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ARTICLES (PEER REVIEWED)

Integrating Knowledge Management with Total Quality Management to Enhance Construction Project Delivery in Ghana

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Abstract

The integration of knowledge management (KM) with total quality management (TQM) has a significant impact on project and organization performance. While previous literature has linked KM with TQM within the broader concept of organizational development and project performance, there was a notable gap concerning their application to construction projects in developing countries like Ghana. Thus, there is little information on the variables that contribute to their relationship. This study aimed to fill these gaps

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by investigating the integration of KM practices with TQM principles specifically in the Ghanaian construction industry, and identifying essential factors for this integration. A cross-sectional survey design was used and the population considered in this study consisted of architects, quantity surveyors, and civil engineers in the Ghanaian construction industry. The study adopted a purposive sampling technique. Quantitative data were collected from 256 professionals. Descriptive statistical techniques and the partial least squares structural equation modeling techniques were used to analyze the data. The findings revealed that a one-unit rise in knowledge management processes (KMPs) corresponds to a roughly 0.839-standard deviation increase in TQM, suggesting that implementing KM will potentially improve the implementation of TQM principles during the delivery of construction projects. Conversely, a decrease in KMP is associated with a decrease in TQM. This can be implemented practically when there is leadership competence and commitment to ensure a culture of KM processes and TQM practices for the project to perform effectively. Theoretically, the study contributes to current discourse on KM and TQM from a fresh perspective.

Keywords

Construction Project Delivery; Integration; Knowledge Management; Total Quality Management

Introduction

Globally, there is an increase in demand for construction projects, fostering the construction industry to keep up with these demands (Yu and Yang, 2018). The infrastructure services have helped to increase gross domestic product (GDP) and also promote the expansion of other businesses in most countries (Irani, Beskese, and Love, 2004; Unegbu, Yawas and Dan-asabe, 2021). In Ghana, the construction industry contributes GHS3558.70 million and approximately 15% of GDP to the Ghanaian economy (Ghana Statistical Service, 2021). It has been identified as a significant contributor to the country's GDP growth as it is the third largest in the economy (Arthur-Aidoo, Ansary, and Aigbavboa, 2016).

Conversely, Ghana's construction industry faces several issues related to project management, cost, quality, and productivity (Ofori, 2012). Other issues include failure to complete projects within set timelines, which often leads to an increase in the cost of production. Most construction projects in Ghana exceed their initial budgets, suggesting inadequate financial planning and forecasting within the industry, resulting in cost overruns (Hammond, 2018). This contributes to a negative cycle of financial inefficiency. Poor project management practices affect the quality of the project outcome, which could affect the achievement of project objectives and, by extension, its contribution to GDP growth (Boateng, Ameyaw and Mensah, 2020).

Damoah and Akwei (2017) emphasized the failures in project management, particularly in meeting deadlines, managing costs, and satisfying stakeholders. The study further highlighted that risk management practices in the construction industry are ad hoc and not well structured. This could increase delays and compromise project quality. Therefore, establishing standardized and rigorous project management practices is essential to ensure that projects stay on track regarding cost, time, and deliverables.

According to the *Project Management Body of Knowledge*, knowledge management (KM) is about making sure the skills, experience, and expertise of the project team are used before, during, and after the project (PMBOK, 2017). The International Organization for Standardization (ISO) acknowledged the value of KM policy in enterprises and incorporated it into ISO 9001:2015, which requires businesses to view KM as a crucial resource (Gawlak, 2015; Wilson and Campbell, 2016). Incorporating KM within the ISO 9001:2015 standards can serve as a pivotal organizational asset, potentially driving significant organizational transformations and enhancing project performance. This consideration addresses the needs

and expectations of interested parties involved in the supply chain in construction project delivery (Wilson and Campbell, 2016; Jewell and Flanagan, 2019).

In the construction industry, the basic means of conveying information during the lifecycle of a project is the construction documents (Shreekanth, 2014). The literature indicates that construction is an information- and knowledge-driven industry (Anumba, Charles, and Carrillo, 2005; Abdul, 2013). In addition, it is one of the high-risk industries operating in an information-rich environment, which strongly relies on knowledge as a strategic resource to ensure that project team members carry out their duties successfully and efficiently (Renukappa, Suresh, and Alosaimi, 2019).

The literature has discovered the successful implementation of KM and its impact as a change agent that could facilitate the success and expansion of quality practice (Ribiere and Khorramshahgol, 2004; Ribeiro, 2009; Raja Rajeshwaran and Aktharsha, 2017; Barua, 2021). Although KM and total quality management (TQM) have been linked to project performance in the literature, it appears that there is a gap in the body of knowledge regarding their application to construction projects especially in the Ghanaian context (Bukari, *et al.*, 2023).

A study by Honarpour and Jusoh (2017) revealed the reciprocal causation between TQM and KM as synergetic effects. However, the study did not examine the possible variables that contribute to this relationship. It also did not consider the impact the relationship of KM and TQM has on practices and the processes in project performance. Moreover, the study was conducted in Malaysia, and the authors recommended further studies to examine the interaction between TQM and KM and the possible variables that contribute to this relationship.

Barua (2021) emphasized further in his study that leadership, employee empowerment, customer focus, benchmarking, and information technology were all positively and significantly correlated with the four knowledge conversion types and the knowledge-creation process: socialization, externalization, combination and internalization, which is one aspect of the KM processes. Meanwhile, the data were collected from departments for marketing, sales, finance, human resources, and information technology firms in Bangladesh limiting the generalization. The author suggested looking into how TQM affects other KM processes, including knowledge acquisition, storage, sharing and application.

The purpose of this study was to investigate the mindset of construction professionals in terms of the possible integration of KM practices and TQM principles to align with best practice in construction project delivery in the Ghanaian construction industry to address the areas regarding the relationship between KM and TQM and their impact on project performance in Ghana and the essential factors necessary for the integration of KM and TQM and to develop a model by integrating knowledge management practices and total quality management processes.

Based on this discourse, the following hypotheses were developed to respond to the research objective:

H^1: There is a positive relationship between the KM, TQM, and project performance.
H^2: There is a positive relationship between essential factors for the integration of KM and TQM and project performance.

The following is the structure of the paper: the first section reviews the literature on integrating knowledge management practices and total quality management principles, and the relationship between KM and TQM on project performance. The next sections discuss the methodology and data collection, data analysis, discussion and findings, limitations for further studies, implications for practice and conclusion.

Related literature

INTEGRATING KNOWLEDGE MANAGEMENT PRACTICES WITH TOTAL QUALITY MANAGEMENT PRINCIPLES

The accumulation of knowledge across every phase of a project lifecycle, spanning from inception through supply chain, plays a crucial role in enhancing operational efficiency and realizing the objectives of consistent quality and cost competitiveness (Calnan, *et al.*, 2021). Raudeliūnienė et al. (2018) suggested that KM cycle, encompassing knowledge acquisition, sharing, development, preservation, and application, plays a pivotal role in facilitating effective project execution while TQM principles emphasize the importance of innovation in quality improvement efforts, encouraging organizations to adopt new technologies, processes, and methodologies to stay ahead of the competition (Owino and Makokha, 2021).

Other studies on the integration of KM practices with TQM principles have represented a symbiotic relationship aimed at enhancing organizational effectiveness, innovation, and competitiveness but did not identify the key variables in the relationship (Ribiere and Khorramshahgol, 2004; Hung, Lien and Fang, 2010; Honarpour, Jusoh, and Nor, 2012; Honarpour and Jusoh, 2017). Even though the relationship demonstrates that KM practices with TQM principles offer organizations a comprehensive approach to quality management, fostering a culture of continuous improvement, innovation, and client focus, this study focused on the employees in the IT firms in India (Raja Rajeshwaran and Aktharsha, 2017). This suggests that organizations can achieve sustained success in today's competitive business environment by leveraging knowledge assets, empowering employees, and prioritizing client satisfaction (Nonaka, 2008; Loke, *et al.*, 2012; Yousaf and Bris, 2020). Therefore, the integration process can ultimately lead to the development of a constantly evolving repository of optimal practices, which can then be applied in forthcoming projects.

Adem and Virdi (2020) highlighted that how to effectively capture, maintain, store, share, and utilize this knowledge within a network is indispensable for driving continuous improvement in operational performance. This study was limited to the ISO-registered manufacturing firms in Ethiopia.

Since both TQM and KM are geared toward enhancing organizational performance, it is necessary to foster the creation and utilization of knowledge because knowledge transfer has a positive influence on TQM (Honarpour and Jusoh, 2017). Other empirical studies have established how KM and TQM concepts have played important roles in the contemporary project management progress. Some of these studies have explored the relationship between KM and TQM and innovation (Hung, Lien, and Fang, 2010; Yusr, *et al.*, 2017). Other findings showed that all four KM processes (knowledge creation, capture and storage, sharing, and application) had a positive and significant impact on operational, quality, and innovation (Ribiere and Khorramshahgol, 2004; Honarpour, Jusoh and Nor, 2012; Grover and Froese, 2016). The results of a study by Yusr, *et al.* (2017) support a positive and significant impact of TQM practices on KM processes. Moreover, the literature has revealed that KM has a synergistic role in knowledge creation through documents and manuals that specify the principles and action plans of TQM.

By delving into the literature, it was revealed that both KM and TQM rely on the capacity and feedback mechanisms to track performance, identify deviations from standards, and drive improvement (Zetie, 2002; Colurcio, 2009), suggesting that KM efforts often prioritize understanding customer needs, preferences, and feedback to drive product, service, and project innovation while TQM principles also prioritize customer satisfaction and strive to meet or exceed client expectations through the delivery of high-quality products and project outcome. This suggests that TQM principles are much more effective at creating knowledge and realizing higher levels of improved performance because multiple quality management practices capture the complexities of knowledge creation, thereby supporting the knowledge creation process (Barua, Zaman, and Urme, 2018). Although the literature indicates a relationship between KM and TQM on project

performance, literature on the impact on construction project performance from developing countries is limited(Bukari *et al.*, 2023).

THE RELATIONSHIP BETWEEN KNOWLEDGE MANAGEMENT AND TOTAL QUALITY MANAGEMENT ON PROJECT PERFORMANCE

Several studies (Duran, Çetindere and Özcan, 2014; Honarpour and Jusoh, 2017; Yusr, *et al.*, 2017; Barua, Zaman, and Urme, 2018; Barua, 2021) have examined the relationship between KM and TQM and linked it to project performance. According to Rhem (2017), the quality of a project is related to how a project organization makes use of knowledge. The PMBOK (2017) guide further emphasized that KM serves as a facilitator for establishing a robust quality system throughout the whole project lifecycle. However, conventional quality management systems often lack robust options for KM and knowledge development (Garstenauer, Blackburn, and Olson, 2015). Hence, there is a notable gap in the existing body of knowledge regarding a quality management strategy that effectively integrates KM with TQM (Garstenauer, Blackburn and Olson, 2015). Jutidharabongse, et al. (2020) indicated that cultivating essential skills, rooted in existing human information and experience, begins with aligning strategic intuition with KM practices.

Most of the previous studies on the areas of TQM practices and operational performance have specifically indicated that TQM enables companies to achieve better operational performance measured in terms of quality, cost, productivity, flexibility and delivery time. TQM is identified as a driver for building relationships and enhancing knowledge transfers from these sources and this is significantly related to a firm's performance (Fotopoulos and Psomas, 2010; Grover and Froese, 2016; Panuwatwanich and Tung, 2017; Keenan and Rostami, 2019). Other literature has further emphasized the significance of KM in fostering a quality–centric culture within an organization (Garstenauer, Blackburn and Olson, 2015; Bukari *et al.*, 2023). For many companies, integrating TQM and KM emerges as a strategic management approach to ensure the effective application of both disciplines, thereby ensuring sustained competitiveness. The key principles of TQM can provide actionable guidelines for the implementation of KM practices (Rajeshwaran and Aktharsha, 2017; Barua, Zaman and Urme, 2018; Barua, 2021).

Although these studies have delved into the relationship between KM and TQM, there is little information on possible variables that contribute to their relationship (Ribiere and Khorramshahgol, 2004; Soltanpanah and Vaisi, 2014; Honarpour and Jusoh, 2017). How KM and TQM could be integrated and practically implemented to ensure the impact on construction project performance was also not indicated. Again, other studies have not indicated where their relationship was implemented (Honarpour, Jusoh, and Nor, 2012). Although the studies suggested a connection between TQM and KM, they provided little information on how it may be put into practice. Others were limited to software and IT firms (Asrar-ul-haq, 2017; Rajeshwaran and Aktharsha, 2017). Notably, the majority of research related to the connection between TQM and KM was conducted in the manufacturing and service sectors and from developed countries (Hsu and Shen, 2005; Duran, Çetindere, and Özcan, 2014; Raja Rajeshwaran and Aktharsha, 2017; Barua, Zaman and Urme, 2018; Barua, 2021). Therefore, research on KM processes and TQM principles in the delivery of construction projects, particularly from developing countries like Ghana, must be conducted to ascertain the impact on the construction project delivery.

Research methodology

The study adopted a cross-sectional survey design. The population considered in this study is construction professionals in the Ghanaian construction industry. The target population of the study comprises built environment professionals registered with their respective professional institutions. The built environment professionals included in the study are architects, quantity surveyors, and civil engineers. As of 2023, there were 3,221 built environment professionals in good standing. The sample size was determined using Krejcie

and Morgan's (1970) table of specifications, which provides the minimum sample size required for different population sizes. The expectation was to obtain different views from a larger number of professionals to contribute to knowledge. Therefore the target sample size obtained from the population of 3,221 was 346. Out of 346 questionnaires distributed, 256 were returned, indicating a response rate of 74%. Finchman (2008) suggested that a 60% response rate should serve as a general benchmark for most research studies. However, when using surveys with the aim of generalizing findings to the entire population, researchers should aim for a response rate of 80%. The responses from the construction team were 101, and those of the design team were 155. The professionals selected were those who had attained a minimum of 2 years of work experience as qualified professionals. A person seeking to become a professional is required to be employed in an organization with two or more employees who are already members of the professional institution of interest. Additionally, the entrant must complete the necessary membership form, endorsed by a fellow of the institution, and upon being accepted must serve as a probationer or a trainee engineer for a minimum of 2 years before writing the requisite professional examinations. Membership is contingent on the probationer or trainee engineer passing the professional examination and a selection interview. Having passed their probation or trainee tests, the probationers were considered qualified with the requisite knowledge and skills. Arguably, the experience that probationers and trainees who have had an additional 2 years post-qualification experience was deemed appropriate for the conduct of the survey, given the knowledge and experience required to respond to the survey questionnaire items.

A closed-ended questionnaire was developed to facilitate the data collection in this study. The questionnaire was used as a tool to collect data from the professionals within the construction team and the design teams from the various institutions in the Ghanaian construction industry to understand the similarities and differences between their approaches and views on KM and TQM during the project delivery. The responses to the various questions in the questionnaires were evaluated using a seven-point Likert scale of 1 to 7, because a seven-point scale reveals more information about the motif and, consequently, practically appeals to the participants' faculty of reason (Cox, 1980; Joshi, *et al.*, 2015). The variables found in the literature were used to create the questionnaire's content based on the aims of the study (Tarí, Molina, and Castejón, 2007; Mantas, 2015; Barua, 2021).

The questionnaire's design allowed respondents to rank multiple choices and select from a list of options. Content validity was checked with an expert panel consisting of two experts in project management and one professor of research to evaluate the items to see how exhaustive they are of the aspects of the topic under study and to identify problems with wording, content, and question ambiguity. The reliability of the questionnaire was tested using Cronbach coefficient alpha, which measures the internal consistency of the items on the questionnaire (Ebel and Frisbie, 1991).

There was a direct visit to various institutional offices and construction sites to administer the questionnaire. Professionals were briefed on what the study was about and its significance in the delivery of construction projects. They were assured that the information acquired will be kept under strict confidentiality–respecting the privacy and identity of respondents and will be used solely for academic purposes. Data were collected from March 2023 to July 2023. The responses were checked and edited for consistency and accuracy, making necessary corrections and coding, and then the variables were entered into SPSS. The study employed both descriptive and inferential analytical approaches to address the objectives of the study. The partial least squares structural equation modeling (PLS-SEM) technique was chosen for this purpose because PLS-SEM is recognized as a "causal–predictive" approach to SEM (Sarstedt *et al.*, 2016), which emphasizes explaining the variance in the model's dependent variables (Chin, et al., 2020). The data were first coded and set up in SPSS software. Descriptive statistics, independent t-test, exploratory factor analysis and Cronbach's alpha were estimated with the aid of SPSS, and structural equation modeling was estimated with the aid of EQS version 6.2 software.

Results

A structural model was used, based on the variables of the KM processes and TQM principles in the questionnaire and the literature review, to examine the relationships among these factors using structural equation modeling with the AMOS statistical package. It comprises six constructs for knowledge management (knowledge diagnosing, knowledge acquisition, knowledge generation, knowledge sharing, knowledge storing, and knowledge application) and five constructs for total quality management (quality plan, leadership and commitment, continuous improvement, benchmarking, and client focus).

The variables of the relationship between KM and TQM the mean, standard deviation, and t-values are presented in Table 1. The t-value measures the size of the difference relative to the variation in the sample data, while the p-value determines the statistical significance of this difference. A high absolute t-value corresponds to a small p-value (> 0.05), suggesting that the observed difference is statistically significant.

Table 1. Knowledge management and TQM and their impact on project performance.

Variables	Design team		Construction team		Overall		t-Value	p-Value
	Mean (SD)	Rank	Mean (SD)	Rank	Mean (SD)	Rank		
Knowledge management and quality standards and practices	-							
KMQSP1	5.33 (1.571)	1	5.12 (1.739)	4	5.25 (1.64)	3	1.003	0.317
KMQSP2	5.23 (1.328)	2	4.9 (1.889)	6	5.1 (1.578)	5	1.647	0.101
KMQSP3	4.98 (1.527)	6	5.44 (1.41)	3	5.16 (1.496)	4	−2.401	0.017
KMQSP4	5.15 (1.399)	3	5.47 (1.39)	2	5.27 (1.401)	1	−1.776	0.077
KMQSP5	5.12 (1.329)	4	5.01 (1.797)	5	5.07 (1.528)	6	0.543	0.588
KMQSP6	5.1 (1.413)	5	5.49 (1.635)	1	5.25 (1.513)	2	−2.019	0.045
Overall score	**5.15 (1.117)**		**5.24 (1.294)**		**5.18 (1.188)**		**−0.561**	**0.575**
KM with TQM and the organization for project performance	-							
KMTQMOPP1	5.08 (1.292)	5	5.06 (1.509)	5	5.07 (1.379)	5	0.102	0.919
KMTQMOPP2	5.27 (1.345)	3	5.22 (1.671)	3	5.25 (1.479)	3	0.280	0.779
KMTQMOPP3	5.39 (1.364)	2	5.07 (1.478)	4	5.26 (1.416)	2	1.774	0.077
KMTQMOPP4	5.54 (1.207)	1	5.3 (1.507)	1	5.45 (1.336)	1	1.436	0.152
KMTQMOPP5	5.21 (1.332)	4	5.23 (1.63)	2	5.21 (1.454)	4	−0.114	0.909
Overall score	**5.3 (1.107)**		**5.17 (1.372)**		**5.25 (1.217)**		**0.764**	**0.446**

Table 1. continued

Variables	Design team		Construction team		Overall		t-Value	p-Value
	Mean (SD)	Rank	Mean (SD)	Rank	Mean (SD)	Rank		
Generation and utilization of KM practices and TQM principles for project performance	-							
GKMPTQMP1	5.25 (1.307)	1	5.39 (1.816)	2	5.3 (1.527)	1	−0.688	0.492
GKMPTQMP2	5.05 (1.586)	9	5.27 (1.838)	6	5.14 (1.69)	7	−0.998	0.319
GKMPTQMP6	5.2 (1.23)	3	5.4 (1.738)	1	5.28 (1.452)	2	−1.056	0.292
GKMPTQMP3	5.12 (1.393)	7	5.38 (1.832)	3	5.22 (1.582)	5	−1.255	0.211
GKMPTQMP4	5.17 (1.395)	6	5.32 (1.606)	4	5.23 (1.48)	4	−0.787	0.432
GKMPTQMP5	5.23 (1.356)	2	5.11 (1.649)	7	5.18 (1.476)	6	0.618	0.537
GKMPTQMP7	5.08 (1.472)	8	5.03 (1.584)	8	5.06 (1.515)	8	0.279	0.780
GKMPTQMP8	5.18 (1.256)	5	4.88 (1.657)	9	5.06 (1.432)	9	1.641	0.102
GKMPTQMP9	5.2 (1.181)	4	5.31 (1.586)	5	5.24 (1.353)	3	−0.617	0.538
Overall score	**5.16 (1.075)**		**5.23 (1.369)**		**5.19 (1.197)**		**−0.403**	**0.687**

Note: Coding was performed using the items under the three sub-constructs in the table, which can be found in Appendix 1. Source: Author's field survey data (2023).
KM, knowledge management; TQM, total quality management.

According to Table 1, the item with the highest rating under the KM and quality standard and practices was KMQSP 1 for the design team, with a mean value of 5.33, and KMQSP 6 for the construction team, with a mean value of 5.49, demonstrating "somewhat agree". The value with the lowest mean score for the design team was KMQSP2 with a mean value of 4.9, and the lowest mean score for the construction team was KMQSP2 with a mean value of 4.98, both of which indicate "somewhat agree". The p-values for the item show that there was no significant difference between the opinions of the two teams. The sum of all of their means, which ranged from 5.07 and 5.27, shows "somewhat agree". However, with items KMQSP3 and KMQSP6, the differences were found to be statistically significant. This implies that the design and construction teams held significantly different views concerning the institution of incentive structures and the impact of training on employee experience.

The top–rated component of KM with TQM in the organization for project performance was KMTQMOPP4 with a mean value of 5.54, and the construction team with a mean value of 5.3; the mean of their combined scores was 5.45, demonstrating "agree". KMTQMOPP1 was the item that received the lowest ratings from both teams, and the sum of their means was 5.08, 5.06, and 5.07, representing somewhat agreement. According to the p-values, which ranged from 0.153 to 0.919, there was no significant difference between the opinions of the two teams.

Under generation and utilization of KM practices and TQM principles for project performance (GKMPTQMP), the highest -rated item was GKMPTQMP1 with a mean value of 5.25 for the design

team and GKMPTQMP3 with a mean value of 5.28 for the construction team; the least-rated item for the design team was GKMPTQMP2 with a mean value of 5.05, and for the construction team, it was GKMPTQMP8 with a mean value of 4.88. All these mean values represent "somewhat agree". The p–value of the items indicates that there was no significant difference in the views of both teams. Table 2 shows the reliability of the items between KM and TQM.

Table 2. Reliability of the indicators of relationship between KM and TQM.

Items	Corrected correlation	Item-total Cronbach's alpha	Cronbach's alpha	N of items
KMQSP1	0.633	0.959	0.959	20
KMQSP2	0.675	0.958		
KMQSP3	0.643	0.958		
KMQSP4	0.723	0.957		
KMQSP5	0.726	0.957		
KMQSP6	0.658	0.958		
KMTQMOPP1	0.734	0.957		
KMTQMOPP2	0.799	0.956		
KMTQMOPP3	0.726	0.957		
KMTQMOPP4	0.793	0.957		
KMTQMOPP5	0.749	0.957		
GKMPTQMP1	0.753	0.957		
GKMPTQMP2	0.800	0.956		
GKMPTQMP6	0.805	0.956		
GKMPTQMP3	0.737	0.957		
GKMPTQMP4	0.698	0.958		
GKMPTQMP5	0.737	0.957		
GKMPTQMP7	0.710	0.957		
GKMPTQMP8	0.656	0.958		
GKMPTQMP9	0.684	0.958		

Source: Author's field survey data (2023).
KM, knowledge management; TQM, total quality management.

The reliability of the indicators between KM and TQM is indicated in Table 2. The Cronbach's alpha was 0.959 indicating excellent internal consistency. According to George and Mallery (2003), Cronbach's alpha value above 0.90 indicates excellent internal consistency, above 0.80 is good, above 0.70 is acceptable, above 0.60 is questionable, above 0.50 is poor, and below 0.50 is unacceptable. Therefore the measurement variables met the criteria for the level of excellence.

In Table 3, the path indicates the relationship being examined between the latent variable TQM and the various observed variables, including QP1, QP2, LCOM1, CI1, and CLFO1. The unstandardized estimate represents the estimated regression coefficient for the relationship between TQM and the respective observed variable. It shows the change in the dependent variables associated with a one-unit change in TQM. The standardized estimate value of 0.713 represents the strength and direction of the relationship in terms of standard deviations. It is valuable for comparing the relative importance of different paths in the model. The Z-value and p-value are associated with the statistical significance of the path coefficient. In the table, all the p-values were close to 0 ($p < 0.001$), indicating a strong statistical significance. An R-square value of 0.507 indicates the proportion of variance in the dependent variable explained by the independent variable(s). Cronbach's alpha which measures the internal consistency reliability for the scales was 0.961. The reliability coefficient (Rho) of 0.963 also measures the reliability. The paths with p-values less than a significance level (< 0.05) are considered statistically significant. The results indicate significant positive relationships between TQM and the other variables in the model. These relationships are statistically significant ($p < 0.001$) and suggest that changes in TQM are associated with changes in the other observed variables such as QP1, QP2, LCOM1, CI1, and CLFO1, with the strength of the relationships quantified by the standardized estimates.

Table 3. Loadings, Z-scores, and reliability of knowledge management and total quality management.

Path direction			Unstandardized estimate	Standardized estimate	Z-value	R-square	p-Value	Cronbach's alpha	Reliability coefficient Rho
TQM	→	QP8	1.000	0.713	**Fixed**	0.507	**Fixed**	0.961	0.963
TQM	→	QP7	0.897	0.597	9.360	0.355	0.000		
TQM	→	QP6	0.897	0.625	9.793	0.388	0.000		
TQM	→	QP5	0.977	0.693	10.876	0.479	0.000		
TQM	→	QP4	1.067	0.758	11.901	0.572	0.000		
TQM	→	QP3	1.092	0.753	11.824	0.565	0.000		
TQM	→	QP2	0.861	0.623	9.758	0.411	0.000		
TQM	→	QP1	0.852	0.614	9.621	0.380	0.000		
TQM	→	LCOM1	1.010	0.742	11.647	0.549	0.000		
TQM	→	LCOM2	1.057	0.767	12.041	0.587	0.000		
TQM	→	LCOM3	1.067	0.730	11.459	0.531	0.000		
TQM	→	LCOM4	0.962	0.664	10.416	0.440	0.000		
TQM	→	LCOM5	1.010	0.679	10.647	0.461	0.000		
TQM	→	LCOM6	1.004	0.694	10.894	0.483	0.000		
TQM	→	LCOM7	0.753	0.566	8.869	0.321	0.000		
TQM	→	CI1	0.896	0.671	10.522	0.449	0.000		
TQM	→	CI2	0.728	0.594	9.300	0.350	0.000		
TQM	→	CI3	0.724	0.635	9.948	0.400	0.000		

Table 3. continued

Path direction			Unstandardized estimate	Standardized estimate	Z-value	R-square	p-Value	Cronbach's alpha	Reliability coefficient Rho
TQM	→	CI4	0.733	0.608	9.531	0.368	0.000		
TQM	→	CLF1	0.871	0.629	9.853	0.392	0.000		
TQM	→	CLF2	0.880	0.665	10.422	0.439	0.000		
TQM	→	CLF3	0.804	0.625	9.789	0.387	0.000		
TQM	→	CLF4	1.058	0.729	11.452	0.530	0.000		
KMP	→	KAP6	1.000	0.727	**Fixed**	0.546	**Fixed**		
KMP	→	KAP5	0.827	0.602	9.355	0.377	0.000		
KMP	→	KAP4	1.015	0.755	11.817	0.570	0.000		
KMP	→	KAP3	0.908	0.668	10.413	0.444	0.000		
KMP	→	KAP2	1.046	0.754	11.795	0.568	0.000		
KMP	→	KAP1	0.922	0.687	10.713	0.469	0.000		
KMP	→	KST2	0.900	0.681	10.619	0.462	0.000		
KMP	→	KST1	0.841	0.600	9.321	0.358	0.000		
KMP	→	KSH7	0.978	0.701	10.948	0.492	0.000		
KMP	→	KSH3	0.785	0.630	9.802	0.397	0.000		
KMP	→	KSH1	0.744	0.610	9.477	0.370	0.000		

Source: Authors' research.

TQM, total quality management; KMP, knowledge management process.

MODEL FOR THE RELATIONSHIP BETWEEN KNOWLEDGE MANAGEMENT AND TOTAL QUALITY MANAGEMENT

The relationship between knowledge management processes (KMPs): KSH 1, KSH 3, KSH 7 KST 1, KST 2, and KAP 1–6 in Figure 1 shows how KM, a latent construct, is measured using various observed indicators related to knowledge sharing, knowledge application and knowledge storage, and TQM sub-constructs, all observed variables (QP1 to CLF04). Each path in the diagram has a factor loading that indicates the strength and direction of the relationship. The diagram demonstrates how TQM, a latent construct, is measured through various observed indicators related to the quality plan, leadership commitment, continuous improvement, and client focus. The standardized coefficient was 0.839, suggesting that this path is statistically significant. This demonstrates that KM practices have a strong and positively significant effect on TQM, and that if there is an increase in KM usage, it will positively influence the implementation of TQM.

Table 4 indicates the relationship between various constructs related to KM (KD: knowledge diagnosing, CLF: KG; knowledge generation, (KSH: knowledge sharing; KST: knowledge storage; KAP: knowledge application) and TQM (CLF: client focus; LCOM: leadership commitment; QP: quality plan; CI: continuous improvement).

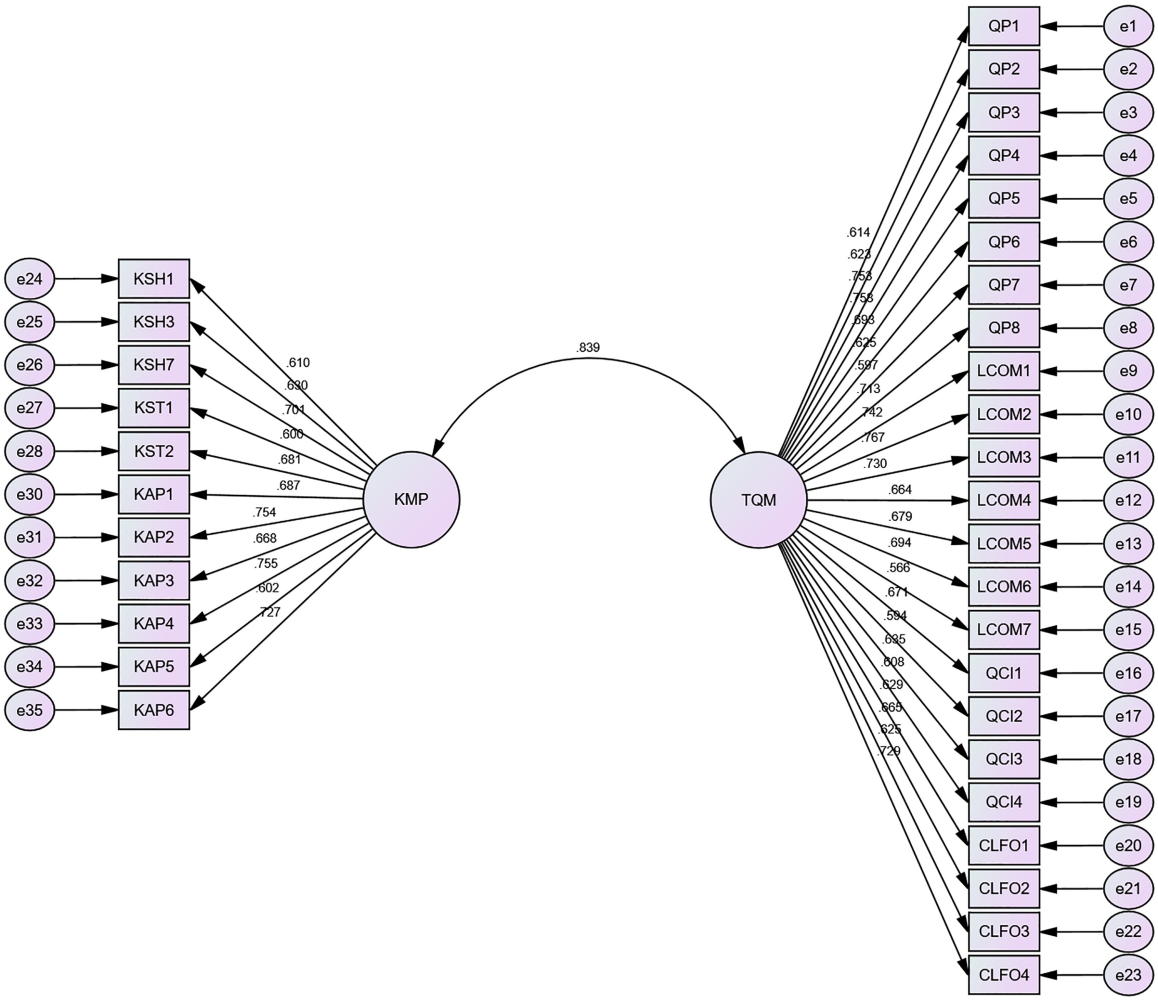

Figure 1. Relationship between knowledge management and total quality management.
Source: authors

Table 4 further details the connections between KM and TQM as well as the connections between the KMP and TQM sub-constructs: 1.112 was the unstandardized coefficient and 0.839 was the standardized coefficient. The standardized coefficient (Std. Coeff.) of 0.839 indicates that KMP and TQM are strongly positively correlated. To be more precise, a one-unit rise in KMP corresponds to a roughly 0.839 standard deviation increase in TQM. The statistical significance of this link is indicated by the p-value of 0.000.

RELATIONSHIPS BETWEEN THE SUB-CONSTRUCTS OF KNOWLEDGE MANAGEMENT PROCESSES AND TOTAL QUALITY MANAGEMENT

The table also shows the connections between the KMPs KD, KG, KSH, KST, and KAP sub-constructs and TQM. The table's rows correspond to various KMP sub-constructs and how they relate to TQM. The unstandardized coefficients show how strong the links are. The standardized coefficients (Std. Coeff.) give information in standard deviation units regarding the strength and direction of the correlations. The precision of the estimates was measured using the standard errors (SEs). The statistical significance of the correlations was evaluated using the Z-statistics and p-values.

The standardized coefficients compare the relative strength of these relationships in standard deviation units. The p-values indicate that these relationships are statistically significant ($p < 0.05$). The findings

Table 4. Relationship between KM and TQM and among the sub-constructs of KMP and TQM.

Relationship			Unstd. coeff.	Std. coeff.	SE	Z-statistics	p-Value
KD	↔	QP	−0.435	−0.207	0.097	−4.482	0.000
KD	↔	LCOM	0.838	0.353	0.152	5.503	0.000
KD	↔	CI	−0.266	−0.109	0.111	−2.392	0.017
CLF	↔	KD	0.224	0.098	0.118	1.906	0.057
KG	↔	QP	0.299	0.314	0.054	5.542	0.000
KG	↔	LCOM	−0.350	−0.326	0.066	−5.305	0.000
KG	↔	CI	0.080	0.072	0.049	1.645	0.100
CLF	↔	KG	0.635	0.615	0.095	6.662	0.000
KSH	↔	QP	−0.259	−0.326	0.048	−5.453	0.000
KSH	↔	LCOM	0.213	0.238	0.048	4.453	0.000
KSH	↔	CI	0.633	0.688	0.093	6.798	0.000
CLF	↔	KSH	0.082	0.096	0.040	2.078	0.038
KST	↔	QP	0.179	0.174	0.046	3.914	0.000
KST	↔	LCOM	0.623	0.536	0.095	6.550	0.000
KST	↔	CI	−0.583	−0.489	0.091	−6.417	0.000
CLF	↔	KST	0.381	0.342	0.074	5.133	0.000
KAP	↔	QP	0.753	0.756	0.109	6.914	0.000
KAP	↔	LCOM	0.113	0.101	0.045	2.544	0.011
KAP	↔	CI	0.385	0.334	0.063	6.153	0.000
CLF	↔	KAP	−0.336	−0.311	0.061	−5.459	0.000
KMP	**↔**	**TQM**	**1.112**	**0.839**	**0.148**	**7.539**	**0.000**

Source: Authors' field survey data (2023).

KM, knowledge management; TQM, total quality management; KMP, knowledge management process.

based on the standardized coefficients and p-values for the sub-constructs of KMP and TQM are as follows: KG and KST have strong positive relationships with TQM. KSH and KAP also have strong positive relationships with TQM. KD has a negative relationship with TQM. The standardized coefficients indicate the relative strength of these relationships in standard deviation units. All of these relationships are statistically significant as the p-value is 0.000.

The model in Figure 2 further demonstrates the relationship between the sub-construct of KM practices and TQM principles. The yellow blocks represent the sub-construct of KM and TQM and the relationship between them. From left to right, the constructs are (1) knowledge application, (2) knowledge generation, (3) knowledge sharing, (4) knowledge storage, (5) knowledge application connecting to (6) client focus, (7) continuous improvement, (8) leadership commitment, (9) quality plan, and (10) knowledge diagnosing.

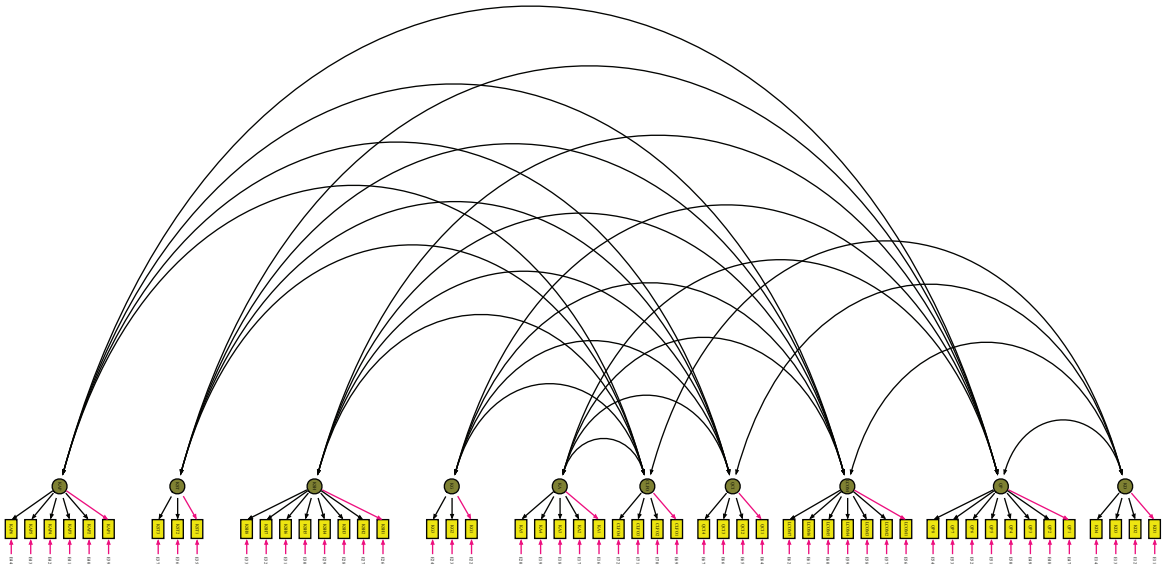

Figure 2. Model for the relationship among the sub-constructs of KMP and TQM. KMP, knowledge management process; TQM, total quality management.

Discussion/findings

Objective 1 of this study sought to investigate the relationship between KM and TQM and their impact on project performance in Ghana. The findings indicate that both the design and the construction team accepted the view that there should be a culture of KM processes and TQM principles for project performance, and this is in line with several studies (Imbeah, 2012; Magnusson, Nilsson, and Valentin, 2013; Duran, Çetindere, and Özcan, 2014; Calnan *et al.*, 2021). Stewart and Waddell (2008) concluded in their study that, for organizations to successfully compete in such a dynamic business environment, embracing a quality culture would be essential to implementing knowledge management. In other words, the successful integration of TQM and KM has a major impact on project performance.

The finding further indicated that the role of quality personnel is very necessary and must be defined and documented. This will ensure clarity of purpose regarding their responsibilities for an effective project outcome. Due to the limited ability of the workforce and remote job sites, it is hard to control and track the quality system implementation in all sites. Therefore, communication problems between personnel because of language differences and cultural differences within the workforce need to be addressed (Imbeah, 2012; Ofori, 2012; Meijer and Visscher, 2017; Calnan, *et al.*, 2021).

The findings again revealed that the design and detail of the quality management practices provide people with the knowledge related to their roles in the project delivery in an organization, which is in line with the assertion of Musa, et al. (2022) that the primary objective of comprehensive quality management and knowledge transfer is to establish suitable social control within the organization to promote a trustworthy environment. There are several processes associated with this component of the quality management system that contribute to the overall management and utilization of knowledge within the organization (Ju, *et al.*, 2006; Colurcio, 2009).

THE ESSENTIAL FACTORS NECESSARY FOR THE INTEGRATION OF KM AND TQM

Key findings based on the standardized coefficients and p-values for the sub-constructs of KM practices and TQM revealed that knowledge generation and knowledge storage have strong positive relationships with

TQM. Knowledge sharing and knowledge application also have strong positive relationships with TQM. Knowledge diagnosing has a negative relationship with TQM. The standardized coefficients indicate the relative strength of these relationships in standard deviation units. All of these relationships are statistically significant ($p < 0.05$). Overall, the results suggest that KMP, specifically sub-constructs like knowledge generation, knowledge storage, knowledge sharing, and knowledge application, have strong positive relationships with TQM. However, knowledge diagnosing has a negative relationship with TQM. These findings revealed relationships between different aspects of KM and TQM in the analysis.

The findings show the strength and direction of the relationships between various constructs related to KM and TQM. Knowledge diagnosing is correlated with leadership commitment. This is in line with Sami and Bedawy (2020) who indicated leadership as a critical contributing factor to establishing a significant influence on successful project performance. Knowledge generation has a positive correlation with quality plan, and knowledge sharing is positively correlated with leadership commitment and continuous improvement. Again there is a positive correlation between knowledge storage, quality plan, and leadership commitment. Knowledge application is correlated with QP and CI. Rajeshwaran and Aktharsha (2017) emphasized further that strategic planning, employee involvement, leadership commitment, continuous improvement, recognition and reward, and high-quality training were the most important determinants of organizational performance. According to Elbashir (2018), the effective adoption of TQM was facilitated by various variables such as organizational culture, employee participation, quality education, top management's dedication and leadership, and interactions between top managers and workers. Positive relationships indicate that an increase in one construct is associated with an increase in another. This implies that enforcing KM practices will possibly improve TQM principles during the delivery of construction projects while a negative relationship suggests a decrease in one is associated with an increase in the other. This is in line with Ch, et al. (2009) who indicated that the integration of KM processes of TQM leads to improving the quality of products and services continually. Overall, the results suggest that KMP sub-constructs like knowledge generation, knowledge storage, knowledge sharing, and knowledge application, have strong positive relationships with TQM sub-constructs like quality plan, leadership commitment and continuous improvement.

THEORETICAL IMPLICATION

This research has contributed theoretically and practically. The first theoretical contribution is the creation of a conceptual model that links KM with TQM to enhance performance. This model provides the relationship between KM and TQM constructs and determines the key factors for integrating KM with TQM structures. This model can help firms identify which KM processes are necessary to improve TQM principles within their organizational structures.

PRACTICAL IMPLICATION

The study highlights the strong correlation between KM and TQM in the Ghanaian construction industry. Knowledge generation, storage, sharing, and application positively impact TQM sub-constructs: quality plan, continuous improvement, and leadership commitment. However, challenges include resource constraints, a lack of enabling culture, and resistance to change. Arguably, given an enabling environment and a desired level of commitment of project teams these challenges can become surmountable. In this regard key steps required for an effective integration of KM with TQM include the establishment of a construction industry council in Ghana, ensuring an enabling legal framework to incentivize a construction culture.

LIMITATIONS AND DIRECTIONS FOR FUTURE RESEARCH

The study investigated the views of construction professionals of the built environment on the possible integration of KM and TQM in the Ghanaian construction industry. Additionally, professionals from other related sectors may have varied opinions on how the KM and TQM could be integrated. Thus, future studies should adopt a qualitative research strategy to explore the nature of the apparent association that exists between variables in this study. Such an approach will provide more insightful answers as to why, or if at all any causal relationships exist between the KM and TQM constructs.

Conclusion

The study utilized quantitative data from 256 construction professionals in Ghana and employed PLS-SEM. The study identified several gaps in current knowledge that it aims to address, particularly on the integration of KM with TQM in the construction industry, especially in developing countries like Ghana. While KM with TQM has been linked to project performance in general literature, there is a gap in the body of knowledge regarding their application to construction projects, especially within the Ghanaian context. There is generally little information on the possible variables that contribute to their relationship. The findings revealed a statistically significant positive relationship, indicating that a one-unit rise in knowledge management process corresponds to approximately a 0.839-standard deviation increase in TQM. This suggests that implementing KM can potentially improve TQM principles in construction projects.

The findings further provide insights into the specific sub-constructs of KMP that significantly influence TQM. Key findings based on the standardized coefficients and p-values for the sub-constructs of KMP and TQM KG and KST have strong positive relationships with TQM. KSH and KAP also have strong positive relationships with TQM. KD has a negative relationship with TQM. It highlights the importance of actively generating, sharing, storing, and applying knowledge within an organization for successful TQM implementation. Additionally, addressing and mitigating knowledge diagnosis is crucial for maintaining a high level of quality in organizational processes. Both design and construction teams in the Ghanaian construction industry agree on the importance of a KM process and TQM practices for project performance, as organizational culture motivates knowledge production, preservation, and exchange. The study emphasized the crucial role of quality personnel in ensuring a project's success by meeting quality standards, adhering to regulations, and achieving its objectives.

When roles are clearly defined and documented, it becomes easier to evaluate and improve the overall quality of the project. The results also underscore the importance of well-structured and comprehensive quality management practices within an organization. These practices will not only improve the overall quality of project delivery but also equip individuals with the essential knowledge related to their roles. Additionally, thorough quality management practices empower individuals by offering them a clear understanding of their responsibilities within the project. This knowledge is essential for team members to effectively carry out their responsibilities for the successful completion of the project.

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Appendix 1

Relationship between KM and QM and their impact on project performance

Items	Minimum	Maximum	Mean	Standard deviation
Knowledge management and the quality standards and practices				
There is a formal and informal integration of knowledge processing with quality management principles.	1	7	5.12	1.739
Knowledge management roles and quality standards have been instituted.	1	7	4.90	1.889
There are incentive structures, knowledge - sharing policies and quality practices to ensure project performance.	1	7	5.44	1.410
There is a culture of KM processes and TQM practices.	2	7	5.47	1.390
Knowledge gained from other projects is incorporated into quality practices.	1	7	5.01	1.797
The required training for the employees serves as the organization's objectives in improving employees' experience.	1	7	5.49	1.635
KM with TQM and the organization for project performance	-			
Provide the required training to the employees, for effective project delivery	1	7	5.06	1.509
Assist in improving employees' experience with project performance	1	7	5.22	1.671
Comply with the quality management principles which provide details on roles, responsibilities, and accountabilities	1	7	5.07	1.478
The design and detail of the quality management practices provide people with the knowledge related to their roles in the project delivery in my company.	1	7	5.30	1.507
The role of the quality personnel is well defined and documented to ensure clarity of purpose for effective project outcome	1	7	5.23	1.630

continued

Items	Minimum	Maximum	Mean	Standard deviation
Generation and utilization of KM practices and TQM principles for project performance.	-			
Knowledge related to the project is key to enabling the fundamental role of the effective delivery process to produce quality project outcomes.	1	7	5.39	1.816
The management of this knowledge is integrated into the quality management system in several ways.	1	7	5.27	1.838
There are processes associated with this component of the quality management system that contribute to the overall management within the organization.	1	7	5.40	1.738
There is a review of the TQM and its effectiveness used to identify areas of improvement.	1	7	5.42	1.779
The review process results in adjustments to standards and practices, ensuring that newly acquired knowledge is systematically and sustainably integrated into daily operations.	1	7	5.38	1.832
These reviews are conducted at the site to review the relevant level of KM and TQM management.	1	7	5.54	1.565
Knowledge generation and utilization are controlled through review and metrics processes.	1	7	5.12	1.751
The regular project review provides a key contribution to KM processes and TQM practices.	2	7	5.32	1.606
The process description and associated knowledge are utilized as part of deviation and change management.	1	7	5.19	1.488
The KM activities give a clear view of what TQM constitutes for the firm.	1	7	5.11	1.649
There is a KM and TQM system which is easy to use and implement.	2	7	5.03	1.584
The top management puts equal emphasis on KM and TQM and integrates them to realize higher rates of success.	2	7	4.88	1.657
There are KM and TQM training strategies in place in my company.	1	7	5.31	1.586

Appendix 2

Knowledge management applications, knowledge sharing practices and decision-making processes

Items	Minimum	Maximum	Mean	Standard deviation
Knowledge diagnosing				
In my organization				
The required information is provided in the design	1	7	5.66	1.438
Procedures and instructions of project knowledge are well communicated	2	7	6.01	1.044
There is a dedicated department to diagnose knowledge and report periodically to the design team.	1	7	5.30	1.496
There are periodic tests to diagnose existing knowledge that employees have	1	7	4.97	1.457
Knowledge acquisition				
In my company				
There are multiple sources of information and ideas to enable workers to acquire knowledge.	1	7	5.25	1.440
Training programs are a means of giving employees the necessary knowledge.	1	7	5.26	1.367
There are processes for generating new knowledge from existing knowledge.	1	7	5.08	1.479
There are processes for acquiring knowledge about new project.	1	7	5.45	1.290
Workers recruited possess the required expertise.	1	7	5.48	1.393
Knowledge generation				
My company				
Encourages its staff to generate new ideas	1	7	5.60	1.346
Provides an opportunity for staff members to use their tacit knowledge effectively	1	7	5.48	1.407
Creates the motivation to help employees learn and apply their knowledge	1	7	4.68	1.693

continued

Items	Minimum	Maximum	Mean	Standard deviation
Knowledge sharing				
In my company				
Employees are engaged in making decisions, which helps in sharing knowledge.	1	7	5.20	1.331
Advanced technology is utilized to facilitate efficient knowledge sharing and encourage active participation.	1	7	4.94	1.528
There is a level of trust existing between employees in knowledge sharing.	1	7	5.00	1.314
Staff are evaluated according to their tacit knowledge.	1	7	5.17	1.263
Implementation of the KM system is treated equally and importantly.	1	7	4.98	1.475
There is a periodic movement between sections and departments as a means of sharing knowledge.	1	7	4.45	1.656
There are regular monthly meetings of all members for dialogue and exchange of ideas	1	7	4.47	1.676
There are incentives for employees for sharing knowledge.	1	7	4.54	1.645
People who have the potential and attitudes to share and acquire knowledge are employed.	1	7	4.64	1.463
There is motivation to help employees learn and apply their knowledge,	1	7	4.79	1.618
Knowledge storing				
My company				
Has special systems for storing and documenting the project knowledge	1	7	4.65	1.573
Encourages its expert staff to document their tacit knowledge	1	7	4.59	1.511
Has a knowledge storage system that is effective and easier for everyone to retrieve at any time	1	7	4.80	1.635

continued

Items	Minimum	Maximum	Mean	Standard deviation
Knowledge application				
In my company				
Systems and procedures have enough flexibility to make immediate modifications to apply new knowledge.	1	7	5.03	1.558
Responds quickly to clients' requirements by providing insight into the project	1	7	5.18	1.484
There is a need to respond quickly to changing technology.	1	7	5.19	1.521
Responds to the modern trend of project knowledge and actions taken	1	7	4.90	1.557
There is a department responsible for overseeing the implementation of new knowledge, conducting follow-ups, and evaluating the outcomes.	1	7	4.77	1.631
Management underlines the importance of new knowledge, its use and its significance.	1	7	4.64	1.607
There is documented information about the successes and failures of project development.	1	7	4.88	1.599
A database, repositories, and IT applications are used to store knowledge, ensuring easier access to all employees.	1	7	4.90	1.469

Appendix 3

Total quality management principles

Items	Minimum	Maximum	Mean	Std. deviation
Quality plan				
My company				
Describes how quality requirements will be maintained to ensure quality assurance to improve project performance	1	7	5.13	1.399
Defines the individuals responsible for implementing the quality plan in detail	1	7	5.37	1.419
Describes the key activities necessary to deliver the project quality for effective project performance	1	7	5.19	1.515
Describes procedures for remedying defects to improve project performance	1	7	5.26	1.499
Defines the requirements and expectations of client in the quality plan	1	7	5.16	1.475
Sets out a special training requirement to ensure quality is maintained	1	7	5.13	1.553
Appoints personnel to champion total TQM practices	1	7	5.05	1.724
Allocates adequate resources for effective TQM for project performance	1	7	5.22	1.447
Leadership and commitment				
My company				
Demonstrates leadership commitment with respect to total quality management during the project phase	1	7	5.45	1.349
Takes accountability for the effectiveness of the total quality management to improve project performance	1	7	5.51	1.306
Ensures that the quality policy and quality objectives are established for the TQM at the project phase	1	7	5.56	1.285
Considers total quality management as a real slogan and basis for project performance	2	7	5.61	1.256

continued

Items	Minimum	Maximum	Mean	Std. deviation
Agrees that the application of TQM principles leads to maintaining the competitive position for project performance	1	7	5.25	1.487
Maintains clear evidence of the quality policy that contains all necessary instructions and standards for measuring and tracking project performance	1	7	5.32	1.472
Emphasizes the identification of deviation from set targets to improve project performance	1	7	5.23	1.220
Identifies the best TQM practices to ensure effective project performance	1	7	5.19	1.196
Emphasizes the implementation of best TQM principles for effective project performance	1	7	5.35	1.204
Client focus				
My company				
Actively and regularly seeks client inputs to identify their needs and expectations during design for effective project delivery	1	7	5.34	1.420
Determines client requirements in the design and consistently meets to improve project performance	1	7	5.50	1.355
The risks and opportunities that can affect conformity of the project performance to enhance client satisfaction are determined and addressed in the design.	1	7	5.63	1.295
The design focuses on enhancing client satisfaction to improve project performance.	1	7	5.49	1.388
Clients are able to give us feedback on quality and project performance.	1	7	5.51	1.245
Client complaints are used to make changes in the design to improve project performance.	1	7	5.45	1.382
Client satisfaction is measured systematically and maintained to influence project performance.	1	7	5.39	1.412
Surveys are conducted periodically to identify client's needs and desires to improve project outcome.	2	7	5.59	1.258
There is a periodic meeting to strengthen ties with clients to improve project performance.	1	7	5.15	1.537