes	3	26	8.666667	16.33333
No	3	14	4.666667	14.33333
No Idea	3	10	3.333333	6.333333

ANOVA

Source of Varia	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	70.22222	2	35.11111	37.17647	0.002606	6.944272
Columns	46.22222	2	23.11111	24.47059	0.005709	6.944272
Error	3.777778	4	0.944444			
Total	120.2222	8				

Job & Q2

Count of Q2	Column Labels			
Row Labels	**1**	**2**	**3**	**Grand Total**
Contractor	8	7	2	17
Consultant	6	4		10
Site Eng.	12	3	8	23
Grand Total	**26**	**14**	**10**	**50**

	Yes	No	No Idea	Total
Contractor	8	7	2	**17**
Consultant	6	4	0	**10**
Site Eng.	12	3	8	**23**

	Yes	No	No Idea	Total
Contractor	47%	41%	12%	100%
Consultant	60%	40%	0%	100%
Site Eng	52%	13%	35%	100%

Anova: Two-Factor Without Replication

SUMMARY	*Count*	*Sum*	*Average*	*Variance*
Contracto	3	17	5.666667	10.33333
Consultan	3	10	3.333333	9.333333
Site Eng.	3	23	7.666667	20.33333
Yes	3	26	8.666667	9.333333
No	3	14	4.666667	4.333333
No Idea	3	10	3.333333	17.33333

ANOVA

Source of Varia	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	28.22222	2	14.11111	1.671053	0.29681	6.944272
Columns	46.22222	2	23.11111	2.736842	0.178272	6.944272
Error	33.77778	4	8.444444			
Total	108.2222	8				

Educ & Q2

Count of Q2	Column Labels			
Row Labels	**1**	**2**	**3**	**Grand Total**
High school	3	3	1	7
University degree	17	8	6	31
High degree	6	3	3	12
Grand Total	**26**	**14**	**10**	**50**

	Yes	No	No Idea	Total
High school	3	3	1	7
University degree	17	8	6	31
High degree	6	3	3	12

	Yes	No	No Idea	Total
High school	43%	43%	14%	100%
University	55%	26%	19%	100%
Higher	50%	25%	25%	100%

Anova: Two-Factor Without Replication

SUMMARY	*Count*	*Sum*	*Average*	*Variance*
High schoo	3	7	2.333333	1.333333
University	3	31	10.33333	34.33333
High degre	3	12	4	3
Yes	3	26	8.666667	54.33333
No	3	14	4.666667	8.333333
No Idea	3	10	3.333333	6.333333

ANOVA

Source of Varia	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	106.8889	2	53.44444	6.871429	0.050824	6.944272
Columns	46.22222	2	23.11111	2.971429	0.161844	6.944272
Error	31.11111	4	7.777778			
Total	184.2222	8				

Experience & Q2

Count of Q2	Column Labels			
Row Labels	**1**	**2**	**3**	**Grand Total**
<10 yrs	10	4	4	18
10-25 yrs	14	7	6	27
>25 yrs	2	3		5
Grand Total	**26**	**14**	**10**	**50**

	Yes	No	No Idea	Total
<10 yrs	10	4	4	18
10-25 yrs	14	7	6	27
>25 yrs	2	3	0	5

	Yes	No	No Idea	Total
<10 yrs	56%	22%	22%	100%
10-25 yrs	52%	26%	22%	100%
>25 yrs	40%	60%	0%	100%

Anova: Two-Factor Without Replication

SUMMARY	*Count*	*Sum*	*Average*	*Variance*
<10 yrs	3	18	6	12
10-25 yrs	3	27	9	19
>25 yrs	3	5	1.666667	2.333333
Yes	3	26	8.666667	37.33333
No	3	14	4.666667	4.333333
No Idea	3	10	3.333333	9.333333

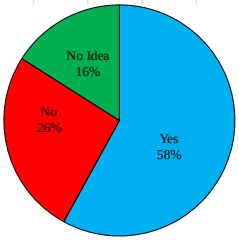
ANOVA

Source of Varia	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	81.55556	2	40.77778	7.978261	0.040174	6.944272
Columns	46.22222	2	23.11111	4.521739	0.094044	6.944272
Error	20.44444	4	5.111111			
Total	148.2222	8				

Q-03 Results

Row Labels	Count of Q3
1	29
2	13
3	8
Grand Total	**50**

Q3	
Yes	29
No	13
No Idea	8



Age & Q3

Count of Q3	Column Labels			
Row Labels	**1**	**2**	**3**	**Grand Total**
< 30 yrs	9	4	1	14
30-50 yrs	14	9	5	28
> 50 yrs	6		2	8
Grand Total	**29**	**13**	**8**	**50**

	Yes	No	No Idea	Total
< 30 yrs	9	4	1	14
30-50 yrs	14	9	5	28
> 50 yrs	6	0	2	8

	Yes	No	No Idea	
< 30 years	64%	29%	7%	100%
30 - 50 years	50%	32%	18%	100%
> 50 years	75%	0%	25%	100%

Anova: Two-Factor Without Replication

SUMMARY	*Count*	*Sum*	*Average*	*Variance*
< 30 yrs	3	14	4.666667	16.33333
30-50 yrs	3	28	9.333333	20.33333
> 50 yrs	3	8	2.666667	9.333333
Yes	3	29	9.666667	16.33333
No	3	13	4.333333	20.33333
No Idea	3	8	2.666667	4.333333

ANOVA

Source of Varia	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	70.22222	2	35.11111	11.92453	0.02063	6.944272
Columns	80.22222	2	40.11111	13.62264	0.016389	6.944272
Error	11.77778	4	2.944444			
Total	162.2222	8				

Job & Q3

Count of Q3	Column Labels			
Row Labels	**1**	**2**	**3**	**Grand Total**
Contractor	9	7	1	17
Consultant	7	2	1	10
Site Eng.	13	4	6	23
Grand Total	**29**	**13**	**8**	**50**

	Yes	No	No Idea	Total
Contractor	9	7	1	**17**
Consultant	7	2	1	**10**
Site Eng.	13	4	6	**23**

	Yes	No	No Idea	Total
Contractor	53%	41%	6%	100%
Consultant	70%	20%	10%	100%
Site Eng	57%	17%	26%	100%

Anova: Two-Factor Without Replication

SUMMARY	*Count*	*Sum*	*Average*	*Variance*
Contracto	3	17	5.666667	17.33333
Consultan	3	10	3.333333	10.33333
Site Eng.	3	23	7.666667	22.33333
Yes	3	29	9.666667	9.333333
No	3	13	4.333333	6.333333
No Idea	3	8	2.666667	8.333333

ANOVA

Source of Varia	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	28.22222	2	14.11111	2.853933	0.169775	6.944272
Columns	80.22222	2	40.11111	8.11236	0.039116	6.944272
Error	19.77778	4	4.944444			
Total	128.2222	8				

Educ & Q3

Count of Q3	Column Labels			
Row Labels	**1**	**2**	**3**	**Grand Total**
High school	3	3	1	7
University degree	17	9	5	31
High degree	9	1	2	12
Grand Total	**29**	**13**	**8**	**50**

	Yes	No	No Idea	Total
High school	3	3	1	7
University degree	17	9	5	31
High degree	9	1	2	12

	Yes	No	No Idea	Total
High school	43%	43%	14%	100%
University	55%	29%	16%	100%
Higher	75%	8%	17%	100%

Anova: Two-Factor Without Replication

SUMMARY	*Count*	*Sum*	*Average*	*Variance*
High schoo	3	7	2.333333	1.333333
University	3	31	10.33333	37.33333
High degre	3	12	4	19
Yes	3	29	9.666667	49.33333
No	3	13	4.333333	17.33333
No Idea	3	8	2.666667	4.333333

ANOVA

Source of Varia	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	106.8889	2	53.44444	6.088608	0.061138	6.944272
Columns	80.22222	2	40.11111	4.56962	0.092679	6.944272
Error	35.11111	4	8.777778			
Total	222.2222	8				

Experience & Q3

Count of Q3	Column Labels			
Row Labels	**1**	**2**	**3**	**Grand Total**
<10 yrs	7	8	3	18
10-25 yrs	17	5	5	27
>25 yrs	5			5
Grand Total	**29**	**13**	**8**	**50**

	Yes	No	No Idea	Total
<10 yrs	7	8	3	18
10-25 yrs	17	5	5	27
>25 yrs	5	0	0	5

	Yes	No	No Idea	Total
<10 yrs	39%	44%	17%	100%
10-25 yrs	63%	19%	19%	100%
>25 yrs	100%	0%	0%	100%

Anova: Two-Factor Without Replication

SUMMARY	*Count*	*Sum*	*Average*	*Variance*
<10 yrs	3	18	6	7
10-25 yrs	3	27	9	48
>25 yrs	3	5	1.666667	8.333333
Yes	3	29	9.666667	41.33333
No	3	13	4.333333	16.33333
No Idea	3	8	2.666667	6.333333

ANOVA

Source of Varia	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	81.55556	2	40.77778	3.511962	0.131658	6.944272
Columns	80.22222	2	40.11111	3.454545	0.134444	6.944272
Error	46.44444	4	11.61111			
Total	208.2222	8				

Column Labels					
	1	2	3	4	5 Grand Total
Count of Q4.1	5	16	6	11	12 50

Column Labels					
	1	2	3	4	5 Grand Total
Count of Q4.2	2	17	8	16	7 50

Column Labels					
	1	2	3	4	5 Grand Total
Count of Q4.3	2	12	12	15	9 50

Column Labels					
	1	2	3	4	5 Grand Total
Count of Q4.4	2	15	12	14	7 50

Column Labels					
	1	2	3	4	5 Grand Total
Count of Q4.5	3	7	14	11	15 50

Column Labels					
	1	2	3	4	5 Grand Total
Count of Q4.6	3	6	18	16	7 50

Column Labels					
	1	2	3	4	5 Grand Total
Count of Q4.7	3	8	20	10	9 50

Column Labels					
	1	2	3	4	5 Grand Total
Count 4.8	2	9	14	11	14 50

Column Labels					
	1	2	3	4	5 Grand Total
Count 4.9	2	12	13	8	15 50

Column Labels					
	1	2	3	4	5 Grand Total
Count 4.10	3	13	12	10	12 50

Q-04 overall

	1	2	3	4	5	Mean		
Q4.1	5	16	6	11	12	3.18	Min	3.18
Q4.2	2	17	8	16	7	3.18	Min	
Q4.3	2	12	12	15	9	3.34		
Q4.4	2	15	12	14	7	3.18	Min	
Q4.5	3	7	14	11	15	3.56	Max	3.56
Q4.6	3	6	18	16	7	3.36		
Q4.7	3	8	20	10	9	3.28		
Q4.8	2	9	14	11	14	3.52	Average	3.33
Q4.9	2	12	13	8	15	3.44	SD	0.139
Q4.10	3	13	12	10	12	3.30		

	1	2	3	4	5	Mean	
Q4.5	3	7	14	11	15	3.56	Labour
Q4.8	2	9	14	11	14	3.52	Site staff
Q4.9	2	12	13	8	15	3.44	Financial issues
Q4.6	3	6	18	16	7	3.36	Equipment
Q4.3	2	12	12	15	9	3.34	Contractual agreements
Q4.10	3	13	12	10	12	3.30	Project's environment
Q4.7	3	8	20	10	9	3.28	Sub-contractors
Q4.1	5	16	6	11	12	3.18	The project
Q4.2	2	17	8	16	7	3.18	Design of the project
Q4.4	2	15	12	14	7	3.18	Materials

Labour	6%	14%	28%	22%	30%
Site staff	4%	18%	28%	22%	28%
Financial issues	4%	24%	26%	16%	30%
Equipment	6%	12%	36%	32%	14%
Contractual agreements	4%	24%	24%	30%	18%
Project's environment	6%	26%	24%	20%	24%
Sub-contractors	6%	16%	40%	20%	18%
The project	10%	32%	12%	22%	24%
Design of the project	4%	34%	16%	32%	14%
Materials	4%	30%	24%	28%	14%

Q-04 & AGE

Count 4.1	Column Labels					
Row Labels	1	2	3	4	5	Grand Total
1	2	3	1	4	4	14
2	3	11	2	6	6	28
3		2	3	1	2	8
Grand Total	5	16	6	11	12	50

Count 4.2	Column Labels					
Row Labels	1	2	3	4	5	Grand Total
1		6	3	4	1	14
2	1	8	5	11	3	28
3	1	3		1	3	8
Grand Total	2	17	8	16	7	50

Count 4.3	Column Labels					
Row Labels	1	2	3	4	5	Grand Total
1	1	4	3	4	2	14
2		6	8	9	5	28
3	1	2	1	2	2	8
Grand Total	2	12	12	15	9	50

Count 4.4	Column Labels					
Row Labels	1	2	3	4	5	Grand Total
1	1	4	2	5	2	14
2		7	9	8	4	28
3	1	4	1	1	1	8
Grand Total	2	15	12	14	7	50

Count 4.5	Column Labels					
Row Labels	1	2	3	4	5	Grand Total
1	1	2	3	3	5	14
2	1	4	10	5	8	28
3	1	1	1	3	2	8
Grand Total	3	7	14	11	15	50

Count 4.6	Column Labels					
Row Labels	1	2	3	4	5	Grand Total
1	1	1	4	6	2	14
2	1	3	12	8	4	28
3	1	2	2	2	1	8
Grand Total	3	6	18	16	7	50

Count 4.7	Column Labels					
Row Labels	1	2	3	4	5	Grand Total
1	1	3	3	5	2	14
2	1	3	16	3	5	28
3	1	2	1	2	2	8
Grand Total	3	8	20	10	9	50

Count 4.8	Column Labels					
Row Labels	1	2	3	4	5	Grand Total
1	1	3	1	5	4	14
2		4	11	5	8	28
3	1	2	2	1	2	8
Grand Total	2	9	14	11	14	50

Count 4.9	Column Labels					
Row Labels	1	2	3	4	5	Grand Total
1	2	3	2	3	4	14
2		8	8	3	9	28
3		1	3	2	2	8
Grand Total	2	12	13	8	15	50

Count 4.10	Column Labels					
Row Labels	1	2	3	4	5	Grand Total
1	1	5	2	3	3	14
2	2	6	9	5	6	28
3		2	1	2	3	8
Grand Total	3	13	12	10	12	50

<30 yrs								
	1	2	3	4	5	Mean		
Q4.1	2	3	1	4	4	3.36		
Q4.2	0	6	3	4	1	3.00	Min	3.00
Q4.3	1	4	3	4	2	3.14		
Q4.4	1	4	2	5	2	3.21		
Q4.5	1	2	3	3	5	3.64	Max	3.64
Q4.6	1	1	4	6	2	3.50		
Q4.7	1	3	3	5	2	3.29		
Q4.8	1	3	1	5	4	3.57		
Q4.9	2	3	2	3	4	3.29		
Q4.10	1	5	2	3	3	3.14		

30-50 yrs								
	1	2	3	4	5	Mean		
Q4.1	3	11	2	6	6	3.04	Min	3.04
Q4.2	1	8	5	11	3	3.25		
Q4.3	0	6	8	9	5	3.46		
Q4.4	0	7	9	8	4	3.32		
Q4.5	1	4	10	5	8	3.54		
Q4.6	1	3	12	8	4	3.39		
Q4.7	1	3	16	3	5	3.29		
Q4.8	0	4	11	5	8	3.61	Max	3.61
Q4.9	0	8	8	3	9	3.46		
Q4.10	2	6	9	5	6	3.25		

>50 yrs								
	1	2	3	4	5	Mean		
Q4.1	0	2	3	1	2	3.38		
Q4.2	1	3		1	3	3.25		
Q4.3	1	2	1	2	2	3.25		
Q4.4	1	4	1	1	1	2.63	Min	2.63
Q4.5	1	1	1	3	2	3.50		
Q4.6	1	2	2	2	1	3.00		
Q4.7	1	2	1	2	2	3.25		
Q4.8	1	2	2	1	2	3.13		
Q4.9	0	1	3	2	2	3.63		
Q4.10	0	2	1	2	3	3.75	Max	3.75

4.1 The project
4.2 Design of the project
4.3 Contractual agreements
4.4 Materials
4.5 Labour
4.6 Equipment
4.7 Sub-contractors
4.8 Site staff
4.9 Financial issues
4.1 Project's environment

	<30 yrs	30-50 yrs	>50 yrs
Q4.1	3.36	3.04	3.38
Q4.2	3.00	3.25	3.25
Q4.3	3.14	3.46	3.25
Q4.4	3.21	3.32	2.63
Q4.5	3.64	3.54	3.50
Q4.6	3.50	3.39	3.00
Q4.7	3.29	3.29	3.25
Q4.8	3.57	3.61	3.13
Q4.9	3.29	3.46	3.63
Q4.10	3.14	3.25	3.75
mean	3.31	3.36	3.28
SD	0.205	0.167	0.322

Anova: Two-Factor Without Replication

SUMMARY	Count	Sum	Average	Variance
Q4.1	3	9.767857	3.255952	0.036458
Q4.2	3	9.5	3.166667	0.020833
Q4.3	3	9.857143	3.285714	0.026786
Q4.4	3	9.160714	3.053571	0.140625
Q4.5	3	10.67857	3.559524	0.005527
Q4.6	3	9.892857	3.297619	0.069303
Q4.7	3	9.821429	3.27381	0.000425
Q4.8	3	10.30357	3.434524	0.072173
Q4.9	3	10.375	3.458333	0.028805
Q4.10	3	10.14286	3.380952	0.105017
<30 yrs	10	33.14286	3.314286	0.042177
30-50 yrs	10	33.60714	3.360714	0.027905
>50 yrs	10	32.75	3.275	0.103472

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Rows	0.586905	9	0.065212	1.203802	0.350876	2.456281
Columns	0.03682	2	0.01841	0.339845	0.716351	3.554557
Error	0.975085	18	0.054171			
Total	1.59881	29				

Q-04 & JOB

Count 4.1	Column Labels					
Row Labels	1	2	3	4	5	Grand Total
1		3	3	5	6	17
2	1	6	1	1	1	10
3	4	7	2	5	5	23
Grand Total	5	16	6	11	12	50

Count 4.2	Column Labels					
Row Labels	1	2	3	4	5	Grand Total
1	1		5	7	4	17
2		7	1	1	1	10
3	1	10	2	8	2	23
Grand Total	2	17	8	16	7	50

Count 4.3	Column Labels					
Row Labels	1	2	3	4	5	Grand Total
1		1	3	8	5	17
2		5	3	1	1	10
3	2	6	6	6	3	23
Grand Total	2	12	12	15	9	50

Count 4.4	Column Labels					
Row Labels	1	2	3	4	5	Grand Total
1		3	2	8	4	17
2		6	2	1	1	10
3	2	6	8	5	2	23
Grand Total	2	15	12	14	7	50

Count 4.5	Column Labels					
Row Labels	1	2	3	4	5	Grand Total
1			3	7	7	17
2	1	2	4	1	2	10
3	2	5	7	3	6	23
Grand Total	3	7	14	11	15	50

Count 4.6	Column Labels					
Row Labels	1	2	3	4	5	Grand Total
1		1	6	5	5	17
2	1	2	3	4		10
3	2	3	9	7	2	23
Grand Total	3	6	18	16	7	50

Count 4.7	Column Labels					
Row Labels	1	2	3	4	5	Grand Total
1		1	6	5	5	17
2		2	5	2	1	10
3	3	5	9	3	3	23
Grand Total	3	8	20	10	9	50

Count 4.8	Column Labels					
Row Labels	1	2	3	4	5	Grand Total
1			6	5	6	17
2		3	3	2	2	10
3	2	6	5	4	6	23
Grand Total	2	9	14	11	14	50

Count 4.9	Column Labels					
Row Labels	1	2	3	4	5	Grand Total
1		3	3	4	7	17
2		2	4	1	3	10
3	2	7	6	3	5	23
Grand Total	2	12	13	8	15	50

Count 4.10	Column Labels					
Row Labels	1	2	3	4	5	Grand Total
1		4	4	6	3	17
2		3	2	2	3	10
3	3	6	6	2	6	23
Grand Total	3	13	12	10	12	50

Contractor								
	1	2	3	4	5	Mean		
Q4.1	0	3	3	5	6	3.82		
Q4.2	1	0	5	7	4	3.76		
Q4.3	0	1	3	8	5	4.00		
Q4.4	0	3	2	8	4	3.76		
Q4.5	0	0	3	7	7	4.24	Max	4.24
Q4.6	0	1	6	5	5	3.82		
Q4.7	0	1	6	5	5	3.82		
Q4.8	0	0	6	5	6	4.00		
Q4.9	0	3	3	4	7	3.88		
Q4.10	0	4	4	6	3	3.47	Min	3.47

Consultant								
	1	2	3	4	5	Mean		
Q4.1	1	6	1	1	1	2.50	Min	2.50
Q4.2	0	7	1	1	1	2.60		
Q4.3	0	5	3	1	1	2.80		
Q4.4	0	6	2	1	1	2.70		
Q4.5	1	2	4	1	2	3.10		
Q4.6	1	2	3	4	0	3.00		
Q4.7	0	2	5	2	1	3.20		
Q4.8	0	3	3	2	2	3.30		
Q4.9	0	2	4	1	3	3.50	Max	3.50
Q4.10	0	3	2	2	3	3.50	Max	

Site Eng.								
	1	2	3	4	5	Mean		
Q4.1	4	7	2	5	5	3.00		
Q4.2	1	10	2	8	2	3.00		
Q4.3	2	6	6	6	3	3.09		
Q4.4	2	6	8	5	2	2.96		
Q4.5	2	5	7	3	6	3.26	Max	3.26
Q4.6	2	3	9	7	2	3.17		
Q4.7	3	5	9	3	3	2.91	Min	2.91
Q4.8	2	6	5	4	6	3.26		
Q4.9	2	7	6	3	5	3.09		
Q4.10	3	6	6	2	6	3.09		

	Contractor	Consultant	Site Eng.
Q4.1	3.82	2.50	3.00
Q4.2	3.76	2.60	3.00
Q4.3	4.00	2.80	3.09
Q4.4	3.76	2.70	2.96
Q4.5	4.24	3.10	3.26
Q4.6	3.82	3.00	3.17
Q4.7	3.82	3.20	2.91
Q4.8	4.00	3.30	3.26
Q4.9	3.88	3.50	3.09
Q4.10	3.47	3.50	3.09
mean	3.86	3.02	3.08
SD	0.198	0.361	0.120

Anova: Two-Factor Without Replication

SUMMARY	Count	Sum	Average	Variance
Q4.1	3	9.323529412	3.107843137	0.446655
Q4.2	3	9.364705882	3.121568627	0.350219
Q4.3	3	9.886956522	3.295652174	0.392665
Q4.4	3	9.421227621	3.140409207	0.308761
Q4.5	3	10.59616368	3.532054561	0.377379
Q4.6	3	9.997442455	3.332480818	0.188408
Q4.7	3	9.93657289	3.312190963	0.216686
Q4.8	3	10.56086957	3.520289855	0.172974
Q4.9	3	10.46930946	3.489769821	0.158242
Q4.10	3	10.05754476	3.352514919	0.053107
Contractor	10	38.58823529	3.858823529	0.039369
Consultant	10	30.2	3.02	0.130667
Site Eng.	10	30.82608696	3.082608696	0.014472

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Rows	0.697223583	9	0.077469287	1.447502	0.240576	2.456281
Columns	4.366847435	2	2.183423717	40.79694	2.06E-07	3.554557
Error	0.963347423	18	0.053519301			
Total	6.027418441	29				

Q-04 & EDUCATION

Count 4.1	Column Labels				
Row Labels	1	2	3	4	5 Grand Total
High school		2	1	3	1 7
University degree	4	9	4	5	9 31
High degree	1	5	1	3	2 12
Grand Total	5	16	6	11	12 50

Count 4.2	Column Labels				
Row Labels	1	2	3	4	5 Grand Total
High school		1	2	3	1 7
University degree	1	11	5	10	4 31
High degree	1	5	1	3	2 12
Grand Total	2	17	8	16	7 50

Count 4.3	Column Labels				
Row Labels	1	2	3	4	5 Grand Total
High school			2	3	2 7
University degree	1	7	9	9	5 31
High degree	1	5	1	3	2 12
Grand Total	2	12	12	15	9 50

Count 4.4	Column Labels				
Row Labels	1	2	3	4	5 Grand Total
High school			2	3	2 7
University degree	1	10	9	7	4 31
High degree	1	5	1	4	1 12
Grand Total	2	15	12	14	7 50

Count 4.5	Column Labels				
Row Labels	1	2	3	4	5 Grand Total
High school			2	3	2 7
University degree	1	6	9	4	11 31
High degree	2	1	3	4	2 12
Grand Total	3	7	14	11	15 50

Count 4.6	Column Labels				
Row Labels	1	2	3	4	5 Grand Total
High school			2	4	1 7
University degree	1	5	11	9	5 31
High degree	2	1	5	3	1 12
Grand Total	3	6	18	16	7 50

Count 4.7	Column Labels				
Row Labels	1	2	3	4	5 Grand Total
High school			3	4	7
University degree	1	7	12	4	7 31
High degree	2	1	5	2	2 12
Grand Total	3	8	20	10	9 50

Count 4.8	Column Labels				
Row Labels	1	2	3	4	5 Grand Total
High school			2	4	1 7
University degree	1	8	8	4	10 31
High degree	1	1	4	3	3 12
Grand Total	2	9	14	11	14 50

Count 4.9	Column Labels				
Row Labels	1	2	3	4	5 Grand Total
High school		1	1	3	2 7
University degree	2	8	8	3	10 31
High degree		3	4	2	3 12
Grand Total	2	12	13	8	15 50

Count 4.10	Column Labels				
Row Labels	1	2	3	4	5 Grand Total
High school		2	2	2	1 7
University degree	3	7	8	6	7 31
High degree		4	2	2	4 12
Grand Total	3	13	12	10	12 50

High school								
	1	2	3	4	5	Mean		
Q4.1	0	2	1	3	1	3.43		
Q4.2	0	1	2	3	1	3.57		
Q4.3	0	0	2	3	2	4.00	Max	
Q4.4	0	0	2	3	2	4.00	Max	
Q4.5	0	0	2	3	2	4.00	Max	4.00
Q4.6	0	0	2	4	1	3.86		
Q4.7	0	0	3	4	0	3.57		
Q4.8	0	0	2	4	1	3.86		
Q4.9	0	1	1	3	2	3.86		
Q4.10	0	2	2	2	1	3.29	Min	3.29

University degree						
	1	2	3	4	5	Mean
Q4.1	4	9	4	5	9	3.19
Q4.2	1	11	5	10	4	3.16
Q4.3	1	7	9	9	5	3.32
Q4.4	1	10	9	7	4	3.10
Q4.5	1	6	9	4	11	3.58
Q4.6	1	5	11	9	5	3.39
Q4.7	1	7	12	4	7	3.29
Q4.8	1	8	8	4	10	3.45
Q4.9	2	8	8	3	10	3.35
Q4.10	3	7	8	6	7	3.23

High degree								
	1	2	3	4	5	Mean		
Q4.1	1	5	1	3	2	3.00		
Q4.2	1	5	1	3	2	3.00		
Q4.3	1	5	1	3	2	3.00		
Q4.4	1	5	1	4	1	2.92	Min	2.92
Q4.5	2	1	3	4	2	3.25		
Q4.6	2	1	5	3	1	3.00		
Q4.7	2	1	5	2	2	3.08		
Q4.8	1	1	4	3	3	3.50	Max	3.50
Q4.9	0	3	4	2	3	3.42		
Q4.10	0	4	2	2	4	3.50		

	High school	University degree	High degree
Q4.1	3.43	3.19	3.00
Q4.2	3.57	3.16	3.00
Q4.3	4.00	3.32	3.00
Q4.4	4.00	3.10	2.92
Q4.5	4.00	3.58	3.25
Q4.6	3.86	3.39	3.00
Q4.7	3.57	3.29	3.08
Q4.8	3.86	3.45	3.50
Q4.9	3.86	3.35	3.42
Q4.10	3.29	3.23	3.50
mean	3.74	3.31	3.17
SD	0.259	0.145	0.229

Anova: Two-Factor Without Replication

SUMMARY	Count	Sum	Average	Variance
Q4.1	3	9.622119816	3.207373272	0.046062
Q4.2	3	9.732718894	3.244239631	0.086793
Q4.3	3	10.32258065	3.440860215	0.260493
Q4.4	3	10.01344086	3.33781362	0.336978
Q4.5	3	10.83064516	3.610215054	0.141281
Q4.6	3	10.24423963	3.414746544	0.184247
Q4.7	3	9.945084485	3.315028162	0.060017
Q4.8	3	10.80875576	3.602918587	0.049058
Q4.9	3	10.62864823	3.542882744	0.075025
Q4.10	3	10.01152074	3.337173579	0.020782
High schoo	10	37.42857143	3.742857143	0.06712
University	10	33.06451613	3.306451613	0.021101
High degre	10	31.66666667	3.166666667	0.052469

ANOVA

Source of Varia	SS	df	MS	F	P-value	F crit
Rows	0.551358342	9	0.061262038	1.542581	0.207133	2.456281
Columns	1.806616942	2	0.903308471	22.74535	1.18E-05	3.554557
Error	0.714851861	18	0.039713992			
Total	3.072827145	29				

Q-04 & EXPERIENCE

Count 4.1	Column Labels				
Row Labels	1	2	3	4	5 Grand Total
1	4	6	2	3	3 18
2	1	7	4	7	8 27
3		3		1	1 5
Grand Total	5	16	6	11	12 50

Count 4.2	Column Labels				
Row Labels	1	2	3	4	5 Grand Total
1		9	4	3	2 18
2	1	6	3	12	5 27
3	1	2	1	1	5
Grand Total	2	17	8	16	7 50

Count 4.3	Column Labels				
Row Labels	1	2	3	4	5 Grand Total
1	1	7	4	3	3 18
2	1	3	7	10	6 27
3		2	1	2	5
Grand Total	2	12	12	15	9 50

Count 4.4	Column Labels				
Row Labels	1	2	3	4	5 Grand Total
1	1	7	5	2	3 18
2	1	6	5	11	4 27
3		2	2	1	5
Grand Total	2	15	12	14	7 50

Count 4.5	Column Labels				
Row Labels	1	2	3	4	5 Grand Total
1	2	4	3	3	6 18
2	1	3	8	7	8 27
3			3	1	1 5
Grand Total	3	7	14	11	15 50

Count 4.6	Column Labels				
Row Labels	1	2	3	4	5 Grand Total
1	2	4	5	4	3 18
2	1	2	9	11	4 27
3			4	1	5
Grand Total	3	6	18	16	7 50

Count 4.7	Column Labels				
Row Labels	1	2	3	4	5 Grand Total
1	1	6	7	4	18
2	2	2	10	9	4 27
3			3	1	1 5
Grand Total	3	8	20	10	9 50

Count 4.8	Column Labels				
Row Labels	1	2	3	4	5 Grand Total
1	1	5	3	2	7 18
2	1	4	8	7	7 27
3			3	2	5
Grand Total	2	9	14	11	14 50

Count 4.9	Column Labels				
Row Labels	1	2	3	4	5 Grand Total
1	2	6	4	1	5 18
2		6	6	6	9 27
3			3	1	1 5
Grand Total	2	12	13	8	15 50

Count 4.10	Column Labels				
Row Labels	1	2	3	4	5 Grand Total
1	2	6	6	4	18
2	1	6	4	8	8 27
3		1	2	2	5
Grand Total	3	13	12	10	12 50

<10 yrs								
	1	2	3	4	5	Mean		
Q4.1	4	6	2	3	3	2.72	Min	2.72
Q4.2	0	9	4	3	2	2.89		
Q4.3	1	7	4	3	3	3.00		
Q4.4	1	7	5	2	3	2.94		
Q4.5	2	4	3	3	6	3.39		
Q4.6	2	4	5	4	3	3.11		
Q4.7	1	6	7	0	4	3.00		
Q4.8	1	5	3	2	7	3.50	Max	3.50
Q4.9	2	6	4	1	5	3.06		
Q4.10	2	6	6	0	4	2.89		

10-25 yrs						
	1	2	3	4	5	Mean
Q4.1	1	7	4	7	8	3.52
Q4.2	1	6	3	12	5	3.52
Q4.3	1	3	7	10	6	3.63
Q4.4	1	6	5	11	4	3.41
Q4.5	1	3	8	7	8	3.67
Q4.6	1	2	9	11	4	3.56
Q4.7	2	2	10	9	4	3.41
Q4.8	1	4	8	7	7	3.56
Q4.9	0	6	6	6	9	3.67
Q4.10	1	6	4	8	8	3.59

>25 yrs								
	1	2	3	4	5	Mean		
Q4.1	0	3	0	1	1	3.00		
Q4.2	1	2	1	1	0	2.40	Min	2.40
Q4.3	0	2	1	2	0	3.00		
Q4.4	0	2	2	1	0	2.80		
Q4.5	0	0	3	1	1	3.60	Max	3.60
Q4.6	0	0	4	1	0	3.20		
Q4.7	0	0	3	1	1	3.60		
Q4.8	0	0	3	2	0	3.40		
Q4.9	0	0	3	1	1	3.60	Max	
Q4.10	0	1	2	2	0	3.20		

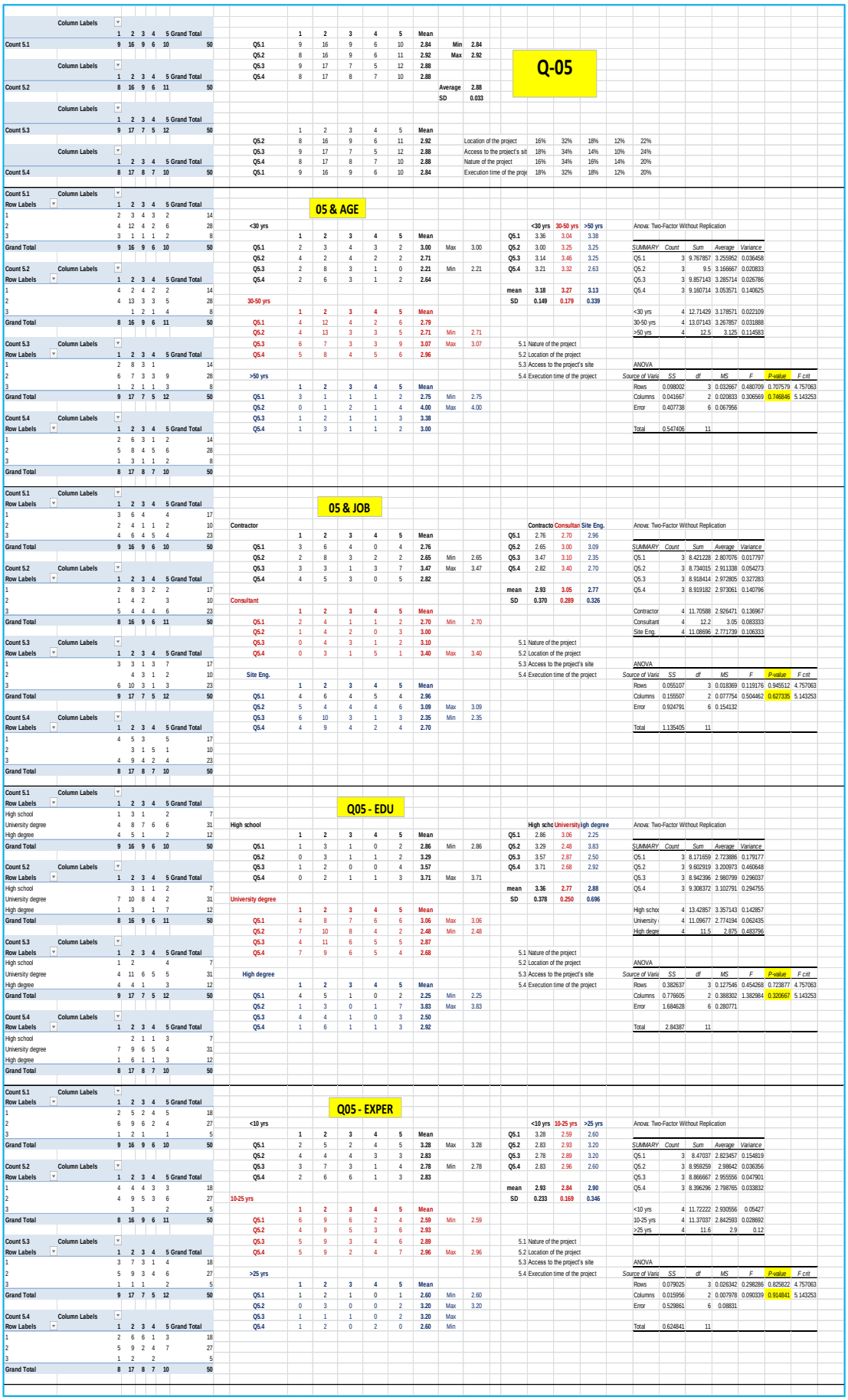
	<10 yrs	10-25 yrs	>25 yrs
Q4.1	2.72	3.52	3.00
Q4.2	2.89	3.52	2.40
Q4.3	3.00	3.63	3.00
Q4.4	2.94	3.41	2.80
Q4.5	3.39	3.67	3.60
Q4.6	3.11	3.56	3.20
Q4.7	3.00	3.41	3.60
Q4.8	3.50	3.56	3.40
Q4.9	3.06	3.67	3.60
Q4.10	2.89	3.59	3.20
mean	3.05	3.55	3.18
SD	0.235	0.093	0.394

Anova: Two-Factor Without Replication

SUMMARY	Count	Sum	Average	Variance
Q4.1	3	9.240740741	3.080246914	0.163352
Q4.2	3	8.807407407	2.935802469	0.314422
Q4.3	3	9.62962963	3.209876543	0.132144
Q4.4	3	9.151851852	3.050617284	0.10069
Q4.5	3	10.65555556	3.551851852	0.021029
Q4.6	3	9.866666667	3.288888889	0.055309
Q4.7	3	10.00740741	3.335802469	0.093845
Q4.8	3	10.45555556	3.485185185	0.006214
Q4.9	3	10.32222222	3.440740741	0.112387
Q4.10	3	9.681481481	3.227160494	0.124353
<10 yrs	10	30.5	3.05	0.055178
10-25 yrs	10	35.51851852	3.551851852	0.008672
>25 yrs	10	31.8	3.18	0.155111

ANOVA

Source of Varia	SS	df	MS	F	P-value	F crit
Rows	1.079930956	9	0.119992328	2.424833	0.052425	2.456281
Columns	1.356763603	2	0.678381802	13.7089	0.000241	3.554557
Error	0.890726109	18	0.049484784			
Total	3.327420668	29				



Q-05

Column Labels	1	2	3	4	5	Grand Total
Count 5.1	9	16	9	6	10	50
Count 5.2	8	16	9	6	11	50
Count 5.3	9	17	7	5	12	50
Count 5.4	8	17	8	7	10	50

	1	2	3	4	5	Mean		
Q5.1	9	16	9	6	10	2.84	Min	2.84
Q5.2	8	16	9	6	11	2.92	Max	2.92
Q5.3	9	17	7	5	12	2.88		
Q5.4	8	17	8	7	10	2.88		
							Average	2.88
							SD	0.033

Location of the project	16%	32%	18%	12%	22%	
Access to the project's sit	18%	34%	14%	10%	24%	
Nature of the project	16%	34%	16%	14%	20%	
Execution time of the proje	18%	32%	18%	12%	20%	

Q5 & AGE

Row Labels	1	2	3	4	5	Grand Total
1	2	3	4	3	2	14
2	4	12	4	2	6	28
3	3	1	1	1	2	8
Grand Total	9	16	9	6	10	50

<30 yrs	1	2	3	4	5	Mean		
Q5.1	2	3	4	3	2	3.00	Max	3.00
Q5.2	4	2	4	2	2	2.71		
Q5.3	2	8	3	1	0	2.21	Min	2.21
Q5.4	2	6	3	1	2	2.64		

30-50 yrs	1	2	3	4	5	Mean		
Q5.1	4	12	4	2	6	2.79		
Q5.2	4	13	3	3	5	2.71	Min	2.71
Q5.3	6	7	3	3	9	3.07	Max	3.07
Q5.4	5	8	4	5	6	2.96		

>50 yrs	1	2	3	4	5	Mean		
Q5.1	3	1	1	1	2	2.75	Min	2.75
Q5.2	0	1	2	1	4	4.00	Max	4.00
Q5.3	1	2	1	1	3	3.38		
Q5.4	1	3	1	1	2	3.00		

	<30 yrs	30-50 yrs	>50 yrs
Q5.1	3.36	3.04	3.38
Q5.2	3.00	3.25	3.25
Q5.3	3.14	3.46	3.25
Q5.4	3.21	3.32	2.63
mean	3.18	3.27	3.13
SD	0.149	0.179	0.339

5.1 Nature of the project
5.2 Location of the project
5.3 Access to the project's site
5.4 Execution time of the project

Anova: Two-Factor Without Replication

SUMMARY	Count	Sum	Average	Variance
Q5.1	3	9.767857	3.255952	0.036458
Q5.2	3	9.5	3.166667	0.020833
Q5.3	3	9.857143	3.285714	0.026786
Q5.4	3	9.160714	3.053571	0.140625
<30 yrs	4	12.71429	3.178571	0.022109
30-50 yrs	4	13.07143	3.267857	0.031888
>50 yrs	4	12.5	3.125	0.114583

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Rows	0.098002	3	0.032667	0.480709	0.707579	4.757063
Columns	0.041667	2	0.020833	0.306569	0.746846	5.143253
Error	0.407738	6	0.067956			
Total	0.547406	11				

Q5 & JOB

Row Labels	1	2	3	4	5	Grand Total
1	3	6	4		4	17
2	2	4	1	1	2	10
3	4	6	4	5	4	23
Grand Total	9	16	9	6	10	50

Contractor	1	2	3	4	5	Mean		
Q5.1	3	6	4	0	4	2.76		
Q5.2	2	8	3	2	2	2.65	Min	2.65
Q5.3	3	3	1	3	7	3.47	Max	3.47
Q5.4	4	5	3	0	5	2.82		

Consultant	1	2	3	4	5	Mean		
Q5.1	2	4	1	1	2	2.70	Min	2.70
Q5.2	1	4	2	0	3	3.00		
Q5.3	0	4	3	1	2	3.10		
Q5.4	0	3	1	5	1	3.40	Max	3.40

Site Eng.	1	2	3	4	5	Mean		
Q5.1	4	6	4	5	4	2.96		
Q5.2	5	4	4	4	6	3.09	Max	3.09
Q5.3	6	10	3	1	3	2.35	Min	2.35
Q5.4	4	9	4	2	4	2.70		

	Contracto	Consultan	Site Eng.
Q5.1	2.76	2.70	2.96
Q5.2	2.65	3.00	3.09
Q5.3	3.47	3.10	2.35
Q5.4	2.82	3.40	2.70
mean	2.93	3.05	2.77
SD	0.370	0.289	0.326

5.1 Nature of the project
5.2 Location of the project
5.3 Access to the project's site
5.4 Execution time of the project

Anova: Two-Factor Without Replication

SUMMARY	Count	Sum	Average	Variance
Q5.1	3	8.421228	2.807076	0.017797
Q5.2	3	8.734015	2.911338	0.054273
Q5.3	3	8.918414	2.972805	0.327283
Q5.4	3	8.919182	2.973061	0.140796
Contractor	4	11.70588	2.926471	0.136967
Consultant	4	12.2	3.05	0.083333
Site Eng.	4	11.08696	2.771739	0.106333

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Rows	0.055107	3	0.018369	0.119176	0.945512	4.757063
Columns	0.155507	2	0.077754	0.504462	0.627335	5.143253
Error	0.924791	6	0.154132			
Total	1.135405	11				

Q05 - EDU

Row Labels	1	2	3	4	5	Grand Total
High school	1	3	1		2	7
University degree	4	8	7	6	6	31
High degree	4	5	1		2	12
Grand Total	9	16	9	6	10	50

High school	1	2	3	4	5	Mean		
Q5.1	1	3	1	0	2	2.86	Min	2.86
Q5.2	0	3	1	1	2	3.29		
Q5.3	1	2	0	0	4	3.57		
Q5.4	0	2	1	1	3	3.71	Max	3.71

University degree	1	2	3	4	5	Mean		
Q5.1	4	8	7	6	6	3.06	Max	3.06
Q5.2	7	10	8	4	2	2.48	Min	2.48
Q5.3	4	11	6	5	5	2.87		
Q5.4	7	9	6	5	4	2.68		

High degree	1	2	3	4	5	Mean		
Q5.1	4	5	1	0	2	2.25	Min	2.25
Q5.2	1	3	0	1	7	3.83	Max	3.83
Q5.3	4	4	1	0	3	2.50		
Q5.4	1	6	1	1	3	2.92		

	High scho	University	igh degree
Q5.1	2.86	3.06	2.25
Q5.2	3.29	2.48	3.83
Q5.3	3.57	2.87	2.50
Q5.4	3.71	2.68	2.92
mean	3.36	2.77	2.88
SD	0.378	0.250	0.696

5.1 Nature of the project
5.2 Location of the project
5.3 Access to the project's site
5.4 Execution time of the project

Anova: Two-Factor Without Replication

SUMMARY	Count	Sum	Average	Variance
Q5.1	3	8.171659	2.723886	0.179177
Q5.2	3	9.602919	3.200973	0.460648
Q5.3	3	8.942396	2.980799	0.296037
Q5.4	3	9.308372	3.102791	0.294755
High schoo	4	13.42857	3.357143	0.142857
University	4	11.09677	2.774194	0.062435
High degre	4	11.5	2.875	0.483796

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Rows	0.382637	3	0.127546	0.454268	0.723877	4.757063
Columns	0.776605	2	0.388302	1.382984	0.320667	5.143253
Error	1.684628	6	0.280771			
Total	2.84387	11				

Q05 - EXPER

Row Labels	1	2	3	4	5	Grand Total
1	2	5	2	4	5	18
2	6	9	6	2	4	27
3	1	2	1		1	5
Grand Total	9	16	9	6	10	50

<10 yrs	1	2	3	4	5	Mean		
Q5.1	2	5	2	4	5	3.28	Max	3.28
Q5.2	4	4	4	3	3	2.83		
Q5.3	3	7	3	1	4	2.78	Min	2.78
Q5.4	2	6	6	1	3	2.83		

10-25 yrs	1	2	3	4	5	Mean		
Q5.1	6	9	6	2	4	2.59	Min	2.59
Q5.2	4	9	5	3	6	2.93		
Q5.3	5	9	3	4	6	2.89		
Q5.4	5	9	2	4	7	2.96	Max	2.96

>25 yrs	1	2	3	4	5	Mean		
Q5.1	1	2	1	0	1	2.60	Min	2.60
Q5.2	0	3	0	0	2	3.20	Max	3.20
Q5.3	1	1	1	0	2	3.20	Max	
Q5.4	1	2	0	2	0	2.60	Min	

	<10 yrs	10-25 yrs	>25 yrs
Q5.1	3.28	2.59	2.60
Q5.2	2.83	2.93	3.20
Q5.3	2.78	2.89	3.20
Q5.4	2.83	2.96	2.60
mean	2.93	2.84	2.90
SD	0.233	0.169	0.346

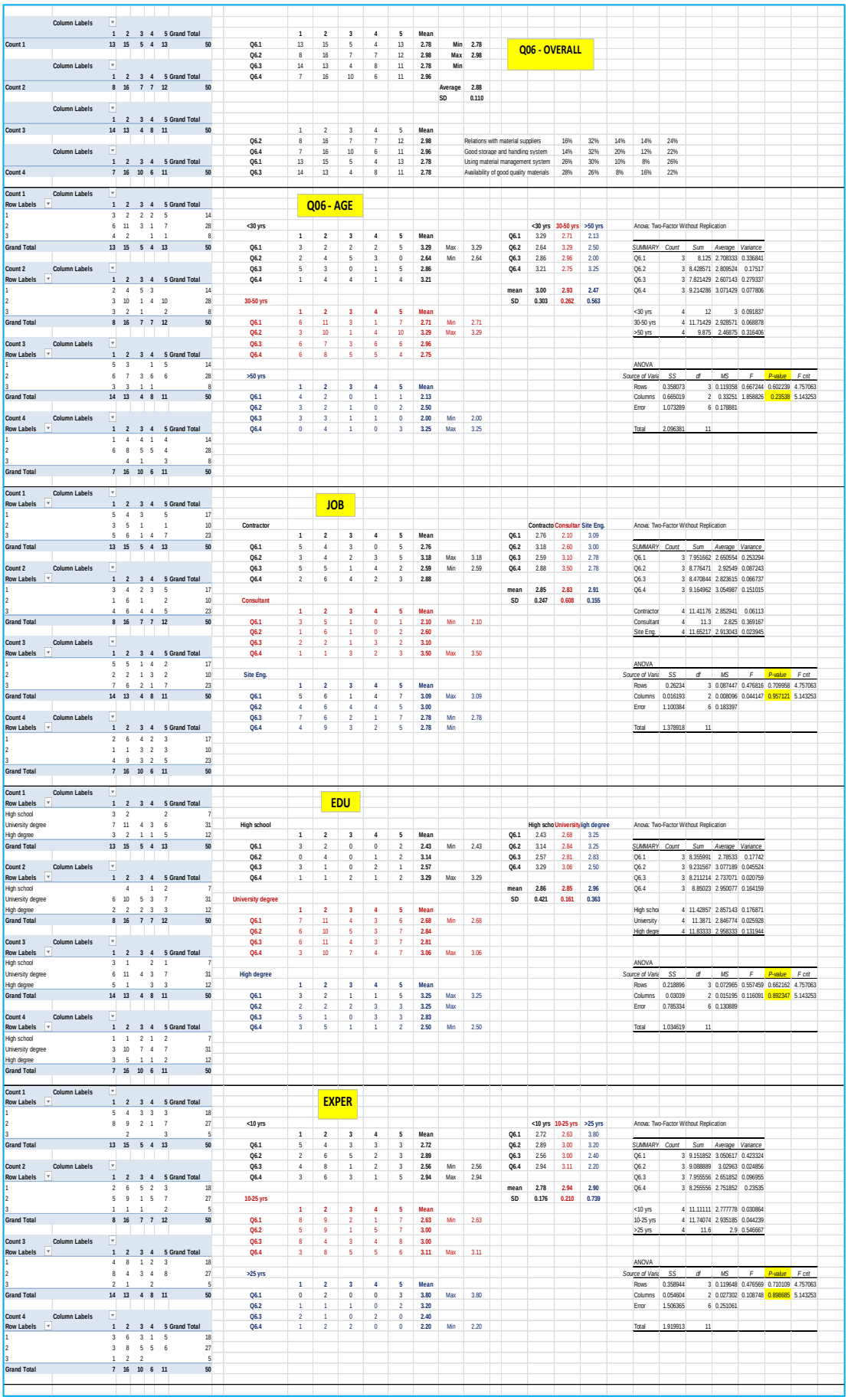
5.1 Nature of the project
5.2 Location of the project
5.3 Access to the project's site
5.4 Execution time of the project

Anova: Two-Factor Without Replication

SUMMARY	Count	Sum	Average	Variance
Q5.1	3	8.47037	2.823457	0.154819
Q5.2	3	8.959259	2.98642	0.036356
Q5.3	3	8.866667	2.955556	0.047901
Q5.4	3	8.396296	2.798765	0.033832
<10 yrs	4	11.72222	2.930556	0.05427
10-25 yrs	4	11.37037	2.842593	0.028692
>25 yrs	4	11.6	2.9	0.12

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Rows	0.079025	3	0.026342	0.296286	0.825822	4.757063
Columns	0.015956	2	0.007978	0.090339	0.914841	5.143253
Error	0.529861	6	0.08831			
Total	0.624841	11				



Column Labels

	1	2	3	4	5	Grand Total
Count 1	13	15	5	4	13	50

Column Labels

	1	2	3	4	5	Grand Total
Count 2	8	16	7	7	12	50

Column Labels

	1	2	3	4	5	Grand Total
Count 3	14	13	4	8	11	50

Column Labels

	1	2	3	4	5	Grand Total
Count 4	7	16	10	6	11	50

	1	2	3	4	5	Mean		
Q6.1	13	15	5	4	13	2.78	Min	2.78
Q6.2	8	16	7	7	12	2.98	Max	2.98
Q6.3	14	13	4	8	11	2.78	Min	
Q6.4	7	16	10	6	11	2.96		
							Average	2.88
							SD	0.110

Q06 - OVERALL

Relations with material suppliers	16%	32%	14%	14%	24%
Good storage and handling system	14%	32%	20%	12%	22%
Using material management system	26%	30%	10%	8%	26%
Availability of good quality materials	28%	26%	8%	16%	22%

Q06 - AGE

Count 1

Row Labels	1	2	3	4	5	Grand Total
1	3	2	2	2	5	14
2	6	11	3	1	7	28
3	4	2		1	1	8
Grand Total	13	15	5	4	13	50

Count 2

Row Labels	1	2	3	4	5	Grand Total
1	2	4	5	3		14
2	3	10	1	4	10	28
3	3	2	1		2	8
Grand Total	8	16	7	7	12	50

Count 3

Row Labels	1	2	3	4	5	Grand Total
1	5	3		1	5	14
2	6	7	3	6	6	28
3	3	3	1	1		8
Grand Total	14	13	4	8	11	50

Count 4

Row Labels	1	2	3	4	5	Grand Total
1	1	4	4	1	4	14
2	6	8	5	5	4	28
3		4	1		3	8
Grand Total	7	16	10	6	11	50

<30 yrs

	1	2	3	4	5	Mean		
Q6.1	3	2	2	2	5	3.29	Max	3.29
Q6.2	2	4	5	3	0	2.64	Min	2.64
Q6.3	5	3	0	1	5	2.86		
Q6.4	1	4	4	1	4	3.21		

30-50 yrs

	1	2	3	4	5	Mean		
Q6.1	6	11	3	1	7	2.71	Min	2.71
Q6.2	3	10	1	4	10	3.29	Max	3.29
Q6.3	6	7	3	6	6	2.96		
Q6.4	6	8	5	5	4	2.75		

>50 yrs

	1	2	3	4	5	Mean		
Q6.1	4	2	0	1	1	2.13		
Q6.2	3	2	1	0	2	2.50		
Q6.3	3	3	1	1	0	2.00	Min	2.00
Q6.4	0	4	1	0	3	3.25	Max	3.25

	<30 yrs	30-50 yrs	>50 yrs
Q6.1	3.29	2.71	2.13
Q6.2	2.64	3.29	2.50
Q6.3	2.86	2.96	2.00
Q6.4	3.21	2.75	3.25
mean	3.00	2.93	2.47
SD	0.303	0.262	0.563

Anova: Two-Factor Without Replication

SUMMARY	Count	Sum	Average	Variance
Q6.1	3	8.125	2.708333	0.336841
Q6.2	3	8.428571	2.809524	0.17517
Q6.3	3	7.821429	2.607143	0.279337
Q6.4	3	9.214286	3.071429	0.077806
<30 yrs	4	12	3	0.091837
30-50 yrs	4	11.71429	2.928571	0.068878
>50 yrs	4	9.875	2.46875	0.316406

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Rows	0.358073	3	0.119358	0.667244	0.602239	4.757063
Columns	0.665019	2	0.33251	1.858826	0.23538	5.143253
Error	1.073289	6	0.178881			
Total	2.096381	11				

JOB

Count 1

Row Labels	1	2	3	4	5	Grand Total
1	5	4	3		5	17
2	3	5	1		1	10
3	5	6	1	4	7	23
Grand Total	13	15	5	4	13	50

Count 2

Row Labels	1	2	3	4	5	Grand Total
1	3	4	2	3	5	17
2	1	6	1		2	10
3	4	6	4	4	5	23
Grand Total	8	16	7	7	12	50

Count 3

Row Labels	1	2	3	4	5	Grand Total
1	5	5	1	4	2	17
2	2	2	1	3	2	10
3	7	6	2	1	7	23
Grand Total	14	13	4	8	11	50

Count 4

Row Labels	1	2	3	4	5	Grand Total
1	2	6	4	2	3	17
2	1	1	3	2	3	10
3	4	9	3	2	5	23
Grand Total	7	16	10	6	11	50

Contractor

	1	2	3	4	5	Mean		
Q6.1	5	4	3	0	5	2.76		
Q6.2	3	4	2	3	5	3.18	Max	3.18
Q6.3	5	5	1	4	2	2.59	Min	2.59
Q6.4	2	6	4	2	3	2.88		

Consultant

	1	2	3	4	5	Mean		
Q6.1	3	5	1	0	1	2.10	Min	2.10
Q6.2	1	6	1	0	2	2.60		
Q6.3	2	2	1	3	2	3.10		
Q6.4	1	1	3	2	3	3.50	Max	3.50

Site Eng.

	1	2	3	4	5	Mean		
Q6.1	5	6	1	4	7	3.09	Max	3.09
Q6.2	4	6	4	4	5	3.00		
Q6.3	7	6	2	1	7	2.78	Min	2.78
Q6.4	4	9	3	2	5	2.78	Min	

	Contracto	Consultar	Site Eng.
Q6.1	2.76	2.10	3.09
Q6.2	3.18	2.60	3.00
Q6.3	2.59	3.10	2.78
Q6.4	2.88	3.50	2.78
mean	2.85	2.83	2.91
SD	0.247	0.608	0.155

Anova: Two-Factor Without Replication

SUMMARY	Count	Sum	Average	Variance
Q6.1	3	7.951662	2.650554	0.253294
Q6.2	3	8.776471	2.92549	0.087243
Q6.3	3	8.470844	2.823615	0.066737
Q6.4	3	9.164962	3.054987	0.151015
Contractor	4	11.41176	2.852941	0.06113
Consultant	4	11.3	2.825	0.369167
Site Eng.	4	11.65217	2.913043	0.023945

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Rows	0.26234	3	0.087447	0.476816	0.709958	4.757063
Columns	0.016193	2	0.008096	0.044147	0.957121	5.143253
Error	1.100384	6	0.183397			
Total	1.378918	11				

EDU

Count 1

Row Labels	1	2	3	4	5	Grand Total
High school	3	2			2	7
University degree	7	11	4	3	6	31
High degree	3	2	1	1	5	12
Grand Total	13	15	5	4	13	50

Count 2

Row Labels	1	2	3	4	5	Grand Total
High school		4		1	2	7
University degree	6	10	5	3	7	31
High degree	2	2	2	3	3	12
Grand Total	8	16	7	7	12	50

Count 3

Row Labels	1	2	3	4	5	Grand Total
High school	3	1		2	1	7
University degree	6	11	4	3	7	31
High degree	5	1		3	3	12
Grand Total	14	13	4	8	11	50

Count 4

Row Labels	1	2	3	4	5	Grand Total
High school	1	1	2	1	2	7
University degree	3	10	7	4	7	31
High degree	3	5	1	1	2	12
Grand Total	7	16	10	6	11	50

High school

	1	2	3	4	5	Mean		
Q6.1	3	2	0	0	2	2.43	Min	2.43
Q6.2	0	4	0	1	2	3.14		
Q6.3	3	1	0	2	1	2.57		
Q6.4	1	1	2	1	2	3.29	Max	3.29

University degree

	1	2	3	4	5	Mean		
Q6.1	7	11	4	3	6	2.68	Min	2.68
Q6.2	6	10	5	3	7	2.84		
Q6.3	6	11	4	3	7	2.81		
Q6.4	3	10	7	4	7	3.06	Max	3.06

High degree

	1	2	3	4	5	Mean		
Q6.1	3	2	1	1	5	3.25	Max	3.25
Q6.2	2	2	2	3	3	3.25	Max	
Q6.3	5	1	0	3	3	2.83		
Q6.4	3	5	1	1	2	2.50	Min	2.50

	High scho	University	igh degree
Q6.1	2.43	2.68	3.25
Q6.2	3.14	2.84	3.25
Q6.3	2.57	2.81	2.83
Q6.4	3.29	3.06	2.50
mean	2.86	2.85	2.96
SD	0.421	0.161	0.363

Anova: Two-Factor Without Replication

SUMMARY	Count	Sum	Average	Variance
Q6.1	3	8.355991	2.78533	0.17742
Q6.2	3	9.231567	3.077189	0.045524
Q6.3	3	8.211214	2.737071	0.020759
Q6.4	3	8.85023	2.950077	0.164159
High schoo	4	11.42857	2.857143	0.176871
University	4	11.3871	2.846774	0.025928
High degre	4	11.83333	2.958333	0.131944

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Rows	0.218896	3	0.072965	0.557459	0.662162	4.757063
Columns	0.03039	2	0.015195	0.116091	0.892347	5.143253
Error	0.785334	6	0.130889			
Total	1.034619	11				

EXPER

Count 1

Row Labels	1	2	3	4	5	Grand Total
1	5	4	3	3	3	18
2	8	9	2	1	7	27
3		2			3	5
Grand Total	13	15	5	4	13	50

Count 2

Row Labels	1	2	3	4	5	Grand Total
1	2	6	5	2	3	18
2	5	9	1	5	7	27
3	1	1	1		2	5
Grand Total	8	16	7	7	12	50

Count 3

Row Labels	1	2	3	4	5	Grand Total
1	4	8	1	2	3	18
2	8	4	3	4	8	27
3	2	1		2		5
Grand Total	14	13	4	8	11	50

Count 4

Row Labels	1	2	3	4	5	Grand Total
1	3	6	3	1	5	18
2	3	8	5	5	6	27
3	1	2	2			5
Grand Total	7	16	10	6	11	50

<10 yrs

	1	2	3	4	5	Mean		
Q6.1	5	4	3	3	3	2.72		
Q6.2	2	6	5	2	3	2.89		
Q6.3	4	8	1	2	3	2.56	Min	2.56
Q6.4	3	6	3	1	5	2.94	Max	2.94

10-25 yrs

	1	2	3	4	5	Mean		
Q6.1	8	9	2	1	7	2.63	Min	2.63
Q6.2	5	9	1	5	7	3.00		
Q6.3	8	4	3	4	8	3.00		
Q6.4	3	8	5	5	6	3.11	Max	3.11

>25 yrs

	1	2	3	4	5	Mean		
Q6.1	0	2	0	0	3	3.80	Max	3.80
Q6.2	1	1	1	0	2	3.20		
Q6.3	2	1	0	2	0	2.40		
Q6.4	1	2	2	0	0	2.20	Min	2.20

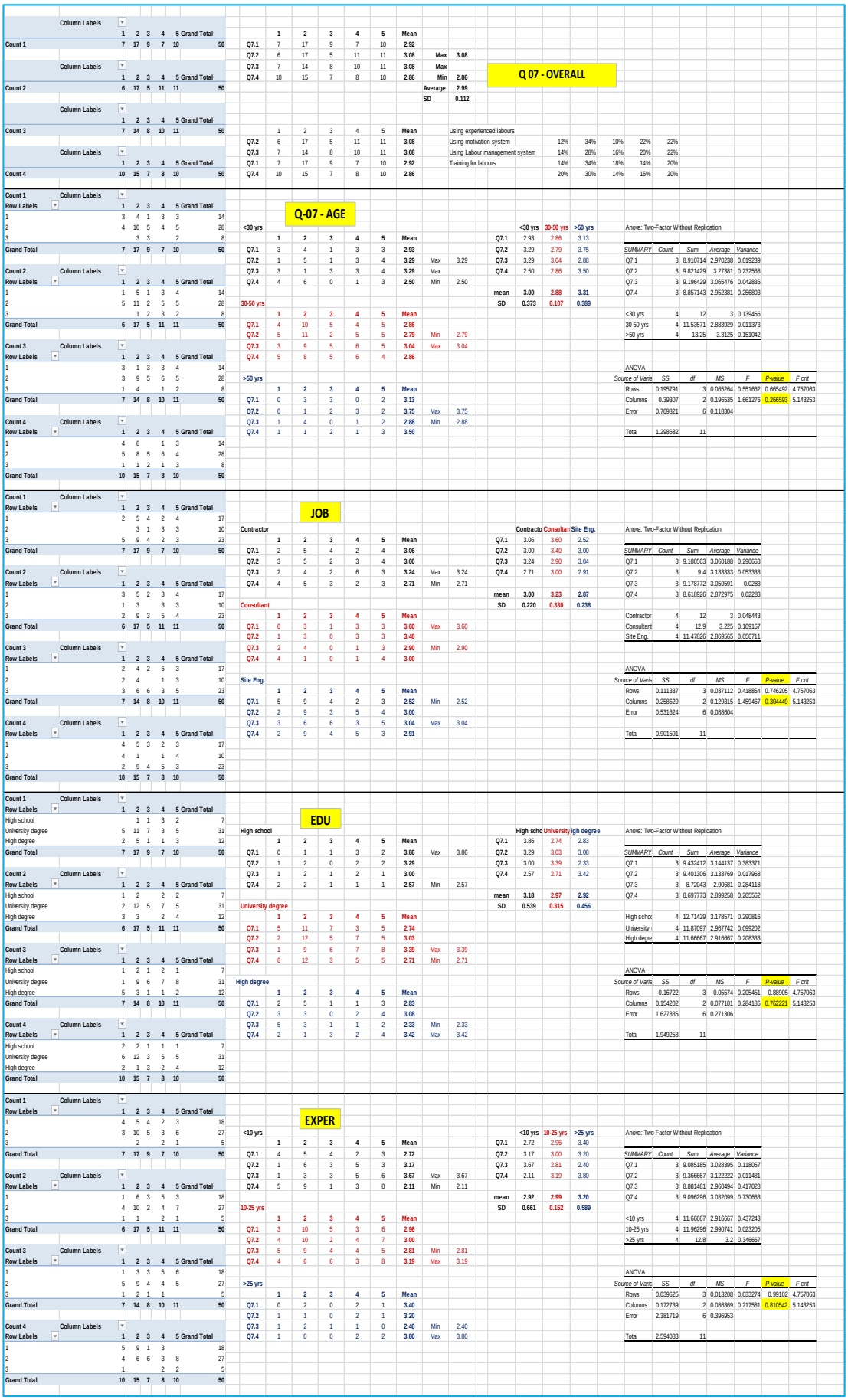
	<10 yrs	10-25 yrs	>25 yrs
Q6.1	2.72	2.63	3.80
Q6.2	2.89	3.00	3.20
Q6.3	2.56	3.00	2.40
Q6.4	2.94	3.11	2.20
mean	2.78	2.94	2.90
SD	0.176	0.210	0.739

Anova: Two-Factor Without Replication

SUMMARY	Count	Sum	Average	Variance
Q6.1	3	9.151852	3.050617	0.423324
Q6.2	3	9.088889	3.02963	0.024856
Q6.3	3	7.955556	2.651852	0.096955
Q6.4	3	8.255556	2.751852	0.23535
<10 yrs	4	11.11111	2.777778	0.030864
10-25 yrs	4	11.74074	2.935185	0.044239
>25 yrs	4	11.6	2.9	0.546667

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Rows	0.358944	3	0.119648	0.476569	0.710109	4.757063
Columns	0.054604	2	0.027302	0.108748	0.898685	5.143253
Error	1.506365	6	0.251061			
Total	1.919913	11				



Column Labels	1	2	3	4	5	Grand Total
Count 1	7	17	9	7	10	50
Column Labels	1	2	3	4	5	Grand Total
Count 2	6	17	5	11	11	50
Column Labels	1	2	3	4	5	Grand Total
Count 3	7	14	8	10	11	50
Column Labels	1	2	3	4	5	Grand Total
Count 4	10	15	7	8	10	50

	1	2	3	4	5	Mean		
Q7.1	7	17	9	7	10	2.92		
Q7.2	6	17	5	11	11	3.08	Max	3.08
Q7.3	7	14	8	10	11	3.08	Max	
Q7.4	10	15	7	8	10	2.86	Min	2.86
							Average	2.99
							SD	0.112

Q 07 - OVERALL

	1	2	3	4	5	Mean
Q7.1	7	17	9	7	10	2.92
Q7.2	6	17	5	11	11	3.08
Q7.3	7	14	8	10	11	3.08
Q7.4	10	15	7	8	10	2.86

Using experienced labours	12%	34%	10%
Using motivation system	14%	28%	16%
Using Labour management system	14%	34%	18%
Training for labours	20%	30%	14%

22%	22%	
20%	22%	
14%	20%	
16%	20%	

Q-07 - AGE

Row Labels	1	2	3	4	5	Grand Total
1	3	4	1	3	3	14
2	4	10	5	4	5	28
3		3	3		2	8
Grand Total	7	17	9	7	10	50

<30 yrs	1	2	3	4	5	Mean		
Q7.1	3	4	1	3	3	2.93		
Q7.2	1	5	1	3	4	3.29	Max	3.29
Q7.3	3	1	3	3	4	3.29	Max	
Q7.4	4	6	0	1	3	2.50	Min	2.50

Row Labels	1	2	3	4	5	Grand Total
1	1	5	1	3	4	14
2	5	11	2	5	5	28
3		1	2	3	2	8
Grand Total	6	17	5	11	11	50

30-50 yrs	1	2	3	4	5	Mean		
Q7.1	4	10	5	4	5	2.86		
Q7.2	5	11	2	5	5	2.79	Min	2.79
Q7.3	3	9	5	6	5	3.04	Max	3.04
Q7.4	5	8	5	6	4	2.86		

Row Labels	1	2	3	4	5	Grand Total
1	3	1	3	3	4	14
2	3	9	5	6	5	28
3	1	4		1	2	8
Grand Total	7	14	8	10	11	50

>50 yrs	1	2	3	4	5	Mean		
Q7.1	0	3	3	0	2	3.13		
Q7.2	0	1	2	3	2	3.75	Max	3.75
Q7.3	1	4	0	1	2	2.88	Min	2.88
Q7.4	1	1	2	1	3	3.50		

Row Labels	1	2	3	4	5	Grand Total
1	4	6		1	3	14
2	5	8	5	6	4	28
3	1	1	2	1	3	8
Grand Total	10	15	7	8	10	50

	<30 yrs	30-50 yrs	>50 yrs
Q7.1	2.93	2.86	3.13
Q7.2	3.29	2.79	3.75
Q7.3	3.29	3.04	2.88
Q7.4	2.50	2.86	3.50
mean	3.00	2.88	3.31
SD	0.373	0.107	0.389

Anova: Two-Factor Without Replication

SUMMARY	Count	Sum	Average	Variance
Q7.1	3	8.910714	2.970238	0.019239
Q7.2	3	9.821429	3.27381	0.232568
Q7.3	3	9.196429	3.065476	0.042836
Q7.4	3	8.857143	2.952381	0.256803
<30 yrs	4	12	3	0.139456
30-50 yrs	4	11.53571	2.883929	0.011373
>50 yrs	4	13.25	3.3125	0.151042

ANOVA

Source of Varia	SS	df	MS	F	P-value	F crit
Rows	0.195791	3	0.065264	0.551662	0.665492	4.757063
Columns	0.39307	2	0.196535	1.661276	0.266593	5.143253
Error	0.709821	6	0.118304			
Total	1.298682	11				

JOB

Row Labels	1	2	3	4	5	Grand Total
1	2	5	4	2	4	17
2		3	1	3	3	10
3	5	9	4	2	3	23
Grand Total	7	17	9	7	10	50

Contractor	1	2	3	4	5	Mean		
Q7.1	2	5	4	2	4	3.06		
Q7.2	3	5	2	3	4	3.00		
Q7.3	2	4	2	6	3	3.24	Max	3.24
Q7.4	4	5	3	2	3	2.71	Min	2.71

Row Labels	1	2	3	4	5	Grand Total
1	3	5	2	3	4	17
2	1	3		3	3	10
3	2	9	3	5	4	23
Grand Total	6	17	5	11	11	50

Consultant	1	2	3	4	5	Mean		
Q7.1	0	3	1	3	3	3.60	Max	3.60
Q7.2	1	3	0	3	3	3.40		
Q7.3	2	4	0	1	3	2.90	Min	2.90
Q7.4	4	1	0	1	4	3.00		

Row Labels	1	2	3	4	5	Grand Total
1	2	4	2	6	3	17
2	2	4		1	3	10
3	3	6	6	3	5	23
Grand Total	7	14	8	10	11	50

Site Eng.	1	2	3	4	5	Mean		
Q7.1	5	9	4	2	3	2.52	Min	2.52
Q7.2	2	9	3	5	4	3.00		
Q7.3	3	6	6	3	5	3.04	Max	3.04
Q7.4	2	9	4	5	3	2.91		

Row Labels	1	2	3	4	5	Grand Total
1	4	5	3	2	3	17
2	4	1		1	4	10
3	2	9	4	5	3	23
Grand Total	10	15	7	8	10	50

	Contractor	Consultant	Site Eng.
Q7.1	3.06	3.60	2.52
Q7.2	3.00	3.40	3.00
Q7.3	3.24	2.90	3.04
Q7.4	2.71	3.00	2.91
mean	3.00	3.23	2.87
SD	0.220	0.330	0.238

Anova: Two-Factor Without Replication

SUMMARY	Count	Sum	Average	Variance
Q7.1	3	9.180563	3.060188	0.290663
Q7.2	3	9.4	3.133333	0.053333
Q7.3	3	9.178772	3.059591	0.0283
Q7.4	3	8.618926	2.872975	0.02283
Contractor	4	12	3	0.048443
Consultant	4	12.9	3.225	0.109167
Site Eng.	4	11.47826	2.869565	0.056711

ANOVA

Source of Varia	SS	df	MS	F	P-value	F crit
Rows	0.111337	3	0.037112	0.418854	0.746205	4.757063
Columns	0.258629	2	0.129315	1.459467	0.304449	5.143253
Error	0.531624	6	0.088604			
Total	0.901591	11				

EDU

Row Labels	1	2	3	4	5	Grand Total
High school		1	1	3	2	7
University degree	5	11	7	3	5	31
High degree	2	5	1	1	3	12
Grand Total	7	17	9	7	10	50

High school	1	2	3	4	5	Mean		
Q7.1	0	1	1	3	2	3.86	Max	3.86
Q7.2	1	2	0	2	2	3.29		
Q7.3	1	2	1	2	1	3.00		
Q7.4	2	2	1	1	1	2.57	Min	2.57

Row Labels	1	2	3	4	5	Grand Total
High school	1	2		2	2	7
University degree	2	12	5	7	5	31
High degree	3	3		2	4	12
Grand Total	6	17	5	11	11	50

University degree	1	2	3	4	5	Mean		
Q7.1	5	11	7	3	5	2.74		
Q7.2	2	12	5	7	5	3.03		
Q7.3	1	9	6	7	8	3.39	Max	3.39
Q7.4	6	12	3	5	5	2.71	Min	2.71

Row Labels	1	2	3	4	5	Grand Total
High school	1	2	1	2	1	7
University degree	1	9	6	7	8	31
High degree	5	3	1	1	2	12
Grand Total	7	14	8	10	11	50

High degree	1	2	3	4	5	Mean		
Q7.1	2	5	1	1	3	2.83		
Q7.2	3	3	0	2	4	3.08		
Q7.3	5	3	1	1	2	2.33	Min	2.33
Q7.4	2	1	3	2	4	3.42	Max	3.42

Row Labels	1	2	3	4	5	Grand Total
High school	2	2	1	1	1	7
University degree	6	12	3	5	5	31
High degree	2	1	3	2	4	12
Grand Total	10	15	7	8	10	50

	High school	University	High degree
Q7.1	3.86	2.74	2.83
Q7.2	3.29	3.03	3.08
Q7.3	3.00	3.39	2.33
Q7.4	2.57	2.71	3.42
mean	3.18	2.97	2.92
SD	0.539	0.315	0.456

Anova: Two-Factor Without Replication

SUMMARY	Count	Sum	Average	Variance
Q7.1	3	9.432412	3.144137	0.383371
Q7.2	3	9.401306	3.133769	0.017968
Q7.3	3	8.72043	2.90681	0.284118
Q7.4	3	8.697773	2.899258	0.205562
High schoo	4	12.71429	3.178571	0.290816
University	4	11.87097	2.967742	0.099202
High degre	4	11.66667	2.916667	0.208333

ANOVA

Source of Varia	SS	df	MS	F	P-value	F crit
Rows	0.16722	3	0.05574	0.205451	0.88905	4.757063
Columns	0.154202	2	0.077101	0.284186	0.762221	5.143253
Error	1.627835	6	0.271306			
Total	1.949258	11				

EXPER

Row Labels	1	2	3	4	5	Grand Total
1	4	5	4	2	3	18
2	3	10	5	3	6	27
3		2		2	1	5
Grand Total	7	17	9	7	10	50

<10 yrs	1	2	3	4	5	Mean		
Q7.1	4	5	4	2	3	2.72		
Q7.2	1	6	3	5	3	3.17		
Q7.3	1	3	3	5	6	3.67	Max	3.67
Q7.4	5	9	1	3	0	2.11	Min	2.11

Row Labels	1	2	3	4	5	Grand Total
1	1	6	3	5	3	18
2	4	10	2	4	7	27
3	1	1		2	1	5
Grand Total	6	17	5	11	11	50

10-25 yrs	1	2	3	4	5	Mean		
Q7.1	3	10	5	3	6	2.96		
Q7.2	4	10	2	4	7	3.00		
Q7.3	5	9	4	4	5	2.81	Min	2.81
Q7.4	4	6	6	3	8	3.19	Max	3.19

Row Labels	1	2	3	4	5	Grand Total
1	1	3	3	5	6	18
2	5	9	4	4	5	27
3	1	2	1	1		5
Grand Total	7	14	8	10	11	50

>25 yrs	1	2	3	4	5	Mean		
Q7.1	0	2	0	2	1	3.40		
Q7.2	1	1	0	2	1	3.20		
Q7.3	1	2	1	1	0	2.40	Min	2.40
Q7.4	1	0	0	2	2	3.80	Max	3.80

Row Labels	1	2	3	4	5	Grand Total
1	5	9	1	3		18
2	4	6	6	3	8	27
3	1			2	2	5
Grand Total	10	15	7	8	10	50

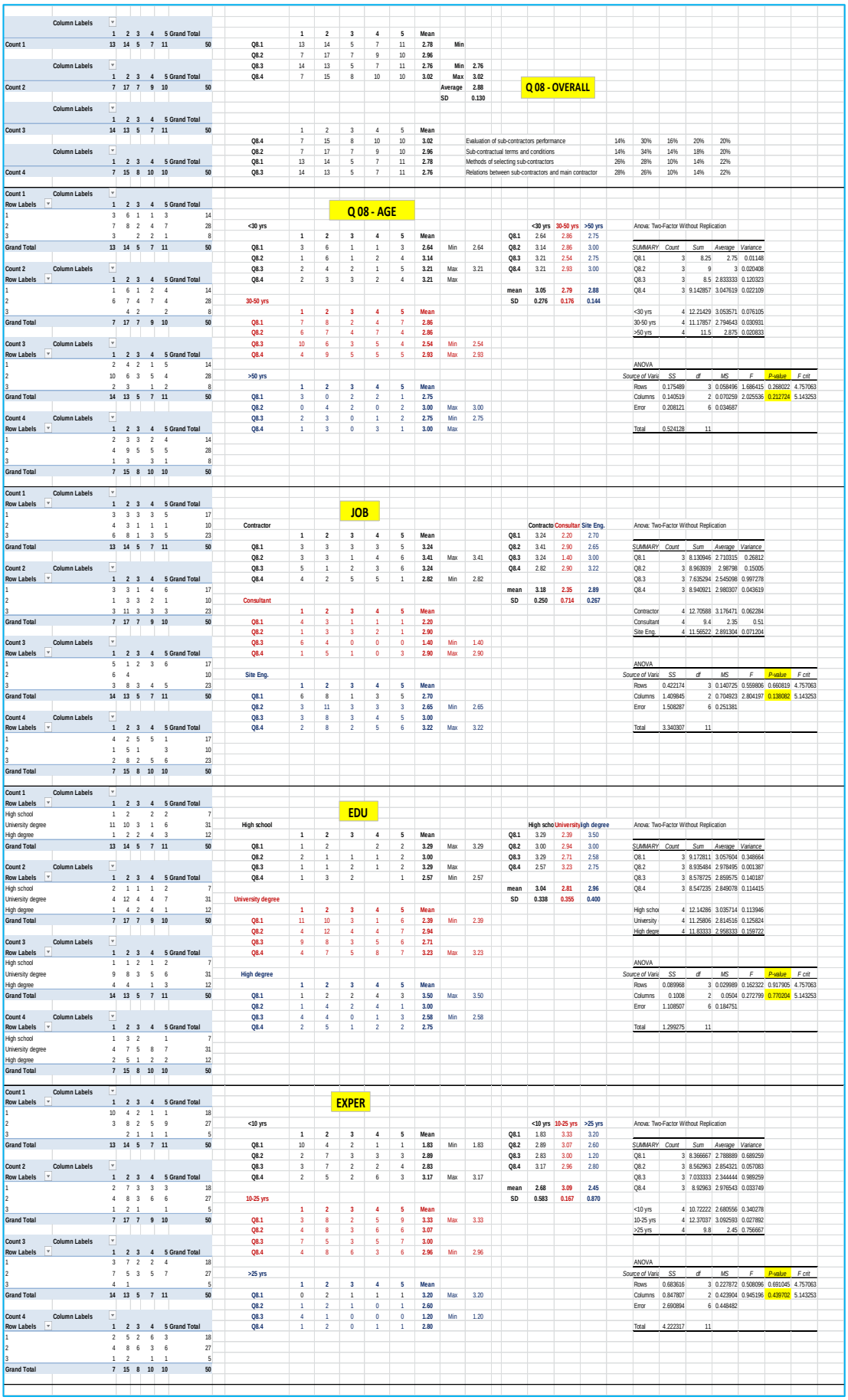
	<10 yrs	10-25 yrs	>25 yrs
Q7.1	2.72	2.96	3.40
Q7.2	3.17	3.00	3.20
Q7.3	3.67	2.81	2.40
Q7.4	2.11	3.19	3.80
mean	2.92	2.99	3.20
SD	0.661	0.152	0.589

Anova: Two-Factor Without Replication

SUMMARY	Count	Sum	Average	Variance
Q7.1	3	9.085185	3.028395	0.118057
Q7.2	3	9.366667	3.122222	0.011481
Q7.3	3	8.881481	2.960494	0.417028
Q7.4	3	9.096296	3.032099	0.730663
<10 yrs	4	11.66667	2.916667	0.437243
10-25 yrs	4	11.96296	2.990741	0.023205
>25 yrs	4	12.8	3.2	0.346667

ANOVA

Source of Varia	SS	df	MS	F	P-value	F crit
Rows	0.039625	3	0.013208	0.033274	0.99102	4.757063
Columns	0.172739	2	0.086369	0.217581	0.810542	5.143253
Error	2.381719	6	0.396953			
Total	2.594083	11				



Column Labels	1	2	3	4	5	Grand Total
Count 1	13	14	5	7	11	50

	1	2	3	4	5	Mean		
Q8.1	13	14	5	7	11	2.78	Min	
Q8.2	7	17	7	9	10	2.96		
Q8.3	14	13	5	7	11	2.76	Min	2.76
Q8.4	7	15	8	10	10	3.02	Max	3.02
							Average	2.88
							SD	0.130

Q 08 - OVERALL

Column Labels	1	2	3	4	5	Grand Total
Count 2	7	17	7	9	10	50

Column Labels	1	2	3	4	5	Grand Total
Count 3	14	13	5	7	11	50

Column Labels	1	2	3	4	5	Grand Total
Count 4	7	15	8	10	10	50

	1	2	3	4	5	Mean
Q8.4	7	15	8	10	10	3.02
Q8.2	7	17	7	9	10	2.96
Q8.1	13	14	5	7	11	2.78
Q8.3	14	13	5	7	11	2.76

Evaluation of sub-contractors performance	14%	30%	16%	20%	20%
Sub-contractual terms and conditions	14%	34%	14%	18%	20%
Methods of selecting sub-contractors	26%	28%	10%	14%	22%
Relations between sub-contractors and main contractor	28%	26%	10%	14%	22%

Q 08 - AGE

Count 1 / Column Labels						
Row Labels	1	2	3	4	5	Grand Total
1	3	6	1	1	3	14
2	7	8	2	4	7	28
3	3		2	2	1	8
Grand Total	13	14	5	7	11	50

Count 2 / Column Labels						
Row Labels	1	2	3	4	5	Grand Total
1	1	6	1	2	4	14
2	6	7	4	7	4	28
3		4	2		2	8
Grand Total	7	17	7	9	10	50

Count 3 / Column Labels						
Row Labels	1	2	3	4	5	Grand Total
1	2	4	2	1	5	14
2	10	6	3	5	4	28
3	2	3		1	2	8
Grand Total	14	13	5	7	11	50

Count 4 / Column Labels						
Row Labels	1	2	3	4	5	Grand Total
1	2	3	3	2	4	14
2	4	9	5	5	5	28
3	1	3		3	1	8
Grand Total	7	15	8	10	10	50

<30 yrs	1	2	3	4	5	Mean		
Q8.1	3	6	1	1	3	2.64	Min	2.64
Q8.2	1	6	1	2	4	3.14		
Q8.3	2	4	2	1	5	3.21	Max	3.21
Q8.4	2	3	3	2	4	3.21	Max	

30-50 yrs	1	2	3	4	5	Mean		
Q8.1	7	8	2	4	7	2.86		
Q8.2	6	7	4	7	4	2.86		
Q8.3	10	6	3	5	4	2.54	Min	2.54
Q8.4	4	9	5	5	5	2.93	Max	2.93

>50 yrs	1	2	3	4	5	Mean		
Q8.1	3	0	2	2	1	2.75		
Q8.2	0	4	2	0	2	3.00	Max	3.00
Q8.3	2	3	0	1	2	2.75	Min	2.75
Q8.4	1	3	0	3	1	3.00	Max	

	<30 yrs	30-50 yrs	>50 yrs
Q8.1	2.64	2.86	2.75
Q8.2	3.14	2.86	3.00
Q8.3	3.21	2.54	2.75
Q8.4	3.21	2.93	3.00
mean	3.05	2.79	2.88
SD	0.276	0.176	0.144

Anova: Two-Factor Without Replication

SUMMARY	Count	Sum	Average	Variance
Q8.1	3	8.25	2.75	0.01148
Q8.2	3	9	3	0.020408
Q8.3	3	8.5	2.833333	0.120323
Q8.4	3	9.142857	3.047619	0.022109
<30 yrs	4	12.21429	3.053571	0.076105
30-50 yrs	4	11.17857	2.794643	0.030931
>50 yrs	4	11.5	2.875	0.020833

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Rows	0.175489	3	0.058496	1.686415	0.268022	4.757063
Columns	0.140519	2	0.070259	2.025536	0.212724	5.143253
Error	0.208121	6	0.034687			
Total	0.524128	11				

JOB

Count 1 / Column Labels						
Row Labels	1	2	3	4	5	Grand Total
1	3	3	3	3	5	17
2	4	3	1	1	1	10
3	6	8	1	3	5	23
Grand Total	13	14	5	7	11	50

Count 2 / Column Labels						
Row Labels	1	2	3	4	5	Grand Total
1	3	3	1	4	6	17
2	1	3	3	2	1	10
3	3	11	3	3	3	23
Grand Total	7	17	7	9	10	50

Count 3 / Column Labels						
Row Labels	1	2	3	4	5	Grand Total
1	5	1	2	3	6	17
2	6	4				10
3	3	8	3	4	5	23
Grand Total	14	13	5	7	11	50

Count 4 / Column Labels						
Row Labels	1	2	3	4	5	Grand Total
1	4	2	5	5	1	17
2	1	5	1		3	10
3	2	8	2	5	6	23
Grand Total	7	15	8	10	10	50

Contractor	1	2	3	4	5	Mean		
Q8.1	3	3	3	3	5	3.24		
Q8.2	3	3	1	4	6	3.41	Max	3.41
Q8.3	5	1	2	3	6	3.24		
Q8.4	4	2	5	5	1	2.82	Min	2.82

Consultant	1	2	3	4	5	Mean		
Q8.1	4	3	1	1	1	2.20		
Q8.2	1	3	3	2	1	2.90		
Q8.3	6	4	0	0	0	1.40	Min	1.40
Q8.4	1	5	1	0	3	2.90	Max	2.90

Site Eng.	1	2	3	4	5	Mean		
Q8.1	6	8	1	3	5	2.70		
Q8.2	3	11	3	3	3	2.65	Min	2.65
Q8.3	3	8	3	4	5	3.00		
Q8.4	2	8	2	5	6	3.22	Max	3.22

	Contractor	Consultant	Site Eng.
Q8.1	3.24	2.20	2.70
Q8.2	3.41	2.90	2.65
Q8.3	3.24	1.40	3.00
Q8.4	2.82	2.90	3.22
mean	3.18	2.35	2.89
SD	0.250	0.714	0.267

Anova: Two-Factor Without Replication

SUMMARY	Count	Sum	Average	Variance
Q8.1	3	8.130946	2.710315	0.26812
Q8.2	3	8.963939	2.98798	0.15005
Q8.3	3	7.635294	2.545098	0.997278
Q8.4	3	8.940921	2.980307	0.043619
Contractor	4	12.70588	3.176471	0.062284
Consultant	4	9.4	2.35	0.51
Site Eng.	4	11.56522	2.891304	0.071204

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Rows	0.422174	3	0.140725	0.559806	0.660819	4.757063
Columns	1.409845	2	0.704923	2.804197	0.138082	5.143253
Error	1.508287	6	0.251381			
Total	3.340307	11				

EDU

Count 1 / Column Labels						
Row Labels	1	2	3	4	5	Grand Total
High school	1	2		2	2	7
University degree	11	10	3	1	6	31
High degree	1	2	2	4	3	12
Grand Total	13	14	5	7	11	50

Count 2 / Column Labels						
Row Labels	1	2	3	4	5	Grand Total
High school	2	1	1	1	2	7
University degree	4	12	4	4	7	31
High degree	1	4	2	4	1	12
Grand Total	7	17	7	9	10	50

Count 3 / Column Labels						
Row Labels	1	2	3	4	5	Grand Total
High school	1	1	2	1	2	7
University degree	9	8	3	5	6	31
High degree	4	4		1	3	12
Grand Total	14	13	5	7	11	50

Count 4 / Column Labels						
Row Labels	1	2	3	4	5	Grand Total
High school	1	3	2		1	7
University degree	4	7	5	8	7	31
High degree	2	5	1	2	2	12
Grand Total	7	15	8	10	10	50

High school	1	2	3	4	5	Mean		
Q8.1	1	2		2	2	3.29	Max	3.29
Q8.2	2	1	1	1	2	3.00		
Q8.3	1	1	2	1	2	3.29	Max	
Q8.4	1	3	2		1	2.57	Min	2.57

University degree	1	2	3	4	5	Mean		
Q8.1	11	10	3	1	6	2.39	Min	2.39
Q8.2	4	12	4	4	7	2.94		
Q8.3	9	8	3	5	6	2.71		
Q8.4	4	7	5	8	7	3.23	Max	3.23

High degree	1	2	3	4	5	Mean		
Q8.1	1	2	2	4	3	3.50	Max	3.50
Q8.2	1	4	2	4	1	3.00		
Q8.3	4	4	0	1	3	2.58	Min	2.58
Q8.4	2	5	1	2	2	2.75		

	High school	University degree	High degree
Q8.1	3.29	2.39	3.50
Q8.2	3.00	2.94	3.00
Q8.3	3.29	2.71	2.58
Q8.4	2.57	3.23	2.75
mean	3.04	2.81	2.96
SD	0.338	0.355	0.400

Anova: Two-Factor Without Replication

SUMMARY	Count	Sum	Average	Variance
Q8.1	3	9.172811	3.057604	0.348664
Q8.2	3	8.935484	2.978495	0.001387
Q8.3	3	8.576725	2.859575	0.140187
Q8.4	3	8.547235	2.849078	0.114415
High school	4	12.14286	3.035714	0.113946
University	4	11.25806	2.814516	0.125824
High degree	4	11.83333	2.958333	0.159722

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Rows	0.089968	3	0.029989	0.162322	0.917905	4.757063
Columns	0.1008	2	0.0504	0.272799	0.770204	5.143253
Error	1.108507	6	0.184751			
Total	1.299275	11				

EXPER

Count 1 / Column Labels						
Row Labels	1	2	3	4	5	Grand Total
1	10	4	2	1	1	18
2	3	8	2	5	9	27
3		2	1	1	1	5
Grand Total	13	14	5	7	11	50

Count 2 / Column Labels						
Row Labels	1	2	3	4	5	Grand Total
1	2	7	3	3	3	18
2	4	8	3	6	6	27
3	1	2	1		1	5
Grand Total	7	17	7	9	10	50

Count 3 / Column Labels						
Row Labels	1	2	3	4	5	Grand Total
1	3	7	2	2	4	18
2	7	5	3	5	7	27
3	4	1				5
Grand Total	14	13	5	7	11	50

Count 4 / Column Labels						
Row Labels	1	2	3	4	5	Grand Total
1	2	5	2	6	3	18
2	4	8	6	3	6	27
3	1	2		1	1	5
Grand Total	7	15	8	10	10	50

<10 yrs	1	2	3	4	5	Mean		
Q8.1	10	4	2	1	1	1.83	Min	1.83
Q8.2	2	7	3	3	3	2.89		
Q8.3	3	7	2	2	4	2.83		
Q8.4	2	5	2	6	3	3.17	Max	3.17

10-25 yrs	1	2	3	4	5	Mean		
Q8.1	3	8	2	5	9	3.33	Max	3.33
Q8.2	4	8	3	6	6	3.07		
Q8.3	7	5	3	5	7	3.00		
Q8.4	4	8	6	3	6	2.96	Min	2.96

>25 yrs	1	2	3	4	5	Mean		
Q8.1	0	2	1	1	1	3.20	Max	3.20
Q8.2	1	2	1	0	1	2.60		
Q8.3	4	1	0	0	0	1.20	Min	1.20
Q8.4	1	2	0	1	1	2.80		

	<10 yrs	10-25 yrs	>25 yrs
Q8.1	1.83	3.33	3.20
Q8.2	2.89	3.07	2.60
Q8.3	2.83	3.00	1.20
Q8.4	3.17	2.96	2.80
mean	2.68	3.09	2.45
SD	0.583	0.167	0.870

Anova: Two-Factor Without Replication

SUMMARY	Count	Sum	Average	Variance
Q8.1	3	8.366667	2.788889	0.689259
Q8.2	3	8.562963	2.854321	0.057083
Q8.3	3	7.033333	2.344444	0.989259
Q8.4	3	8.92963	2.976543	0.033749
<10 yrs	4	10.72222	2.680556	0.340278
10-25 yrs	4	12.37037	3.092593	0.027892
>25 yrs	4	9.8	2.45	0.756667

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Rows	0.683616	3	0.227872	0.508096	0.691045	4.757063
Columns	0.847807	2	0.423904	0.945196	0.439702	5.143253
Error	2.690894	6	0.448482			
Total	4.222317	11				