

The Impact of Applying Quality Systems on the Efficiency of Marketing Performance in Service Organizations

Buraie B. M. Ali^{1,*}, Anaam M. G. Elmoustafa¹, Amani A. A. Atta², Khalda A. M. Mohamed¹, and Mona H. A. Mohamed¹

¹ Applied College, Najran University, P.O. box 1988 Najran 66257, Saudi Arabia

² College Of Business Administration, Najran University, P. O. Box 1988, Najran 66257, Saudi Arabia

Received: 27 Oct. 2025, Revised: 1 Dec. 2025, Accepted: 17 Jan. 2025

Published online: 1 May 2026

Abstract: With increasing competition in the services sector, service organizations are adopting advanced marketing strategies to attract and retain customers. This study aims to analyze how key quality indicators-such as operational excellence, service efficiency, infrastructure, customer support, and human resource practices-interact with quality management systems to shape marketing performance, focusing on ISO certification as a strategic lever. The study relied on collecting quantitative data through a field questionnaire administered to a representative sample of customers of the Sudanese Telecommunications Company (Sudatel). The data were analyzed using descriptive statistics and the chi-square test at a significance level of $\alpha = 0.05$. The results showed strong statistical support for all three hypotheses: Sudatel's ISO certification significantly contributes to improving its organizational performance; there is a strong positive relationship between the implementation of quality management systems and marketing performance; and customer satisfaction is statistically significantly related to the quality of marketing performance. However, the study revealed a significant gap in after-sales services, which threatens the sustainability of customer satisfaction despite the overall improvement in the indicators. Based on this, the study concludes that ISO certification is not merely a compliance standard, but a strategic tool that enhances market share, revenue, and competitive advantage-provided it is applied comprehensively throughout the customer journey. The study recommends integrating quality principles into the marketing mix, strengthening after-sales support mechanisms, and encouraging Sudanese organizations to adopt quality systems as a developmental vision. It also suggests future research to explore the role of digital transformation-such as customer relationship management systems and data analytics-in amplifying the impact of quality systems through comparative studies of telecommunications companies.

Keywords: Quality indicators, Marketing performance, Digital transformation, Quality systems, After-sales services, Customer satisfaction

1 Introduction

The competitive environment for economic units, both production and service-oriented, has witnessed a marked increase in intensity recently [1]. This escalation is attributed to a range of structural developments and phenomena, particularly those linked to the Information and Communication Technologies (ICT) revolution [2].

Transformations in the global market structure, exemplified by the emergence of economic blocs and mergers and acquisitions among companies operating in the same sector, have also contributed to reshaping the balance of power [3]. These systematic strategies primarily aim to strengthen the competitive position of the merged entities and ensure their continuity and survival within the context of a constantly evolving and globalized business market [4].

To achieve competitive advantage, an organization must pool and optimize the use of its essential resources, including intellectual capital, human resources, and material resources, along with the effective management of time and space, to reach its desired strategic goals [5]. In this context, the ongoing challenge facing contemporary management is determining the optimal path that ensures survival within the constraints of available resources and contracts, while efficiently and effectively achieving organizational objectives [6]. However, achieving objectives is not limited to

* Corresponding author e-mail: buraimahmoud66@yahoo.com

adhering to internal constraints; it primarily requires meeting the diverse needs and desires of the customer. Therefore, the bulk of management attention should be focused on fulfilling these requirements, which constitute the core of the strategy encompassing. Meeting customer needs, expectations, and desires, and gaining their loyalty and satisfaction. Focusing on this dimension is a pivotal strategy that ensures the sustainability of a competitive advantage. Achieving the strategic objectives of competitiveness and customer satisfaction is inextricably linked to adopting and implementing quality management systems [7].

Economic success requires the application of comprehensive quality standards at all stages of production. This approach aims to offer competitively priced products with precise delivery times. Product characteristics must be clearly defined to meet both stated and implied customer expectations. Measuring customer satisfaction after use is a crucial step in performance evaluation. Customer feedback is utilized to develop specialized and effective market research. Quality has become an imperative for penetrating global markets in the context of trade liberalization. An organization's market share depends on the efficiency of its management and marketing department. A flexible marketing mix must be developed to adapt to changes in competitors and consumer behavior. Improving administrative performance through quality systems contributes to the institutionalization of marketing activities. Continuous communication with customers ensures that their evolving needs are effectively met. This strategy enables organizations to gain a leading position both locally and internationally. This research aims to evaluate the impact of quality systems on marketing efficiency in Sudan. The study uses Sudatel as a case study. The research seeks to demonstrate the role of quality as a competitive advantage for Sudanese products globally.

The transformations in the contemporary economic landscape confirm that achieving effective access to local and international markets, and sustainability in a fiercely competitive environment, goes beyond simply adhering to minimum product standards. No marketing offering can gain legitimacy or success without a strong strategic focus on quality. Based on this framework, adopting, integrating, and implementing TQM systems becomes a top strategic priority for organizations operating in Sudan, aiming for continuous improvement in both product development processes and marketing performance. Strengthening these aspects is essential for securing smoother and more consistent access to broader markets. Therefore, the current research problem focuses on answering the following pivotal questions:

To what extent does the application of quality management systems affect the efficiency and effectiveness of organizations' marketing performance?

Do quality management systems provide organizations with a sustainable competitive advantage in the markets?

How have businesses benefited from implementing these systems, particularly with regard to obtaining ISO certification?

The fundamental importance of this research stems from its centrality in demonstrating the causal relationship between adopting and implementing quality management systems and obtaining ISO certification, and achieving operational efficiency and a competitive advantage for Sudanese institutions. This research presents empirical evidence supporting the hypothesis that quality frameworks are not merely procedural requirements, but rather provide a sustainable competitive advantage for institutions. The importance of the study lies in the following:

- Supporting the Strategic Adoption Decision: Providing clear analytical information on the tangible positive impact of implementing quality systems, with the aim of encouraging more Sudanese institutions to pursue ISO certification.
- Enhancing Corporate Culture: Contributing to the development and dissemination of a culture of quality and corporate excellence more broadly within the region.
- Facilitating Access to the Global Market: Highlighting the role of adherence to international standards in improving the competitiveness of products and services, enabling institutions to capture a larger market share in the increasingly open global business environment.
- Promoting Sustainability and Reputation: Contributing to enhancing the global reputation of Sudanese companies, encouraging innovation and the adoption of environmentally friendly sustainable development practices, thus increasing their credibility and competitive value on the international stage.

The study is based on three main hypotheses. The first is that the Sudanese Telecommunications Company (Sudatel) has done better as an organization since it got ISO certification. The second is that using quality management systems improves the marketing performance of Sudatel's services. And the third is that customer satisfaction is positively and statistically significantly linked to the quality of Sudatel's marketing performance. The theories will be tested using both qualitative and quantitative methods. Our goal is to get a full picture of how ISO certification and quality management standards affect marketing and operating results. The point of this study is to look into how the results could make customers happier and help the general business plan in the telecoms industry.

This research primarily aims to conduct an in-depth analytical study of the products and services offered by the Sudanese Telecommunications Company Sudatel in the market, along with an evaluation of its internal quality assurance and control system implemented in its operations. Based on customer feedback, the research seeks to achieve a set of specific qualitative objectives:

- Effectiveness Assessment: Identifying and evaluating the efficiency and effectiveness of Sudatel's quality procedures, and identifying strengths and areas for improvement needed to enhance operational efficiency and maximize customer satisfaction.
- Marketing Impact Assessment: Analyzing the direct and indirect impact of implementing quality assurance procedures on the company's marketing efforts and overall performance.
- Strategic Recommendations Formulation: Providing evidence-based strategic recommendations and development proposals, through meticulous monitoring of customer feedback and the identification of key performance indicators (KPIs), with the goal of fostering innovation and the company's competitiveness.
- Knowledge and Leadership Contribution: The research's contribution extends beyond simply improving performance at Sudatel; it aspires to serve as a leading model for similar organizations in the telecommunications sector that strive for excellence in marketing and operational performance.

2 Previous Studies

This study offers a comprehensive review of quality management in the industrial age and demonstrates how advanced digital technologies such as artificial intelligence and the Internet of Things are transforming traditional practices into intelligent and predictive quality systems. It includes an analysis of the gaps in traditional quality models and presents a strategic framework for integrating core quality principles with industry tools to enhance operational efficiency and customer satisfaction. The study also reviews the evolution of quality management concepts and discusses the challenges and solutions required to implement a data-driven DMAIC methodology to ensure continuous improvement. The ultimate goal is to guide organizations toward operational excellence, resilience, and sustainability in the evolving digital industrial landscape [8]. This academic study, published in the Czech Journal of Interdisciplinary Innovations, investigates the effectiveness of TQM and its impact on marketing performance in Iraqi government institutions. The research focuses on the role of continuous improvement as a mediating variable linking aspects of TQM (such as improved training, teamwork, culture change, and full employee engagement) with marketing performance outcomes (opportunity focus, calculated risk, and value creation).

Researchers used data from a sample of 94 employees in Iraqi government institutions and applied statistical analysis using SPSS software to demonstrate the correlations between these variables. The findings and recommendations aim to assist decision-makers in the public sector in adopting TQM practices to enhance service quality and meet employee expectations and market needs [9]. This study aims to develop a practical model illustrating how supply chain risk management (SCRM) and value creation evolve together, to help multinational SMEs navigate geopolitical disruptions such as the US-China trade war. The methodology employs an inductive case study involving semi-structured interviews with eight affected companies. Data were analyzed using grounded theory techniques to develop a theoretical model. The findings reveal that the evolution of SCRM occurs in four stages, each corresponding to a corresponding stage in the value creation process.

Zheng and et al. have provided an integrated framework linking risk management and value delivery, thus providing a strategic roadmap for enhancing resilience and competitiveness [10]. This study focuses on the relationship between market orientation (MO) and organizational performance (OP), exploring the role of service quality (SQ) as a moderating variable within the context of the Malaysian hotel industry. The abstract explains that the researchers used path modeling to collect and analyze data from 187 executives, finding that the competitor orientation dimension of market orientation is positively correlated with performance. Crucially, the results confirm that service quality acts as a mediating factor in the relationship between market orientation and hotel performance. The study also includes a detailed conceptual discussion of the dimensions of market orientation, service quality, and organizational performance, along with hypothesis testing and an explanation of the theoretical and practical implications of the findings for managers and researchers [11]. This study examines the impact of TQM practices and strategies on organizational performance, with a particular focus on its implementation in Pakistan. It reviews the literature on the relationship between TQM and organizational performance, noting conflicting findings regarding its impact. The study outlines the eight principles of TQM and details its implementation levels in Pakistan, which include quality control, quality assurance, and continuous improvement. However, it points out the limited number of companies that have achieved quality awards. The study concludes that customer satisfaction and management leadership are essential elements for successful TQM implementation and improved organizational performance [12].

This study provides a quantitative investigation into the impact of implementing quality management system frameworks, specifically ISO 9001, ISO 45001, ISO 14001, and ISO 31000 standards, on the operational performance of the manufacturing sector in Nigeria. The research focuses on four key operational performance measures: efficiency, defect reduction, customer satisfaction, and process improvement. Each ISO standard is used to examine its impact on a specific measure. The results, obtained through simple and multiple regression analysis using a sample of employees from major Nigerian companies, indicate a significant and synergistic positive impact of these systems on overall performance improvement. The ISO 31000 standard on risk management emerges as the strongest driver of process improvement. The study supports the importance of companies adopting a comprehensive quality management system framework to achieve a competitive advantage and sustainability in the volatile Nigerian market environment [13]. This study aims to determine the impact of quality management system implementation practices and outcomes, such as ISO 9000 certification and local certifications (three products and one label), on the operational efficiency of small and medium-sized agricultural processing enterprises in China. Researchers used a combination of network data envelope analysis and slope score matching models to analyze data from 366 companies in Anhui Province. The results showed that developing refrigerated transport capacity improves operational efficiency, while establishing specialized quality inspection departments and adopting smart agricultural management methods, in addition to obtaining certifications, tend to reduce overall efficiency, particularly at the profit-making stage [14].

This study focuses on Siemens' digital transformation and its impact on quality management and sales force performance. The study employs a hybrid methodology combining quantitative and qualitative data, including company data and annual reports, to assess results related to indicators such as defect rates and customer satisfaction. The findings demonstrate that investment in digital technologies, such as digital twins, is associated with significant improvements in operational performance and sales effectiveness. The research also underscores the strategic importance of digitalization in enhancing Siemens' competitive advantage and positioning it as a leading model in the context of the Fourth Industrial Revolution [15]. This study examines the impact of implementing the ISO 9001:2015 QMS on the marketing performance and product quality of PT Timah Tbk, a leading Indonesian tin manufacturer. The research is conducted in the context of declining revenues and profits experienced by the company in 2023 due to production fluctuations and weak global demand. Using a quantitative and descriptive approach and structural equation modeling, the study concludes that implementing ISO 9001:2015 has a strong and positive impact on improving product quality, which in turn enhances marketing performance and increases customer confidence. The findings underscore the importance of quality management as a key factor for competitiveness and sustainable business success [16].

3 Research Methodology and Systems Approach in Marketing

This paper adopts an analytical quantitative model to evaluate the direct causal impact of implementing TQM systems on marketing performance efficiency and effectiveness indicators within service sector organizations. The methodology is based on developing a comprehensive theoretical framework to guide hypothesis testing and employing systematic and accurate field data collection tools. This is followed by the application of statistical analysis techniques.

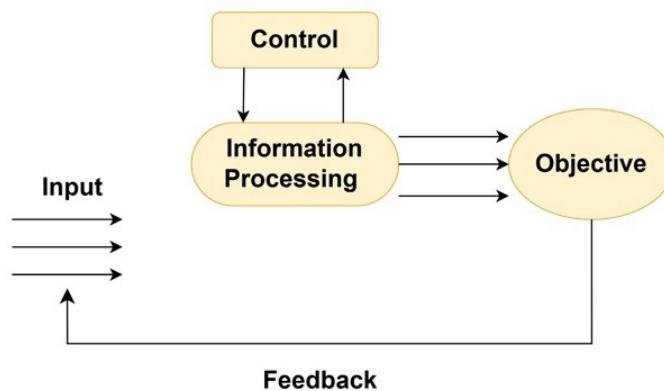
Figure 1 presents the methodological framework of the study, illustrating the proposed analytical model for investigating the direct impact of implementing quality management systems on marketing performance efficiency indicators within the context of service sector organizations. This framework comprises three key elements: inputs (quality systems), processes (systematic implementation), and outputs (marketing performance efficiency).

A system is defined as: (a structured set of capabilities that combine and depend on each other to ultimately form a unified whole). The concept of a system can be viewed from several angles. For example, the human body is an integrated system that includes the digestive, circulatory, and nervous systems, which are all parts of this system. Although systems theory is a relatively new approach in marketing, much has been said about it in literature on organizational and management theories. Regarding its application to marketing, the structured set of elements mentioned in the definition includes goods, price, distribution channels, and promotion. The systems approach in marketing is a complex method for addressing marketing problems under conditions of uncertainty. In such conditions, in particular, a set of alternative goals, plans, and programs is required. The organizational approach is based on principles that were applied in the military during World War II (1939-1945) to develop offensive and defensive plans and strategies. Therefore, it is defined as a study that helps decision-makers choose a course of action involving a company's comparative analysis of the costs, efficiencies, and risks of alternative strategies to achieve those objectives [17]. The systems approach helps focus attention on facts and problems within a broader scope than a single marketing perspective. It also enables the analysis of marketing activity by:

- 1- Emphasizing the marketing links between the company and its environment.
- 2- Emphasizing the relationships between inputs and outputs.

**Fig. 1:** The methodological framework

- 3- Shedding more light on the surrounding environmental conditions.
- 4- Serving as an approach to marketing control.
- 5- Fostering initiative and innovation.
- 6- Enabling the measurement of output.

**Fig. 2:** The model representing the systems approach

This diagram illustrates the dynamic structure adopted by modern organizations such as Sudatel to ensure efficient performance. William Lazer addressed the systems approach, explaining its reliance on the work of Von Bertalanffy, who is credited with introducing general systems theory. From this perspective, the set of interacting elements within marketing activity can be viewed as "marketing systems. These systems are defined as groups with specific and interconnected

characteristics. Examples of marketing systems include distribution channels and the physical distribution system which includes transportation, storage, and inventory control. Lazer also presented another model of marketing systems as shown in Figure 3.



Fig. 3: The model representing the systems approach

Traditionally, physical distribution activities—such as transportation, warehousing, inventory control, and materials handling—were managed as separate, independent operations, resulting in high operating costs for many companies. To overcome this problem, systems theory and macroeconomic analysis methodologies were applied to this field. The use of advanced mathematical models has led to significant improvements in the efficiency of physical distribution systems.

4 Theoretical Foundations of Quality

The notion of quality has a variety of interpretations, and each interpretation reflects a distinct viewpoint of the manner in which goods and services need to satisfy expectations [18]. According to one commonly accepted definition, quality is defined as the collection of attributes that a product has that allow it to meet the requirements of its consumers. This idea states that a product's or service's quality can vary based on its features, how it's used, and the customer's expectations. The consumer's perception of the quality of a product or service is directly correlated with their degree of satisfaction, which leads to an increase in the profitability and revenue of the business that produces it. Quality can also mean no flaws or mistakes that require rework or cause product failure and customer dissatisfaction. Quality is associated with the concept of cost reduction in this context, since the minimization of defects eventually leads to a decrease in expenditures related to operations [19].

The American National Standards Institute and the American Society for Quality Control both provide definitions of the term quality [20]. The former describes it as "the totality of features and characteristics of a product or service that bears on its ability to satisfy given needs, while the latter defines it as the degree or level of excellence. On the other hand, the American Oxford Dictionary provides a definition of "quality" as "the degree or level of excellence. The word "quality" has different meanings depending on who defines it and the product or service in question. Quality has become an essential consideration in the purchase of goods and services from the standpoint of the customer. Consumers nowadays are aware of brands that offer higher-quality items, and this knowledge significantly influences their purchase choices.

Individuals who buy goods and services for personal or business use, merchants who purchase products with the intention of selling them again, and manufacturers who purchase unprocessed materials are all examples of what is meant by the word "consumer." W. Edwards Deming places a great deal of importance on the role of the customer in the process of production planning. He says quality should meet both current and future consumer needs. Thus, a product's or service's quality is determined by the buyer's expectations and willingness to pay. Due to the fact that the requirements of customers vary, their anticipations of quality are also diverse. Thus, quality is defined by how well a product or service serves its intended purpose. The design phase is where the appropriateness is determined, since producers are required to consider the different demands of different customer groups. For instance, products such as Mercedes and Ford trucks are both deemed appropriate for usage; nonetheless, each of these vehicles has been constructed with unique attributes and qualities to cater to diverse groups of customers. The quality of design is the term for this difference, which is defined as the process of translating a product's intended quality features into specifications. Consumers evaluate the quality of manufactured goods based on several key dimensions. These include performance, which is a reflection of the product's primary operating characteristics; features, which are additional attributes of the product; reliability, or the likelihood that the product will function without failure over a specified period; conformance to established standards; durability;

serviceability, which is concerned with the ease and speed of repair; aesthetics, which are related to sensory appeal; and safety, particularly in products such as automobiles. Brand reputation and the efforts that are carried out to promote a product or service are two more factors that may need to be taken into account.

On the other hand, service quality is measured in different ways because customers and service providers interact directly with each other. Evans and Lindsay identify the principal dimensions of service quality as speed, completeness, employee behavior, consistency, ease of access, and accuracy. To ensure that their products and services meet customer expectations, businesses must carefully consider all of these characteristics during the design process. This aspect makes it imperative for organizations to conduct continuous assessments of the preferences and requirements of their customers. When seen from the viewpoint of the manufacturer, quality is defined as the process of creating and manufacturing goods that are in compliance with the requirements that have been developed to fulfill the demands of consumers. Once the design process concludes, the primary focus shifts to meeting the requirements. A hotel, for instance, fails to meet quality standards if guest rooms are not thoroughly cleaned according to predefined requirements. Good-quality products are those that conform to design specifications, while poor-quality products fail because they deviate from established standards.

A number of variables have an impact on conformity, including the design of the manufacturing process, the levels of operational performance, the technology and equipment that are available, the materials that are used, the amount of training and supervision that is provided to employees, and the degree to which procedures for controlling quality are utilized. Engineering teams play a critical role in ensuring that design requirements are met. When it comes to the relationship between price and quality, consumers tend to believe that the two are positively correlated, but manufacturers must determine a way to strike a balance between the two, since the cost of a product is an important design parameter. In the end, the coordination of consumer-driven design and manufacturer-driven manufacturing processes is required to achieve quality, which demonstrates that neither viewpoint can independently guarantee quality without the cooperation of the other.

According to Sallis, it is possible to comprehend what quality is from two separate but necessary perspectives. The first of the two perspectives is the production-oriented viewpoint, which defines quality as the degree to which a product complies with the specifications that were set for it in advance. This second point of view is all about the customer. This point of view says that a product is good if it meets the needs, wants, and values of the people who will use it. Different points of view show the challenge quality is, and it is not useful to reduce it to a single norm. The nine unique characteristics that constitute quality in this context each function with a reasonably high degree of independence from one another. Consequently, a particular product may be outstanding in certain respects while only achieving satisfactory or even subpar results in other areas, and only a small percentage of items can be considered to be excellent in every dimension.

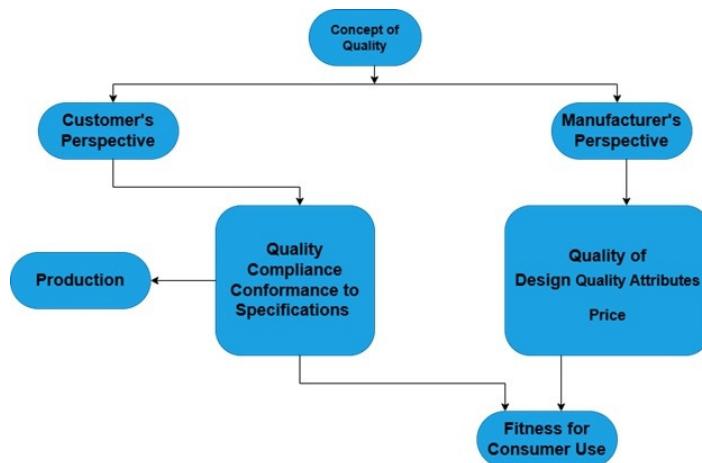


Fig. 4: The concept of quality

The main aspects that determine the quality of a product are the product's performance, which refers to its capacity to operate in the way that it was intended to, and the product's features, which relate to the extra qualities that augment the fundamental functions of the product [21]. The degree to which a product is in compliance with predetermined specifications and production standards is referred to as conformance. On the other hand, dependability is a measure of

how consistently a product functions throughout its lifespan. Durability is the length of time that a product may be used before it has to be repaired or replaced, while serviceability is the ease with which maintenance can be obtained and the efficacy of issue resolution. Responsiveness, or the degree of civility and efficiency shown in contacts, including those that take place between consumers and sales professionals, is another factor that contributes to perceived quality. Furthermore, a sense of beauty, which is shown in the ability to attract the senses, and reputation, which is founded on previous results and the legitimacy of the brand, have a considerable impact on the opinions that customers have about quality. There are a number of differentiating features that characterize quality, which illustrates its complex and multi-dimensional nature. Superiority is linked to this concept, which means that it is excellent when compared to other items on the market [22].

Additionally, since the changes in the performance and attributes of the product may be used as a means of evaluating the quality, it can be categorized as a product-based approach. When it comes to quality, from the point of view of the consumer, it is determined by the product's capacity to meet the wants and expectations of the customer. When seen from the perspective of production, quality is defined as the extent to which a product complies with the standards of its design. In addition to this, the significance of making sure that quality fulfills the expectations of customers at every single level across the complete organizational chain is emphasized by the viewpoint of value-based or sample-based analysis. Defects that occur at any level of the process may lead to a snowball effect, creating issues in the phases that follow. This is because, in many firms, each department serves the dual role of both a supplier and a customer. The establishment of Quality Control (QC) systems, which are internal quality measurement instruments that have four primary components (quality control, quality assurance, quality of the management system, and quality of management) is often necessary in order to tackle such problems.

The technique for quality control includes keeping an eye on the process of manufacturing both while it is taking place and after it has been completed [23]. It is employed in order to identify and eliminate any and all defects. The concept has undergone a metamorphosis during the course of history. In the early twentieth century, it was first used as a plain inspection mechanism, and it has since developed into a more complete approach that places a higher priority on the avoidance of mistakes. In the modern day, quality control is considered to be an all-encompassing monitoring system that ensures the maintenance of appropriate standards throughout the process of production. This is often accomplished by inspections that are scheduled on a regular basis and at intervals that are selected at random. Within the framework of TQM, Juran asserts that the three essential management processes are the following: quality control, which is defined as a systematic process for the monitoring and control of procedures in order to preserve stability, minimize unforeseen fluctuations, and guarantee consistent performance. Three types of quality control contribute to achieving TQM when implemented collectively. Input quality control aims to prevent the entry of materials or components that fail to meet required conditions. In-process quality control ensures that production stages are executed correctly, particularly when transitioning between stages, as errors at this point may be costly. Post-production quality control occurs after manufacturing is complete and ensures that finished products meet established specifications. Defective products are returned for correction or rejected entirely.

The components of quality control include a wide variety of actions that take place throughout the manufacturing process. This involves determining the parameters of the product-which is often accomplished by means of market research and translating them into technical requirements as well as maintaining the quality of the materials that are received. In addition, it is essential to keep a close eye on the quality of the product throughout the manufacturing process by monitoring procedures, equipment, and operating techniques. The basic elements that are required for the inspection, testing, packing, storage, and transportation of finished goods are as follows. Additionally, the activities that are included in post-sale quality control include the following: marketing, sales, distribution, installation, operation, technical help, and maintenance. In the end, successful quality management is the process that incorporates all of the administrative components that are necessary for the business to continuously enhance and maintain quality. On the other hand, Quality Assurance (QA) places its primary attention on the prevention of faults and quality issues prior to their emergence [24]. By creating and implementing systems, methods, and activities that guarantee constant compliance with quality standards, it places an emphasis on incorporating quality into every phase of the manufacturing process. The primary emphasis of quality assurance is not on the identification of flaws but rather on the prevention of such flaws. This change results in an increase in efficiency as well as a decrease in the probability of quality problems reoccurring [25].

5 Comparison Between Quality Control & Quality Assurance

The term QA is frequently considered to be a more complete term than QC since it refers to actions that occur before, during, and after the manufacturing process [26]. The primary objective of quality control is to find any issues that may arise after the manufacturing process is complete. The idea that quality is an essential component of the product, and that all workers are responsible for following standards and avoiding mistakes, is the foundation of the concept of quality

assurance. In contrast, the process of quality control is primarily concerned with the identification and resolution of problems after they have taken place. In addition, quality assurance requires the verification that the actual performance matches the specified objectives via the use of financial control as well as continuous review of performance throughout operations. After this assessment has been completed, the findings are then compared to the predetermined criteria, and the information is disseminated to the employees with the intent of making improvements. The primary objective of quality assurance is to make certain that there are procedures in place that are effective in controlling things [27]. After operations have been finished, the results of their performance are recorded and shared with all of the necessary stakeholders, which includes manufacturers, managers, and customers. This allows for an increase in transparency and supports the process of making decisions that are well-informed.

The most important formulas used in basic quality control methodologies are as follows:

$$UCL = \bar{X} + A_2 \bar{R} = D_4 \bar{R}, \quad (1)$$

$$LCL = \bar{X} - A_2 \bar{R} = D_3 \bar{R}, \quad (2)$$

where A_2 , D_3 , and D_4 are constants determined by subgroup size, as referenced in SPC tables.

The Potential Capability Cp is defined as

$$Cp = \frac{USL - LSL}{63c3}, \quad (3)$$

where USL (LSL) refer to Upper (Lower) Specification Limit, $3c3$ is the population standard deviation and C_{pk} is the Actual Capability

$$C_{pk} = \min \left(\frac{USL - \mu}{33c3}, \frac{\mu - LSL}{33c3} \right). \quad (4)$$

Binomial (extensive quantities):

$$\bar{\bar{X}} = \frac{\sum_{i=1}^k \bar{x}_i}{k} \quad (5)$$

The number of samples is indicated by k

$$R_i = \max(x_i) - \min(x_i), \quad (6)$$

$$\bar{R} = \frac{\sum_{i=1}^k R_i}{k}, \quad (7)$$

$$UCL_R = D_4 \bar{R}, \quad (8)$$

$$LCL_R = D_3 \bar{R}, \quad (9)$$

$$UCL_{\bar{x}_i} = \bar{\bar{X}} + A_2 \bar{R}, \quad (10)$$

$$LCL_{\bar{x}_i} = \bar{\bar{X}} - A_2 \bar{R}. \quad (11)$$

6 Quality Management System (QMS)

The Greek word isos, which means equal is the source of the abbreviation ISO. When it comes to standards, the International Organization for Standardization (ISO) expresses the concept of equivalency or compliance with a particular specification. The ISO is a non-governmental body that has created standards that are both voluntary and globally recognized. It is essential to differentiate between a product standard, which defines the features of a tangible

product, and a quality management system standard, which guarantees that an organization is able to reliably manufacture products or services that adhere to the specified quality specifications.

The ISO has released an estimated 10,900 standards since it was established in 1947. These standards span a wide range of disciplines, such as engineering and healthcare [28]. In the year 1997, it was the first to provide a complete collection of ISO, including ISO 9000, ISO 9001, and ISO 9004. These standards have since been extensively implemented worldwide as fundamental foundations for quality management systems. A structured system that is comprised of the policies, procedures, plans, resources, processes, and hierarchy of authority of an organization is referred to as a QMS. This system is designed to ensure that products or services meet the needs of customers while also supporting the overall objectives of the organization. Typically, a quality management system will have official paperwork, including the quality policy, the quality handbook, quality goals, operational processes, and standardized records.

The development of the ISO 9000 series aimed to provide a unified basis for facilitating international trade. Prior to its issuance, many local and international quality standards existed—such as the Japanese Industrial Standards (JIS) of 1981—but they were often unsuitable for broad commercial application. ISO later expanded its standards into two major series: ISO 14000, which focuses on environmental management systems, and ISO 9000, which pertains to quality management systems. The ISO 9000 standards have been accepted by more nations as national benchmarks than any other specification pertaining to quality, and this trend is continuing in the present day. Even though the ISO 9000 standard is not as extensive as the larger concept of TQM, it is completely consistent with the ideas that TQM espouses.

Organizations that adhere to the ISO 9000 standards can enjoy a wide array of advantages, which include, but are not limited to, improved quality of products and services, increased productivity, timely delivery, lower defect rates, higher customer satisfaction, stronger market competitiveness, and improved alignment with customers' increasing expectations. When these results are considered together, they all work to increase the efficiency of the business and to maintain a competitive edge in the long run.

The following are the most important relevant formulas and metrics used in evaluating, monitoring, and improving quality management systems, including those compliant with ISO 9001.

$$CSAT\% = \frac{(\text{Number of satisfied customers})}{(\text{Total respondents})} \%$$
 (12)

On-Time Delivery (OTD)

$$OTD = \frac{(\text{Orders delivered ontime})}{(\text{Total orders shipped})} \%$$
 (13)

First Pass Yield (FPY)

$$FPY(\%) = \frac{(\text{Units that pass inspection first time})}{(\text{Total units produced})} \%$$
 (14)

7 Total Quality Management (TQM)

Ensuring that goods and services meet predetermined quality specifications requires a comprehensive organizational commitment to quality. This holistic approach is known as TQM. The accomplishment of quality, according to the idea of TQM, is influenced by the procedures, structures, and internal circumstances of an organization. It is necessary to conduct a systematic examination of these aspects to ascertain how they contribute to or impede production, as well as how they increase or decrease the quality of the results. The idea of "Total" highlights the importance of everyone participating at every level within the business. This notion demonstrates that quality is not the exclusive duty of one department; rather, it is a shared task that is undertaken by the entire workforce.

The concept of total quality refers to quality in its widest and most complete definition. Occasionally, this concept is defined as big quality [29,]. This point of view takes into consideration every single aspect of a company, including the goods and services that it provides, the people who work there, the procedures that are in place, and the conditions of the workplace. It is a notion that is in direct opposition to the more narrowly defined idea of "Little Quality." The latter focuses on discrete quality features or specific components within the larger system. Organizations strive to include all of these elements into a cohesive endeavor that is intended to facilitate continuous development and the maintenance of high standards over an extended period of time by TQM.

Importance TQM is a significant concept because it is capable of providing a technique that is adaptable and flexible. It is more sensitive to change than the old systems that are based on inflexible processes and judgments [30,]. By having an impact on and modifying the actions of employees in order to instill a collective comprehension of quality, (TQM) encourages dedication to the business. Its holistic nature ensures that the organization focuses on all of its activities collectively rather than concentrating solely on the end consumer. TQM acknowledges that the interaction between both internal and external customers is what produces quality outcomes. It is considered to be an integrated strategy. The importance of TQM is further shown by the way it aids in the improvement of the company's reputation, the enhancement of employee morale, the cultivation of a strong feeling of collaboration across the organization, and the development of connections between producers and suppliers.

The objectives of quality management, especially within the context of (TQM), are to improve the quality of both goods and services while at the same time decreasing the expenses that are incurred by the business. (TQM) plays a role in the enhancement of customer service and the more successful satisfaction of customers' demands by reaching these objectives. The minimization of mistakes, the reduction of rework rates, and the decrease in the amount of overtime that is not required are all considered to be part of its key aims, as is the goal of cutting expenses [31]. TQM also seeks to increase organizational revenue and profitability by expanding sales and market share. Another fundamental goal is to improve customer satisfaction, which will eventually lead to customer joy. This is because consumers who are happy with a company's products or services are more likely to make repeat purchases and promote the company as a whole. Furthermore, TQM places a strong emphasis on empowering workers by giving them more authority and responsibility, which aids in the prevention of future issues and encourages ongoing development across the whole business.

The creation of TQM can be traced back to the efforts of a number of prominent individuals who made significant contributions to the understanding and implementation of quality in the United States, Japan, and other countries across the world. Walter A. Shewhart, a member of the Bell Telephone Laboratories, was one of the early pioneers to the field of quality control. He established the technological underpinnings of the field throughout the 1920s. The contemporary quality movement was founded on the basis of his pioneering work in the field of statistical quality control, and his research had an impact on the ways in which both American and Japanese organizations went about improving quality. Shewhart was instrumental in the promotion of the notion of statistical quality characteristics at AT&T. He also laid the groundwork for the scientific foundation that would be used to monitor and improve production processes. These techniques served as the basis for guaranteeing that products would be consistent and that processes would remain stable for a number of decades. However, the original text is cut off before it goes into detail on the continuation of this historical progression.

Among Shewhart's most notable followers was W. Edwards Deming, who transformed quality assurance from a technical activity into a comprehensive philosophy of management. During the year 1927, Deming came into contact with Shewhart when he was employed at the United States Department of Agriculture. The intellectual partnership that ensued had a profound influence on the work that Deming would go on to do in the future. Deming's introduction of the application of statistical process control in large-scale administrative processes took place in 1940, when he became an employee of the Bureau of the Census. He made a substantial contribution to the production of military goods and services during the Second World War by establishing national training programs that provided instruction in statistical quality procedures to the engineers and managers of enterprises that were involved in the war effort.

Deming made his most significant contribution in the 1950s, when he started working as a consultant in Japan and introduced Japanese business to the ideas of quality control. The groundwork for the industrial revolution of Japan after the war was established by his services. The concept of continual improvement, as well as the synchronization of product quality with design criteria, was an essential component of the strategy that he used. Deming recognized two key sources of process improvement: resolving particular departmental or individual inefficiencies and reducing systemic reasons of quality problems—such as poor product design and insufficient personnel training—in order to enhance overall quality.

The philosophy that Deming developed was formalized in his famous 14 Points for Management, which advocate for the following: the establishment of a consistent purpose, the implementation of a preventative approach to quality, the reduction of dependence on inspection, the selection of suppliers based on quality rather than price, the continuous improvement of all processes, the provision of suitable job training, and the encouragement of leadership that assists employees in excelling. The other elements include, but are not limited to, reducing fear in the workplace, increasing collaboration across departments, eliminating meaningless slogans and numerical quotas, restoring pride in craftsmanship, introducing extensive education and training, and ensuring that senior management is committed to quality improvement. The Plan-Do-Study-Act cycle, which was first proposed by Shewhart and then further modified by Deming, was also a result of his work. This iterative four-step model (which consists of developing improvements, executing them on a modest scale, assessing results, and institutionalizing successful changes) continues to serve as a cornerstone of continuous quality improvement.

An important change happened in the idea of quality because of the work of Shewhart, Deming, and other early leaders in the field of quality. In response to this change, the idea of quality changed significantly. It went from focusing

only on checking and finding flaws to a more comprehensive management theory that values customer satisfaction, group learning, and ongoing growth. These improvements made it possible TQM to become popular. TQM is a way to improve people, processes, services, and goods all at the same time.

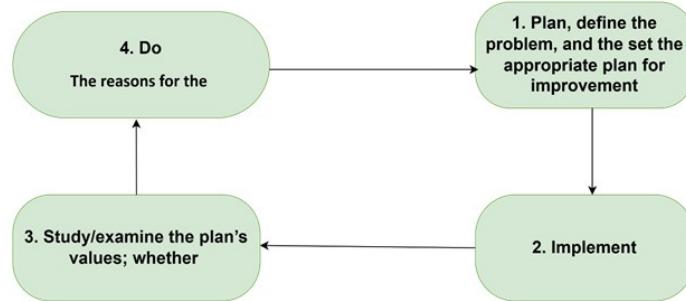


Fig. 5: Deming Wheel

In addition to the contributions made by Deming and Shewhart, there were several other pioneers who made substantial contributions to the creation of current quality management. In the year 1954, one of the individuals who went to Japan was Joseph M. Juran, who was an author and consultant of renown. He was there to provide an in-depth training program on the topic of quality management. Juran had previously contributed to the quality program at Western Electric, and his work in Japan greatly enhanced the country's industrial quality movement. Juran, in contrast to Deming, who placed an emphasis on leadership philosophy and statistical control, concentrated on strategic quality planning, which includes determining the necessary level of product quality, designing production processes that are capable of achieving that level, and defining the essential quality characteristics of the product. His argument was that the integration of such planning into the yearly quality program of every single firm was necessary to maintain a consistent level of progress.

Philip Crosby, another prominent individual, also had a role in the creation of quality management. He made his contributions through the widely read book *Quality is Free*. Crosby questioned the notion that a certain degree of inefficiency is an unavoidable reality and instead contended that quality ought to be characterized as meeting specifications, with zero faults as the only acceptable benchmark. The concept that putting money into quality systems would eventually result in lower total expenses due to the elimination of waste, rework, and inefficiencies was supported by his research from the 1980s.

Armand V. Feigenbaum made a major contribution to the expansion of the breadth of the field by introducing the concept of TQC. He also stressed that increasing quality is not only a technical endeavor but rather an organizational effort that encompasses all aspects of the company. According to his statement, each and every department, as well as every person working as an individual, has the responsibility of guaranteeing quality. He also said that it is essential to have full managerial commitment and consistent participation from every member of the organization in order to reach a high standard of quality. Due to the significant impact of this ideology, Japanese businesses began to adopt and expand the concept of quality control across their entire organizations. This approach eventually led to the integration of quality improvement into the industrial culture of the country.

In a similar manner, Dr. Kaoru Ishikawa, who was a professor at the University of Tokyo and a well-known specialist on quality control circles, advocated for the dissemination of methodologies for managing quality at every level of a firm. The idea of quality circles was first proposed by Ishikawa. These are comprised of a small number of employees, between five and ten, who convene at regular intervals in order to address various problems, assess the progress of their work, and provide recommendations for making improvements. This was based on the principles of Feigenbaum. The reason that empowering workers in this way improves their capacity to make a contribution to ongoing development and emphasizes their common responsibility for quality is a belief that he had.

Juran, Crosby, Feigenbaum, and Ishikawa all made important advances that have made the theory and practical foundations of TQM better when looked at as a whole. Their ideas heavily emphasized strategic planning, group loyalty, growth through participation, and cultural change. Modern quality control systems around the world still use these components as models.

The development of the quality movement has progressed through several distinct stages, each reflecting the evolving needs of industrial production and organizational management. The first stage, known as the Inspection Stage, emerged during the early eighteenth century with the advent of the Industrial Revolution. As production shifted toward large-scale manufacturing, organizations required systematic methods for inspecting goods to ensure their conformity to

specifications. This stage introduced the use of sampling techniques and basic inspection procedures, laying the foundation for more advanced quality practices.

The second stage, Statistical Quality Control, gained prominence during World War II, particularly in Japan. This phase marked a significant shift from simple inspection to the application of statistical methods to monitor and control quality. Techniques such as statistical sampling, acceptance sampling for processes, and control charts were adopted to ensure consistency in production and to detect variations that could compromise product quality. The widespread use of these methods contributed to the rise of Japan as a global leader in industrial quality during the post-war era.

The third stage, termed Quality Control and Assurance, emerged in 1956 with the contributions of Armand V. Feigenbaum. This stage expanded quality management beyond inspection and statistical control by emphasizing the study of quality costs and the economic considerations necessary to determine the optimal level of quality. It also highlighted the importance of measuring the quality of multi-component products and designing goods to be free of defects. Most significantly, this stage introduced the concept of TQC, which later evolved into the core philosophy of TQM. This approach underscored the need for organization-wide commitment and integration of quality into every function and process.

8 Presentation and discussion of results

The Sudanese Telecommunications Company (Sudatel) obtaining ISO certification led to an increase in its performance level.

Hypothesis I : The performance level of the Sudanese Telecommunications Company (Sudatel) rose because of obtaining International Organization for Standardization (ISO) certification.

(1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree)

Table 1: The frequency and percentage distribution of responses from the study sample regarding the statements of hypothesis I

Statements	1	2	3	4	5
The quality that enhances the company's reputation from your point of view	0	0	2	26	22
Quality for retaining customers and attracting new ones	1	0	2	31	16
Quality improves productivity	0	0	3	33	14
Quality achieves competitive advantage	0	0	5	25	26
Quality increases sales and profits	0	0	5	30	15
Quality enhances the company's growth objectives	1	0	2	31	16

The results in the table 1 and figure 1 above show that the majority of the study sample agree with the content and substance of the hypothesis statements, and their responses are positive. Therefore, it can be concluded that the sample agrees that Sudatel's ISO certification leads to an improvement in its performance.

Table 2: The probability value of the statements of hypothesis I

Statements	Mean	STD	χ^2	df	Sig
The quality that enhances the company's reputation from your point of view	4.40	0.57	19.84	2	0.0
Quality for retaining customers and attracting new ones	4.22	0.71	47.76	3	0.0
Quality improves productivity	4.22	0.55	27.64	2	0.0
Quality achieves competitive advantage	4.30	0.65	13	2	0.0
Quality increases sales and profits	4.20	0.61	19	2	0.0
Quality enhances the company's growth objectives	4.22	0.71	47.76	3	0.0

The statistical data in the table shows that the arithmetic means of the statements are greater than the hypothetical arithmetic mean (3), confirming that the majority of the surveyed sample agreed that Sudatel's ISO certification led to an improvement in its performance. The low standard deviation (0.55-0.71) reflects the homogeneity and similarity of the

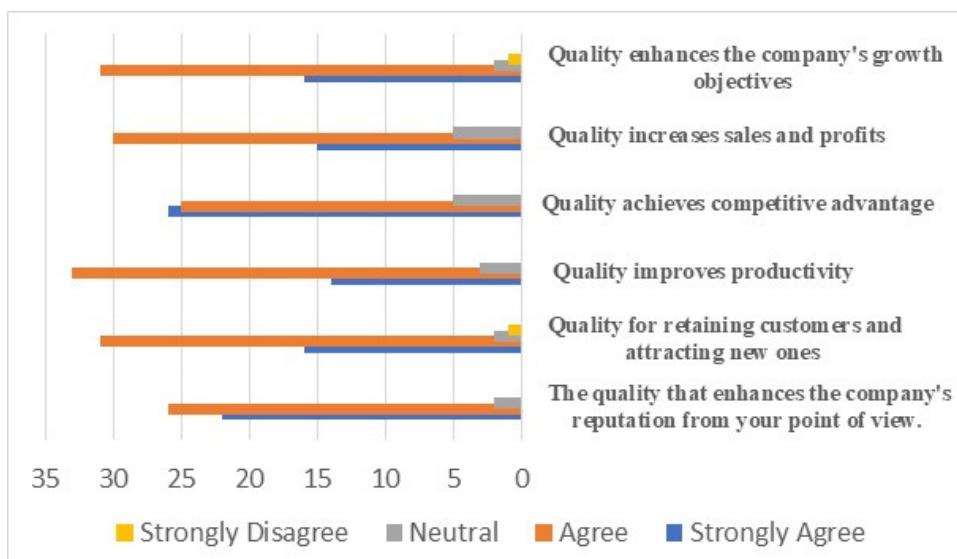


Fig. 6: Distribution of frequencies and percentages of responses from the study sample related to the statements of the first hypothesis

sample's responses. Furthermore, the chi-squared value (less than the significance level of 0.05) indicates statistically significant differences between the responses, supporting the hypothesis that ISO certification positively impacted performance.

Hypothesis II

A statistically significant correlation exists between the implementation of quality management systems and the marketing performance of services at the Sudanese Telecommunications Company (Sudatel).

Table 3: The frequency and percentage distribution of responses from the study sample regarding the statements of hypothesis II

Statements	1	2	3	4	5
The value of the service provided by Sudatel is reasonable compared to the price I paid.	0	1	3	30	16
The company's services are available according to the client's needs.	0	1	3	30	16
The company has highly qualified employees.	0	4	6	26	16
Promoting and advertising the service by the company leads to attracting new customers.	0	0	6	28	16
Sudatel provides you with information about the activities and services it offers.	0	0	6	27	17
The service provided, in terms of ease, accuracy, and speed upon request, is suitable.	0	0	4	33	13

The data presented in the table, the figure show that most participants have a positive attitude and fully agree with the statements made. Therefore, we conclude that the majority of the study participants acknowledge a statistically significant relationship between implementing quality management systems and improving the marketing performance of Sudatel's services.

The tabulated results indicate that the arithmetic means of the statements exceeded the hypothetical mean (3), confirming the positive trend in the respondents' answers and their conviction that there is a statistically significant relationship between the application of quality systems and the marketing performance of Sudatel's services. The homogeneous standard deviation (0.56-0.77) further strengthens the reliability of these responses. The chi-squared value (less than 0.05) also supported the results, confirming the existence of statistically significant differences in favor of accepting this relationship.

Hypothesis III

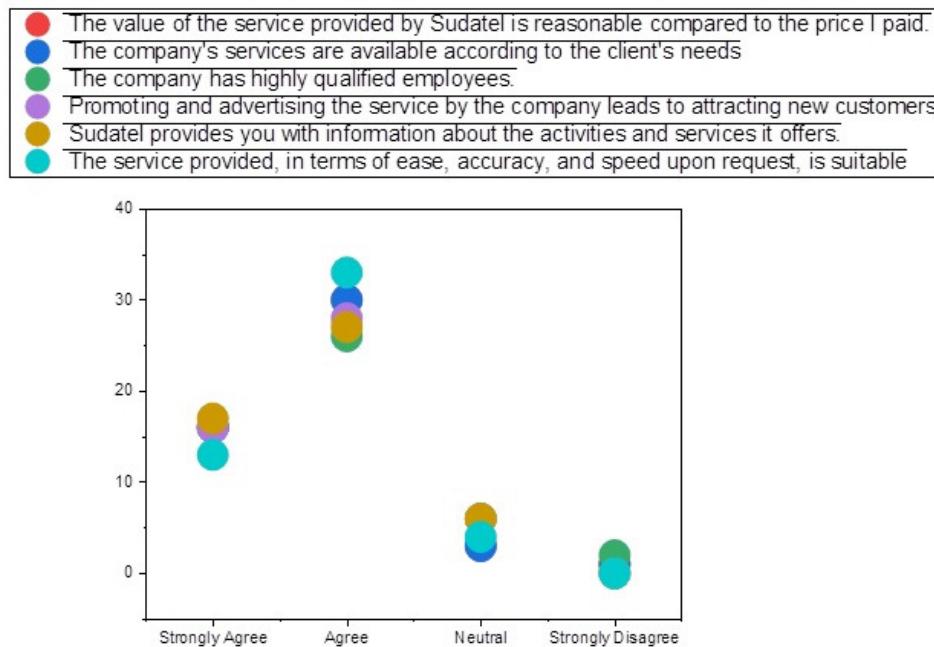


Fig. 7: The distribution of frequencies and percentages of responses from the study sample regarding the statements of the second hypothesis.

Table 4: The probability value of the statements of hypothesis II

Statements	Mean	STD	χ^2	df	Sig.
The value of the service provided by Sudatel is reasonable compared to the price I paid.	4.22	0.65	43.28	3	0.0
The company's services are available according to the client's needs.	4.22	0.65	43.28	3	0.0
The company has highly qualified employees.	4.12	0.77	27.76	3	0.0
Promoting and advertising the service by the company leads to attracting new customers.	4.20	0.64	14.56	2	0.0
Sudatel provides you with information about the activities and services it offers.	4.22	0.65	13.24	2	0.0
The service provided, in terms of ease, accuracy, and speed upon request, is suitable.	4.18	0.56	26.44	2	0.0

There is a statistically significant relationship between consumer satisfaction and the quality of marketing performance of the Sudanese Telecommunications Company (Sudatel).

Analysis of the responses from the surveyed sample (as shown in the tables 1-6 and figure 6,7,8) indicates widespread agreement with the content of the hypothesis statements. These results demonstrate a consensus among the sample that there is a statistically significant and positive relationship between the implementation of quality management systems and the effectiveness of Sudatel's marketing performance.

From the table above, we find that the arithmetic means of the statements in the table are greater than the hypothetical arithmetic mean (3). This indicates that the responses of the surveyed sample towards these statements are moving in the positive direction, meaning that they agree that there is a statistically significant relationship between the application of quality systems and the marketing performance of the services of the Sudanese Telecommunications Company (Sudatel). We also find that the standard deviation of the statements in the table ranges between (0.66-0.71), and the difference between the two deviations is less than one. This is evidence of the homogeneity of the responses of the surveyed sample towards the statements. We also find in the same table the probability value of the chi-squared test for each of those statements referred to in the table is less than the significance level of 0.05. This is evidence of the existence of statistically significant differences between the responses of the surveyed sample towards the statements, which is attributed to the agreement of the surveyed sample regarding the existence of a statistically significant

Table 5: The distribution of frequencies and percentages of responses from the study sample regarding the statements of the third hypothesis

Statements	1	2	3	4	5
The company's services, provided since 2002, have met your aspirations and expectations.	0	1	5	27	17
Dealing with the company's marketing departments is easy and simple.	0	1	8	28	13
Dealing with the company's marketing departments has no downsides.	0	0	8	26	15
Problems are resolved directly with customer service	0	1	5	28	16
The marketing performance of the company (Sudatel) is good and satisfactory to the consumer.	0	0	6	27	18
The services provided by the company (Sudatel) are satisfactory to the subscribers' requirements	0	1	4	26	19

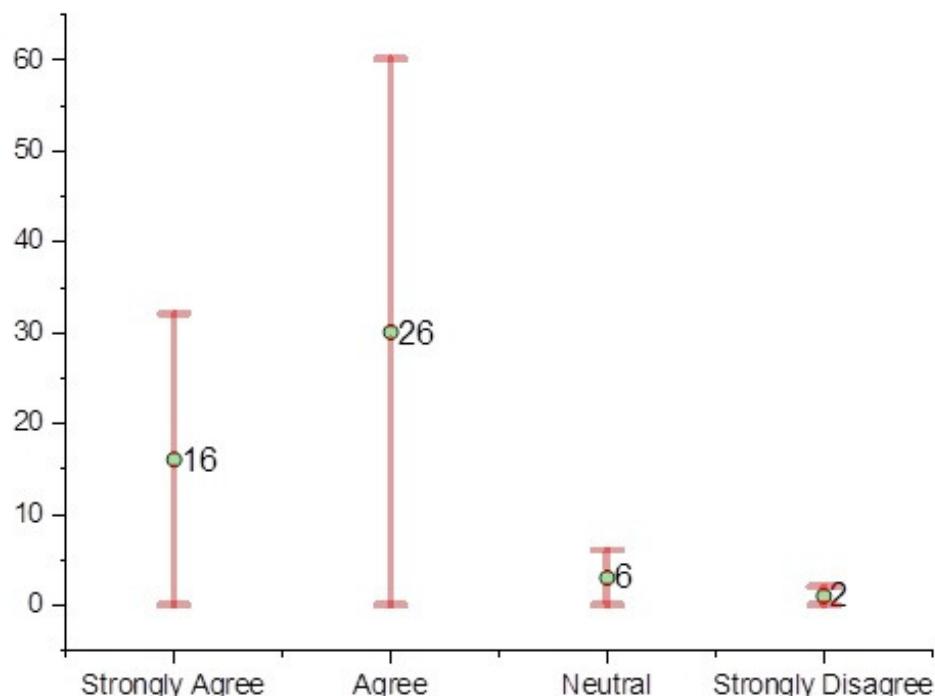


Fig. 8: The distribution of frequencies and percentages of responses from the study sample regarding the statements of the third hypothesis

Table 6: The probability value of the statements of hypothesis III

Statements	Mean	STD	χ^2	df	Sig
The company's services, provided since 2002, have met your aspirations and expectations.	4.20	0.70	33.52	3	0.0
Dealing with the company's marketing departments is easy and simple.	4.06	0.71	31.44	3	0.0
Dealing with the company's marketing departments has no downsides.	4.14	0.67	11.08	3	0.0
Problems are resolved directly with customer service	4.18	0.69	35.28	2	0.0
The marketing performance of the company (Sudatel) is good and satisfactory to the consumer.	4.24	0.66	12.16	3	0.0
The services provided by the company (Sudatel) are satisfactory to the subscribers' requirements	4.26	0.69	43.32	2	0.0

relationship between the application of quality systems and the marketing performance of the services of the Sudanese Telecommunications Company (Sudatel).

Hypothesis Analysis

Hypothesis 1: Sudatel's ISO certification led to an improvement in its performance level.

The descriptive analysis of the study sample's responses (see tables 1, 2 and figure 6) showed that the numerical means for all statements related to this hypothesis exceeded the pivotal value (3), indicating a positive bias in the responses. This conclusion is further supported by the low standard deviation of the statements (ranging between 0.55 and 0.71), which indicates the homogeneity and consistency of the respondents' opinions. The chi-square test also indicated that the probability values for all statements were less than the statistical significance level (0.05), demonstrating statistically significant differences favoring the sample's agreement with the hypothesis. Therefore, it can be concluded that Sudatel's ISO certification significantly contributed to improving its organizational performance, which aligns with the practical results indicating increased market share and higher profitability rates.

Second Hypothesis: A Statistically Significant Relationship Exists Between Quality Management Systems Implementation and Marketing Performance

The results in tables 3, 4 and figure 7 confirm that the majority of the sample agree on a positive relationship between adopting quality management systems and marketing performance. The arithmetic means for the statements were above 3, with low standard deviations (0.56–0.77), reflecting a clear consensus in viewpoints. Furthermore, the chi-square test showed strong statistical significance ($p < 0.05$), supporting a significant relationship between the two variables. This correlation is explained by improved service quality, marketing mix effectiveness, and increased customer trust, which positively impacted revenue volume and expenditure efficiency. This confirms that quality management systems are not merely an administrative standard, but a strategic lever for marketing excellence.

Third Hypothesis: A Statistically Significant Relationship Exists Between Customer Satisfaction and Marketing Performance

Although the hypothesis addressed a relationship between customer satisfaction and marketing performance, the results in tables 5, 6 and figure 8 showed a relative consensus on the existence of this relationship, with the arithmetical means exceeding the threshold (3), and a homogeneous standard deviation (0.66–0.71). The chi-square test indicated strong statistical significance, reinforcing the credibility of the relationship between the two variables. However, the results also revealed a practical gap: the company's weak response in resolving customer problems after service delivery. This suggests a gap in the after-sales phase that could threaten the long-term sustainability of customer satisfaction, even with improvements in overall performance indicators.

9 Conclusion

This research focused on the impact of implementing quality management systems—particularly ISO certification—on improving Sudatel's marketing performance and its role as a competitive advantage enabling Sudanese institutions to access local and global markets. The study aimed to answer three main questions related to the impact of quality on marketing efficiency, competitiveness, and the benefits of ISO certification.

The results confirmed all the research hypotheses: a statistically significant relationship was demonstrated between Sudatel obtaining ISO certification and improved performance levels, a positive correlation was found between implementing quality management systems and marketing performance, and a significant relationship was found between customer satisfaction and the quality of marketing performance. However, the study revealed a critical gap: weak after-sales service, which threatens the sustainability of customer satisfaction.

The research objectives were achieved, confirming that adopting quality management systems is not an administrative luxury but a strategic necessity for enhancing efficiency and competitiveness. The study recommends that Sudatel improve its customer support mechanisms and encourages service institutions to integrate quality into their marketing mix. It highlights the importance of future research using mixed methodologies or comparisons between telecommunications companies, and exploring the role of digital transformation such as CRM systems and data analytics in enhancing the effectiveness of quality systems.

References

- [1] Gao, J., Yao, Y., Zhu, V. C., Sun, L., & Lin, L. (2011). Service-oriented manufacturing: a new product pattern and manufacturing paradigm. *Journal of Intelligent Manufacturing*, 22 (3), 435-446
- [2] Latzer, M. (2009). Information and communication technology innovations: radical and disruptive?. *New Media & Society*, 11 (4), 599-619.
- [3] Hearn, J. (2006). The implications of information and communication technologies for sexualities and sexualised violences: Contradictions of sexual citizenships. *Political Geography*, 25 (8), 944-963.
- [4] Ausat, A. M. A. (2025). In-depth study of the strategic interaction between electronic commerce, innovation, and attainment of competitive advantage in the context of SMEs. *International Journal of Analysis and Applications*, 23, 78-78.

[5] Omerzel, D. G., & Gulev, R. E. (2011). Knowledge Resources and Competitive Advantage. *Managing Global Transitions: International Research Journal*, 9 (4).

[6] Miles, R. E., Snow, C. C., Fjeldstad, D., Miles, G., & Lettl, C. (2010). Designing organizations to meet 21st-century opportunities and challenges. *Organizational Dynamics*, 39 (2), 93-103.

[7] Dongmo, C., & Onojaefe, D. (2013). Using customer satisfaction to understand implementation benefits of the ISO 9001 quality management system. *Business Management Dynamics*, 3 (3), 1-9.

[8] Gomaa, A. H. (2025). Quality Management Excellence in the Era of Industry 4.0 (Quality 4.0): A Comprehensive Review, Gap Analysis, and Strategic Framework. *Advancements in Science and Technology*, 1-40.

[9] Awad, I. K., & Mohammed, G. S. (2025). Effectiveness of total quality management in marketing performance and the role of continuous improvement as a mediator for Iraqi institutions. *Czech Journal of Multidisciplinary Innovations*, 41, 47-58.

[10] Zheng, L. J., Islam, N., Zhang, J. Z., Behl, A., Wang, X., & Papadopoulos, T. (2025). Aligning risk and value creation: a process model of supply chain risk management in geopolitical disruptions. *International Journal of Operations & Production Management*, 45 (5), 1178-1210.

[11] Chin, C. H., Lo, M. C., & Ramayah, T. (2013). Market orientation and organizational performance: The moderating role of service quality. *Sage Open*, 3 (4), 2158244013512664.

[12] Al-Qahtani, N. D., Alshehri, S. S. A., & Aziz, A. A. (2015). The impact of Total Quality Management on organizational performance. *European Journal of Business and Management*, 7 (36), 119-127.

[13] Adedeji, A. J. (2025). Effect of quality management systems framework specifically ISO 9001, ISO 45001, ISO 14001 and ISO 31000 standards on operational performance: an investigation of Nigeria's manufacturing sector. *Brazilian Journal of Operations & Production Management*, 22 (3), 2488-2488.

[14] Wei, J., & Wang, X. (2025). Impact of quality management system on operational efficiency in agro-processing SMEs. *Total Quality Management & Business Excellence*, 1-39.

[15] Daldiran, B., Daldiran, K., & Güllü, K. (2025). Digital transformation for quality management, operational excellence, and sales force effectiveness in an Industry 4.0 context: Evidence from Siemens AG. *Turkish Journal of Marketing*, 10(2), 87-106.

[16] Silitonga, R. Y., & Heryanto, D. (2025). The Influence of ISO 9001: 2015 Quality Management System Implementation on Marketing Performance at PT Timah Tbk. *Journal of Management Studies and Development*, 4 (01), 24-33.

[17] Layton, R. A. (2011). Towards a theory of marketing systems. *European journal of marketing*, 45 (12), 259-276.

[18] Harvey, L., & Green, D. (1993). Defining quality. *Assessment & evaluation in higher education*, 18 (1), 9-34.

[19] Gupta, M., & Campbell, V. S. (1995). The cost of quality. *Production and Inventory Management Journal*, 36, 43-43.

[20] Hamilton, D. B., & CICM, C. (1998). American Society for Quality (ASQ) software quality engineer certification program. In *Handbook of software quality assurance* (3rd ed.) (pp. 171-194).

[21] Srinivasan, R., Lilien, G. L., Rangaswamy, A., Pingitore, G. M., & Seldin, D. (2012). The total product design concept and an application to the auto market. *Journal of Product Innovation Management*, 29, 3-20.

[22] Anwar, G., & Abdullah, N. N. (2021). The impact of Human resource management practice on Organizational performance. *International journal of Engineering, Business and Management (IJEBM)*, 5.

[23] Sioma, A. (2023). Vision system in product quality control systems. *Applied sciences*, 13 (2), 751.

[24] Qamar, S. Z., Al-Hinai, N., & M644rquez, F. P. G. (2024). *Quality Control and Quality Assurance: Techniques and Applications*. BoD—Books on Demand.

[25] Wang, C., Yang, Z., Li, Z. S., Damian, D., & Lo, D. (2024). Quality assurance for artificial intelligence: A study of industrial concerns, challenges and best practices. *arXiv preprint arXiv:2402.16391*.

[26] Perico-Franco, L. S., & Rosas-Pérez, J. E. (2025). Synthetic peptides quality control and assurance. In *Antimicrobial Peptides* (pp. 405-416). Elsevier

[27] Fan, G., & Wang, Q. (2021). Quality control and quality assurance. In *Clinical molecular diagnostics* (pp. 97-113). Singapore: Springer Singapore.

[28] Maldonado Garc64aa, M. I. (2024). Standardization process and linguistic feature documentation of the Pakistan variety of English language as a pluricentric language in conflict.

[29] Martin, J., Elg, M., & Gremyr, I. (2025). The many meanings of quality: towards a definition in support of sustainable operations. *Total Quality Management & Business Excellence*, 36 (3), 185-198.

[30] Dooley, K. J., Johnson, T. L., & Bush, D. H. (1995). TQM, chaos and complexity. *Human systems management*, 14 (4), 287-302.

[31] Qing, L. Z., Mohd-Rahim, F. A., & Mazura Mahdzir, M. H. (2025). Design Errors' Impact on Construction Project Costs. *Journal of Construction in Developing Countries*, 30 (2), 25-47