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Modeling the Sustainable Integration of Quality and Energy Management in Power Plants

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Abstract: (1) Background: this paper aimed at modeling the sustainable integration of quality and energy management system (IQEM) via identifying critical success factors (CSFs) and analyzing the effect on energy management; (2) Methods: The research adopted theoretical and practical methods, through carefully examining the literature to extract the research gap and CSFs that establish a sustainable model for the integration of quality and energy management, while the practical method was energy experts' arbitration and to develop a sustainable model in power plants. The study used SmartPLS and SPSS software for analysis purposes, collected data using a 5-point Likert scale and employed a cross-sectional approach survey questionnaire; (3) Results: The research succeeded in identifying the most important CSFs necessary for the sustainable integration of (IQEM). This investigation discovered that the identified CSFs are significantly related to the electricity sector's energy management integration success (EMIS). The study's results showed that the identified IQEM's CSFs, such as EP with *p*-values (0.000), SQI (0.000), EMT (0.019), A (0.003), SP (0.010), are significantly associated with EMIS and improve quality and energy management; (4) Conclusions: This study succeeded in modeling a framework that ensures integrated and sustainable success between energy management and quality in developing countries power plants.

Keywords: integrated system; ISO 50001; energy efficiency; conceptual framework

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1. Introduction

The electricity sector plays a vital role in the socioeconomic development of post-war countries such as Iraq [1,2], Lebanon, Kosovo [3], and Afghanistan [4,5]. Several issues related to the unsustainability of energy management (ISO 50001) and quality management (such as ISO 29001: 2020) focused on the oil and gas plants in the Iraqi electricity sector, including mismanagement, lack of an organizational culture, and poor interest in energy and quality management's CSFs [6–12]. According to the Iraqi Ministry of Electricity's (MOE) annual reports, about 30% of electricity produced is lost and wasted due to irresponsible and inconsiderate quality and energy management behaviour. A lack of sustainable quality and energy management in Iraqi power plants has increased the acute shortage of electrical supply problems [13]. Corruption and mismanagement in the electricity sector also led to neglecting energy management and its CSF weakness [10,14]. This study focuses on Iraqi gas power plants in Baghdad to address these issues.

The gas power plants constitute the largest percentage within the company and 70% of the total power plants. In addition to many workers, most of these stations are old and have multiple problems; therefore, these plants are ideal locations for this investigation.

Moreover, as Baghdad is Iraq's administrative and economic capital, it houses more power plants than the rest of Iraq's provinces. Effective energy management is crucial at

Iraqi electricity power plants, especially power plants responsible for providing electricity to urban areas such as Baghdad; especially, the implementation of Energy Management (EM) following ISO 50001 standards will significantly influence 60% of the world's energy use. Numerous studies were conducted to identify energy management's critical success factors (CSFs) [15]. Other studies focusing on the importance of implementing energy management in the electrical sector pointed out that drivers, barriers, and incentives are crucial in the execution process [16]. The study investigates the integration of the CSFs for energy and quality management because the energy management system ISO 50001 is based on the PDCA (plan–do–check–act) cycle that focuses on continuous improvement. The ISO standards aim to make the integration of various management systems easier. Therefore, ISO 9001 and ISO 14001 are usually adopted before implementing ISO 50001, which means ISO 9001 and ISO14001 are the foundation for adopting ISO 50001 [17,18]. However, ISO 29001 is applied in the petroleum, petrochemical and natural gas industries for quality management systems. It is a supplement to ISO 9001: 2015, which provides a quality management system for enterprises that provide products and services [19]. Since this study was carried out in gas generating stations, integrating energy management systems ISO 50001 and quality management systems ISO 9001: 2015 and ISO 29001: 2020 is possible and easy [20]. The integrated QM and EM produce a more efficient single IQEM system. EM and QM systems' similarities also allow organizations to reduce costs and defects, improve efficacy, align goals and organizational foundations, harmonize, and unify their ability to solve problems [21,22]. In short, IQEM is an all round system that addresses energy and quality issues, including the CSFs for energy and quality management that have been identified via literature analysis, such as energy audit (EA), service quality improvement (SQI), awareness (A), energy policy (EP), top management support (TMS), energy management team (EMT), and strategic planning (SP).

Similarly, several studies on quality management have been conducted in the electricity sector [23–25]. The country's electricity sector is important and related to people. With the increase in global demand for energy, continuous losses in energy production require more research efforts to investigate the success factors of the sustainability and integration of energy management. Thus, it is imperative to understand Iraq's energy and quality management systems.

The purpose of the study aims to achieve three objectives: (1) to systematically investigate the research taxonomy of sustainable integration for quality and energy management (IQEM), (2) to determine the indicators of critical success factors (CSFs) IQEM in the Iraqi gas power plants, (3) to develop a conceptual framework for the successful integration of sustainable energy management. Therefore, this study seeks to answer the following research questions: (RQ1) what is the current research taxonomy for the sustainable integration of quality and energy management (IQEM)? (RQ2) What is the best conceptual framework to integrate CSFs for IQEM in gas power plants? This research's carefully studied and analysed literature is the first study to identify IQEM's CSFs and their impact on Iraq's electricity sector's energy management. Therefore, this study highlighted the indicators of critical success factors (CSFs) to facilitate the development and implementation of EMs in the power plants. To conduct an accurate and reliable investigation, the outputs of the analysis of previous literature were employed to develop a sustainable model and then presented to a group of energy experts.

The study developed a conceptual framework that presented a vision for sustainable energy management and quality in gas power plants from the practical side. Iraq's gas power plants were selected as a case study. Due to the old age of Iraqi power stations and the multiple electricity problems, as is the case in most developing countries, we have considered Iraqi power stations an ideal and successful case for applying the model of this study, in order to create a new and sustainable concept for the successful integration of energy management and quality management. In accord with previous literature analysis [19,26–28], no noteworthy studies have investigated the sustainable integration of CSFs for energy management ISO 50001 and quality management ISO 29001. The lack of sustainable integration of CSFs for energy management and quality underscores the need for more attention. This research sheds light on future gaps in terms of the academic side.

2. Research Hypotheses Development

2.1. Problem Statement

Iraq's power related crisis since 2003 is expected to continue and, to mitigate this predicament, various attempts have been made by focusing on supply whilst overlooking the importance of upgrading energy efficacy to meet demands. The losses in 2018 alone, according to the Iraqi Ministry of Electricity, were IQD 1,145,256 million (USD 958.37 million) [29]. Iraq spent approximately USD 85.512 billion between 2006 and 2019 because of the failure to adapt and succeed in energy management, while the lack of energy management and integration with quality management in the country has hindered development efforts, with the power outages continuing [14,30–32]. In Iraq, the electricity sector faced many problems, such as consumers' low levels of awareness, bribery, poor management, and organizational cultures. For that reason, this study identifies and examines IQEM's CSFs to ensure successful energy management in the electricity sector.

2.2. Energy Management System

Energy management system (EMs), in an industrial context, are a series of systematically executed actions, processes, and practices. These actions include strategizing/developing, implementing/operating, controlling, and organizational culture. Policymakers responsible for implementing industrial and energy production policies must understand that effective energy management is key to determining a policy's success. In today's competitive environment, energy management has been one of the competitive strategies for the success of any organization. According to [15,33], several types of research explored the connection between EM practices' CSFs and an organization's success. The literature reported that EM ISO50001 is a key element to ensure an organization's achievement and impacts the success of implemented energy management [27].

2.3. Quality Management

In areas of energy management, quality is known as a factor that determines the success of any implemented strategies. The authors of [34] believed that, as the manufacturing environment becomes highly competitive, these companies are dependent on their capacity to produce high quality products to survive. The authors of [35–37] highlighted QM's paramount roles, as it helps improve organizational efficacy, allows companies to keep up with the competition, encourages innovative processes, and enhances customer satisfaction. Respective empirical studies by [38–40] examined whether QM practices are correlated with successful energy performance and reported that QM's role is substantial in ensuring the energy management strategies' successes. Quality management, especially ISO 9001 and ISO 14001, is considered the appropriate ground for the application of energy management ISO 50001 and must be implemented before it [17,18]. While ISO 29001 is applied in the gas industries for quality management systems. The literature shows that QM positively affects energy management and is crucial for any organization to succeed.

2.4. Justifications of Integration of Energy Management and Quality Management

Energy management seeks to lower energy costs by improving energy efficiency and supporting activities and management practices that will help achieve this efficiency. ISO 50001 is an international standard that gives guidance for implementing energy management [41]. ISO 50001 has the flexibility to improve and integrate with other management systems. António da Silva Gonçalves and Mil-Homens dos Santos, in [42], carefully examine the previous literature and used expert judgment to identify four research gaps in ISO 50001, which are the actual management of energy risks, rapid developments in the field of energy efficiency, the follow up to rapid development techniques, and, most importantly, reducing environmental impacts due to energy use through ISO 9001, ISO 14001, and ISO 29001 in the field of oil and gas. The fundamental motivation for integrating the standards concerns the environment, particularly climate change and quality management. The pursuit of higher customer satisfaction and the reduction in energy costs are also important reasons for integration. Another intriguing conclusion is that ISO 9001 and ISO 14001 are typically implemented before ISO 50001; therefore, the integration between ISO 50001 and ISO 9001 is an ideal integration and a significant research gap [22]. The fact that ISO standards have existed with similar architecture since 2012 is intriguing. Its goal was to make the integration of various management systems easier. ISO standards cover quality management systems (ISO 9001), environmental management systems (ISO 14001), occupational health and safety management systems (ISO 45001 based on OHSAS 18001), and ISO 29001: 2020 Petroleum, petrochemical, and natural gas industries [43]. The ISO organization has changed many different standards to facilitate their integration, so the organization published an appendix in 2012 to standardize its internal structure and the structure of the standards, to facilitate the integration of management systems [44–46]. The benefits and justifications resulting from the integration and implementation were mentioned in the following literature [47,48]. The previous literature expresses the integration between ISO 50001 and ISO 9001 or 14001 and ISO 29001, and that it is possible, given that their structures are similar [49]. Despite this, there is an evident dearth of literature regarding the integration of ISO 50001 with ISO 9001 or 14001, as well as ISO 29001 [50]. According to [51], the symmetrical structure and integrative role of energy management, quality management, and environment are known, especially for ISO 50001, ISO 9001 or 14001, and ISO 29001. However, the previous literature did not explore it much. Another study discussed the common structures between ISO 50001:2011, ISO 9001:2015 and ISO 14001:2015, in order to facilitate an integrated management system [52]. Studies have discovered many commonalities and similar structures between ISO standards, to gain a competitive advantage among the different management systems and facilitate integration into one management system. [53] Development tools facilitate integration between different management systems, such as ISO 50001 with ISO, ISO 9001 or 14001, and ISO 29001. While [54] used a matrix for performance energy management with quality management, the matrix is based on integrated management systems activities (ISO 9001, ISO 14001, and ISO 50001).

2.5. Sustainable Integrated Quality and Energy Management (IQEM)

An ISO for quality and energy management systems is designed to be compatible with existing management system standards, such as ISO 9001, ISO 50001, and ISO 14001. It is used for strategic planning and continuous development. Ref. [53] posited that companies, in an attempt to survive in competitive economic situations without compromising their responsibility towards sustainability, must consider incorporating management systems and specifications to continue being relevant in the 21st century. According to [44], these companies should consider implementing an integrated management system by combining two or more compatible systems into one effective system. Refs. [55–57] emphasized integration's value and advantages, as it would allow an organization to reduce costs, comply with legislative rules, improve its image, help optimize resources, improve internal communication, provide operational gains, and achieve better efficacy. Ref. [58] views quality management as a factor that focuses on customer satisfaction, continuous improvement, and service quality improvement. On the other hand, energy management focuses on customer satisfaction and other stakeholders' concerns, such as service quality improvement, governmental departments, consumer groups, policy improvement, planning, operation, and organizational culture [59,60]. Refs. [56,61,62] opined that an integrated QM and EM produces a more efficient single IQEM system. It enables organizations to reduce costs, increase productivity, align aims and procedures, reduce repetitive guidelines and processes, and improve technological advancement. Furthermore, EM and QM systems' similarities also allow organizations to reduce costs and defects, improve efficacy, align goals and organizational foundations, harmonize, and unify ability to solve problems. In short, IQEM is an all round system that addresses energy and quality issues. Table 1 highlights EM and QM's CSFs, including energy audit (EA), service quality improvement (SQI), awareness (A), energy policy (EP), top management support (TMS), energy management team (EMT), and strategic planning (SP). EM and QM's common and key factors, obtained from the reviewed literature, are shown in the following Table 1.

Table 1. Construct measurement and related construct.

CSFs	QM CSFs Proposed by Previous Studies	EMs CSFs Proposed by Previous Studies	No.	%
SQI	[63–92]	[93–98]	30	18%
EP	[64,66,75,78,90]	[15,33,63,93–111]	27	16%
A	[74,77–80,82,84–90,92,112,113]	[15,93,94,96,97,102,107–110,114]	27	16%
TMS	[78–92,112,113]	[15,93–95,107,108,111,115,116]	26	15%
SP	[78,82–84,86,88,89,92,112,113]	[15,33,94,96,97,107,109,111,116,117]	20	12%
EMT	[64,68,78,82,84,113]	[15,33,65,93,95–98,108,110,111,116–118]	20	12%
EA	[90]	[15,33,94–96,98,107–111,116–121]	18	11%
	Total		168	100%

2.6. Independent Variables

2.6.1. Service Quality Improvement (SQI)

Service organizations strive to enhance their quality of service constantly. Quality improvement is a term that collectively describes quality service, quality management, quality processes, and control. When describing service operations, the term SQI refers to public and private service operations offering services that help to improve the organization. Nevertheless, [122] stated that not much is known about service operations related quality management. As quality is perceived differently by individuals and organizations, it generally meets consumers' expectations. According to [123], quality service provided by organizations to the public is related to quality management; therefore, it is imperative to comply with the requirements to ensure that the services undergo continuous upgrading. This continuity is crucial, to ensure that the services provided exclude any deviation from the specified requirements [124]. In energy production, [125] believed that SQI would ensure that power plants would focus on producing high quality energy. Improving quality service, primarily through ISO 9001: 2015 and ISO 29001: 2020, is possible, to integrate with energy management systems ISO 50001, ensuring continued improvements [20]. This study views SQI's importance in determining the quality of an organization's performance. The hypothesis that has been proposed is:

Hypothesis 1. *SQI is statistically significant in influencing EMIS.*

2.6.2. Energy Management Team (EMT)

The energy management team (EMT) has a role in ensuring organizational success, as it helps in engaging different departments (e.g., procurement, production, facilities, etc.) in an organization to collaborate when tasked to develop and implement EnMS [126,127]. These collaborative practices align with QM's expectations, as QM's core is an improvement process, and, for that process to work, employees must be given a platform to work together [128,129]. QM expects an organization's management to provide a conducive platform for employees to work together on shared views and ideas, and create a work culture that encourages them to respect energy use [130]. Most importantly, the provided platform should be geared towards implementing EnMS successfully and helping organizations to attain goals. Energy management ISO 50001 and quality management ISO 9001 with ISO 14001 require a management team to coordinate with senior management to provide resources. There are ways to activate the energy management team cycle within the organization structure [117]. The literature reviewed showed that EMT has a substantial role in helping organizations to attain their aims and the importance of involving employees in their decision-making procedures. The hypothesis that has been proposed is:

Hypothesis 2. *EMT is statistically significant in influencing EMIS.*

2.6.3. Energy Audit (EA)

An energy audit is a team of dedicated energy efficiency services. According to [131], an energy audit verifies, monitors, and analyses energy consumption; it is a part of the ISO 5001 set of standards for managing energy systems. EA also submits a technical report that provides suggestions based on cost effective analysis to improve energy efficacy and an action plan to assist organizations with their energy-saving plans. Introducing an energy audit as part of the organization is the first step toward a comprehensive energy management strategy. Regular audits are necessary to ensure that quality is not compromised, as the auditing process allows the management to evaluate a companies' personnel, systems, procedures, and the organizations' overall quality. Outcomes from the audit can rectify identified issues and help organizations improve their standards [132], as such, an energy audit is imperative in EM and QM practices. The hypothesis that has been proposed is:

Hypothesis 3. *EA is statistically significant in influencing EMIS.*

2.6.4. Strategic Planning (SP)

The authors of [133] defined strategic planning as a process of examining ways taken by companies to develop, communicate, execute plans as they work on improving strategies and policies to attain their targets. Ref. [134] commented that proposed strategies should be developed and implemented based on novel and proven ideas, to ensure their efficacy when planning to execute a workable framework to manage and supervise energy and the environment. These views aligned with [34,135,136], who stated that, to meet consumer demands and expectations, plans must be strategically devised prior to executing steps to enhance organizational quality and energy management and performance. Strategic planning is used in energy and quality management for continuous improvement processes and all types of ISO, such as ISO 50001, ISO 14001, ISO 9001, and ISO 29001, supporting the integration between different management systems. Strategic planning is believed to be an influential factor when implementing an effective integrated management system; therefore, the hypothesis that has been proposed is:

Hypothesis 4. *SP is statistically significant in influencing EMIS.*

2.6.5. Energy Policy (EP)

Energy policy is one of the proposed solutions aiming to preserve energy sources and is part of the family ISO 50001. Besides being part of the factors determining organizations' accomplishments, EP's ability to build a sustainable organizational culture should not be overlooked [137]. The most important step in adopting energy management is the top management's willingness to commit to the process of management. After being informed of energy management's advantages, those responsible in the top management should be ready to commit and create a suitable policy that includes energy management and complies with legislative rules and other anticipated prerequisites [138], as such, EP is crucial when implementing QM within the organization [90]. In line with these views, EP is chosen as it allows the relationship between energy policies and EMIS in Iraq's electricity sector to be further investigated. The hypothesis that has been proposed is:

Hypothesis 5. *EP is statistically significant in influencing EMIS.*

2.6.6. Top Management Support (TMS)

Top management support means an organization's ability to participate in activities, attitudes, and behaviors that support successful activities [139]. Top managers' roles should not be underestimated, as they are key to determining whether their respective organizations could succeed; therefore, it is considered an essential factor in integrating energy management and quality management because of its significant role in facilitating operations and speeding up procedures. The authors of [140] reported that investigation into these managers' influence on implemented energy-saving policies showed that they could substantially affect the industry's energy savings behavior, particularly energy practices. Furthermore, [113,141] commented that top management commitment, i.e., leadership, is identified as a factor that could make or break an implemented quality framework. Apart from being the individuals tasked with building a sustainable organizational culture, these personnel are also responsible for executing QM practices. The following hypothesis is proposed based on the reviewed literature and TMS's possible relationship with EMIS:

Hypothesis 6. *TMS is statistically significant in influencing EMIS.*

2.6.7. Awareness (A)

The authors of [142] defined awareness (A) as the ability to observe performance, whilst acting on the observations is the state of being conscious of something. According to [143], organizations should not overlook awareness' significance, as steps to be taken to educate the masses and increase consumer awareness. Energy-saving awareness is categorized into two main components, namely, knowledge and practice. Most implemented energy efficiency measures (or yet to be implemented) involve technological interventions. However, the implementation's success relies heavily on consumers' behavior, including their awareness of the energy consumed, as that awareness is deemed significant in implementing an effective integrated management system. The hypothesis that has been proposed is:

Hypothesis 7. *A is statistically significant in influencing EMIS.*

2.7. Dependent Variable: Energy Management Integration Success (EMIS)

Energy management's (EM) prominence in conserving the environment has led to the emergence of many policies, guidelines, publications, and organizations aiming to provide clarity and guidance to those aiming to manage energy efficiently. Ref. [144] defined energy management as an organized and coordinated process that allows the act of producing, conversing, distributing, and consuming energy without compromising the environment and economic goals. As energy prices rise, energy-saving becomes a need rather than a choice. Therefore, industrial organizations begin to see energy efficiency as a profitable step that improves productivity and simultaneously reduces costs incurred during production [145]. EM is selected as the study's dependent variable, based on its important role in operating and controlling processes [146].

2.8. Conceptual Framework

After identifying integrated quality and energy management's (IQEM) critical success factors (CSFs) and their influence on Iraq's electricity sector's energy management integration success (EMIS), a thorough literature review to help identify the problem was conducted. The review enabled the researcher to finalize the conceptual framework where the seven identified CSFs related to IQEM practices are EP, SQI, TMS, A, SP, EMT, and EA. Their overall impact on Iraq's electricity sector's EMIS is shown in Figure 1.

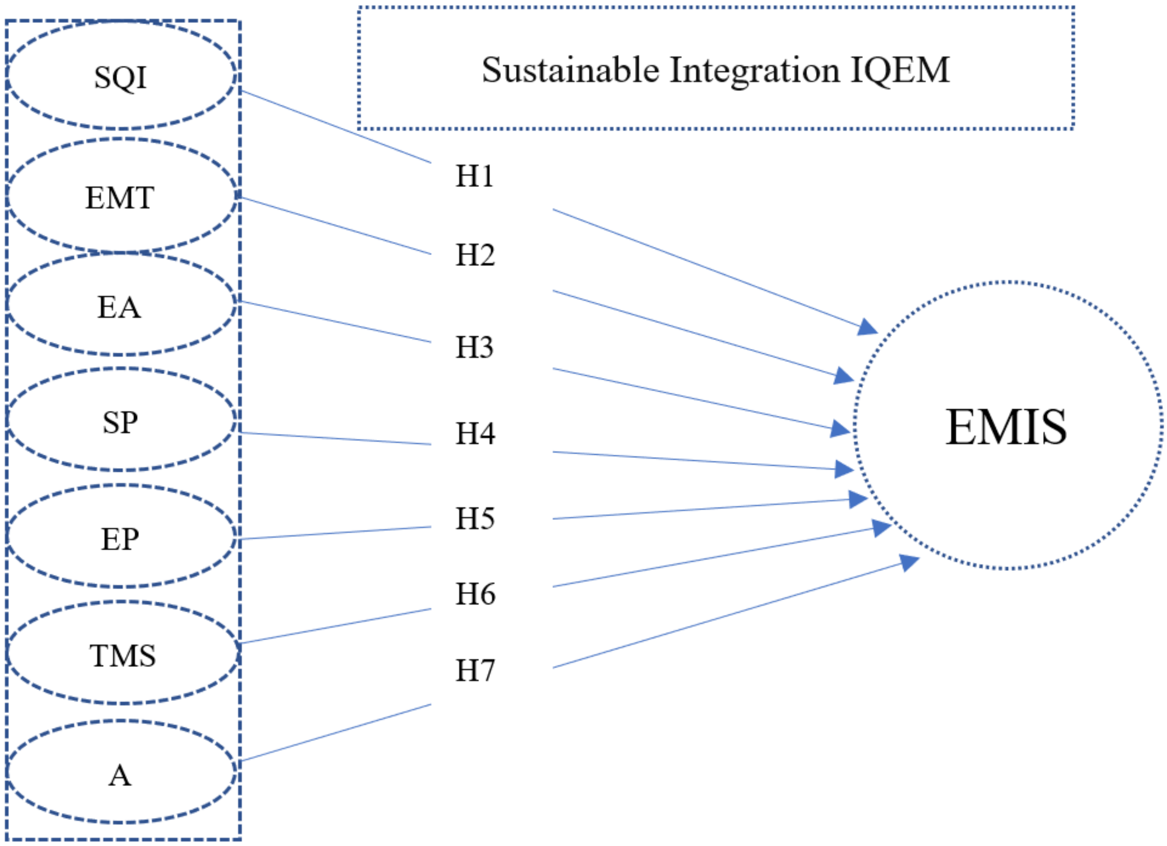

Figure 1. Research model.

Theoretical Background of the Study

This study is underpinned by economic growth theory (EGT) and organizational culture theory (OCT). EGT is widely accepted, as it focuses on economic growth and energy relationship [147]. According to [148], energy demands help the economy grow as consumption comes from demand. The following theory, OCT, represents what the organization's members believe and assume, and defines how the firm's business is performed [149]. An organization's culture is considered effective when managers use it to enhance how everyone performs and the standards of the production levels [150]. Due to inadequate theoretical pieces of evidence supporting the assumption of the existence of the manager's knowledge in areas of organizational culture efficacy, a thorough examination is required [151].

3. Methodology

The literature analysis outputs were employed to develop a sustainable model and then presented to a group of energy experts. Iraq's gas power plants were selected as a case study. Due to the old age of Iraqi power stations and the multiple electricity problems, as is the case in most developing countries, we have considered Iraqi power stations an ideal and successful topic for applying the model of this study in order to create a new and sustainable concept for the successful integration.

3.1. Data Collection

Using a structured questionnaire, this quantitative study collected data from power plants, top managers, and engineers.

3.2. Questionnaire

The questionnaires used in the research were adapted from [26,152–157] and the modified questionnaire was given to industrial and academic experts for validation purposes. After obtaining feedback from experts, the questionnaire underwent an improvement process where certain items were revised to remove ambiguity. Based on recommendation from [158], Cronbach's α of more than 0.7 was used to measure the questionnaire's reliability. The data collection was from the gas power plants and was obtained from the owners/managers or personnel's understanding and awareness of energy and quality management. Responses were measured using a five-point Likert scale.

3.3. Sample Size

The quantitative research consists of samples taken from the company responsible power plants in the middle of Iraq. As the survey sample is selected from a specific population, [159,160] recommended the sample must consist of a representative population of sufficiently large samples displaying the population representing the scientist's area of concern. The value sample size shown is 249 personnel from a population of approximately 1100 respondents, according to the following equation developed to compute the sampling size by [161–163].

3.4. Data Analysis

The study used the PLS-SEM to analyze data because PLS-SEM is suitable when predicting correlations between constructs, and SPSS statistical software to analyze critical data, detect outliers missing values and assess normality and to test the hypotheses [164,165]. Based on Anderson and Gerbing's (1988) recommendations, SmartPLS-3 is preferred when evaluating measurements and structural models [166].

4. Results and discussion

4.1. Measurement Model Assessment

The main criteria for evaluating a measurement model are reliability and validity [167]. Loadings and composite reliability assess the measurement model's reliability. The outer loading will be measured while the construct's reliability is assessed using composite reliability to determine whether an item is reliable. According to Ref. [168], items loadings should be 0.60 and above, and [164] suggested that composite reliability should be 0.70 or higher.

Moreover, the measurement model's validity is assessed by convergent and discriminant validity using average variance extracted (AVE); [164] stated the validity is acceptable when it shows a value of 0.5 or greater. The study's latent variables met the desired criteria (see Table 2). The Fornell–Larcker criterion, as ref [169] suggested, was utilized to determine discriminant validity. The validity was determined based on each latent variable's AVE's square root, which should be higher than correlated against the other variables. Results obtained using this approach showed that the AVE square root was more significant than its correlation (see Table 2).

Table 2. Model Measurement.

CSFs	CA	CR	AVE	SQI	EMT	EA	SP	EP	TMS	A	EMIS
SQI	0.800	0.805	0.540	0.840							
EMT	0.782	0.945	0.575	0.423	0.780						
EA	0.989	0.810	0.630	0.586	0.687	0.765					
SP	0.830	0.797	0.685	0.441	0.446	0.610	0.763				
EP	0.815	0.825	0.524	0.383	0.517	0.573	0.416	0.749			
TMS	0.914	0.727	0.620	0.489	0.420	0.610	0.511	0.471	0.757		
A	0.902	0.861	0.684	0.574	0.425	0.617	0.429	0.439	0.492	0.768	
EMIS	0.703	0.903	0.533	0.441	0.406	0.472	0.390	0.306	0.323	0.336	0.780

Notes: CR: Composite Reliability; AVE: Average Variance Extracted; CA: Cronbach's Alpha.

Heterotrait–monotrait ratio (HTMT) was used to evaluate discriminant validity, which has a threshold value of 0.85 [170]. This approach helps estimate whether two latent variables are correlated; any value higher than 0.85 lacks discriminant validity. Figure 2 shows the PLS algorithm's items loadings and path coefficients. Regarding Table 3, the values shown are below the threshold; hence, it can be assumed that the measurement model fulfilled the HTMT criterion.

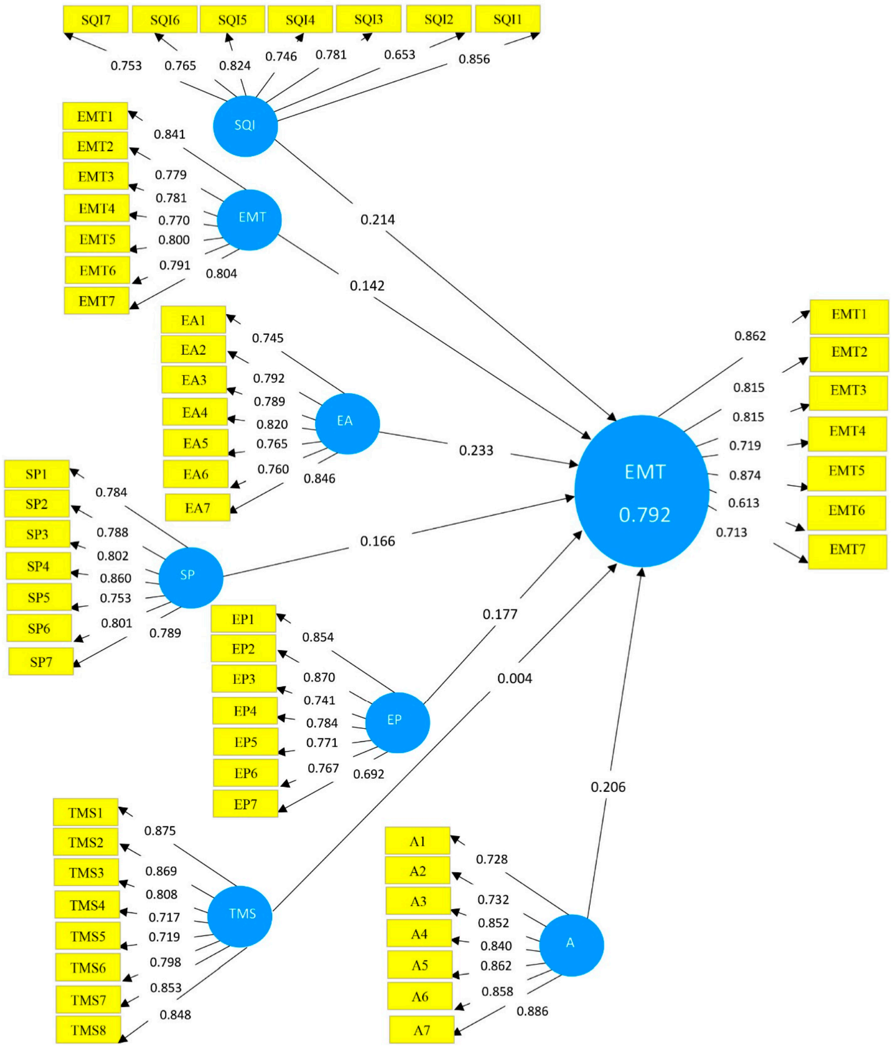

Figure 2. Measurement model through the PLS algorithm.

Table 3. Heterotrait–monotrait ratio (HTMT).

Const	SQI	EMT	EA	SP	EP	TMS	A	EMIS
SQI								
EMT	0.720							
EA	0.830	0.718						
SP	0.741	0.504	0.760					
EP	0.783	0.401	0.745	0.730				
TMS	0.569	0.325	0.752	0.457	0.452			
A	0.677	0.562	0.425	0.543	0.442	0.721		
EMIS	0.644	0.423	0.589	0.596	0.369	0.523	0.688	

4.2. Structural Model Assessment (Inner Model)

The authors of [171] described the structural model as a representation of a hypothetical correlation between the constructs in the inner model. According to [164], the coefficient of determination R^2 has been used when evaluating the model, as R^2 values exemplify the exogenous latent variables impact on the endogenous variables. Furthermore, [164] explained that R^2 basic principles are as follows: (i) weak—0.3 < R2 value < 0.5; (ii) moderate—0.5 < R^2 value < 0.7; and (iii) strong—R^2 > 0.7. The R^2 value in this study is 0.79, showing that the endogenous variables are significantly strong at 79 percent variance. Bootstrapping 5000 replications yielded the path coefficients, t, and *p* values, as [164] suggested. The one tailed test was executed, as [171] recommended, as the present study's hypotheses were positively and directly correlated. The structural model's PLS output is shown in the following Table 4.

Table 4. Structural model summary.

Hypt	Path	Path Coefficient	*t*-Values	*p*-Values	Decision
H1	SQI E → MIS	0.214	3.728	0.000	Support
H2	EMT → EMIS	0.142	2.350	0.019	Support
H3	EA → EMIS	0.233	1.800	0.073	Not Support
H4	SP → EMIS	0.166	3.346	0.010	Support
H5	EP → EMIS	0.177	4.405	0.000	Support
H6	TMS → EMIS	0.004	0.066	0.948	Not Support
H7	A → EMIS	0.206	3.942	0.003	Support

Based on the outcomes of the PLS algorithm, the relationship of SQL and EMIS was significant at (β = 0.214, t = 2.328), and the correlation with EMT and EMIS also showed some significance levels at (β = 0.142, t = 2.350). Although the relationship between SP, EP and A and EMIS were positive at (β = 0.166, t = 3.346), (β = 0.177, t = 4.405), (β = 0.206, t = 3.942), respectively, EA and TMS are not positively correlated with EMIS at (β = 0.233, t = 1.800) and (β = 0.004, t = 0.066). The results supported the following hypotheses, namely, H1, H2, H4, H5, and H7, but rejected H3 and H6. The outcomes also showed that EP, SQL, and A are substantial factors to ensure EMIS's success. At the same time, other CSFs, such as EMT, SP, and EP, are identified as CSFs that could significantly influence Iraq's electricity sectors. The following CSFs' impact on power plants' EMIS was also measured. The outcomes revealed that the CSFs mentioned above, except for EA and TMS, were substantially related to EMIS. The varying outcomes could be attributed to diverse cultures and scenarios (advanced and emerging countries).

Nevertheless, energy goals are achievable when EM is effectively implemented. An organization's EM can be enhanced by educating employees to increase awareness of energy consumption, encouraging them to be involved in deciding to improve the power plant's performance. Keeping the employees actively involved in energy management empowers and makes them feel that their roles are important to attain their goals.

Apart from EM, TMS is equally important, as its roles are crucial when addressing and resolving issues and improving products. TMS is also responsible for ensuring that organizations can attain their objectives, succeed and produce/maintain/improve services' quality. At the time of data collection, the researcher discovered that TMS's roles were not fully implemented, as there was a communication gap between those in the managerial positions and the other staff, particularly in terms of sharing views on the latest resources and inventions. EA is related to inspection surveys, energy flow analyses, and effectively using available resources. As a critical factor, power plants should emphasize quality and EA-related areas, and, by working together with TMS, EA could help these plants improve their performance. TMS's roles should also be clear. These personnel are responsible for ensuring that those in the power plants work together to enhance performance and productivity without compromising implemented EA and other CSFs in their respective organizations. All identified CSFs significantly affect the organization's performance. These factors are crucial to ensure that the power plants, particularly those in developing countries such as Iraq, can survive in a competitive environment.

5. Conclusions

Integrating management systems, especially between similar structures, allows saving time, reducing costs, improving the organization's reputation, and achieving continuous improvement goals. This study investigated the integration of energy and quality management systems. On the other hand, the ISO 50001 energy management system is used along with other management standards, such as the ISO of quality management systems (ISO 9001), environmental management systems (ISO 14001), occupational health and safety management systems (ISO 45001 based on OHSAS 18001), and ISO 29001: 2020 Petroleum, petrochemical, and natural gas industries, to contribute to energy savings, improving energy performance and reducing costs [43]. The study succeeded in modeling a sustainable integration between critical success factors for energy management and critical success factors for quality management. The methodology of this research was based on two approaches. The first is to systematically study and analyze the previous literature carefully and systematically to determine the critical success factors for integration and identify the research gap. While the second approach was based on the judgment of energy experts, a sustainable model via a case study in power plants was then developed.

The measurement model's validity was assessed by convergent and discriminant validity using average variance extracted (AVE), achieving excellent values higher than 0.5, as recommended by previous studies. The validity was determined based on each latent variable's AVE's square root. This approach showed that the AVE square root was more significant than its correlation, as shown in Table 2. The Fornell–Larcker criterion has been used to determine discriminant validity. The heterotrait–monotrait ratio (HTMT) has been used to evaluate discriminant validity, with a threshold value of 0.85. The result for HTMT shown is below the threshold; hence, it can be assumed that the measurement model fulfilled the HTMT criterion as shown in Table 3.

Although the literature corroborated quality management's role in enhancing power plants' efficacy, it is insufficient, as consumers demand energy to manage power related crises effectively. To determine other aspects that could assist these plants in addressing energy issues, the study's results showed that the identified IQEM's CSFs, such as EP with *p*-values (0.000), SQI (0.000), EMT (0.019), A (0.003), SP (0.010), are significantly associated with EMIS and can improve quality and energy management. The results of the PLS algorithm proved that the relationship between SQL and EMIS was significant at (β = 0.214, t = 2.328), and the correlation with EMT and EMIS also showed significant levels at (β = 0.142, t = 2.350). Although the relationships between SP, EP and A and EMIS were positive at (β = 0.166, t = 3.346), (β = 0.177, t = 4.405), (β = 0.206, t = 3.942), respectively, EA and TMS are not positively correlated with EMIS at (β = 0.233, t = 1.800) and (β = 0.004, t = 0.066). The results supported the following hypotheses, namely, H1, H2, H4, H5, and H7 but rejected H3 and H6. The outcomes revealed that the CSFs mentioned above, except for EA and TMS, were substantially related to EMIS. The outcomes also showed that EP, SQL, and A are substantial factors to ensure EMIS's success and ensure the sustainable integration of quality and energy management in power plants. The varying outcomes could be attributed to diverse cultures and scenarios in advanced and emerging countries.

The research recommended expanding the research sample and respondents within the gas and thermal power; plants to obtain more accurate results using the same methodology: PLS-SMART. According to the results, the Iraqi power plants suffer from the neglect of energy management programs and integration with other systems such as quality management, especially service quality improvement, and personnel performance factors such as performance shaping factors, human factor, and neglecting to improve personnel performance, leading to poor energy management performance. Therefore, further research is required to integrate the CSFs of performance shaping factors, including human factors and personnel performance, with CSFs for energy management performance. This paper recommends more investigation on the role of organizational culture and leadership style as a mediator to successful adoption and improves energy management.

Research Implications

The study's findings provide valuable insights for power plants by practicing identified integrated quality and energy management (IQEM) critical success factors (CSFs), such as energy policy, service quality improvement, top management support, awareness, strategic planning, and simultaneously focusing on the energy management team and energy audit. Integrating these CSFs would help power plants improve their energy management. However, the practices will also help upgrade their organizational image, improve, and give them the competitive edge needed to produce quality energy, improving their financial performance.

Implementing and practicing IQEM in power plants providing energy to countries facing energy crises is part of energy management ISO50001, which enhances electricity production's stability and pushes the plants to provide consumers with quality energy. By practicing IQEM in the local power plants, it is possible to produce high quality electricity with maximum benefits.

Furthermore, the study helps to provide the foundation and a platform for future researchers to continue similar studies and reduce the difficulty of implementing ISO 50001 in power plants. This study also hopes that the findings will help reduce electricity losses in Iraqi power plants and enhance their stability. Therefore, the Ministry of Electricity needs to focus more on energy and quality issues.

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