*VFAST Transactions on Software Engineering*
*https://vfast.org/journals/index.php/VTSE@ 2025, ISSN(e): 2309-3978, ISSN(p): 2411-6246*
*Volume 13, Number 2, April-June 2025* *pp:99-120*

# Leveraging Software Engineering Principles: An IT-Enabled Component-Based Knowledge Management Model for Healthcare Information Systems in Developing Countries

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***Keywords***: *Knowledge Management; Information Management; Healthcare Information Systems; Component-Based Model; Mixed Methods Approach*

***Journal Info***:
*Submitted:*
*February 14, 2025*
*Accepted:*
*April 30, 2025*
*Published:*
*May 18, 2025*

## Abstract

In the contemporary era, the integration of Information Technology (IT) with Knowledge Management (KM) infrastructures has significantly transformed the healthcare sector. This study investigates the current use and effectiveness of IT in supporting KM functions within public-sector healthcare organizations in Pakistan. It further explores and evaluates key factors influencing the success of KM practices in this context. Employing a triangulated mixed-method approach, the research examines the maturity level of KM within healthcare information systems (HCIS) and the general understanding of KM concepts among stakeholders. Empirical findings reveal that most of the proposed hypotheses were statistically significant, except for two: the impact of exogenous factors on KM specifications and the impact of KM success on overall organizational performance, which were found to be weak and non-significant. A conceptual model was initially develop based on the hypothesized relationships, followed by an empirical model tested through Partial Least Squares Structural Equation Modeling (PLS-SEM) to assess significance ($p < 0.05$) and model fit. Based on these analyses, the study proposes an integrated, component-based KM model aimed at enhancing the governance and effectiveness of HCIS.

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DOI: 10.21015/vtse.v13i2.2060

## 1 Introduction

Nowadays, almost every organization strives to improve its procedural and process performance by developing and enhancing its capability to innovate. This potential and capacity of innovating have been classified as the absorptive capability [1]. This idea

was also extended by [2] , and he argued that the generation of the innovative outcome depends upon the knowledge that has been previously absorbed and accumulated by the potential organizations [3].

Knowledge management (KM) is nowadays believed to be one of the top most critical functions of an organization and an essential complement to the organization's professional activities. It is critical for organizations to realize the importance of KM implementation procedures along with the tools and aids required for KM success [4]. Most of the organizations lack a clear strategic vision of KM, its definition and its role in the organizational processes [5].

Although various organizations have understood the value of knowledge creation, dissemination, and management as a critical factor for success in today's environment, adequate attention to the KM dimension still lacks practical implementation [6]. One of the crucial facts is that the KM concept is still misunderstood by the masses and is wrongly associated with technological solutions, such as databases, and data communication systems [7]. A clear distinction between information and knowledge is still a matter of concern in organizations and a critical hurdle in understanding and implementing the KM processes, procedures and frameworks [8].

The study presents both conceptual and empirical models, the innovation of the proposed Knowledge Management (KM) model lies in its component-based, IT-enabled architecture specifically tailored for Healthcare Information Systems (HCIS) in developing countries. Unlike traditional KM models that treat KM as a monolithic or linear process, this model adopts modular design principles from software engineering, enabling flexibility, scalability, and adaptability. The model applies component-based development concepts commonly used in software engineering to KM, allowing different KM functions (specification, implementation, processing, and application) to be developed, improved, and managed independently.

## 1.1 Context of the study

This study and research emphasis on investigating and evaluation of the use of Information Technology (IT) and its existing state to support KM functions in "public-sector healthcare organizations of Pakistan." One of the underlying factors supporting and motivating this study is that the KM has received very little attention in understanding its value and significance in the healthcare systems of developing countries as an area of research [9].

KM in the healthcare industry is a triangulation of management, information technology, and healthcare domain. Healthcare professionals remain expert in their domains of study as they acquire high medical degrees, which also is a barrier for knowledge sharing across the specialized areas [10]. A Knowledge Management System (KMS) may use the existing IT infrastructure available in the organization (e.g., shared databases, information system applications, intranets, email systems, etc.) but some researchers focus on development and implementation of specific IT systems for KM [11].

## 1.2 Knowledge Management & Healthcare

KM in healthcare organizations helps healthcare workers and professionals to keep updated with current and latest medical knowledge [12]. Their expertise highly relies on the knowledge accessed, shared, and exchanged via the available ICT infrastructure. KMS support also enables them to create and sustain best practices in healthcare [13]. "The explicit and tacit elements of organizational knowledge play an essential and vital role in the growth and innovation of an organization" [14].

Lack of attention to KM discipline [15], and nonexistence of generally recognized KM principles [16], are some of the disparities observed in this discipline. Among the commonly accepted KM principles or recommendations that are overlooked are the criteria for know-how, understanding and measuring success linked with KM in the Healthcare industry. There are four main kinds of KM processes that lead to innovation [17]. These processes are knowledge discovery, capture, sharing, and application. The complexity of the required knowledge increases the difficulty level of capturing and reusing the knowledge for conversion, innovation and new knowledge creation [18]. Furthermore, KM practices and innovation are classified into

three main perspectives as System, Organizational, and people although there is no absolute boundary between these perspectives [19].

### 1.3 Healthcare organizations in Pakistan

"Pakistan is a republic that is densely populated with almost 65 percent of the population residing in rural areas [20]. Healthcare in Pakistan is administered mainly in private-sector organizations and public-sector organizations [21]. "Even though numerous healthcare centres and qualified professionals are available in many areas, the implementation of effective and high-quality KM procedures is still missing" [22]. The recent studies exhibit that "several of the initial problems correlated to the deficient environment are due to lack of public awareness about KM know-how, missing associated processes & necessary procedures" [23].

### 1.4 Gap and deficiency analysis

The initial steps in any quality enhancement and improvement process are to identify, define, measure, and analyze the problems at hand [24]. Unfortunately, the healthcare industry in Pakistan has been lacking a distinctive and compelling focus of researchers related to KM domain due to a combination of multiple disciplines and much has not been done in this domain of research. The primary reasons behind the problems and deficiencies related to KM in healthcare explored during this study are classified into five main categories that are mentioned as:

1. Lack of appropriate organizational leadership
2. Lack of top management role and commitment
3. Lack of understanding KM importance and its processes
4. Lack of understanding the knowledge-innovation relationship
5. Lack of appropriate procedures for mitigating the effect of influential factors

"Access to knowledge and dissemination of correct knowledge to the right person at the right time" [25, 26], is one of the biggest current challenges that require proper attention. Problems such as errors in data capturing, maintaining proper patient histories, incomplete or subquality data entries, lack of decision support for evidence-based medicine, lack of decision support systems [27], social and organizational culture, data security and information privacy issues, and poor infrastructure for E Health and telemedicine [28], "Lack of understanding of key concepts of KM and relationship between available technologies & knowledge processes in the healthcare industry of Pakistan" [29], are some of the other issues that require specific focus for successful implementation of KMS.

## 2 Background and Literature Review

### 2.1 Data, Information, Knowledge,& Wisdom

Knowledge has a great association with other concepts named as data, information, and wisdom [26]. Defining knowledge at times become challenging due to its intimate relationship with information, data, and wisdom as they have a very fine borderline among their official definitions. In practice, all these four have huge differences among them [26]. Figure 1 presents a diagrammatic illustration about the relationship between data, information, knowledge, and wisdom that shows how we can achieve a better decision making state while understanding daily life problems as identified by [26–33] in their studies.

### 2.2 Knowledge Management role, concepts and practices

KM is about ensuring the availability of the right knowledge to the right people at the right time for the right purpose [26]. "It is the coordination and utilization of organizational knowledge resources, that strive to create overall benefit and competitive advantage for the organization" [34]. A similar comprehensive definition and concept of KM introduced by [35], states that "KM is managing the corporation's knowledge through a systematically and organizationally specified process for acquiring, organizing, sustaining, applying, sharing and renewing both the tacit and explicit knowledge of employees to enhance organizational performance and create value." [36].

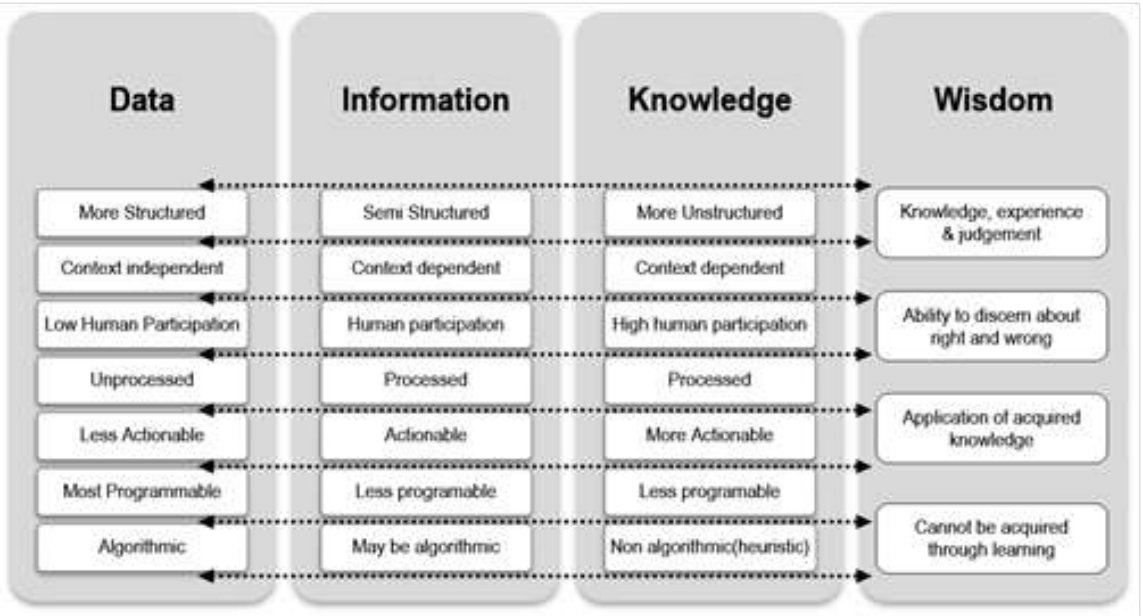


**Figure 1.** Data, Information, Knowledge & Wisdom Attributes [30]

### 2.3 Generalized KM models and frameworks

This section presents a brief account on the comparative analysis of some of the renowned KM models and frameworks proposed and presented by the different scholars as exhibited in table 1.

### 2.4 KM Models Proposed for Healthcare Industry in Pakistan

In table 2, we have summarized some of the work done in this domain by some research workers related to KM in the healthcare industry of Pakistan.

The study's contextual focus on public-sector healthcare in Pakistan and acknowledged the timeliness of integrating Knowledge Management (KM) with Information Technology (IT), particularly post-COVID. They also recognized the methodological soundness of using both conceptual and empirical models validated through PLS-SEM. The country-specific application of the model was seen as a strength that adds practical relevance to the research within developing country contexts.

However, the main contribution of the proposed model. The explicitly highlights the innovative aspect of the KM model its component-based, IT-enabled design inspired by software engineering principles. The model's adaptability, modularity, and empirical validation in a resource-constrained healthcare environment distinguish it from existing KM frameworks. Further, a comparison with state-of-the-art (SOTA) models was included to show how the proposed approach enhances flexibility, integration, and governance in KM practices.

## 3 Research model and hypothesis

The principal emphasis of this research is to identify and investigate those factors that influence the success of KMS implementation in the Pakistani healthcare industry and propose a new KM model in the form of a solution to mitigate the effects of these factors.

Therefore, the research formulates the following hypothesis:

H1. The exogenous factors have an effective and significant relationship with the endogenous factors for KM success in healthcare organizations.
H2. The exogenous and endogenous factors influence the definition of KM system specifications.
H3. The KM system specifications positively influence the KM system implementation activities.
H4. Knowledge capturing/storing activities and the

**Table 1.** A comparative analysis of Generalized KMS Success models

| # | Model / Framework | Purpose / Explanation | Derived from / Influenced by | Objective / Focus on | Reference |
|---|---|---|---|---|---|
| 1 | Wu and Wang KMS Use Model | Empirically success system for KM | D&M IS Success Model | Measuring the relationship between dependent variables: • System quality • Knowledge / Information Quality • Perceived KMS Benefits • User Satisfaction • System Use | [37] |
| 2 | Halawi KMS Model | Empirically tested KMS success in knowledge-based organizations | D&M IS Success Model | Measuring the KMS relationship of KMS: • Appropriate dimensions for evaluating the success of KMS • The relationship between these dimensions • Knowledge / Information Quality | [38] |
| 3 | Kulkarni Knowledge Use Model | Explore KMS use by addressing organization support factors | D&M IS Success Model & Seddon re-specification D&M extension | Measuring the relationship between: • Knowledge sharing (KS) and knowledge management (KM) • The relationship between KS / KM and knowledge use | [39] |
| 4 | Lai KMS Use Model | Factors that affect the outcome of KMS implementation | Extrinsic and intrinsic organization factors | Measuring factors affecting post-KMS implementation: • Rewards • Computer Self-Efficacy • Perceived Power Security | [40] |
| 5 | Goswami Block Diagram | Behavioural and technological that affect implementation KMS | Integration of people, process & technology in organizations | • Block diagram that demonstrates all technological and behavioural factor that affect successful KMS. • Only abstract and no relationships mentioned | [41] |

knowledge-base is positively related to the KM system implementation activities.

H5. There is a significant and positive relationship between knowledge capturing/storing activities and the following:
   a. Knowledge-Base
   b. Knowledge retrieval & approval activities
   c. Knowledge reuse & sharing activities.

H6. There is a significant and positive relationship between knowledge-base and the following KM application activities:
   a. Knowledge retrieval & approval activities
   b. Knowledge reuse & sharing activities.

H7. Knowledge retrieval & approval activities significantly influence knowledge reuse & sharing activities.

H8. The KM system success is effectively and positively influenced by knowledge retrieval/approval activities and knowledge reuse/sharing activities. H9. There is an effective & significant relationship between KM system success and organizational performance.

Figure 2 illustrates the Conceptual Model Diagram (Initial version) that has been developed based on the constructed hypothesis.

## 4 Research design and methodology

### 4.1 Research epistemology, design & approach

Epistemology is related to the branch of philosophy that refers to the theory about knowledge, its validity, methods, scope and the way it can be acquired [43]. The research philosophy used behind this study is a triangulation of mixed method research (Positivism, Interpretivism Realism) [44] which examines the existing state of KM practices in “public-sector healthcare organizations of Pakistan” and proposes “an integrated component-based KM model” that is challenged and its hypotheses are tested and confirmed through scientific tools and statistical techniques [45]. The research design follows [44–46]. However, the part concerning the case study such as observations, walkthroughs, and tools for measuring the maturity of KM practice in the organization(s) was adapted from Knowledge Management Toolkit [39, 47, 48]. Figure 3 illustrates a conceptual view of the development of

**Table 2.** A review of KM Models/Frameworks proposed by some researchers for the Healthcare Industry of Pakistan

| # | Framework/Model | Description | Reference |
|---|---|---|---|
| 1 | Knowledge Management Framework to Operationalize Experiential Knowledge | • Mapping of the explicit form of knowledge with a tacit form of knowledge<br>• The objective of this model is that explicit knowledge in the form of Clinical practice guidelines (CPG) is enriched by tacit, experiential knowledge found in the form of documented experience. | [18] |
| 2 | A Theoretical Technology Driven Knowledge Management Framework | • Aims to advance the understanding of the critical concepts of KM and the relationship between available technologies and Knowledge Processes<br>• Identifies critical factors for making a KM initiative successful | [29] |
| 3 | Healthcare Workflow Management and ICT Model | • The process of management of knowledge involves the ability to identify and capture existing knowledge, create new knowledge and transfer existing knowledge throughout the organization.<br>• Mainly emphasizes the flow of knowledge from one entity to another. | [27] |
| 4 | The HC KM Model | • Knowledge representation is referred to as storing and processing of information and knowledge so that other applications can use it. | [42] |
| 5 | The Enhanced HC KM Model | • Enhanced this model by introducing the personal identity (national identity) of a patient to be recorded by the system. | [28] |

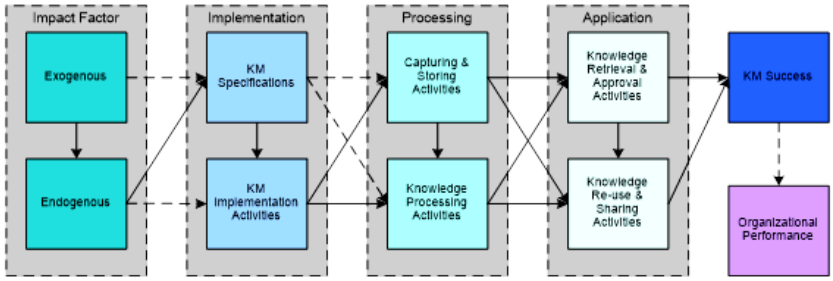


**Figure 2.** Conceptual Model Diagram of the proposed KM Model (1st Draft)

research design.

### 4.1.1 Method selection

How did you select which protocols to use? How are you certain these are representative? Would a naive user get similar performance?

In supplement to case study/site observations, this research is conducted using a mixed method triangulation ESMM (Explanatory Sequential Mixed Method) approach which is a combination of both quantitative method and qualitative method (refer figure 4). This enables opportunities of cross-validating procedures for finding and analyzing for the research [49].

## 4.2 Instrument Development and Validation

This section converses the instrumentation development process for the quantitative study and qualitative study for the current research that is based on the guidelines provided in the Knowledge Management Tool Kit [45, 46, 49]. The process is comprised of three principal phases defined as "Construct conceptualization," "Instrument validation," and "Instrument use" [51] (see Figure 5).

The survey questionnaire for quantitative study consisted of following sections:

- Section I – General Section (Demographic Information)
- Section II – Operationalization of KM System Implementation Activities
- Section III – Operationalization of KM Critical Influential Factors
- Section IV – Reasons for Non-Knowledge Management Adoption

"The interview is probably the most common research method in qualitative research because it provides a smooth, flexible method that can be used to capture essential ideas and detailed opinions to enrich the research" [52]. The interview questionnaire

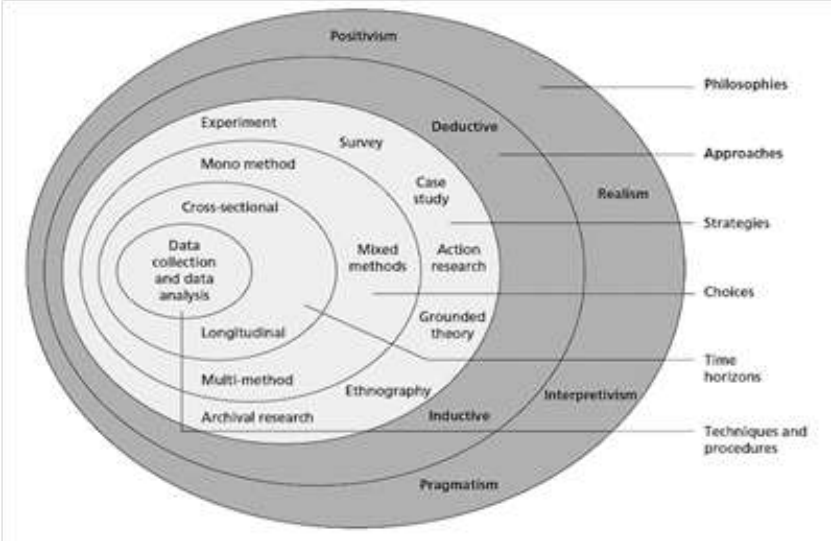


**Figure 3.** Research Design, [44]

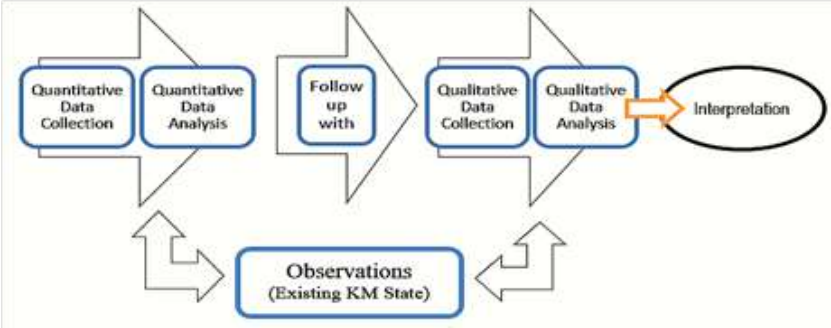


**Figure 4.** . Explanatory Sequential Mixed Method Research Methodology [50]

for qualitative study consisted of following sections:

- Section I – Introductory Information
- Section II – Demographic Information
- Section III – Questions Section

The questionnaire was pretested with a group of information systems Ph.D. students to collect their feedback on the overall structure of the questionnaire for format, content, understandability, terminology, ease, and speed of completion [53]. The content validity of the measurement instruments was further tested in a formal content validity test, to ensure that measurement items reflect all the important aspects of their constructs [54]. This was conducted by calculating CVR (Content Validity Ratio) through a quantitative survey approach [55] involving subject matter experts and KM domain experts. Further, to examine the validity and reliability of the adopted and adapted research instrument [45], a pilot study was conducted. Three ready-made standard instrument tests were used to examine the pilot study, i.e., Descriptive analysis, Reliability Analysis and Exploratory Factor Analysis (EFA) [56].

### 4.3 Population Sampling & size determination

Population refers to the total number of people, things and events projected to be investigated for the study [57]. The targeted population for the research study including a questionnaire survey and interviews was logically divided into four groups as End-users, IT Professionals, Knowledge managers and Domain experts. The sample size is much dependent on the number of

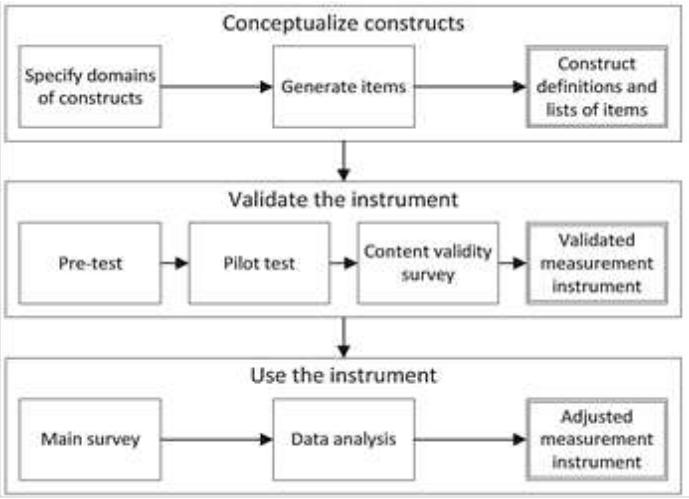


**Figure 5.** "Instrumentation - Development, Validation & Usage Process" [51]

errors such researcher wants to tolerate [52].

One of the conventional methods of determining sample size is Krejcie and Morgan's (1970) sample size determination. Therefore, the researcher used a 95 percent confidence interval level at Plus 5 margin of error to arrive at the required sample. For the current study, the sample size used for quantitative study is 384 participants. Furthermore, comprehensive and thorough interview based on 5 primary and 31 semi structured main questions was conducted with twenty-one (21) experienced and well-educated healthcare professionals and domain experts.

## 4.4 Data and information collection

The current study used a mixed method triangulation, i.e., Observations, quantitative survey and qualitative survey to collect the necessary data. The survey questionnaire was mainly administered in the form of hard copies by hand (containing the web-link of survey form also) and through the social media groups as a web-link to the survey google-form. The interview questionnaire was mainly administered in the form of hard copies. The responses were collected with the help of face-to-face interactions with the participants. All the responses were treated as confidential.

## 4.5 Data cleaning and screening

Verifying the quality of empirical data is necessary before proceeding to the data analysis stage [53]. Data were checked for possible errors during data entry prior to the analysis phase. By using "PASW (Predictive Analysis Software)," the data were screened to determine whether any value was outside the range by checking each variable. No values were found out of the range. In the data analysis, the mean replacement was used to deal with the missing data. Outliers are values that are unusually higher or lower than other values in the data set. To check whether these cases were likely to influence the results for the model as a whole, the value for Cook's distance was checked. Cases with values higher than one (1) are a potential problem [58]. The maximum value for Cook's distance was 0.079, suggesting no significant problems. Therefore, no cases were removed as outliers.

## 4.6 Testing potential sources of bias

The data collected through the quantitative survey was analysed for potential sources of bias through the accomplishment of testing for "non-response bias," checking for "sample representativeness" and checking for "common method bias". To check for "Non-Response Bias", the test was performed using the Mann-Whitney U test [37]. Table 3 illustrates that no statistically significant differences exist among the initial and delayed respondents according to their demographic properties at a significance level (p-value) of 0.05.

For checking sample representativeness, the results obtained from the test show that the Chi-square goodness-of-fit (Gender) 2 = 0.87, p = 0.41 and t-test (age) t = 0.57, p = 0.59. The test results (Table 4) represent that there is "no statistically significant difference" among the respondents and overall population for sample representativeness as compared by their mean age and gender distribution.

A Principal Component Analysis (PCA) was performed on all the items in this study, and the results suggested that the "common method variance or bias" does not cause any significant impact on the current study.

**Table 3.** Non-response bias analysis of the respondents

| Test | Age | Gender | Qualification | Designation | Experience |
|---|---|---|---|---|---|
| Mann-Whitney U | 7139.000 | 7523.000 | 6801.500 | 7693.000 | 7481.500 |
| Wilcoxon W | 23165.000 | 12203.000 | 22571.500 | 9960.500 | 11741.500 |
| Z | -0.557 | 0.0145 | -0.089 | -0.856 | -0.083 |
| p | 0.561 | 0.783 | 0.857 | 0.512 | 0.842 |

**Table 4.** Descriptive statistics for checking sample representativeness

| Indicator | Respondents | Population |
|---|---|---|
| Mean Age | 44.76 Years | 46.35 Years |
| Males | 255 Participants (66.41%) | 141377 Individuals (60.68%) |
| Females | 129 Participants (33.59%) | 91609 Individuals (39.31%) |

## 5 Results analysis

This section discusses and presents the results related to data collection and its analysis. For performing statistical data analysis, SPSS and PLS(SEM) were used as per requirement. SPSS provides a detailed account of the descriptive analysis of instruments used for the study. "SEM is an applicable and adaptable technique to simultaneously evaluate constructs of a model and the hypothesized structural relations between variables thru a measurement model and structural model analysis" [59]. "PLS (Partial least squares) is characterized as a technique most suitable where the research purpose is prediction or exploratory modelling" [60]. Moreover, "PLS-SEM provides estimation on single and multi-component models and canonical correlation" [59].

### 5.1 Case Organizations & Respondents

This section presents information regarding the essential characteristics of 2 government (public-sector) health-care organizations (A & B – pseudonym used to ensure confidentiality) in one of the densely populated provincial capital cities in Pakistan. Table 5 exhibits a summary of case demographics.

Table 6 represents the respondent's demographics.

The researchers selected and exercised a "purposive sampling technique" while conducting exploratory research to acquire and perceive necessary information related to the existing state of current systems. The acquired information revealed the following statistics shown in table 7.

Well, the obtained results were diversified which divided the respondents into two categories, explained as "those who do not have any information or awareness regarding KM" and "those who have substantial knowledge and know-how related to KM domain." This also gave an idea about the selection of potential participants for quantitative and qualitative studies.

### 5.2 Assessment of Measurement model

"The adequacy and capability of the measurement model are determined and assessed by evaluating and examining its item reliability, internal consistency, convergent validity and discriminant validity [61]." While examining Item reliability (also known as indicator reliability), some of the items were found to be unreliable and were eliminated/dropped to update the corresponding measures. The updated measures were re-analysed and re-evaluated to examine the reliability of the indicators. An item is considered as reliable if its factor loading appears to be higher than 0.70 (the threshold value) [62]. As a result of the test, 14 items were found that could not fulfill the threshold criteria and subsequently dropped from the model. The resultant model was re-evaluated with revised scales to obtain acceptable psychometric properties. Refer to figure 6.

By deleting the un-reliable items, it was observed that the "factor loadings and composite reliability" values of the measures tend to improve, signifying better convergent validity. A total of 50 (fifty) items remained for further analysis after dropping 9 (nine) unreliable items. Table 8 represents the psychometric properties and values obtained by measuring item reliability, internal consistency, construct reliability and convergent validity of the constructs.

**Table 5.** Case Demographics

| | **Organization Case A** | **Organization Case B** |
|---|---|---|
| Status | Public Sector | Public Sector |
| Type | Healthcare Organization | Healthcare Organization |
| Beds (Approx.) | 1055 | 945 |
| Employees | 1800 | 2100 |
| Departments | 36 | 32 |
| Inpatients (Per Year) | >90000 | >95000 |
| Outpatients (Per Year) | >1000000 | >900000 |
| Associations | Tertiary Level Healthcare Center<br>Nursing Training Institute<br>Medical College<br>Advanced Research Center | Tertiary Level Healthcare Center<br>Nursing Training Institute<br>Medical College<br>Advanced Research Center |

**Table 6.** Organization Type and Gender-wise Participants

| **Organization Type** | **Participants** | %Participants | **Male** | **Female** | %Male | %Female |
|---|---|---|---|---|---|---|
| Public Sector General Hospital | 179 | 47% | 134 | 45 | 74.86% | 25.14% |
| Healthcare Center (Tertiary Level) | 99 | 26% | 61 | 38 | 61.62% | 38.38% |
| Medical Training Center | 48 | 13% | 22 | 26 | 45.83% | 54.17% |
| Medical Research Center | 58 | 15% | 38 | 20 | 65.52% | 34.48% |
| **Total** | **384** | **100%** | **255** | **129** | **66.41%** | **33.59%** |

**Table 7.** Summary of Responses – Case Organizations A & B

| **Summary of Responses to questions (n = Respondents)?** | **(1) Dont Known n (%)** | **(2) Strongly Disagree n (%)** | **(3) Strongly Disagree n (%)** | **(4) Neutral n (%)** | **(5) Some-What Agree** (%) | **(6) Strongly Agree n (%)** |
|---|---|---|---|---|---|---|
| 1- Have knowledge about the term "knowledge management" (KM) | **15.71**% | **7.14%** | **5.71%** | **10%** | **54.28%** | **7.14%** |
| 2- Have knowledge about the importance of KM | **15.71%** | **7.14%** | **5.71%** | **10%** | **54.28%** | **7.14%** |
| 3- Have awareness about the role of KM in healthcare | **28.57%** | **5.71%** | **5.17%** | **7.14%** | **37.71%** | **7.14%** |
| 4- Aware the benefits of KM in healthcare | **28.57%** | **0%** | **0%** | **14.28%** | **38.57%** | **18.57%** |
| 5- KM process Frame work supported by organizational culture | **52.85%** | **12.85%** | **11.42%** | **21.42%** | **1.42%** | **0%** |
| 6- KM process Frame work implemented in the organization | **28.57%** | **18.57%** | **24.28%** | **27.14%** | **1.42%** | **0%** |
| 7- KM process Frame work implementation supported by top management | **47.14%** | **4.28%** | **5.71%** | **8.57%** | **21.42%** | 2.85% |
| 8- Financial support available for KM process implementation | **28.57%** | **2.85%** | **4.28%** | **7.14%** | **24.28%** | **32.85%** |
| 9- Knowledge innovation usage sharing and storage supported by organizational culture | **28.57%** | **5.71%** | **0%** | **15.71%** | **28.57%** | **21.42%** |
| 10- Existence of KM strategy and framework | **57.14%** | **7.14%** | **4.28%** | **21.42%** | **5.71%** | **4.28%** |
| 11- Role of KM in decision making | **52.85%** | **0%** | **0%** | **4.28%** | **11.42%** | **31.42%** |
| 12- Implementation of best practices about KM for pateint care | **48.57%** | **5.71%** | **8.57%** | **31.42%** | **4.28%** | **1.42%** |
| 13- KM supported by organizational infrastruture | **45.71%** | **0%** | **4.28%** | **2.85%** | **8.57%** | **38.57%** |
| 14- Existence of appropriate Technology Infrastructure | **37.71%** | **2.85%** | **7.14%** | **2.85%** | **15.71%** | **37.71%** |

The discriminant validity is the extent to which a construct is truly distinct from other constructs that implies that a construct is unique '[63]. To evaluate the discriminant validity Fornell Larcker Criterion, Cross Loading Criterion Heterotrait-Monotrait (HTMT) Ratio were used. Tables 9, 10 and 11 represent the values obtained by applying all the three-criterion suggesting a substantial and significant discriminant validity.

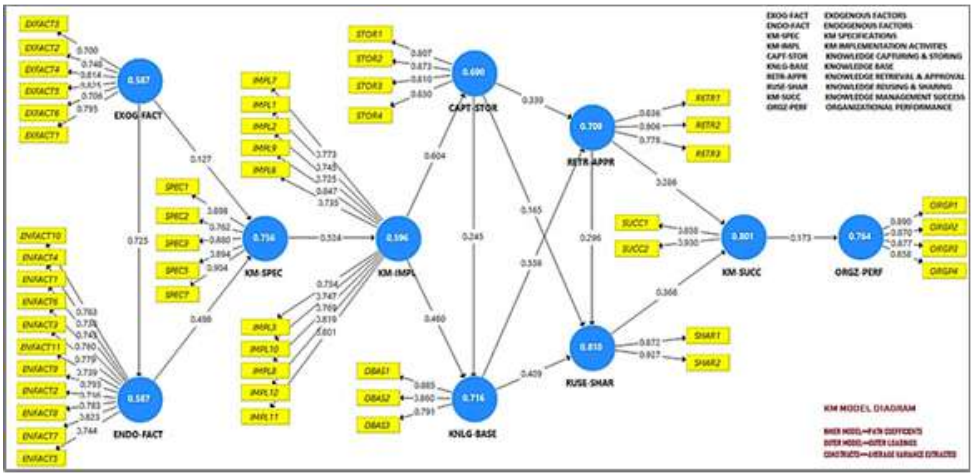


**Figure 6.** Path Coefficients, Outer Loadings & AVE

**Table 8.** Construct Reliability and Validity (PLS Analysis of Measurement Model)

| Constructs | Cronbach's Alpha | rho_A | Composite Reliability | Average Variance Extracted (AVE) |
|---|---|---|---|---|
| CAPT-STOR | 0.850 | 0.853 | 0.899 | 0.690 |
| ENDO-FACT | 0.929 | 0.931 | 0.940 | 0.587 |
| EXOG-FACT | 0.859 | 0.866 | 0.895 | 0.587 |
| KM-SUCC | 0.757 | 0.815 | 0.889 | 0.801 |
| KM-IMPL | 0.925 | 0.928 | 0.937 | 0.596 |
| KM-SPEC | 0.918 | 0.921 | 0.939 | 0.756 |
| KNLG-BASE | 0.806 | 0.837 | 0.883 | 0.716 |
| ORGZ-PERF | 0.897 | 0.905 | 0.928 | 0.764 |
| RETR-APPR | 0.793 | 0.809 | 0.879 | 0.709 |
| RUSE-SHAR | 0.769 | 0.807 | 0.895 | 0.810 |

## 5.3 Assessment of Structural model

Several procedures can be used to assess the explanatory power of the research model. The present research used the assessment procedures for collinearity assessment (VIF – Variance inflation factor), path coefficients assessment (Hypothesis Testing), and coefficients of determination (R2 - Variance explained) assessment. The bootstrapping procedure was used in SMART-PLS 3.0 to assess the structural model. VIF >= 5 indicates a potential collinearity problem [64]. Values below 5 are acceptable, and values below 3 are highly statistically significant [65]. Table 12 represents the obtained values for collinearity assessment (Outer VIF values) and represent no potential collinearity problem in the structural model.

Path coefficient is the coefficient linking construct in the structural model. It represents the hypothesized relationships or the strength of the relationship. A path coefficient value close to "+1" indicates a strong positive relationship, a value near to "0" indicates a weak relationship and a value very close to "0" is not statistically significant. "Chin (1998b) suggested that the magnitude of 0.2 should be considered meaningful (corresponding to a strong enough effect size for the relationship to be considered practically significant)." Table 13 represents the obtained values of path coefficients by running a bootstrapping procedure.

Most researchers use p values (-alpha) to assess significance levels. "The statistical significance of structural paths is evaluated by using a bootstrapping procedure, with 500 resamples [66]." By assuming a significance level of 5 percent, the resulting p values were interpreted as follows: "p 0.05 indicates a statistically significant relationship, p 0.01 indicates highly statistically significant relationship, and p 0.001 indicates very highly statistically significant relationship." Table 14 provide the hypothesis testing results, their interpretation, and effects.

**Table 9.** Fornell & Larcker Criterion (Latent Variables Correlations)

| Constructs | CAPT-STOR | ENDO-FACT | EXOG-FACT | KM-SUCC | KM-IMPL | KM-SPEC | KNLG-BASE | ORGZ-PERF | RETR-APPR | RUSE-SHAR |
|---|---|---|---|---|---|---|---|---|---|---|
| CAPT-STOR | 0.830 | | | | | | | | | |
| ENDO-FACT | 0.259 | 0.766 | | | | | | | | |
| EXOG-FACT | 0.264 | 0.725 | 0.766 | | | | | | | |
| KM-SUCC | 0.120 | 0.615 | 0.625 | 0.895 | | | | | | |
| KM-IMPL | 0.604 | 0.357 | 0.380 | 0.268 | 0.772 | | | | | |
| KM-SPEC | 0.045 | 0.616 | 0.588 | 0.351 | 0.124 | 0.869 | | | | |
| KNLG-BASE | 0.523 | 0.524 | 0.503 | 0.317 | 0.608 | 0.248 | 0.846 | | | |
| ORGZ-PERF | 0.133 | 0.371 | 0.334 | 0.173 | 0.025 | 0.307 | 0.129 | 0.874 | | |
| RETR-APPR | 0.630 | 0.569 | 0.527 | 0.333 | 0.651 | 0.312 | 0.733 | 0.150 | 0.842 | |
| RUSE-SHAR | 0.566 | 0.424 | 0.381 | 0.268 | 0.733 | 0.192 | 0.713 | 0.139 | 0.700 | 0.900 |

**Table 10.** Correlations between constructs compared to square roots of AVE

| Constructs | CAPT-STOR | ENDO-FACT | EXOG-FACT | KM-SUCC | KM-IMPL | KM-SPEC | KNLG-BASE | ORGZ-PERF | RETR-APPR | RUSE-SHAR | AVE | SQRT(AVE) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CAPT-STOR | 1.000 | 0.259 | 0.264 | 0.120 | 0.604 | 0.045 | 0.523 | 0.133 | 0.630 | 0.566 | 0.690 | 0.830 |
| ENDO-FACT | 0.259 | 1.000 | 0.926 | 0.615 | 0.357 | 0.616 | 0.524 | 0.371 | 0.569 | 0.424 | 0.587 | 0.766 |
| EXOG-FACT | 0.264 | 0.725 | 1.000 | 0.625 | 0.380 | 0.588 | 0.503 | 0.334 | 0.527 | 0.381 | 0.587 | 0.766 |
| KM-SUCC | 0.120 | 0.615 | 0.625 | 1.000 | 0.268 | 0.351 | 0.317 | 0.173 | 0.333 | 0.268 | 0.801 | 0.895 |
| KM-IMPL | 0.604 | 0.357 | 0.380 | 0.268 | 1.000 | 0.124 | 0.608 | 0.025 | 0.651 | 0.733 | 0.596 | 0.772 |
| KM-SPEC | 0.045 | 0.616 | 0.588 | 0.351 | 0.124 | 1.000 | 0.248 | 0.307 | 0.312 | 0.192 | 0.756 | 0.869 |
| KNLG-BASE | 0.523 | 0.524 | 0.503 | 0.317 | 0.608 | 0.248 | 1.000 | 0.129 | 0.733 | 0.713 | 0.716 | 0.846 |
| ORGZ-PERF | 0.133 | 0.371 | 0.334 | 0.173 | 0.025 | 0.307 | 0.129 | 1.000 | 0.150 | 0.139 | 0.764 | 0.874 |
| RETR-APPR | 0.630 | 0.569 | 0.527 | 0.333 | 0.651 | 0.312 | 0.733 | 0.150 | 1.000 | 0.700 | 0.709 | 0.842 |
| RUSE-SHAR | 0.566 | 0.424 | 0.381 | 0.268 | 0.733 | 0.192 | 0.713 | 0.139 | 0.700 | 1.000 | 0.810 | 0.900 |

**Table 11.** Heterotrait-Monotrait (HTMT) Ratio

| Constructs | CAPT-STOR | ENDO-FACT | EXOG-FACT | KM-SUCC | KM-IMPL | KM-SPEC | KNLG-BASE | ORGZ-PERF | RETR-APPR | RUSE-SHAR |
|---|---|---|---|---|---|---|---|---|---|---|
| CAPT-STOR | | | | | | | | | | |
| ENDO-FACT | 0.286 | | | | | | | | | |
| EXOG-FACT | 0.306 | 0.816 | | | | | | | | |
| KM-SUCC | 0.159 | 0.732 | 0.777 | | | | | | | |
| KM-IMPL | 0.671 | 0.378 | 0.433 | 0.306 | | | | | | |
| KM-SPEC | 0.064 | 0.666 | 0.659 | 0.427 | 0.140 | | | | | |
| KNLG-BASE | 0.607 | 0.588 | 0.587 | 0.404 | 0.678 | 0.286 | | | | |
| ORGZ-PERF | 0.075 | 0.407 | 0.373 | 0.205 | 0.086 | 0.337 | 0.151 | | | |
| RETR-APPR | 0.758 | 0.663 | 0.634 | 0.418 | 0.757 | 0.369 | 0.812 | 0.182 | | |
| RUSE-SHAR | 0.700 | 0.476 | 0.439 | 0.309 | 0.761 | 0.212 | 0.785 | 0.172 | 0.720 | |

**Table 12.** Outer VIF (Variance Inflation Factor $\leq 5$)

| INDICATORS | VIF | INDICATORS | VIF | INDICATORS | VIF | INDICATORS | VIF | INDICATORS | VIF |
|---|---|---|---|---|---|---|---|---|---|
| DBAS1 | 2.203 | ENFACT1 | 3.105 | EXFACT1 | 2.212 | IMPL1 | 3.123 | ORGP1 | 2.963 |
| DBAS2 | 1.606 | ENFACT10 | 3.124 | EXFACT2 | 1.914 | IMPL10 | 2.617 | ORGP2 | 2.787 |
| DBAS3 | 1.799 | ENFACT11 | 2.308 | EXFACT3 | 1.636 | IMPL11 | 3.316 | ORGP3 | 2.944 |
| SPEC1 | 3.376 | ENFACT2 | 2.852 | EXFACT4 | 2.811 | IMPL12 | 3.142 | ORGP4 | 2.734 |
| SPEC2 | 1.727 | ENFACT3 | 3.438 | EXFACT5 | 2.827 | IMPL2 | 2.123 | RETR1 | 1.821 |
| SPEC3 | 3.137 | ENFACT4 | 2.230 | EXFACT6 | 1.642 | IMPL3 | 2.606 | RETR2 | 2.207 |
| SPEC5 | 3.237 | ENFACT5 | 2.903 | STOR1 | 1.946 | IMPL6 | 2.066 | RETR3 | 1.509 |
| SPEC7 | 3.711 | ENFACT6 | 2.462 | STOR2 | 2.515 | IMPL7 | 2.615 | SHAR1 | 1.638 |
| SUCC1 | 1.590 | ENFACT7 | 2.954 | STOR3 | 1.945 | IMPL8 | 2.620 | SHAR2 | 1.638 |
| SUCC2 | 1.690 | ENFACT8 | 2.790 | STOR4 | 2.274 | IMPL9 | 3.432 | ENFACT9 | 3.584 |

Figure 7 illustrates the hypothesis testing and significance of relationships in diagrammatic format. This figure was acquired by performing the bootstrapping procedure on the available data items in the SMART-PLS 3.0 software.

The coefficients of determinants (R2) also known as variance explained, measures the predictive accuracy of the structural model. The threshold value ranges

**Table 13.** Path Coefficients

| Constructs | CAPT-STOR | ENDO-FACT | EXOG-FACT | KM-SUCC | KM-IMPL | KM-SPEC | KNLG-BASE | ORGZ-PERF | RETR-APPR | RUSE-SHAR |
|---|---|---|---|---|---|---|---|---|---|---|
| CAPT-STOR | | | | | | | 0.245 | | 0.339 | 0.165 |
| ENDO-FACT | | | | | 0.498 | | | | | |
| EXOG-FACT | | 0.725 | | | | 0.127 | | | | |
| KM-SUCC | | | | | | | | 0.173 | | |
| KM-IMPL | 0.604 | | | | | | 0.460 | | | |
| KM-SPEC | | | 0.524 | | | | | | | |
| KNLG-BASE | | | | | | | | 0.556 | 0.409 | |
| ORGZ-PERF | | | | | | | | | | |
| RETR-APPR | | | 0.286 | | | | | | | 0.296 |
| RUSE-SHAR | | | 0.368 | | | | | | | |

**Table 14.** Hypothesis testing and results interpretation

| Hypothesis | | Path Coefficients (r>0) | p Value (p<0.05) | Effect Size ($f^2$) (>0.02) | Effect Results |
|---|---|---|---|---|---|
| EXOG-FACT → ENDO-FACT | H1 | 0.725 | <0.0001 | 0.645 | Significant with Large Effect |
| EXOG-FACT → KM-SPEC** | H2a** | 0.127** | 0.3731** | 0.094** | **Non-significant with Small Effect |
| ENDO-FACT → KM-SPEC | H2b | 0.498 | 0.0002 | 0.554 | Significant with Large Effect |
| KM-SPEC → KM-IMPL | H3 | 0.524 | 0.0270 | 0.216 | Significant with Medium to Large Effect |
| KM-IMPL → CAPT-STOR | H4a | 0.604 | <0.0001 | 0.574 | Significant with Large Effect |
| KM-IMPL → KNLG-BASE | H4b | 0.460 | <0.0001 | 0.247 | Significant with Medium to Large Effect |
| CAPT-STOR → KNLG-BASE | H5a | 0.245 | <0.0001 | 0.164 | Significant with Medium Effect |
| CAPT-STOR → RETR-APPR | H5b | 0.339 | <0.0001 | 0.221 | Significant with Medium to Large Effect |
| CAPT-STOR → RUSE-SHAR | H5c | 0.165 | 0.0044 | 0.217 | Significant with Medium to Large Effect |
| KNLG-BASE → RETR-APPR | H6a | 0.556 | <0.0001 | 0.594 | Significant with Large Effect |
| KNLG-BASE → RUSE-SHAR | H6b | 0.409 | <0.0001 | 0.387 | Significant with Large Effect |
| RETR-APPR → RUSE-SHAR | H7 | 0.296 | 0.0003 | 0.182 | Significant with Medium Effect |
| RETR-APPR → KM-SUCC | H8a | 0.286 | 0.0064 | 0.047 | Significant with Small to Medium Effect |
| RUSE-SHAR → KM-SUCC | H8b | 0.368 | 0.0008 | 0.053 | Significant with Small to Medium Effect |
| KM-SUCC → ORGZ-PERF** | H9** | 0.173** | 0.3073** | 0.031** | **Non-significant with Small Effect |

**Non-Significant relationship with minimal effect

from 0 to 1. The higher levels indicate higher levels of predicting accuracy. According to Chin (1998b), value levels of 0.67, 0.33 and 0.25 are considered as substantial, moderate and weak respectively. The obtained values by performing the bootstrapping procedure in the current study are represented in table 15.

## 5.4 Interview results evaluation

The respondents provided their all-around expert opinions on almost every aspect of KM implementation and application activities along with the external and internal influential factors that impact KM success in "public-sector healthcare organizations in Pakistan." Following are the salient points that have been summarized as findings of the qualitative study:

1. Knowledge management is a term that is not clear or understandable to everyone except those who are connected to it and work in research and development (R&D) departments of public-sector healthcare organizations.
2. Data and information sharing are confused with knowledge sharing. The typical IT management systems are considered as KM systems by ordinary healthcare professionals who do not clearly understand the concepts of KM.
3. Knowledge sharing takes place during casual discussions over tea tables or official breaks rather than through Communities of practices (CoPs).
4. Other knowledge sharing resources used are self-developed internal sharing mechanisms or non-traditional IT tools.
5. Knowledge management and knowledge sharing are restricted to R&D departments of the healthcare organizations and hence are not fully practiced in public-sector healthcare organizations by healthcare professionals and other stakeholders.
6. Knowledge management is essential in view of almost all the respondents concerning public-sector healthcare organizations. However, they also consider the requirement of more valuable

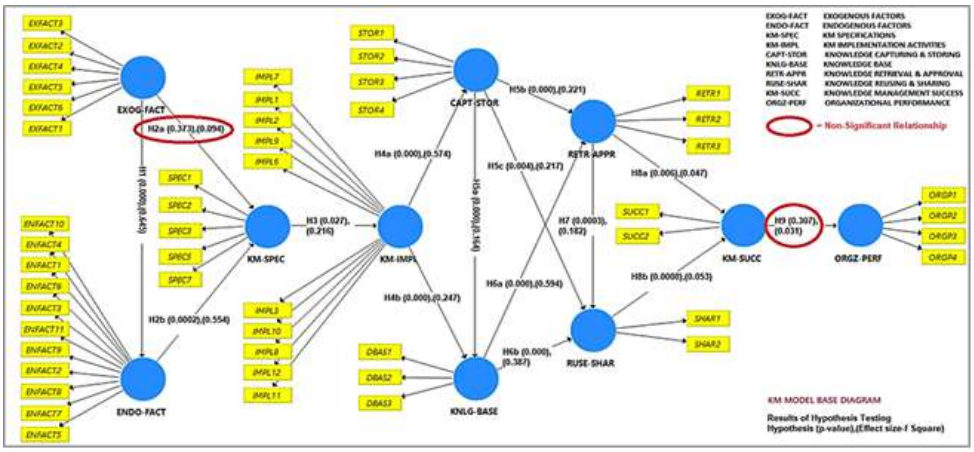


**Figure 7.** KM Model Diagram (Hypothesis testing & relationship significance)

**Table 15.** Coefficient of determinants ($R^2$- Variance Explained) results

| Constructs | R Square | R Square Adjusted | Accuracy Prediction |
|---|---|---|---|
| CAPT-STOR | 0.365 | 0.363 | Moderate |
| ENDO-FACT | 0.858 | 0.857 | Substantial |
| KM-SUCC | 0.113 | 0.109 | Weak |
| KM-IMPL | 0.335 | 0.333 | Moderate |
| KM-SPEC | 0.381 | 0.378 | Moderate |
| KNLG-BASE | 0.408 | 0.405 | Moderate to Substantial |
| ORGZ-PERF | 0.130 | 0.128 | Weak |
| RETR-APPR | 0.622 | 0.620 | Substantial |
| RUSE-SHAR | 0.593 | 0.589 | Moderate to Substantial |

resources in terms of cost and technology to implement KM systems.

7. The respondents wholeheartedly agree to the perception that external and internal influential factors do impose a great deal of impact on the working and functioning of KM implementation and application activities.
8. Economic conditions and social culture are one of the most critical exogenous factors for implementing KM practices successfully.
9. Among influential internal factors, organizational culture, top management support and leadership, IT infrastructure, organizational structure, and performance measurement are the key factors that impact the definition of KM system specifications and implementation activities.
10. According to the respondent's expert opinion, knowledge capturing, storing, retrieval, sharing and reusing activities have a great deal of impact on KM success in healthcare organizations.
11. Top management support & leadership and a significant IT infrastructure are considered to be the most critical factors that influence and encourage the provision of a healthy and suitable working environment for healthcare professionals to involve in the KM practices.

## 6 Development of the component-based model

In scientific understanding, a model represents an idea, an object or even a process or a system that describes and explains a phenomenon that cannot be experienced directly. The proposed KM model for healthcare is determined and developed as a result of 3 staged process as:

- **(Stage-1)** Development of the Conceptual Model
- **(Stage-2)** Development & Assessment of the Statistical (Empirical) Model
- **(Stage-3)** Development of the Component-based Model

A conceptual model represents a system that values concepts and ideas to form the said representation. Figure 8 represents the final draft of conceptual model of the proposed component-based KM model.

In component-based modelling, a component is the superposition of a behavioural model and an interaction model. Behavior models represent the dynamic behavior of components. Interaction models illustrate architectural constraints induced by connections between components. After testing the hypothesis and the empirical model for measurement and structure, the conceptual model was enhanced and converted to an integrated and component-based model using a four layered architecture defined as: 1) The Control Layer; 2) The Application Layer; 3) The Domain Layer; and 4) The User-Interface Layer. Figure 9 illustrates the proposed integrated component-based model.

## 7 Discussions

The implementation of a well-structured KM system by using KM models is evident and inevitable in today's world in service-based industries such as healthcare. Using KM model is a structured way to observe the process of KM used by an organization in order to explore its properties and tailoring it to the organization's specific needs. The development of the proposed integrated and component-based KM model for public-sector healthcare organizations in Pakistan was the ultimate solution to meet the research objectives and address the research questions. The overall findings for each research objective (ROB) are discussed one by one hereunder.

### 7.1 ROB1 – Explore and review existing KM practices

The primary purpose of this research objective was to gain and acquire a clear and evident understanding of the existing state of KM practices (if any) being implemented in the public-sector healthcare organizations of Pakistan. The initial findings were gathered by accomplishing structured walkthroughs, self-observation, SWOT Analysis and review of existing documents in two of the largest and reputed public-sector healthcare organizations of one of the densely populated provincial capital in Pakistan. The initial findings revealed that both the healthcare organizations under study have a significant and sound IT infrastructure which helps to deal with day-to-day healthcare activities and supports all the necessary functions that are performed to gather, acquire and process essential data and information associated to healthcare processes and procedures. The IT systems included conventional database systems for data and information storage that are equipped with front-end applications to support data/information capturing, storing, retrieval, and usage activities.

Furthermore, both the healthcare organizations also exhibited to possess a sound and professional organizational infrastructure that supports the healthcare activities at strategic, tactical and operational levels. Further inquiry disclosed that every mind connected with both the organizations under study has a different understanding or meanings about KM and its concepts. Even professionals believe that using ordinary IT or ICT systems are the same as KM systems and sharing routine information was thought to be sharing knowledge among themselves. This narrative was confirmed by performing a scientific investigative exploration technique known as SWOT Analysis. A significant number of respondents related to Research and Development domain of both the organizations exhibited some meaningful information and knowledge regarding KM and its related concepts.

### 7.2 ROB2 – Explore and investigate the KM influential factors

A significant number of influential factors were explored and were divided into two groups, i.e., Exogenous factors and Endogenous factors. Exogenous factors were related to all those factors which impact the success of KM activities and systems from outside the organization and are extra-organizational. Endogenous factors were related to all those factors that impact the KM success from inside the organization and are intra-organizational. The empirical study of the proposed KM model described a strong and significant relationship between both the exogenous factors and endogenous factors, and it was found that the exogenous factors exhibit a significant impact on endogenous factors and in continuation the

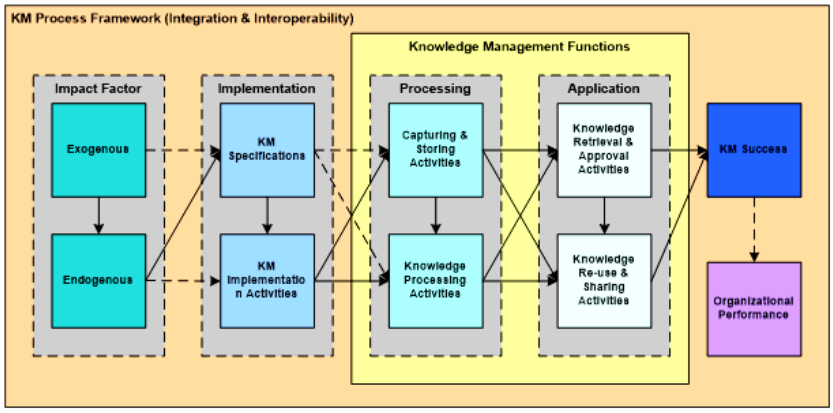


**Figure 8.** Final Draft of the Conceptual model for the proposed KM Model

endogenous factors have a significant impact on the definition and description of KM system specifications. The empirical study also illustrated an indirect but significant impact of influential factors on KM success through the mediating role of KM implementation activities and KM application activities through statistical testing of the structured equation model for the significance of relationships and path coefficients. By performing a detailed quantitative and qualitative study in the public-sector healthcare setup, it was found that the exogenous factors (Social culture, Economic Conditions, Governance, and personal preferences) possess a great deal of impact that influences the organizational culture and strategy for successful implementation of KM practices in healthcare organizations. Furthermore, top management support, IT infrastructure, organizational culture, organizational infrastructure, and KM resources are among some of the endogenous factors that influence the KM practices directly or indirectly in public-sector healthcare organizations of Pakistan.

## 7.3 ROB3 – Analyse and evaluate existing KM models

The primary focus of this objective was to analyse and evaluate the existing KM models proposed by other researchers that are meant to be implemented in healthcare organizations in Pakistan and identify gaps or deficiencies in them. While conducting a literature review, it was determined that not much work had been done in this area of study for the Pakistani healthcare sector. Some of the published research that proposed KM models/frameworks related to the KM in the healthcare industry of Pakistan were studied and evaluated. Each of them possesses its Pros and Cons, but neither of them has presented a KM framework that effectively deals with the procedural implications of KM in the healthcare industry of Pakistan.

## 7.4 ROB4 – Develop an enhanced integrated KM model

The KM model was developed and proposed through a three-staged model development process. Firstly, a conceptual model was proposed; secondly, the conceptual model was converted and enhanced to an empirical model that was tested statistically through a scientific technique known as PLS-SEM for significance and effectiveness. Finally, the integrated and component-based KM model for public-sector healthcare industry was deduced and proposed in the form of a four-layered structured architecture model.

## 7.5 ROB5 – Assess the model fitness by empirical testing

This objective was achieved by testing the proposed KM model by applying a statistical scientific technique known as structured equation modelling (SEM). In this method, the model was tested in two phases: measurement model analysis and structural model analysis. The measurement model analysis tested the significance of construct and their relationships along with

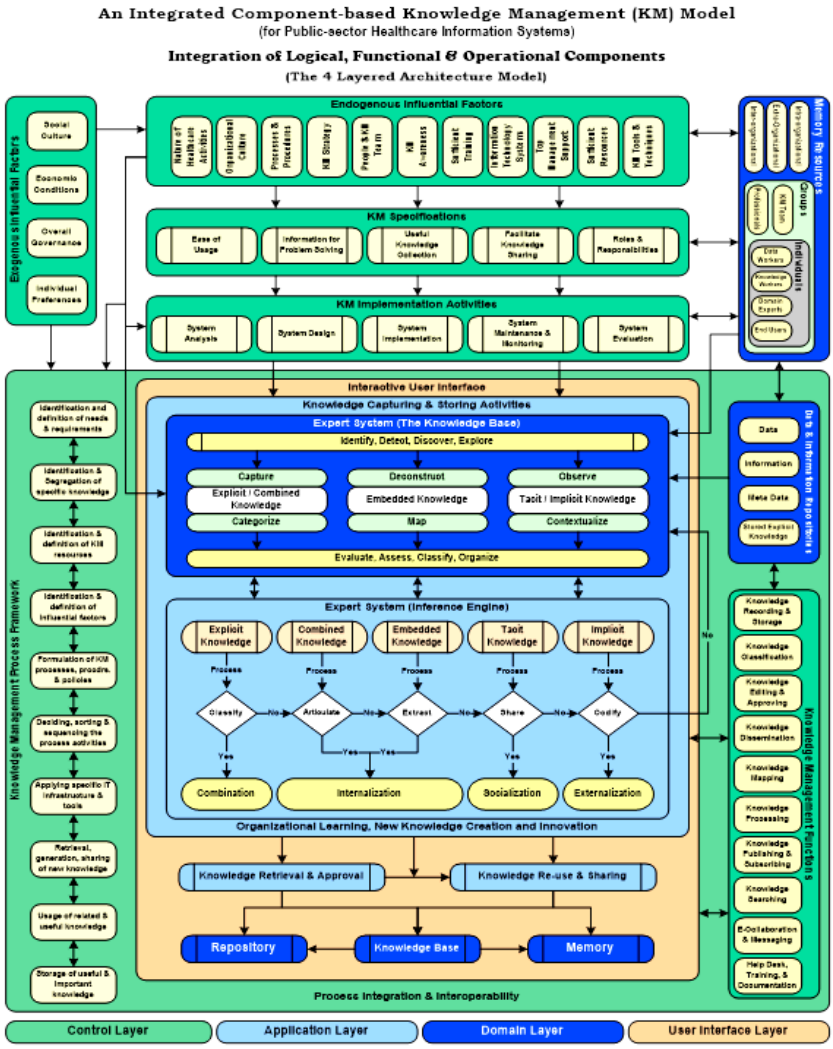


**Figure 9.** Comprehensive & Integrated Component-Based KM Model for Public Sector Healthcare Organizations of Pakistan

the path analysis while the structural model analysis tested the hypothesis and overall variance along with model fitness. The proposed KM model assessment findings showed significant relationships among most of the constructs except between KM success and organizational performance and between Exogenous factors and KM specifications. This also showed that instead of exogenous factors, endogenous factors have a strong and significant relationship with KM system specifications. Other than this, it was also revealed that KM success is not only the particular factor that influences organizational performance. There are multiple factors including KM success that impose a combined effect of impacting organizational performance.

## 8 Implications for practice & limitations

The research implications of the present study describe the impact of the research outcome on future studies associated with the similar domain or subject field. Based on the findings and outcomes of the current study the implications drawn can be expressed as a consolidation of theoretical, practical and methodological implications. The current study attempts to answer several research questions related to know-how and the existing state of KM practices in public-sector healthcare organizations of Pakistan. Specifically, this study provides a robust platform through which the healthcare organizations could make themselves known and improve their material

practices and achieve organizational strategic objectives related to KM. Moreover, the procedures and techniques used to capture, process and present the healthcare and medical data/information/knowledge require a scientific process to simplify the vocabulary of words which is consistent, reliable and centralized throughout the organization. Lack of simplified medical knowledge vocabulary hinders knowledge understanding, its re-use and sharing activities and act as a barrier [67]. Furthermore, motivation and promotion of frequent social interaction between healthcare professionals by creating online communities of practices (OCPs) help to provide a suitable platform for sharing personal experiences in the form of tacit knowledge. Top management and leadership support of the healthcare organizations can encourage such type of communities that can improve the quality of knowledge sharing regarding relevance, to the point and timeliness of dissemination.

The limitations of the current study are accounted regarding the research approach adopted, the research methodology used, the domain area defined for the study and the type of participants of the study. One of the significant limitations of the present study is itself the choice of healthcare domain concerning public-sector healthcare organizations of Pakistan where access to resources for collecting data and information for the investigation is a challenging task to perform and is far more different as compared to private-sector healthcare organizations. Due to multicultural, multilingual and multi-ethnic society, Pakistan possesses a rich cultural diversity. Hence the findings and the results of the study may not be generalized to the whole country and may vary for other environments such as small towns and rural areas due to socio-cultural differences. Another limitation of the current study was reliance and dependency of the construct measurements on the accuracy of responses of the participants' ability, readiness, and understanding of the current state of the healthcare information systems concerning KM that may raise the question of potential sources of bias. Moreover, participants' misconceptions related to knowledge and KM domain present another potential reason for the limitations of the study.

## 9 Future research recommendations

The proposed integrated and component-based KM model is constructed by keeping in view the importance of comprehensiveness and usefulness of the structured methodology that strives to deal with the deficiencies and problems present in other KM models. This recommends and facilitates the successful adoption and implementation of KM in healthcare KM systems in public-sector healthcare organizations of Pakistan. However, there is always an opportunity for improvement and innovation in every research. The present study could be used to examine further the factors that are supplementary to the KM success which influence the organizational performance. Additionally, future research could examine and investigate the proposed model fitness for implementation in the domains and fields of study other than healthcare. The present study could be extended to different geological areas characterizing a heterogeneous society and enhanced accordingly. Similarly, the study could be replicated to extend to the healthcare professionals that are not covered by the present study such as paramedics, nurses, pharmacists, etc. to figure out the generalizability of the research findings. Furthermore, the factors that did not depict a statistical significance in the empirical model of the current study could be re-analysed and re-evaluated for their role in KM success. Similar considerations pertain to identify and define other factors that influence the KM success in multicultural and multi-ethnic environments.

Finally, the current study used a cross-sectional research design methodology to develop and propose the KM model. Therefore, it is suggested for the future studies, that the longitudinal research design methodology could be adopted to construct the same model to perform a comparative analysis among the findings and results of the research. It is also highly recommended that the significance of the proposed KM model must be practically evaluated by performing case studies.

## 10 Conclusions

The primary purpose of the study was to investigate the existing state of KM and to explore the influential factors that impact the successful implementation of KM activities and practices in public-sector healthcare organizations of Pakistan. The initial study revealed numerous problems and research questions. To address these problems a conceptual KM model was proposed based upon the analysis of the existing state of KM practices.

To test the model hypothetically, an explanatory sequential mixed method research design methodology was adopted, and the model was tested empirically by the help of quantitative data obtained through the cross-sectional surveys using PLS-SEM. The results were cross-checked by performing a qualitative analysis by conducting interviews. After testing, the empirical model was further enhanced and converted into a comprehensive and integrated component-based KM model for implementation in the public-sector healthcare organizations of Pakistan. To develop the proposed KM model, a four-layered architecture model was used to segregate the functional components of the KM model for better understanding the complexity and working of the proposed model.

Finally, the current study intended to help healthcare organizations to manage the knowledge in a better, effective and efficient way by devising and proposing a new integrated component-based KM model for improving KM governance. The study suggests that such governance over KM practices and their success cannot be achieved without controlling exogenous and endogenous factors that influence the successful implementation of KM activities.

## Acknowledgements

The authors would like to render special thanks to all those professionals, domain experts and participants of the study whose exclusive support and help made this research and study possible. We would also like to acknowledge and appreciate the kindness and support provided by the concerned authorities related to public-sector healthcare industry of Pakistan.

## Author Contributions

**Arfan Arshad:** Conceptualization, project oversight.**Abid Ghaffar:** Methodology design, drafting, final review. **Muhammad Usman Siddique:**Supervision, Software integration, resource coordination.**Syed Ali Sultan:** Literature survey, validation, refinement.**Asim Manzoor:** Investigation, visualization, technical input.

## Compliance with Ethical Standards

It is declare that all authors don't have any conflict of interest. It is also declare that this article does not contain any studies with human participants or animals performed by any of the authors. Furthermore, informed consent was obtained from all individual participants included in the study.

## Funding Information

No funding was provided for this research

## References

[1] W. M. Cohen and D. A. Levinthal, "Absorptive capacity: A new perspective on learning and innovation," *Administrative Science Quarterly*, vol. 35, no. 1, pp. 128–152, 1990.

[2] C. M. Fiol, "Squeezing harder doesn't always work: Continuing the search for consistency in innovation research," *Academy of Management Review*, vol. 21, no. 4, pp. 1012–1021, 1996.

[3] M. E. Jennex and L. Olfman, "Assessing knowledge management success," *International Journal of Knowledge Management*, vol. 1, no. 2, pp. 33–49, 2004.

[4] K. Ichijo and I. Nonaka, *Knowledge Creation and Management: New Challenges for Managers*. Oxford University Press, 2006.

[5] M. Goswami and A. K. Goswami, "Integrated framework for implementing knowledge management in contemporary organizations," *Global Journal of Management and Business Studies*, vol. 3, no. 6, pp. 611–618, 2013.

[6] C. W. Holsapple and K. D. Joshi, "Description and analysis of existing knowledge management frameworks," in *Proceedings of the 32nd Annual Hawaii International Conference on Systems Sciences*, IEEE, 1999.

[7] B. Marr, O. Gupta, S. Pike, and G. Roos, "Intellectual capital and knowledge management effectiveness," *Management Decision*, vol. 41, no. 8, pp. 771–781, 2003.

[8] S. Martelo-Landroguez, J. G. Cegarra-Navarro, and G. Cepeda-Carrión, "Knowledge management and innovation: Is there a clear link?," *International Journal of Innovation and Learning*, vol. 10, no. 4, pp. 354–367, 2011.

[9] N. Wickramasinghe, R. K. Bali, and E. Geisler, "The major barriers and facilitators for the adoption and implementation of knowledge management in healthcare operations," *International Journal of Electronic Healthcare*, vol. 3, no. 3, pp. 367–381, 2007.

[10] D. Nicolini, J. Powell, P. Conville, and L. Martinez-Solano, "Managing knowledge in the healthcare sector. a review," *International Journal of Management Reviews*, vol. 10, no. 3, pp. 245–263, 2008.

[11] S. S. R. Abidi, Y. N. Cheah, and J. Curran, "A knowledge creation info-structure to acquire and crystallize the tacit knowledge of health-care experts," *IEEE Transactions on Information Technology in Biomedicine*, vol. 9, no. 2, pp. 193–204, 2005.

[12] N. Wickramasinghe, R. K. Bali, M. C. Gibbons, J. H. Choi, and J. L. Schaffer, "A systematic approach: optimization of healthcare operations with knowledge management," *Journal of Healthcare Information Management: JHIM*, vol. 23, no. 3, pp. 44–50, 2009.

[13] R. K. Bali, N. Wickramasinghe, B. Lehaney, J. Schaffer, and M. C. Gibbons, *Healthcare knowledge management primer*. London: Routledge, 2009.

[14] R. Hall and P. Andriani, "Managing knowledge associated with innovation," *Journal of Business Research*, vol. 56, no. 2, pp. 145–152, 2003.

[15] A. M. Fairchild, "Knowledge management metrics via a balanced scorecard methodology," in *Proceedings of the 35th Annual Hawaii International Conference on System Sciences*, pp. 3173–3180, IEEE, 2002.

[16] M. Stankosky and C. Baldanza, "A systems approach to engineering a knowledge management system," in *Knowledge Management: The Catalyst for Electronic Government*, p. 137, Vienna: Management Concepts, 2001.

[17] I. B. Fernandez and R. Sabherwal, *Knowledge management systems and processes*. ME Sharpe, Inc., 2010.

[18] F. Hussain and S. A. Raza, "A knowledge management framework to operationalize experiential knowledge: mapping tacit medical knowledge with explicit practice guidelines," in *National Conference on Emerging Technologies*, p. 93, 2004.

[19] Z. Bin Abd Karim, *Modelling the Relationship Between Intelligence, Knowledge Management and Innovation Among Knowledge Workers in Malaysia*. Doctoral dissertation, International Islamic University Malaysia (IIUM), 2016.

[20] M. F. Noordin, A. Arshad, and R. Othman, "Kiipf—an integrated inter-operable knowledge management process framework for healthcare," *Journal of Cases on Information Technology*, vol. 19, no. 3, pp. 24–41, 2017.

[21] A. Khan, "Pakistan economic survey 2010-11: Health and nutrition." http://www.finance.gov.pk. Ministry of Finance, Retrieved 7 February 2018.

[22] A. Razzaque and A. Jalal-Karim, "Conceptual healthcare knowledge management model for adaptability and interoperability of ehr," in *European, Mediterranean & Middle Eastern Conference on Information Systems*, pp. 12–13, 2010.

[23] A. Arshad, M. F. B. Noordin, and R. B. Othman, "A comprehensive knowledge management process framework for healthcare information systems," in *2016 6th International Conference on ICT for the Muslim World (ICT4M)*, pp. 30–35, IEEE, 2016.

[24] T. S. Purnell *et al.*, "Achieving health equity: closing the gaps in health care disparities," *Health Affairs*, vol. 35, no. 8, pp. 1410–1415, 2016.

[25] A. Burney, Z. Abbas, N. Mahmood, and Q. U. Arifeen, "Prospects for mobile health in pakistan and other developing countries," 2013.

[26] M. F. Noordin, *ICT and Islam*. IIUM Press, 2009.

[27] N. Mahmood, A. Burney, Z. Abbas, and K. Rizwan, "Data and knowledge management in healthcare information systems," *International Journal of Computer Applications*, vol. 50, no. 2, 2012.

[28] S. Hameed, J. Karamat, and K. Mehmood, "Effectual dynamics and prolific usage of km in healthcare," *Life Science Journal*, vol. 9, no. 2, pp. 110–118, 2012.

[29] S. Pasha, "A pragmatic approach for implementing km in pakistani organizations using open source technologies," *International Journal of Computer Applications*, vol. 49, no. 7, 2012.

[30] T. H. Davenport, W. David, and M. C. Beers, "Successful knowledge management projects," *Sloan Management Review*, vol. 39, no. 2, pp. 43–58, 1998.

[31] R. J. Theirauf, *Knowledge Management Systems*. Quorum Books, 1999.

[32] G. Bellinger, D. Castro, and A. Mills, "Data, information, knowledge, and wisdom," 2004.

[33] M. F. Noordin, R. Othman, and N. A. Zakaria, "Peopleware & heartware—the philosophy of km," in *2011 International Conference on Research and Innovation in Information Systems*, pp. 1–6, IEEE, 2011.

[34] P. F. Drucker, "Knowledge-worker productivity: The biggest challenge," *California Management Review*, vol. 41, no. 2, pp. 79–94, 1999.

[35] T. H. Davenport and L. Prusak, *Working Knowledge*. Harvard Business School Press, 2000.

[36] J. Yang, "The impact of knowledge sharing on organizational learning and effectiveness," *Journal of Knowledge Management*, vol. 11, no. 2, pp. 83–90, 2007.

[37] J. H. Wu and Y. M. Wang, "Measuring kms success," *Information & Management*, vol. 43, no. 6, pp. 728–739, 2006.

[38] L. A. Halawi, R. V. McCarthy, and J. E. Aronson, "Empirical investigation of kms success," *Journal of Computer Information Systems*, vol. 48, no. 2, pp. 121–135, 2008.

[39] U. R. Kulkarni, S. Ravindran, and R. Freeze, "A knowledge management success model," *Journal of MIS*, vol. 23, no. 3, pp. 309–347, 2006.

[40] J. Y. Lai, C. T. Wang, and C. Y. Chou, "Knowledge map fit and personalization," *Technovation*, vol. 29, no. 4, pp. 313–324, 2009.

[41] J. N. Lee, M. Q. Huynh, R. C. W. Kwok, and S. M. Pi, "It outsourcing evolution," *Information & Management*, vol. 41, no. 1, pp. 75–82, 2003.

[42] M. Alavi and D. E. Leidner, "Knowledge management and knowledge management systems: Conceptual foundations and research issues," *MIS Quarterly*, vol. 25, no. 1, pp. 107–136, 2001.

[43] H. Tanriverdi, "Information technology relatedness, knowledge management capability, and performance of multibusiness firms," *MIS Quarterly*, vol. 29, no. 2, pp. 311–334, 2005.

[44] B. D. Janz and P. Prasarnphanich, "Understanding the antecedents of effective knowledge management: The importance of a knowledge-centered culture," *Decision Sciences*, vol. 34, no. 2, pp. 351–384, 2003.

[45] T. Andreeva and A. Kianto, "Does knowledge management really matter? linking km practices, competitiveness and economic performance," *Journal of Knowledge Management*, vol. 16, no. 4, pp. 617–636, 2012.

[46] A. H. Gold, A. Malhotra, and A. H. Segars, "Knowledge management: An organizational capabilities perspective," *Journal of Management Information Systems*, vol. 18, no. 1, pp. 185–214, 2001.

[47] W. Tsai, "Knowledge transfer in intraorganizational networks: Effects of network position and absorptive capacity on business unit innovation and performance," *Academy of Management Journal*, vol. 44, no. 5, pp. 996–1004, 2001.

[48] S. A. Zahra and G. George, "Absorptive capacity: A review, reconceptualization, and extension," *Academy of Management Review*, vol. 27, no. 2, pp. 185–203, 2002.

[49] D. J. Teece, G. Pisano, and A. Shuen, "Dynamic capabilities and strategic management," *Strategic Management Journal*, vol. 18, no. 7, pp. 509–533, 1997.

[50] I. Nonaka and H. Takeuchi, *The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation*. Oxford University Press, 1995.

[51] R. M. Grant, "Toward a knowledge-based theory of the firm," *Strategic Management Journal*, vol. 17, no. S2, pp. 109–122, 1996.

[52] I. Becerra-Fernandez and R. Sabherwal, "Organizational knowledge management: A contingency perspective," *Journal of Management Information Systems*, vol. 18, no. 1, pp. 23–55, 2001.

[53] H. Lee and B. Choi, "Knowledge management enablers, processes, and organizational performance: An integrative view and empirical examination," *Journal of Management Information Systems*, vol. 20, no. 1, pp. 179–228, 2003.

[54] R. Sabherwal and I. Becerra-Fernandez, "An empirical study of the effect of knowledge management processes at individual, group, and organizational levels," *Decision Sciences*, vol. 34, no. 2, pp. 225–260, 2003.

[55] R. Maier and U. Remus, "Implementing process-oriented knowledge management strategies," *Journal of Knowledge Management*, vol. 7, no. 4, pp. 62–74, 2003.

[56] A. Tiwana, *The Knowledge Management Toolkit: Orchestrating IT, Strategy, and Knowledge Platforms*. Prentice Hall, 2002.

[57] M. Earl, "Knowledge management strategies: Toward a taxonomy," *Journal of Management Information Systems*, vol. 18, no. 1, pp. 215–233, 2001.

[58] B. Choi and H. Lee, "An empirical investigation of km styles and their effect on corporate performance," *Information & Management*, vol. 40, no. 5, pp. 403–417, 2003.

[59] M. E. D. Koenig, "What is km? knowledge management explained," *KM World*, vol. 21, no. 3, pp. 8–9, 2012.

[60] Y. Malhotra, "Knowledge assets in the global economy: Assessment of national intellectual capital," *Journal of Global Information Management*, vol. 8, no. 3, pp. 5–15, 2000.

[61] K. M. Wiig, "Knowledge management: Where did it come from and where will it go?," *Expert Systems with Applications*, vol. 13, no. 1, pp. 1–14, 1997.

[62] K. E. Sveiby, "A knowledge-based theory of the firm to guide in strategy formulation," *Journal of Intellectual Capital*, vol. 2, no. 4, pp. 344–358, 2001.

[63] T. H. Davenport and L. Prusak, *Working Knowledge: How Organizations Manage What They Know*. Harvard Business Press, 1998.

[64] M. H. Boisot, *Knowledge Assets: Securing Competitive Advantage in the Information Economy*. Oxford University Press, 1998.

[65] U. Schultze and D. E. Leidner, "Studying knowledge management in information systems research: Discourses and theoretical assumptions," *MIS Quarterly*, vol. 26, no. 3, pp. 213–242, 2002.

[66] J. C. Spender, "Making knowledge the basis of a dynamic theory of the firm," *Strategic Management Journal*, vol. 17, no. S2, pp. 45–62, 1996.

[67] M. Alavi and A. Tiwana, "Knowledge integration in virtual teams: The potential role of kms," *Journal of the American Society for Information Science and Technology*, vol. 53, no. 12, pp. 1029–1037, 2002.

[68] T. H. Davenport, W. David, and M. C. Beers, "Successful knowledge management projects," *Sloan Management Review*, vol. 39, no. 2, pp. 43–58, 1998.