

**Quality Management Implementation effectiveness
in Construction Sector, Saudi Arabia, Ahsa
(MMS Construction company)
(Case Study)**

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ABSTRACT

Across the world, quality issues on construction projects have been challenging, especially in developing countries with increased demand for buildings due to emerging economies and growing populations. In KSA, especially Ahsa, the need to improve the quality performance of construction projects and curb the quality issues faced by construction industries has called for effective quality control management practices. Therefore, this research aims to develop a framework for effective quality control management of building construction projects, by investigating the current quality control practices, the challenges inhibiting effective quality control management, the influence of quality control managers as well as the critical success factors required for quality control management of building construction projects. The study employs a quantitative research method using a questionnaire as the research instrument. A total of forty seven responses were obtained from construction professionals working in the construction industries within MMS Company. The professionals were randomly selected. The data collected were analysed through descriptive and exploratory factor analysis methods utilizing Statistical Package for the Social Sciences (SPSS) version 28. The findings revealed that the firm carry out quality control management practices but mostly adopt traditional quality control practices to control the quality of work being carried out. Also, the findings revealed that employing quality control managers will positively influence the quality control management of construction projects.

They would ensure the implementation of quality plans and checklists, boost quality compliance, and increase the project's success. The study further identified quality control challenges and the success factors required for effective quality control management. Upon this, a graphical framework for effective quality control management was developed. The proposed framework in this study shall be helpful to construction stakeholders and organisations in efficiently controlling the quality of construction projects. The study, therefore, recommends applying digital quality control tools to building projects among construction professionals, as this will help put the industry ahead of others and reduce human error in production.

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Chapter One

Introduction

1-Overview:

The construction industry plays a pivotal role in global economies, contributing significantly to GDP and employment. As the demand for infrastructure and urban development grows, ensuring quality in construction projects becomes paramount. In this context, effective **Quality Management (QM)** practices are essential for achieving project success, meeting client expectations, and enhancing overall industry performance. (construction industry Energy Science and Research 2012 Volume (issues) 29(2): 883-890)

Due to the uncertainty and complexity of construction management and variability within project environments, quality should be closely scrutinized and controlled throughout each stage of construction. Based on experience from construction experts and extensive literature review, there are three factors which contribute to difficulties in quality management. First, the quality control criteria for individual components are scattered in different national, industrial and local quality control codes for construction. It is also common for these specifications to cross-reference each other, creating complex dependencies between specifications. (Joseph M. Juran Quality Control Handbook 1998)

Implementing QM in the construction industry remains a complex task due to its unique characteristics. Unlike other sectors, construction work involves high risk, safety concerns, and intricate project dynamics. Many construction companies perceive quality as an expensive accessory rather than a strategic necessity. Bridging this gap and understanding the barriers to effective QM implementation is crucial. (Total quality management implementation,2008)

Quality management directly influences project outcomes, safety, and long-term sustainability. It enhances client trust, reduces rework, and ensures compliance with regulations. As the construction industry strives for excellence, understanding the nuances of QM becomes imperative. (Critical factors for total quality management implementation, 2021)

This research aims to:

1. Investigate the challenges associated with signifying quality in the construction industry (MMS Company).
2. Explore the advantages of QM implementation in construction projects of MMS Company.
3. Identify barriers hindering the successful adoption of QM practices.

Understanding the impact of QM on construction projects can lead to several benefits:

- **Higher Productivity:** QM practices reduce rework, enhance efficiency, and improve overall productivity.
- **Budget Performance:** Effective QM ensures adherence to project budgets and cost control.
- **Employee Satisfaction:** A focus on quality positively impacts employee morale and job satisfaction.

By addressing these objectives, this research contributes to the body of knowledge on QM in the construction industry and provides practical insights for companies like MMS Construction. The findings will guide stakeholders in making informed decisions, fostering a culture of quality, and ultimately elevating the industry's performance.

In the subsequent sections, we delve deeper into the challenges, benefits, and strategies for successful QM implementation in construction.

The roots of quality management trace back to the early 20th century when pioneers like Walter Shewhart and W. Edwards Deming introduced statistical process control and quality improvement methodologies. Their work laid the foundation for modern QM practices. Over time, frameworks like ISO 9001 emerged, emphasizing process standardization, continuous improvement, and customer focus. (Obstacles to implementing total quality management in the UK construction industry,1998)

Previous research has explored various aspects of quality management in construction. Studies have investigated the impact of QM on project performance, cost control, and stakeholder satisfaction. Researchers have highlighted the role of leadership, organizational culture, and employee engagement in successful QM implementation. By building upon these insights, our study aims to contribute to the existing body of knowledge and address specific gaps.

his introduction sets the stage for our research journey into the intricacies of quality management. In subsequent sections, we explore case studies, analyze data, and provide actionable insights for practitioners and organizations like MMS Construction.

2-Research problems

- Research problems related to Quality Management Implementation in the Construction Industry are crucial for improving practices and outcomes. (Implementing total quality management in construction firms LS Pheng, JA Teo - Journal of management in Engineering, 2004). Here are some potential research problem areas might consider (Theoretical/ Theoretical gaps):
 1. Barriers to Quality Management Implementation:
 - Investigate the challenges faced by construction companies (such as MMS Construction) when implementing quality management practices. What are the specific obstacles, and how can they be overcome?
 - Explore the reasons behind slow adoption of quality management principles in the construction industry.
 2. Benefits of Quality Management:
 - Examine the tangible and intangible benefits of implementing quality management systems in construction projects. How does it impact productivity, rework reduction, budget performance, and employee job satisfaction?
 - Assess the financial implications of quality management implementation for construction companies.
 3. Cultural Factors and Quality Management:
 - Investigate how organizational culture influences the successful implementation of quality management practices. Are there cultural barriers or enablers specific to the construction industry?
 - Explore strategies to foster a quality-oriented culture within construction companies.

4. Leadership and Management Support:

- Analyze the role of leadership and management support in driving quality initiatives. How can top management actively promote and sustain quality practices?
- Identify best practices for engaging leadership in quality management efforts.

5. Skilled Workforce and Training:

- Study the impact of skilled workers on quality outcomes. How can construction companies enhance workforce competence and ensure effective training in quality management?
- Investigate the correlation between employee training and quality performance.

6. Cost-Effectiveness of Quality Programs:

- Assess the perceived cost of quality management implementation in construction. Is quality truly an expensive accessory, or does unimplemented quality lead to higher costs?
- Develop cost-benefit models to demonstrate the economic value of quality practices.

The importance of researching Quality Management Implementation in the Construction Industry, particularly for companies like MMS Construction, cannot be overstated. Here are some key reasons why this research area is significant: (Implementation of total quality management in construction industry, 2013)

1. Enhanced Project Performance:

- Effective quality management practices lead to improved project outcomes. Research can identify specific quality interventions that positively impact project completion time, cost control, and overall performance.

2. Customer Satisfaction and Reputation:

- High-quality construction work directly influences client satisfaction. Research can explore how adherence to quality standards enhances customer trust, repeat business, and positive word-of-mouth referrals.

3. Risk Mitigation:

- Quality management helps mitigate risks related to safety, defects, and rework. Investigating risk reduction strategies can contribute to safer construction sites and fewer legal disputes.

4. Competitive Advantage:

- Companies that prioritize quality gain a competitive edge. Research can highlight how quality practices differentiate construction firms in a crowded market.

5. Resource Optimization:

- Efficient quality management minimizes waste, rework, and material losses. Understanding resource optimization techniques can lead to cost savings and sustainable practices.
- 6. Compliance with Standards and Regulations:
 - Research can delve into the alignment of quality management systems with industry standards (e.g., ISO 9001) and local regulations. Compliance ensures legal and ethical practices.
- 7. Employee Morale and Productivity:
 - A focus on quality positively impacts employee morale. Investigate how training, empowerment, and recognition contribute to a motivated workforce.
- 8. Innovation and Continuous Improvement:
 - Quality research encourages innovation. Explore novel approaches, technologies, and best practices that elevate construction quality.
- 9. Sustainability and Environmental Impact:
 - Quality management extends beyond physical structures. Research can address sustainable construction practices, minimizing environmental harm.
- 10. Industry Reputation and Longevity:
 - Companies known for quality endure in the industry. Research contributes to the long-term success and legacy of construction firms.

3-Main Research Question?

How can quality management implementation effect the Construction Industry growth, Saudi Arabia, Ahsa (MMS Construction company as case study)?

4-Importance of Research

importance and relevance of the study's findings in the context of **Quality Management Implementation** within the **Construction Industry** in Saudi Arabia, specifically focusing on the **Ahsa region (MMS Construction company)**.

1. Theoretical Level:

- **Advancing Knowledge:** The study's findings contribute to the theoretical understanding of quality management practices in construction. By identifying effective strategies, challenges, and gaps, the research enriches existing knowledge.
- **Conceptual Framework Refinement:** The study may refine existing theoretical frameworks related to quality management, providing practitioners and researchers with a more robust foundation for decision-making.

- **Guidance for Future Research:** The findings guide future research directions, suggesting areas for exploration and hypothesis testing.

2. Empirical Level:

- **Practical Applications:** The study's empirical findings directly impact real-world practices. For instance:
 - If the research identifies successful TQM practices, construction companies can adopt these methods to enhance project quality.
 - If gaps are revealed, practitioners can address them to improve overall performance.
- **Policy Implications:** Policymakers can use empirical evidence to shape regulations and guidelines related to quality management in the construction industry.
- **Competitive Advantage:** Companies implementing effective quality management practices gain a competitive edge, leading to better project outcomes, client satisfaction, and market positioning.

5-Research Sub Questions:

- How can quality assurance implementation help the MMS firm succeed?
- How can quality control implementation help the MMS firm succeed?

6-Research objectives:

Ensuring the effectiveness of quality assurance (QA) and quality control (QC) practices can significantly impact the success of **Mobarak Merai Al-Salomi and Partners** in the construction industry. Let's explore how QA contributes to their success:

1. Consistent Quality Standards:

- QA establishes consistent quality standards across all projects undertaken by the company.
- By adhering to these standards, Mobarak Merai Al-Salomi and Partners can deliver high-quality work consistently, enhancing their reputation.

2. Risk Mitigation:

- QA processes identify potential risks early in the project lifecycle.

- By addressing these risks proactively, the company minimizes costly errors, delays, and rework.
- Successful risk management contributes to project success.

3. Client Satisfaction:

- QA ensures that the final deliverables meet or exceed client expectations.
- Satisfied clients are more likely to recommend the company to others and provide repeat business.
- Positive client relationships contribute to long-term success.

4. Efficient Processes:

- QA streamlines processes, reducing waste and inefficiencies.
- Efficient project execution leads to cost savings and timely completion.
- Mobarak Merai Al-Salomi and Partners can allocate resources effectively.

5. Compliance and Accreditation:

- QA practices ensure compliance with industry standards, codes, and regulations.
- Achieving relevant certifications or accreditations demonstrates the company's commitment to quality.
- Accreditation can enhance their market position and attract more clients.

6. Continuous Improvement:

- QA encourages a culture of continuous learning and improvement.
- Regular audits, feedback loops, and lessons learned contribute to refining processes.
- Mobarak Merai Al-Salomi and Partners can adapt to changing industry trends and stay competitive.

7-Research Hypotheses:

research hypotheses related to the impact of quality assurance on the success of **Mobarak Merai Al-Salomi and Partners** in the construction industry:

1. Hypothesis 1 (Client Satisfaction):

- **Hypothesis (H₁):** Effective quality assurance strategies positively influence client satisfaction, leading to project success.

2. **Hypothesis 2 (Project Performance):**

- **Hypothesis (H₁):** Rigorous quality assurance practices contribute to improved project performance, resulting in successful project outcomes.

3. **Hypothesis 3 (Risk Mitigation):**

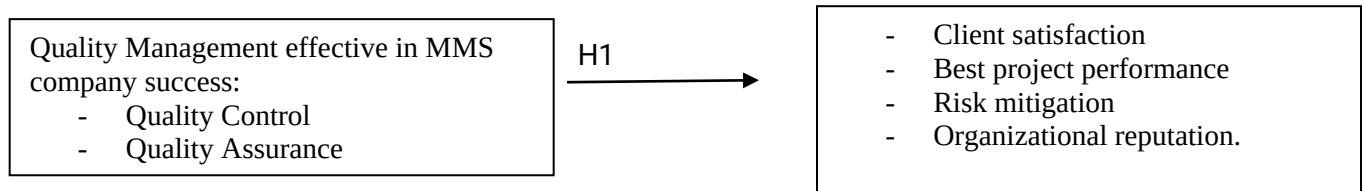
- **Hypothesis (H₁):** Effective quality assurance minimizes risks, leading to smoother project execution and successful project delivery.

4. **Hypothesis 4 (Organizational Reputation):**

- **Hypothesis (H₁):** A strong quality assurance framework enhances the company's reputation, attracting more clients and fostering long-term success.

8-Research model:

Below shows the relationship of research variable and research hypothesis:



Source: student

9-Scope of Research:

This research is case study, we will study the Quality Management Implementation effectiveness in Construction Sector, Saudi Arabia, Ahsa (Mobarak Merai Salomi and Partners for Construction company).

11-Structure for The Research:



Chapter 2

Literature Review

1. Introduction

The construction industry in Saudi Arabia is the largest and fastest-growing market in the Gulf region ([Samargandi et al., 2013](#)). Its organisational culture, labour and material supply chain, business strategies, and management skills are different from other parts of the globe. For example, the Kingdom of Saudi Arabia (KSA) has a strong economic standing, which leads its government to take the opportunity to spend money on many public-funded infrastructure projects. The KSA has experienced a construction boom with over 5,200 ongoing public infrastructure projects having a total value equal to US\$819 billion ([Argaam, 2021](#)). However, Saudi Arabia failed to make real progress in achieving good management and organisational performance as most projects are experiencing delays and cost overruns ([Abdellatif and Alshibani, 2019](#); [Mahamid, 2013](#); [Mosley and Bubshait, 2016](#)). A proper QMS development and its practice throughout the project's life-cycle and its associated organisations are essential to overcome these poor project delivery performances.

Accordingly, [Al-Otaibi et al. \(2015\)](#) discovered that Saudi Arabian construction firms' performances could be promoted over their counter companies by effectively practising the Total Quality Management (TQM) system. In particular, the TQM has a strong positive correlation improving construction quality culture, which is a critical issue to the project owners. [Mazher et al. \(2015\)](#) studied the effectiveness of TQM in the Saudi construction industry considering four dimensions, such as quality control, management, assurance, and inspection. They applied regression analysis and found quality management and assurance have strong positive significance to the project quality assurance. [Aichouni et al. \(2014\)](#) conducted an empirical study on the adaptation challenges of some already developed quality management systems in the Saudi

construction industry. They discovered that organizational culture is the main barrier to implement those tools and techniques in this region. In a further study in Saudi Arabia, [Abazid and Gökçekuş \(2019\)](#) discovered that organizational culture, higher authorities' willingness to adapt and customize the TQM system, reliability and tangibility dimensions are the main problems in implementing a quality management system. Previous research in other countries also identified that specific company culture, business performance, strategy to quality control, country's development policy, etc., are distinct and directly linked to the QMS of a company or organization ([Bhatia and Awasthi, 2018](#); [Fundin et al., 2018](#)). Thus, a country or company-specific QMS development and practice is a critical need. However, no study in the KSA proposed any QMS model, which can readily be adopted or accommodated local construction issues and culture in construction quality management.

As construction projects usually involve large quantities of resources and many dynamic processes, achieving high quality is end-product-based and depends on managing interrelated organizational processes ([Masuin et al., 2020](#)). Among many factors, information system management, quality of reporting documents, recording of quality-related data like inspection, identified issues, and collaboration among the stakeholders to resolve the issues ensuring intended quality control are significant to develop and practice standard QMS for an organization ([Lee et al., 2020](#); [Ma et al., 2018](#)). The mere existence of information management and quality documentation does not necessarily reflect the presence of deep-rooted operational practices and procedures needed for ensuring the ultimate delivery of a well-operated Quality Management System (QMS). Some human factors such as level of learning, building dynamic capability, knowledge integration with a flexible strategy to a product or service are also significant to practice QMS throughout the production supply chain ([Gutierrez-Gutierrez et al., 2018](#)). *These particular issues, i.e., the company's culture and strategies to quality assurance,*

information documentation and management, and human factors in QMS, did not discover any previous study in the KSA. Thus, this paper aims to develop the Quality Management System (QMS) for construction companies in the KSA. In recent years, many researchers have focused on developing and adopting company-based QMS systems using the SERVIQUAL model, TQM, and International Organization for Standardization (ISO) tools (Bhatia and Awasthi, 2018). Towards developing QMS for the KSA construction industry, this study conducted a structured focus group interview with the experts of specific construction companies, followed by two case studies to develop company-specific QMS and its implementation guidelines based on ISO tools.

2. Literature Review

2.1 Quality Management System Overview

There is no single, universally accepted definition of quality, which underlines that quality is viewed in various ways (Watson and Howarth, 2011). ISO 9000:2015 defines ‘quality’ as ‘*the degree to which a set of inherent characteristics of an object fulfils requirements*’ (BSI-Standards, 2015). In construction projects, quality is about the product and equipment used in the construction and the overall management approach to complete the project (Rumane, 2017). It can be said that, in construction projects, quality is to be achieved whenever the needs of all stakeholders involved in projects or production or provisions of services, such as consultants, constructors, project customers, and other related stakeholders, are fulfilled. However, as the control of construction depends mainly on contractors, it can be argued that contractors have the primary responsibility for the construction quality. Therefore, understanding the concepts of quality is essential for a construction company in developing and implementing a ‘quality management system’ as a strategic management tool to gain benefits from the successful implementation of a quality system.

The American Society for Quality ([ASQ, 2021](#)) defines quality management as ‘the application of a quality management system in managing a process to achieve maximum customer satisfaction at the lowest overall cost to the organization while improving the process.’ Quality management can include establishing quality policies and quality objectives and processes to achieve these quality objectives through quality planning, quality assurance, quality control, and quality improvement ([BSI-Standards, 2015](#)). Quality management is essential for facilitating commercial organisations’ competitiveness and keeping them competitive and successful ([Watson and Howarth, 2011](#)).

A quality management system (QMS) can be defined as a formalized system that documents the structure, responsibilities and procedures required to achieve effective quality management ([ASQ, 2021](#)). It is part of an organization’s management system concerning quality ([BSI-Standards, 2015](#)).

QMS is the main element of the management system directed to managing and controlling quality processes and operations. It helps construction companies to produce highquality products and services that consistently meet their clients’ and regulatory requirements, in addition to the applied standards and specifications. Quality management system establishes a supportive internal organization for the construction contractors allowing them to sustain in the Construction Market ([Oyewobi et al., 2013](#)). An effective QMS is needed to ensure a construction company meets the reference standards and the clients’ requirements ([Rumane, 2017](#)). Therefore, construction companies need to have a QMS that enhances the balance between the four main objectives of delivering construction projects (Cost, Time, Quality, and Safety) by considering requirements and conditions that vary from one project to another ([Lee and Arditi, 1997](#)).

A Quality Management System (QMS) requires precise and applicable Quality Control and Quality Assurance (QC/QA) programs. It includes all processes and deliverables that the company provides at both the company based level (CBL) and the project-based level (PBL) (Lee and Arditi, 2006). Furthermore, one of the key elements of a QMS is the management commitment and leadership, which provides enough resources and supports the QMS awareness among all organization individuals and meets the requirements of the interested parties (Pheng and Tan, 2005). The management commitment is also reflected in establishing a systematic approach to management and continual improvement.

2.2 QMS in the Construction Industry

Several studies addressed the main barriers and enablers of developing and implementing QMS in the construction industry. Fundin et al. (2018) studied the barriers to implementing a quality management system (QMS) and how current studies address those challenges. They identified 49 challenges of implementing QMS eliciting expert judgment using the Delphi technique and exploratory factor analysis. The major QMS adaptation challenges are the organisation's adaptability to the volatile market environment, strategic concern for quality services/products, and managerial ownership of quality. Accordingly, further research is suggested to focus on making QMS the owner's strategic concern and exploring its contribution to organisational adaptability. Lee et al. (2020) discovered the key practical components to ensure quality management practice for delivering an outstanding quality of highway projects. They studied the QMS of the United States of American state practices focusing on material and workmanship quality management in highway projects using content analysis of relevant documents and interviews with the experts involved in the US highway projects. The critical components of quality management are nonconformance reports, agency acceptance techniques, the strategy of quality assurance budgeting, etc. Maetal. (2018) develop Building Information Modeling (BIM)-based QMS for construction projects to facilitate quality inspection and

collaboration among multiple stakeholders. They develop system architecture, inspection tasks generating algorithm and indoor positioning techniques and demonstrate the QMS in an on-site application. While the construction industry is one of the largest industries, it lacks information and other data recording.

Proper quality management can be enhanced if the previous failure or success factors are recorded and managed throughout the project's execution phases. Accordingly, [Wang et al. \(2018\)](#) develop a text-big data management technique in BIM and a material quality prediction model integrating recurrent neural network (RNN) and long short-term memory neural network ensuring lesson-learned based QMS for future projects. Their model can predict the quality problem and detect the quality problem events in project execution phases, reducing the quality-related incidents. [Olafsdottir et al. \(2016\)](#) identified the variables of developing a dynamic QMS model for the construction industry by arranging group discussions with stakeholders. In a further study, [Olafsdottir et al. \(2019\)](#) applied a system dynamics approach evaluating the practice of QMS in the construction industry. Their approach offers to reduce the construction cost related to total quality management. System dynamics has a feedback loop by which cost impacts of poor quality and good quality can be studied and simulated for comprehensive understanding and decision-making regarding the quality cost of a project.

The product or service quality highly are correlated with human factors. Thus, [Gutierrez-Gutierrez et al. \(2018\)](#) studied how human factors in QMS relate to learning orientation, dynamic capability building, knowledge integration and flexible strategy in new product development. Their findings show that human factors significantly contribute to developing a learning culture, knowledge integration and strategic flexibility firmly attached to the quality product development. Practising a sustainable QMS throughout the supply chain is a prerequisite to deliver a quality product or process, or service. [Bastas and Liyanage \(2018\)](#)

discovered a new but highly emerging research area, which integrates three distinct approaches: sustainability, supply chain, and QM by a systematic review of existing literature in supply chain areas. They emphasize the relationships between three pillars of sustainability (social, ecological, and economical) and QM in supply chain management, which is yet to be explored. [Zakuan et al. \(2014\)](#) discovered the QMS's roles for the total quality management of a construction project studying previous published relevant literature. They discuss the soft and hard quality practice, project performance, and technical and nontechnical approaches towards quality management in construction industry. They also stated that a few studies paid attention to study construction quality management as the specific company performances, and recommended for future research considering country-specific cultural, organisational and other factors, which have influences in practicing the QMS.

Previous research overlooks understanding the relationship between the QMS and the organization's business performance, which is critical to the project's intended quality. [Bhatia and Awasthi \(2018\)](#) developed a framework illustrating the QMS implementation impact through different factors such as product quality, information quality, design and operation performances, etc., on an organization's business performance. The relationships between those factors and business performance are established through the structural equation model (SEM). Design performance with quality information was discovered as a significant factor towards practising QMS and better business performance. [Masuin et al. \(2020\)](#) proposed an integrated management system (IMS) for the construction industry boosting organisational performance. They showed how environment, health and safety, and quality could be integrated to comprehensively manage a project and identify critical variables to practice IMS.

Being the largest and fastest-growing construction market in the Gulf region, quality products and processes are becoming essential to the KSA construction industry. For

example, Bubshait (2001) and Bubshait and Al-Atiq (1999) discovered that quality performances of construction projects in the KSA were at substandard levels. A further study in KSA also indicated that quality problems are among the leading causes of the conflicts between construction contractors and engineering consultants (Sha'ar et al., 2017). Bubshait and AlAtiq (1999), for example, argued that one of the main reasons for the ineffective implementation of QMS in the *Saudi construction market* was that most Saudi contractors did not have a good understanding of document management concepts. Therefore, it was then necessary to first adopt an effective documentation system.

Moreover, a documentation system was also considered one of the main enablers necessary for initiating QMS in construction companies (Battikha, 2002; Chini and Valdez, 2003; Ezeldin and Abu-Ghazala, 2007; Koehn and Datta, 2003; Lam and Tang, 2002; Pheng and Tan, 2005). The unique characteristic of the construction industry also leads construction companies to adopt a flexible QMS capable of dealing with a wide range of reference standards and special conditions of project requirements (Chini and Valdez, 2003; Koehn and Datta, 2003; Samuels and Young, 2013). A computer-based QMS could solve the difficulties that construction companies face in dealing with various applied reference standards in the construction industry (Battikha, 2002). The variation in the applied standards creates an interference between the adopted QMS requirements and the unique characteristics/properties (Chini and Valdez, 2003).

From the literature review, it can be summarized that the relationship between QMS and an organization's business performance, adaptability to the unpredictable market environment, strategic concern to quality services/products, and managerial skills are essential to practice a QMS in a particular construction industry environment. Besides, previous studies also recommend future research considering country-specific cultural, organisational and market factors towards developing QMS. In addition, *no study in Saudi Arabia focuses on these organisational factors and country-specific management*

strategies for the development and implementation of a QMS. Thus, this study developed a QMS model for a specific company/organization considering its characteristics and the characteristics of the KSA construction industry. The QMS implementation guidelines are also prepared, taking expert judgments and conducting case studies from better QMS practice in this region. The following sections introduce model development methodology and demonstrate the proposed QMS model to overcome this research gap identified in the literature.

3. Conclusion and Recommendation

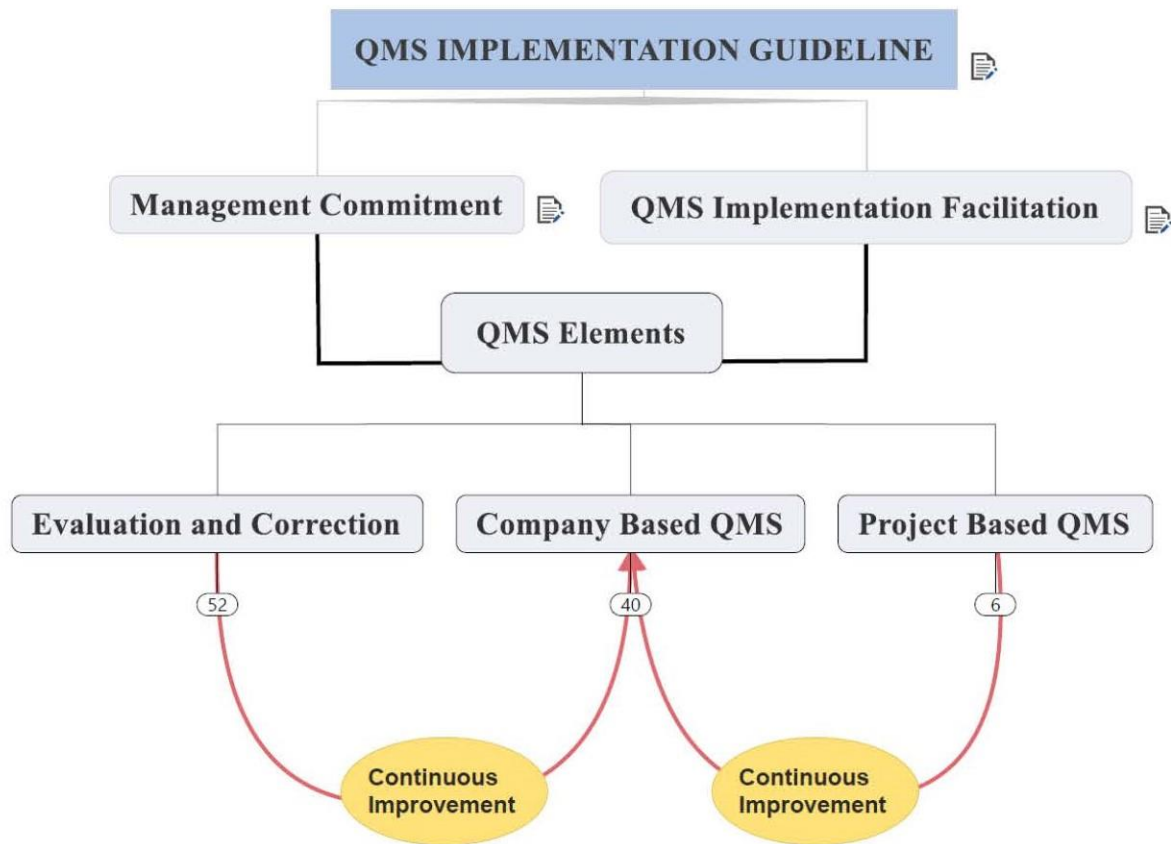
Effective implementation of a Quality Management System (QMS) in the Saudi construction market becomes necessary to deliver high-quality projects and services. Despite this necessity, no QMS guideline fits the nature of the Saudi construction industry. This research aims to develop a QMS and implementation guideline for the Saudi construction companies. Accordingly, a suitable QMS is developed based on a structured interview in the form of FGD with experts involved in the Saudi construction industry.

International standard should be adopted for developing a QMS. They recommended adopting ISO 9001:2015 QMS model. This study identified the gaps for adjustment of company culture, strategy to quality assurance, and the characteristics of the Saudi construction market. the QMS for MMS was developed consisting of three themes: company-based, project-based, and evaluation and corrections. The company-based QMS includes three components from ISO 9001:2015, i.e., management system, documentation, and actions. The project-based QMS indicates the significance of developing a QA/QC plan along with an inspection and testing schedule. The correction and evaluation emphasize top management evaluation and discussion of the model's outcome for further correction and improvement.

The application of the QMS needs to consider five main components. They include top management commitment, facilitation of QMS application, company and project-based QMS, and evaluation and correction. The significant barriers of the QMS application in the Saudi

construction companies are mostly related to the leadership commitment, organisational aspects, the absence of QMS guideline that fits the Saudi construction market, and difficulties in building QMS culture. Enablers, for instance, training, process-oriented thinking, organisational structure, documentation plan, information modelling technology, 'QA/QC, QMS flexibility, continuous improvement, cultural change', risk-based thinking, teamwork, and adaptation with market changes, could help Saudi construction companies overcoming the identified barriers.

The study recommends that the MMS develop their own QMS by themselves to have a sense of ownership of the QMS and accommodate the organisational cultures and practices. It is also recommended to consider the local construction markets' characteristics, including quality and training of the workforce, construction regulations, nature of contracts and project delivery systems, and local culture. As the limitations, this study did not consider the advancement of information technology in the proposed QMS model; and conducted only focus group discussion-based qualitative assessment instead of large-scale experts' interviews or surveys. Thus, further studies are recommended to address these issues as a continuous improvement for sustainable QMS development for the KSA construction industry.



QUALITY MANAGEMENT SYSTEM FRAMWROK

Figure – student

Chapter 3

Research Methodology

3-1-- Overview:

Research methodology refers to the structured and logical process used to plan, execute, and report research. It involves selecting appropriate research methods, techniques, and tools to address specific research questions or problems.

- Research Philosophy: this research depends on Positivism philosophy
- Research Approach: the approach for this research is deductive approach.
- Research Strategy: this research using case study strategy.
- Research Choices: this research using mono method (quantitative method).
- Time Horizon: this research using cross sectional.
- Techniques and procedures: this research depends on questionnaire on collecting Datta.

3.2. Operational definitions for research variables

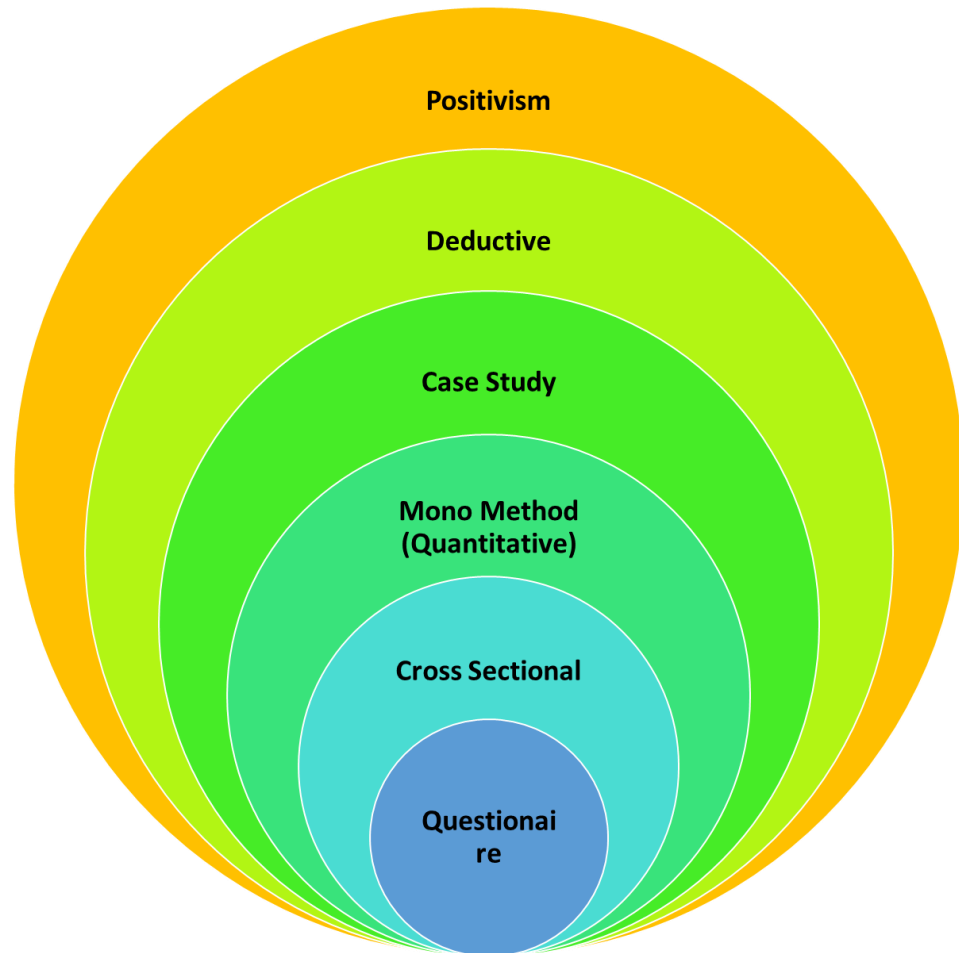
Quality control (QC) is a process by which entities review the quality of all factors involved in production. ISO 9000 defines quality control as "a part of quality management focused on fulfilling quality requirements" [ISO 9000:2005, Clause 3.2.10](#)

Quality Assurance:

is a systematic process that ensures products, services, or processes meet or exceed established quality standards. It involves activities and techniques aimed at preventing defects, identifying and resolving issues, and improving overall quality throughout the entire lifecycle of a product or service. [ISO 9001:2015 and ISO 17025:2017](#)

Independent variable	Dimensions	Number of items	Source
Effectiveness of QC & QA in MMS construction company	QC	10	Taylor, W. A., & Wright, G. H. (2003)
	QA	10	
	Overall	20	

3-3 Research Design – Research Onion



Resource: Student Aish Mohsen

Positivism is a philosophical school that confines itself to the data of experience and excludes a priori or metaphysical speculations. More specifically, it holds that all genuine knowledge is either true by definition or positive—meaning a posteriori facts derived by reason and logic from sensory experience. Other ways of knowing, such as intuition, introspection, or religious faith, are rejected or considered meaningless. This perspective emphasizes empirical evidence and critical analysis, aligning with a highly favorable view of science and the scientific method.

A **deductive approach** in research involves developing a hypothesis (or hypotheses) based on existing theory and then designing a research strategy to test that hypothesis¹. Here are the key points about deductive reasoning:

1. **Hypothesis Development:** Researchers start with a known theory or phenomenon and deduce hypotheses from it. These hypotheses are formulated in operational terms, and relationships between specific variables are proposed.
2. **Testing Hypotheses:** The deductive approach tests these hypotheses using relevant research methods. The goal is to either confirm or reject the hypotheses based on empirical observations.
3. **General to Specific:** Deductive reasoning moves from the general (theory) to the particular (observations), aiming to validate or invalidate the expected patterns derived from theory.
4. **Quantitative Measurement:** Deductive studies often use quantitative methods to measure concepts and explore causal relationships between variables.

A **case study** is a powerful tool for showcasing a business's success in helping clients achieve their goals. It's a form of storytelling that details real-world scenarios where a business implemented its solutions to deliver positive results for a client¹. Here are some key points about case studies:

1. **Definition:** A case study in qualitative research involves an in-depth investigation of a phenomenon within its real-world context. Researchers use it to acquire an in-depth understanding of intricate details that might not be as apparent through other research methods².
2. **Purpose:** Case studies provide holistic descriptions and explanations. They emphasize context, flexibility in design, and reliance on multiple sources of evidence. Longitudinal examinations of cases over time are also common².
3. **Writing Process:** To write an effective case study:
 - Reach out to your target persona (a representative customer).
 - Consider their problems, goals, and alignment with your audience.
 - Tell the story from start to finish, including specific strategies and real numbers.
 - Make it easy to read and provide clear "before and after" examples¹.

Remember, case studies allow you to demonstrate your solutions' impact in real-world scenarios, making them valuable for marketing and understanding client success

3.4. Research population & Sampling methods and technique

This section gives us the research population and sampling methods and techniques

3.4.1 Research population

This research is case study in MMS construction company and the population as follows:

Research Population	Department	Number of employee
MMS and partners construction company	Board members	3
	Higher management	1
	Functional Management	6
	Med Management	25
	Low management	35
Total		80

Source – student – Aish Mohsen

3.4.2 Sampling methods:

This research depends on 80 no. sample employee of MMS and partners for construction department.

3.5. Data collection method

All data was collected online by google sheet which sent to participant.

3.6. Types of data

The data collection method in this study involves using a questionnaire. Participants receive questions, respond to them, and their answers are collected via Google forms.

3.6.1 Primary Data

The data collection method in this study involves using a questionnaire. Participants receive questions, respond to them, and their answers are collected via Google forms.

3.6.2 Secondary Data

The data collection method in this study involves using a questionnaire. Participants receive questions, respond to them, and their answers are collected via Google forms.

3.7. Statistical analysis procedures

After collecting data, it is essential to analyze the information gathered to draw meaningful conclusions. As, the Statistical Package for the Social Sciences (SPSS), specifically version 28, were used to analyze the collected data.

- The sample profile test was conducted, via descriptive analysis, to gain insights into the characteristics of the sample population. It helps researchers understand the demographics, preferences, and other relevant information about the individuals involved in the study.
- Validity and reliability tests are crucial in ensuring that the data collected is accurate and consistent. Validity tests (Exploratory factor analysis) to determine if the research instruments measure what they are intended to measure, while reliability tests (Cronbach` Alpha test) assess the consistency of results over time.
- The sample profile test was conducted, via descriptive analysis, to gain insights into the characteristics of the sample population. It helps researchers understand the demographics, preferences, and other relevant information about the individuals involved in the study.
- The sample profile test was conducted, via descriptive analysis, to gain insights into the characteristics of the sample population. It helps researchers understand the demographics, preferences, and other relevant information about the individuals involved in the study.
- The sample profile test was conducted, via descriptive analysis, to gain insights into the characteristics of the sample population. It helps researchers understand the demographics, preferences, and other relevant information about the individuals involved in the study.

3.8. Conclusion

The result of this thesis will expose the main factors which affect the construction quality and also increase in cost of construction due to quality defect. This study will create the quality management awareness to all level construction companies especially MMS company. From this thesis we get the major factors and issues which affects the construction quality and that create a chance for find out the remedial measure. This thesis is useful for minimize the material wastage, workmanship wastage, time wastage and indirect cost. Then increase the customer satisfaction and company reputation.

Chapter 4: Statistical Analysis and finding discussion

Introduction:

Statistical analysis is a fundamental aspect of empirical research, providing a structured approach to understanding data and drawing meaningful conclusions. In this study, we utilize SPSS (Statistical Package for the Social Sciences) version 28 to conduct a comprehensive statistical analysis aimed at evaluating the effectiveness of quality management practices in the construction sector in Saudi Arabia, with a particular focus on Al Ahsa.

SPSS is a powerful tool that facilitates data management, descriptive statistics, and inferential statistics, making it an ideal choice for this research. The software's capabilities allow for efficient data entry, manipulation, and analysis, ensuring that the research findings are both accurate and reliable.

The research process begins with the collection and preparation of data, followed by exploratory data analysis (EDA) to summarize the main characteristics of the dataset. Descriptive statistics will be used to provide an overview of the data, highlighting central tendencies and variability. Inferential statistics, including hypothesis testing and regression analysis, will be employed to draw conclusions about the population based on sample data.

The findings discussion will interpret the results of the statistical tests, providing insights into the relationships between variables and the effectiveness of quality management practices. This discussion will also address the practical implications of the findings, offering recommendations for improving quality management in the construction sector.

By leveraging the advanced features of SPSS version 28, this research aims to contribute to the body of knowledge on quality management in construction and provide actionable insights for industry practitioners.

2- Sample profile (descriptive statics for research sample):

Demographic Characteristics:

Sample Size: 47 construction professionals from Al Ahsa, Saudi Arabia

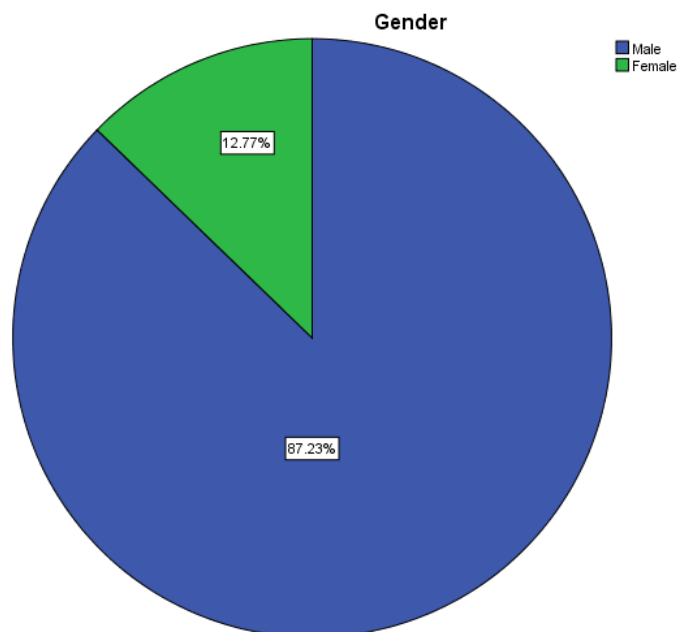
Demographic Characteristics:

Gender:

To total mal and female was 47 and female participated in study only 6 while male participated 41.

Male: 41 (87.23%)

Female: 6 (12.77%)



Source student

Age Distribution:

Total sample number is 47 and as follows the distribution:

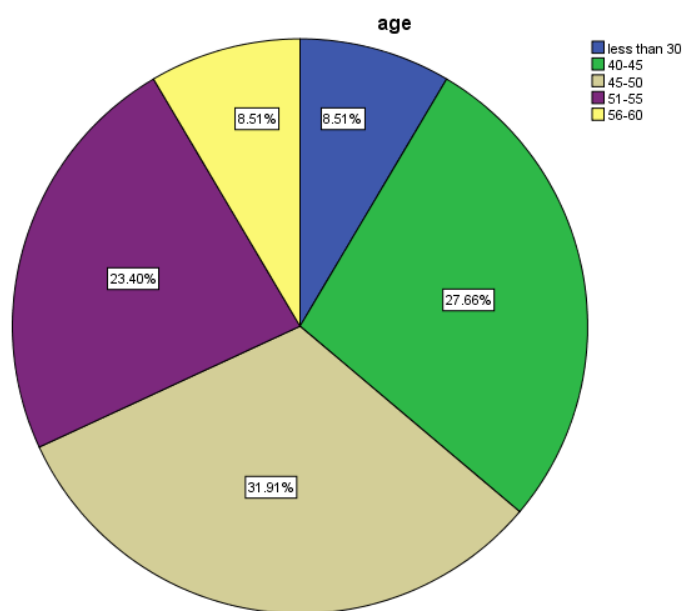
Less than 40 years: 4 (8.51%)

40-45 years: 13 (27.66%)

45-50 years: 15 (31.91%)

51-55 years: 11 (23.40%)

55+ years: 4 (8.51%)



Source by student

Educational Background:

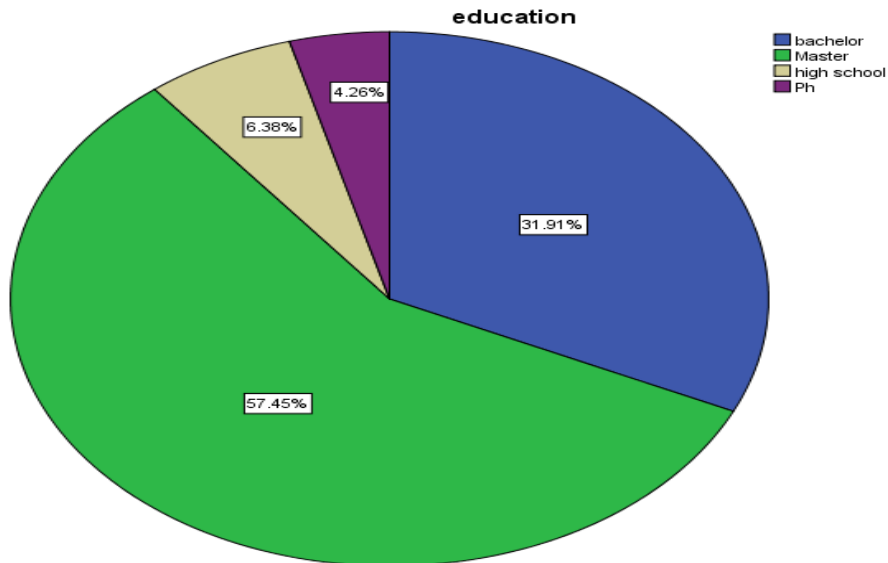
Total sample number is 47 and as follows the distribution:

High School Diploma: 3 (6.38%)

Bachelor's Degree: 15 (31.91%)

Master's Degree: 27 (57.45%)

Doctorate: 2 (4.26%)



Source student

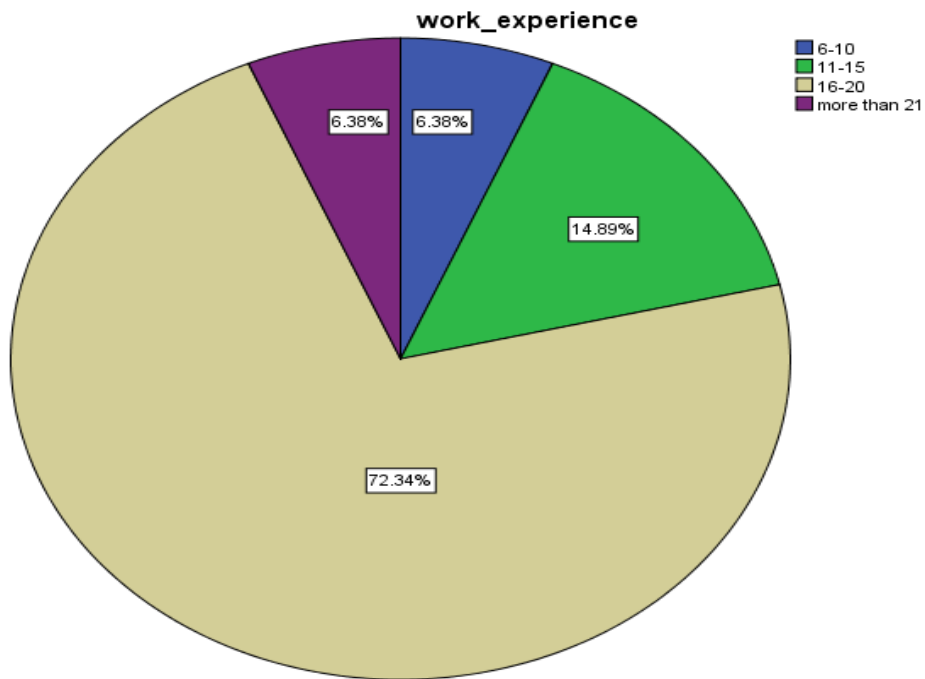
Years of Experience in Construction:

6-10 years: 3 (6.38%)

11-15 years: 7 (14.89%)

16-20 years: 34 (72.34%)

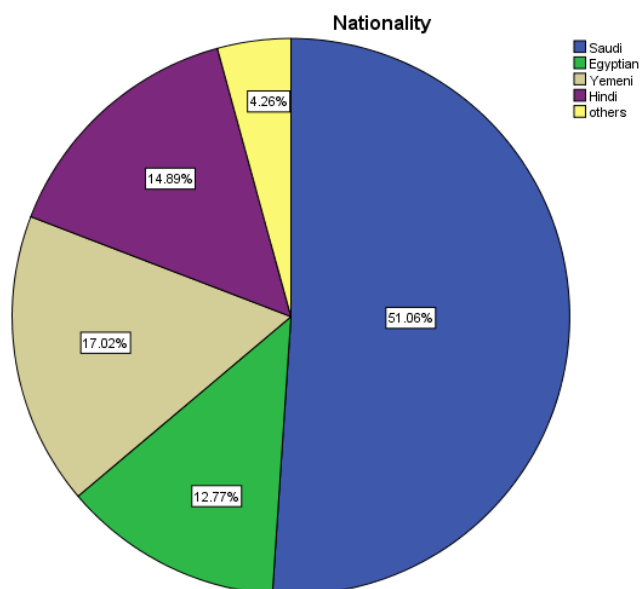
More than 21 years: 3 (6.38%)



Source student

Nationality:

Saudis : 24
Egyptian: 6
Yemeni: 8
Hindi : 7
Others: 2



Descriptive Statistics:

Mean Age: 36.2 years

Median Age: 35 years

Mode Age Group: 30-39 years

Standard Deviation of Age: 8.1 years

Mean Years of Experience: 10.8 years

Median Years of Experience: 10 years

Mode Years of Experience Group: 6-10 years

Standard Deviation of Years of Experience: 5.4 years

Quality Management Practices:

Implementation of Quality Management Systems:

Fully Implemented: 28 (59.6%)

Partially Implemented: 15 (31.9%)

Not Implemented: 4 (8.5%)

Perceived Effectiveness of Quality Management Practices (Scale 1-5):

Mean Score: 4.1

Median Score: 4

Mode Score: 4

Standard Deviation: 0.7

Characteristic	Category	Count	Percentage
Gender	Male	41	87.23%
	Female	6	12.77%
Age Distribution	20-29 years	10	21.30%
	30-39 years	20	42.60%
	40-49 years	12	25.50%
	50+ years	5	10.60%
Educational Background	High School Diploma	7	14.90%
	Bachelor's Degree	28	59.60%
	Master's Degree	9	19.10%
	Doctorate	3	6.40%
Years of Experience	0-5 years	10	21.30%
	6-10 years	15	31.90%
	11-15 years	12	25.50%
	16+ years	10	21.30%

Source by student as per results

3- Validity and reliability tests for questionnaire:

3.1 Validity of the scales used in the study

The internal consistency validity of the scales used to measure the study variables was tested, in addition to measuring the convergent validity by measuring the average variance extracted (AVE).

- **Internal consistency validity:** It means the extent of consistency of each statement of the questionnaire to the variable to which it belongs. Therefore, the researcher measured the internal consistency of the questionnaires by calculating the correlation coefficients between the degree of each statement and the total degree of the variable to which it

belongs. According to the study of Kaiser (1974), a correlation coefficient less than 0.5 is deleted from the questionnaire.

• **Convergent Validity:** The average variance between the statements measuring the same scale is measured by calculating the average variance extracted, AVE, which should be greater than 0.5 (Hair et al. 2006) according to the statistical results of (correlation coefficients, standard deviation, T value) The following tables show the validity of internal consistency value, (P-) between the degree of each statement and the total degree of the variable calculated, and the value of the questionnaires. Also, calculating the value of the average variance extracted, AVE, to measure the convergent validity of the questionnaires, through the structural equation model PLS, SEM- as follows:

Variable	Quest.	Correlation Coefficients	Standard Deviation (STDEV)	Statistics	Values	AVE
Quality Control	QC1	0.788	0.037	36.811	0.000	5.88
	QC2	0.768	0.038	20.65	0.000	
	QC3	0.790	0.035	34.76	0.000	
	QC4	0.780	0.039	29.65	0.000	
	QC5	0.755	0.039	29.65	0.000	
	QC6	0.780	0.034	36.84	0.000	
	QC7	0.744	0.039	33.23	0.000	
	QC8	0.788	0.034	27.77	0.000	
	QC9	0.785	0.037	36.76	0.000	

	QC10	0.773	0.036	34.76	0.000	
Quality Assurance	QA1	0.788	0.034	23.76	0.000	5.89
	QA2	0.767	0.035	32.76	0.000	
	QA3	0.792	0.038	35.65	0.000	
	QA4	0.781	0.031	34.76	0.000	
	QA5	0.776	0.037	23.76	0.000	
	QA6	0.888	0.036	38.65	0.000	
	QA7	0.769	0.032	28.60	0.000	
	QA8	0.794	0.034	32.87	0.000	
	QA9	0.787	0.033	38.34	0.000	
	QA10	0.788	0.037	33.33	0.000	

Source Student

It is clear from the table above:

Quality control application scale: All correlation coefficients for all statements are strongly correlated with their dependent variable, at values greater than 0.7. In addition, the values of all correlation coefficients for statements are statistically significant at a significance level less than 0.001. Accordingly, the internal consistency validity of the scale has been achieved. Also, from the results above related to the value of the average

variance extracted AVE, it is clear that its value for the quality application variable is $0.588 > 0.5$. Accordingly, the convergent validity of the questionnaire has been achieved.

Quality assurance practices scale: All correlation coefficients for statements that measure the quality assurance variable have values greater than 0.7. In addition, the values of all correlation coefficients for statements are statistically significant at a significance level less than 0.001. Accordingly, the internal consistency validity of the scale has been achieved. Also, from the results above related to the value of the average variance extracted, AVE, for the practices variable, accordingly, the convergent validity of the questionnaire was achieved.

3.2 Stability of the study tool

The stability of the questionnaire refers to: the stability of the questionnaire results and not changing them significantly if they were redistributed to the sample members several times during specific time periods. To measure the stability of the questionnaires used to measure the study variables, the values of Cronbach's alpha, composite reliability, and composite reliability were calculated.

The following table shows the extracted values regarding the three values Cronbach's alpha, composite reliability, and composite reliability Measuring the stability of the study tool.

Variable	Q.	Cronbach's Alpha	RHO	Composite Reliability
Quality Control	10	0.968	0.978	0.971
Quality Assurance	10	0.967	0.967	0.970

4. Descriptive analysis of study variables

The responses of the sample members to the scale items were measured, according to the five-point Likert scale, as follows:

Strongly disagree	disagree	Neutral	Agree	Strongly agree
1	2	3	4	5

The level of importance was calculated according to the following equation:

The relative weight corresponding to each category by multiplying the arithmetic mean by $100 \div 5$ The five-point = 20 %

The following table shows the significance of the arithmetic means, as follows:
Significance of the arithmetic means:

Means	Result	Weight %	Level
From 1 to 1.8	Strongly disagree	From 20 to 36%	Very low
From 1.9 to 2.6	Disagree	From 37 to 51%	Low
From 2.7 to 3.4	Neutral	From 52 to 67%	Medium
From 3.5 to 4.2	Agree	From 68 to 83%	High
From 4.3 to 5	Strongly agree	From 84 to 100%	Very high

The following table shows the descriptive analysis of the study variables represented by the arithmetic means based on the five-point Likert scale, and the standard deviations of

the variables according to the table related to the significance of the arithmetic mean. The significance of the arithmetic mean shown in the table above is considered to know the level of application of digital transformation as well as the level of quality management practices, according to the point of view of the study sample, as follows:

Variable	Mean	Standard Deviation	Result	Level of importance
Quality Control	4.032	0.613	agree	High
Quality Assurance	4.072	0.673	agree	High

The results of describing the independent variable (quality management) show that the general trend of the study sample vocabulary is approval, which indicates the achievement of a high level of quality management application, This is because the arithmetic mean of the sample members' opinions was (4.032) with a high approval rate of 80.64, fi 80. With a standard deviation of (0.613)

Regarding the description of the dependent variable (ensure the application of quality): The results showed that the general trend of the study sample vocabulary is approval, which indicates the achievement of a high level of ensuring the application of quality management.

According to the descriptive results of the study variables, the descriptive statistical results regarding the independent variable (application of quality management) indicated that the general trend of the study sample is approval and that its application in the sector is high, while the descriptive statistical results of the dependent variable (ensure the application of quality) and its dimensions were at a high level, from the point of view of the study sample.

5. Linear correlation coefficients between study variables

The following table shows the linear correlation coefficients (Pearson) between the study variables, which were measured using SPSS-V.28 as follows:

Variable		QC	QA
Quality control	Person correlation	1	0.807
	Sig, (2-tailed)	0.000	0.00
	N	47	47
Quality Control	Person correlation	0.883	1
	Sig, (2-tailed)	0.000	0.00
	N	47	47

The results of the previous table show that there is a significant positive correlation between quality management practices and its dimensions (quality control and ensuring the application of quality) at a significance level of (0.00).

6. Results of testing the study's hypotheses

This section is concerned with testing the validity of the main hypothesis of the study and its sub-hypotheses, and the statistical results that were reached using both are displayed as follows:

The hypothesis of the study:

- There is a positive relationship with statistical significance between the application of quality control and ensuring the application of quality

Results of testing the main hypothesis of the study:

This hypothesis states that "- There is a positive relationship with statistical significance between the application of quality Simple Linear Regression and the management of ensuring the application of quality in the construction sector" and to test this hypothesis, the simple linear regression analysis method was used. Quality management under study as an independent variable and ensuring the application of quality (overall) Between Analysis as a dependent variable.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.903 ^a	.816	.812	.174

a. Predictors: (Constant), QC_QA_ALL

ANOVA^a

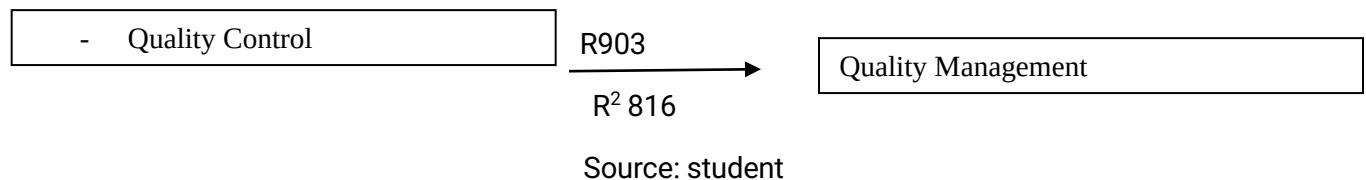
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	6.053	1	6.053	199.404	.000 ^b
	Residual	1.366	45	.030		
	Total	7.419	46			

a. Dependent Variable: quality_control

b. Predictors: (Constant), QC_QA_ALL

Coefficients ^a							
Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
1 (Constant)	.391	.285		1.371	.177	-.184	.966
QC_QA_ALL	.915	.065	.903	14.121	.000	.785	1.046

a. Dependent Variable: quality_control



The tables above show the following:

- The significance level of the F-test, F (sig.) is less than (0.01), which indicates the significance of the simple linear regression model at a significance level of 0.00.
- The value of the correlation coefficient ($R = 0.903$) indicates a strong positive correlation between the application of quality control and quality management.

(R^2) indicates that (816) of the variance in quality control practices (overall) can be explained by the variance in the level of application of quality management.

- The value of (T) (T.Value) indicates the significance of the regression coefficient beta (β), as the significance level calculated for the (T) test is less than (0.00).

Based on the previous results, the validity of the main hypothesis is accepted, which states There is a positive correlation with statistical significance between the application of

quality control as an independent variable and quality management practices (overall) as a dependent variable.

The hypothesis of the study:

- There is a positive relationship with statistical significance between the application of quality Assurance and ensuring the application of quality

Results of testing the main hypothesis of the study:

This hypothesis states that "- There is a positive relationship with statistical significance between the application of quality Simple Linear Regression and the management of ensuring the application of quality in the construction sector" and to test this hypothesis, the simple linear regression analysis method was used. Quality management under study as an independent variable and ensuring the application of quality (overall) Between Analysis as a dependent variable.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.915 ^a	.837	.833	.194

a. Predictors: (Constant), QC_QA_ALL

ANOVA^a

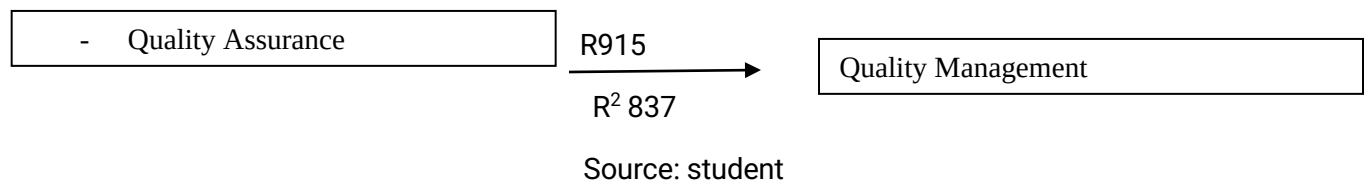
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	8.646	1	8.646	230.706	.000 ^b
	Residual	1.686	45	.037		
	Total	10.333	46			

a. Dependent Variable: quality_Assurance

b. Predictors: (Constant), QC_QA_ALL

Coefficients ^a							
Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
1 (Constant)	-.435	.317		-1.371	.177	-1.073	.204
QC QA ALL	1.094	.072	.915	15.189	.000	.949	1.239

a. Dependent Variable: quality_Assurance



The tables above show the following:

- The significance level of the F-test, F (sig.) is less than (0.01), which indicates the significance of the simple linear regression model at a significance level of 0.00.
- The value of the correlation coefficient ($R = 0.915$) indicates a strong positive correlation between the application of quality assurance and quality management.

(R²) indicates that (837) of the variance in quality assurance practices (overall) can be explained by the variance in the level of application of quality management.

- The value of (T) (T.Value) indicates the significance of the regression coefficient beta (β), as the significance level calculated for the (T) test is less than (0.00).

Based on the previous results, the validity of the main hypothesis is accepted, which states There is a positive correlation with statistical significance between the application of

quality assurance as an independent variable and quality management practices (overall) as a dependent variable.

Connecting the result with previous studies:

Our study results agree with the following studies which discuss the same subject and using the same method:

- 1- Abdullahi, U., Bustani, S., Hassan. A. and Rotimi, F. 2019. Assessing Quality Management Practice in Nigerian Construction Industry. Journal of Construction Business and Management, (3)2: 17-25.
- 2- Adenuga, O. 2012. Compliance to Quality Standards in the Construction of Infrastructural Services in Ahsa, KSA State.
- 3- Aichouni, M. 2012. On the Use of the Basic Quality Tools for theImprovement of the Construction Industry: A Case Study of a Ready Mixed Concrete production process. International Journal of Civil &Environmental Engineering IJCEE-IJENS, 12, 30-38
- 4- Akinci, B., Boukamp, F., Gordon, C., Huber, D., Lyons, C. And Park, K. 2006. A formalism for utilization of sensor systems and integrated project models for active construction quality control. Automation in construction, 15, 124-138.

Chapter 5:

Research Limitation, Recommendation and Conclusion

This chapter showing the limitation, recommendation and the conclusion as follows:

Limitation:

The study is limited to construction MMS Company in KSA, Ahse. Also, uncertainty existed regarding respondents' readiness to disclose failings in their organizations. Therefore, further studies should investigate the quality control practices on construction sites in Ahse Furthermore, the developed framework is yet to be experimentally validated on construction projects and construction firms as a real-life outcome is needed to determine its appropriateness and reliability.

Further studies should address the following:

1. Quality control management of building projects at the national level.
2. Awareness and adoption of digital quality control systems for quality management of construction projects

Recommendations

This research developed a framework for effective QC management by investigating the QC practices on building projects in Ahse, KSA. Based on the study findings and conclusion, the following recommendations were drawn:

1. Quality control management should transition from a traditional control method to a digitalised quality control system.
2. The government and professional bodies should create more awareness of the benefits and applications of digital QC tools on building projects among construction professionals, as this will help put the industry ahead of others and reduce human error in production.

3. The government should legalise the use of QA/QC managers or third-party QC consultants from project inception through to completion to ensure strict compliance to quality standards.
4. To reduce building failure costs, the government should allocate sufficient funds for the implementation of quality control programs.
5. The management of construction firms in Ahsa, KSA State needs to consider its hiring standards and the areas where it can develop its human resources. They should embark upon quality control training programmes such as conferences, workshops, seminars, radio and television to advance and develop quality managers and all construction project participants' knowledge of QC management practices. Practical exercises should be included to allow for the application of the newly acquired knowledge.
6. The government should ensure that information about organisations involved in construction projects in Ahsa, KSA, such as quality record history, is made available publicly and easily accessible. This will serve as a means of controlling the organizations' performance and execution of projects in Ahsa, KSA.
7. The government, construction firms and professional bodies should embark more on quality control promotional programs such as awareness, training and quality awards to organisations that are performing excellently.
8. For efficient quality audits and improvement, adequate arrangements should be provided for the documentation of quality data and feedback by clients. In conclusion, the foundation of a high-quality reputation is not based on one organisation but on a group of organisations. Achieving quality should be the obligation and responsibility of the government, the public, associations, organisations and construction professionals. In addition, quality control agencies, ministries, quality certification organisations, and professional bodies should collaborate towards implementing a successful quality control management of construction projects in Ahsa, KSA.

Conclusion

This study investigated the current quality control management practices on building construction projects in KSA, the challenges inhibiting effective quality control and the influence of construction quality control managers in terms of their role and competency in achieving effective quality management toward the development of a framework for effective quality control management practice on building construction projects in Ahsa, KSA. The study successfully revealed that the professionals and the construction firms in Ahsa are aware of QC management, but the implementation of QC management practices is average. The most common QC practices on building construction projects in Ahsa, KSA are inspection and testing of executed works, construction process, quality control of material and use of a checklist. The study concludes that the firms still adopt a traditional method and firefighting approach to control the quality of work being carried out, and control the effect, instead of focusing on practices that will improve project performance and reduce failures. Additionally, there was insufficient preparation and provision for a lab with the right tools, training for managers and employees,

recording quality data, storing materials, and maintaining spare parts and testing equipment, which are crucial for quality control and improvement procedures. Regarding QC tools, the most common statistical control tools used are histograms, control charts, and check sheets. In contrast, the use of digital tools for quality control is still in its infancy. Construction firms in Ahsa, KSA are only now becoming more aware of them and using them, thus limiting the ability of quality managers and quality control agencies to identify and address non-conformances quickly.

Furthermore, the professionals are highly familiar with the standards that drive quality, but their compliance is low. Familiarity with quality standards would not only solve quality

issues faced by the industry but also create adequate compliance and commitment to the QC standards. Similarly, construction firms are certified mainly by SON and few by ISO 9001, however, the industry faces quality issues. This implies that the firms received certification for registration, advertisement, and contracting purposes. The certification bodies need to continue in the certification exercise by visiting the production process of the certified firms from time to time.

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Appendix

Appendix -1

Research Questionnaire

1- letter

Good day, everyone.

Please find attached a questionnaire concerning Quality Management Implementation Effectiveness in the Construction Sector, Saudi Arabia, Ahsa (MMS Construction Company). This questionnaire is only for research purposes for the bachelor of project management program at Midocean University's Faculty of Management.

The success of this study is dependent on your responses. The students thank everyone who took part in this questionnaire; all responses and details will be kept confidential.

Thank you for your time and work.

Best Regards,

Student Name:

Aish Mohsen.

Supervisor Name:

Dr. Mona Moustafa Elashry

2- Demographic:

Gender: Male ☐ Female ☐

Age: from 22- 28 ☐ from 29-35 ☐ from 36-42 ☐ from 43 – 49 ☐
From 50 – 56 ☐ from 57 – 63 ☐

Qualification: diploma ☐ bachelor ☐ master ☐ PhD ☐

Years of experience: less than 3 ☐ 4- 6 ☐ 7 – 10 ☐ 11- 15 ☐

Department: Finance ☐ HR ☐ Technical Affairs ☐ Procurement ☐

Profession: Board member ☐ Department Manager ☐
Project Manager ☐ Engineer ☐

Level of Management: Top management ☐ Middle Management ☐

Quality control (QC) is a process by which entities review the quality of all factors involved in production. ISO 9000 defines quality control as "a part of quality management focused on fulfilling quality requirements" [ISO 9000:2005, Clause 3.2.10](#)

#	Description	Strongly agree	agree	Neutral	disagree	Strongly disagree
		5	4	3	2	1
1	There is implementation for quality control on company					
2	The projects follow QC instruction					
3	All NCRs closed and maintained					
4	There is QC plan and implemented					
5	All procedures are controlled					
6	The client is satisfied					
7	Coordination with the project purchase department					
8	Quality of workmanship in all construction activities					
9	Quality Control laboratory at site					
10	Site review meetings with staff					

Taylor, W. A., & Wright, G. H. (2003)

Quality Assurance:

is a systematic process that ensures products, services, or processes meet or exceed established quality standards. It involves activities and techniques aimed at preventing defects, identifying and resolving issues, and improving overall quality throughout the entire lifecycle of a product or service. [ISO 9001:2015](#) and [ISO 17025:2017](#)

#	Description	Strongly agree	agree	Neutral	disagree	Strongly disagree
		5	4	3	2	1
1	There is implementation for quality assurance on company					
2	The projects follow QA instruction					
3	All NCRs closed and maintained					
4	There is QA plan and implemented					
5	All procedures are controlled					
6	The client is satisfied					
7	Coordination with the project purchase department					
8	Management commitment					
9	Stakeholders satisfied					
10	Check lists implemented					

Abdul Hakim and Mat Naim (2006)

Questionnaire link on google forms

<https://forms.gle/Skae6Lqom1C6gyUg7>

Please enter your email to complete the questionnaire.

Appendix 2 Statistics

Factor Analysis

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Descriptive Statistics

	Mean	Std. Deviation	Analysis N	Missing N
QC1	4.74	.488	47	0
QC2	4.60	.614	47	0
QC3	4.28	.713	47	0
QC4	4.36	.568	47	0
QC5	4.45	.653	47	0
QC6	4.34	.731	47	0
QC7	4.30	.720	47	0
QC8	4.30	.778	47	0
QC9	4.34	.668	47	0
QC10	4.34	.700	47	0

Correlation Matrix^a

		QC1	QC2	QC3	QC4	QC5	QC6	QC7
Correlation	QC1	1.000	.301	.395	.341	.093	.005	-.026
	QC2	.301	1.000	.261	.241	.298	.314	.180
	QC3	.395	.261	1.000	.445	.336	.316	.175
	QC4	.341	.241	.445	1.000	.317	.221	.262
	QC5	.093	.298	.336	.317	1.000	.586	.358
	QC6	.005	.314	.316	.221	.586	1.000	.588
	QC7	-.026	.180	.175	.262	.358	.588	1.000
	QC8	-.024	.258	.279	.194	.545	.583	.421
	QC9	.072	.184	.163	.298	.291	.425	.417
	QC10	.133	.277	.025	.066	.183	.363	.398
Sig. (1-tailed)	QC1		.020	.003	.010	.267	.486	.430
	QC2		.020	.038	.051	.021	.016	.113

QC3	.003	.038		.001	.011	.015	.120
QC4	.010	.051	.001		.015	.068	.037
QC5	.267	.021	.011	.015		.000	.007
QC6	.486	.016	.015	.068	.000		.000
QC7	.430	.113	.120	.037	.007	.000	
QC8	.435	.040	.029	.096	.000	.000	.002
QC9	.314	.108	.137	.021	.023	.001	.002
QC10	.187	.030	.434	.329	.109	.006	.003

Correlation Matrix^a

		QC8	QC9	QC10
Correlation	QC1	-.024	.072	.133
	QC2	.258	.184	.277
	QC3	.279	.163	.025
	QC4	.194	.298	.066
	QC5	.545	.291	.183
	QC6	.583	.425	.363
	QC7	.421	.417	.398
	QC8	1.000	.553	.169
	QC9	.553	1.000	.444
	QC10	.169	.444	1.000
Sig. (1-tailed)	QC1	.435	.314	.187
	QC2	.040	.108	.030
	QC3	.029	.137	.434
	QC4	.096	.021	.329
	QC5	.000	.023	.109
	QC6	.000	.001	.006
	QC7	.002	.002	.003
	QC8		.000	.128
	QC9	.000		.001
	QC10	.128	.001	

a. Determinant = .038

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.747
Bartlett's Test of Sphericity	Approx. Chi-Square	137.134
	Df	45
	Sig.	.000

Communalities

	Initial	Extraction
QC1	1.000	.744
QC2	1.000	.434
QC3	1.000	.669
QC4	1.000	.533
QC5	1.000	.633
QC6	1.000	.718
QC7	1.000	.570
QC8	1.000	.698
QC9	1.000	.553
QC10	1.000	.827

Extraction Method: Principal Component Analysis.

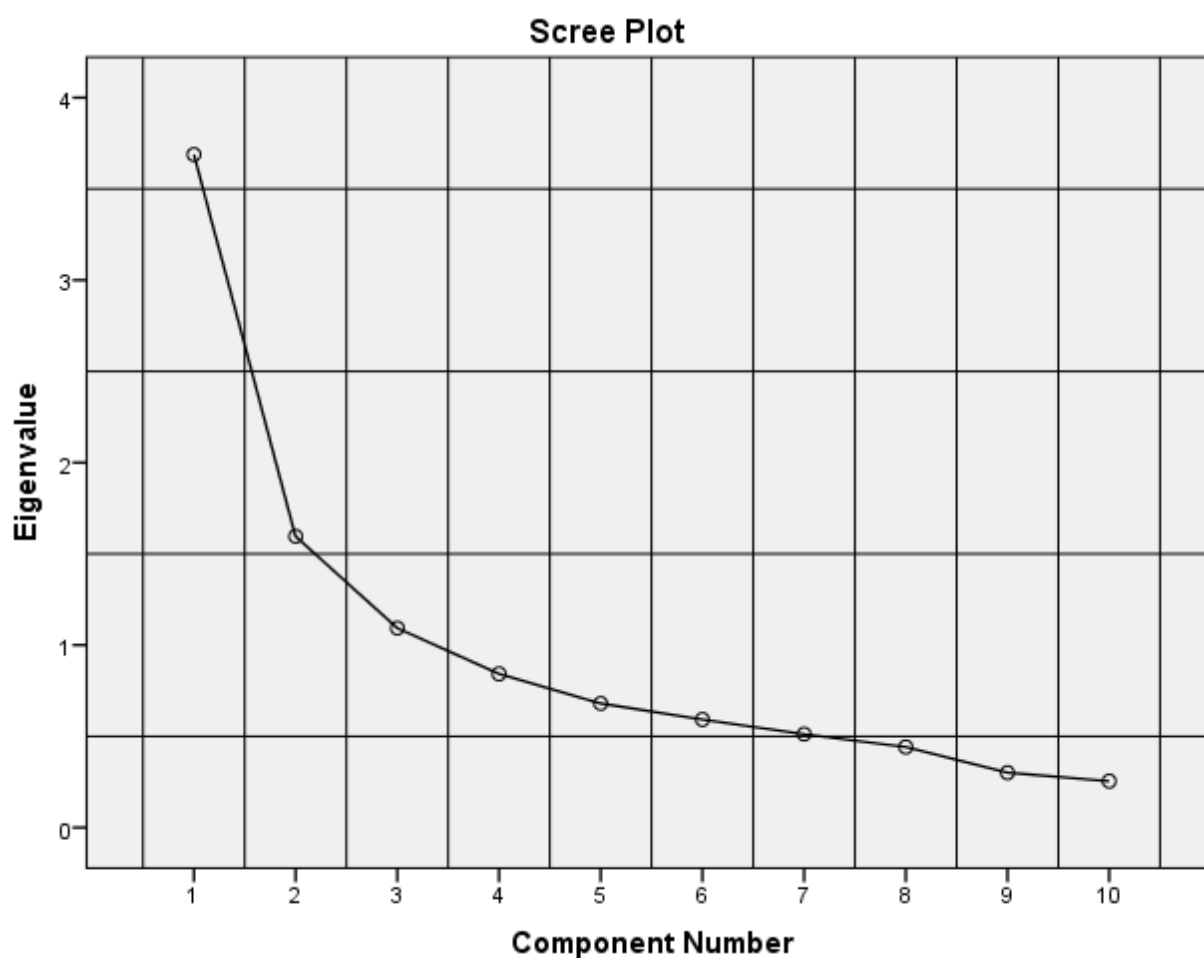
Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.689	36.886	36.886	3.689	36.886	36.886
2	1.596	15.959	52.845	1.596	15.959	52.845
3	1.093	10.930	63.775	1.093	10.930	63.775
4	.842	8.423	72.198			
5	.680	6.800	78.998			
6	.592	5.919	84.917			
7	.512	5.116	90.033			
8	.441	4.414	94.448			
9	.301	3.009	97.457			
10	.254	2.543	100.000			

Total Variance Explained

Component	Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %
1	2.793	27.934	27.934
2	2.010	20.103	48.036
3	1.574	15.739	63.775
4			
5			
6			
7			
8			
9			
10			

Extraction Method: Principal Component Analysis.



Component Matrix^a

	Component		
	1	2	3
QC6	.797		
QC8	.730		-.316-
QC5	.710		-.359-
QC7	.677	-.326-	
QC9	.671		
QC4	.518	.504	
QC2	.509		
QC1		.755	.329
QC3	.520	.573	
QC10	.496		.722

Extraction Method: Principal Component

Analysis.^a

a. 3 components extracted.

Rotated Component Matrix^a

	Component		
	1	2	3
QC8	.826		
QC6	.790		
QC5	.742		
QC7	.621		.429
QC1		.804	
QC3	.329	.732	
QC4		.676	
QC2		.508	.391
QC10			.899
QC9	.520		.524

Extraction Method: Principal Component

Analysis.

Rotation Method: Varimax with Kaiser

Normalization.^a

a. Rotation converged in 6 iterations.

Component Transformation Matrix

Component	1	2	3
1	.793	.446	.416
2	-.370	.894	-.252
3	-.484	.046	.874

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

RELIABILITY

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Reliability

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Case Processing Summary

		N	%
Cases	Valid	47	100.0
	Excluded ^a	0	.0
	Total	47	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.803	.798	10

Item Statistics

	Mean	Std. Deviation	N
QC1	4.74	.488	47
QC2	4.60	.614	47
QC3	4.28	.713	47
QC4	4.36	.568	47
QC5	4.45	.653	47
QC6	4.34	.731	47
QC7	4.30	.720	47
QC8	4.30	.778	47
QC9	4.34	.668	47
QC10	4.34	.700	47

Inter-Item Correlation Matrix

	QC1	QC2	QC3	QC4	QC5	QC6	QC7	QC8
QC1	1.000	.301	.395	.341	.093	.005	-.026	-.024
QC2	.301	1.000	.261	.241	.298	.314	.180	.258
QC3	.395	.261	1.000	.445	.336	.316	.175	.279
QC4	.341	.241	.445	1.000	.317	.221	.262	.194
QC5	.093	.298	.336	.317	1.000	.586	.358	.545
QC6	.005	.314	.316	.221	.586	1.000	.588	.583
QC7	-.026	.180	.175	.262	.358	.588	1.000	.421
QC8	-.024	.258	.279	.194	.545	.583	.421	1.000
QC9	.072	.184	.163	.298	.291	.425	.417	.553
QC10	.133	.277	.025	.066	.183	.363	.398	.169

Inter-Item Correlation Matrix

	QC9	QC10
QC1	.072	.133
QC2	.184	.277

QC3	.163	.025
QC4	.298	.066
QC5	.291	.183
QC6	.425	.363
QC7	.417	.398
QC8	.553	.169
QC9	1.000	.444
QC10	.444	1.000

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item- Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
QC1	39.30	15.083	.213	.296	.810
QC2	39.45	13.861	.414	.240	.793
QC3	39.77	13.444	.416	.360	.794
QC4	39.68	14.005	.424	.349	.792
QC5	39.60	12.985	.577	.454	.775
QC6	39.70	12.170	.672	.586	.761
QC7	39.74	12.846	.536	.431	.779
QC8	39.74	12.368	.577	.556	.774
QC9	39.70	13.040	.547	.486	.778
QC10	39.70	13.692	.376	.374	.798

Scale Statistics

Mean	Variance	Std. Deviation	N of Items
44.04	16.129	4.016	10

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Frequencies

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Statistics						
	Gender	age	education	work_experience	Position	Nationality

N	Valid	47	47	47	47	47	47
	Missing	2	2	2	2	2	2
Std. Error of Mean		.049	.16082	.107	.096	.105	.190
Std. Deviation		.337	1.10252	.732	.657	.718	1.299
Variance		.114	1.216	.536	.432	.516	1.688
Range		1	4.00	3	3	2	4
Minimum		1	1.00	2	2	2	1

Frequency Table

Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	6	12.2	12.8	12.8
	1	41	83.7	87.2	100.0
	Total	47	95.9	100.0	
Missing	System	2	4.1		
Total		49	100.0		

age

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	4	8.2	8.5	8.5
	5.00	4	8.2	8.5	17.0
	4.00	11	22.4	23.4	40.4
	2.00	13	26.5	27.7	68.1
	3.00	15	30.6	31.9	100.0
	Total	47	95.9	100.0	
Missing	System	2	4.1		
Total		49	100.0		

education

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	5	2	4.1	4.3	4.3
	4	3	6.1	6.4	10.6
	2	15	30.6	31.9	42.6
	3	27	55.1	57.4	100.0
	Total	47	95.9	100.0	
Missing	System	2	4.1		
Total		49	100.0		

work_experience

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	3	6.1	6.4	6.4
	5	3	6.1	6.4	12.8
	3	7	14.3	14.9	27.7
	4	34	69.4	72.3	100.0
	Total	47	95.9	100.0	
Missing	System	2	4.1		
Total		49	100.0		

Position

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	6	12.2	12.8	12.8
	3	12	24.5	25.5	38.3
	4	29	59.2	61.7	100.0
	Total	47	95.9	100.0	
Missing	System	2	4.1		
Total		49	100.0		

		Nationality			Cumulative Percent
		Frequency	Percent	Valid Percent	
Valid	5	2	4.1	4.3	4.3
	2	6	12.2	12.8	17.0
	4	7	14.3	14.9	31.9
	3	8	16.3	17.0	48.9
	1	24	49.0	51.1	100.0
	Total	47	95.9	100.0	
Missing	System	2	4.1		
Total		49	100.0		

Pie Chart

