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Measuring Impact of Cloud Computing and Knowledge Management in Software Development and Innovation

Chetna Gupta [1,2,*], Jose Maria Fernandez-Crehuet [1] and Varun Gupta [3]

1 Departamento de Ingeniería de Organización, Administración de Empresas y Estadística, Universidad Politécnica de Madrid, 28006 Madrid, Spain
2 Department of Computer Science & Engineering and Information Technology, Jaypee Institute of Information Technology, Noida 201305, India
3 Department of Economics and Business Administration, University of Alcala, Plaza de la Victoria 2, Alcalá de Henares (Madrid), 28802 Madrid, Spain
* Correspondence: chetnagupta04@gmail.com

Abstract: For organizations, knowledge is a valuable intangible asset that should be obtained, preserved, shared, and applied to assist decision-making. Cloud computing and knowledge management systems bring together technology and organizational methods to help organizations manage their knowledge and enhance their performance. This work investigates how organizations adopt software development and distribution innovation models using ubiquitous computing more specifically cloud-based software services appraise knowledge management (KM) practices. A combined hybrid research model has been developed using extended Technology Acceptance Model (TAM) and Technology-Organization-Environment (TOE) with KM practices. Series of statistical results using structural equation modeling performed on data collected through an online survey from 983 professionals working in distributed software development (DSD) and innovation worldwide are used to put hypotheses to the test. The results of the study indicate that KM practices (knowledge accessibility, storage, application, and sharing) along with TOE (complexity, compatibility, relative advantage, security, privacy and trust, and reputation) have a substantial and positive impact on the adoption of cloud-based software services. Coordination and communication concerns are the backbones of successful practicing distributed development and innovation. Furthermore, results indicate acceptance of the moderating role of geographical (cultural) difference in examining the impact of KM practices and cloud services.

Keywords: cloud computing; coordination and communication; distributed software development; innovation capabilities; knowledge management; process innovation

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1. Introduction

As a paradigm for providing on-demand resources, cloud computing (CC) is growing rapidly. Businesses are increasingly willing to use the cloud to augment, if not completely replace, their present IT infrastructure [1]. According to research, cloud computing benefits include cost savings, dependability, and scalability [2]. A wide range of application features, greater geographic reach, access to and sharing of files beyond the company firewall, and improved knowledge management for its successful implementation [2]. The industry has recognized cloud computing as one of the applications to efficiently manage the progress of knowledge sharing more efficiently within and outside the organization. This is because it facilitates knowledge sharing with no geographical barriers as long as knowledge enquirers and suppliers exist [3–6]. The adoption of cloud computing applications helps in generating trust and promoting the collaborative cross-organization relationship.

In the last few decades, the distributed innovation is considered as the vital building block of innovation management. Distributed innovation systems are a method of organizing for innovation that appears to address the problem of gaining access to knowledge that exists outside the confines of any single company. Distributed innovation provides organizations an advantage in their business development by providing cutting-edge technology that feels unobtrusive to the user. The term "Innovation System" refers to the reality that innovation no longer occurs inside the confines of a single organization. They now entail complicated relationships between a variety of private and public parties, some of whom are competitive while others are cooperative. The way industries and enterprises deal with the numerous and growing difficulties of innovation determines whether they survive or thrive. In general, the innovation process is difficult, uncertain, and ever-changing.

One of the most efficient methods for reducing internal operations and enhancing business efficiency has been recognized as innovation management. Additionally, over the last few decades, there has been a rise in the structure and direction of innovation where the new ideas are becoming more software-centered or software-dependent. Distributed innovation systems, also known as business ecosystems, have become more common in numerous industries over the years. These entities typically include a number of organizations, individuals, and communities that may be independent in their own right but are linked by an underlying, growing technical framework. While software-centered approaches link enterprise software systems to innovation outcomes, they are rather firmly related to the idea of a software-based shift in innovation. It is because the deployment or use of such systems does not always indicate that organizations develop software to enhance or introduce new products and services. A fundamental source of long-term competitive advantage is an innovation process that successfully aligns market demand with technical opportunity. Because of the globalization of markets and technology sources, the amount of strategic networking is expanding. A mixture of multiple types of knowledge is improving the level of technological integration.

This work contributes to the body of knowledge by examining the relationship between software development and innovation outcomes at the business level in the global economy. The central hypothesis motivating the empirical research is that, if a software-based shift occurs in a firm's innovation activities, it is more likely to assist the firm in supporting dispersed development and innovation methods. This study found that the subset of organizations that manufacture software is more likely to introduce product innovations, even after controlling for R&D investments, human resources, international sales, size, business, and several other traditional indicators of a company's propensity to introduce product innovation. While the majority of the literature focuses on the use of software in various components of the innovation process, research on a software-based shift in innovation reveals that new innovations are becoming increasingly software-intensive in practically all service-oriented organizations. Rather than merely using software as a tool in their innovation operations, companies are increasingly developing software as part of their innovation efforts or developing new innovations that contain or rely on existing software inventions. This simply implies that even organizations that do not sell software use it to improve their products and services, streamline internal procedures and logistics, or even change their business model. This decision has ramifications for both new and established cloud service companies. For example, phrases like "Industry 4.0", "Industrial Internet of Things (IIoT)" and "smart manufacturing" have been used to describe the transformation of industry as a result of digitalization. According to the above overview, software development and software infrastructure provide opportunities that are becoming increasingly important for organizations throughout the economy's competitiveness. According to common perception, software development and digitalization open up new opportunities for new services, products, and business models, as well as new ways to improve operational efficiency.

To achieve faster cycle-time accelerations, it is critical to take use of global resource reserves, competitive pricing models, and round-the-clock development [7–9]. The development which is carried out under the umbrella of distributed environment is termed as distributed software development. To keep pace with the time-to-market driven industry, software organizations are constantly adopting innovative ways of knowledge sharing and management to improve the success of their IT projects for software development [10,11]. According to Forbes Insights [12,13], the ability of cloud-based collaborative work based on cloud technology to bring the most diverse teams together across geographical boundaries, time zones, and even organizational borders has already been demonstrated. This is becoming a more critical foundation of success. Apart from the most common cloud platforms, such as Software-as-a-Service (SaaS), Platform-as-a-Service (PaaS), and Infrastructure-as-a-Service (IaaS), Recovery-as-a-Service (RaaS) is a lesser-known IT landscape (RaaS). According to one of the surveys [14] conducted on 1060 IT professionals to gather their feedback and views on the adoption of cloud technologies states that cloud computing service adoption is increasing rapidly with the focus on maximizing the profit and minimizing the associated cost in comparison to traditional systems. During COVID-19, the demand to incorporate and adoption of cloud-based software services has increased many folds across the global [15].

Distributed development and innovation adoption is both difficult and complex. Knowledge sharing has a huge impact on the success of distributed innovation. Knowledge sharing is critical to the success of projects and the ability of teams to collaborate effectively with one another [16]. According to Rich [17], "Knowledge is made up of data and information, that can be thought of as much greater understanding of a situation, relationships, causal phenomena, and the theories and rules (explicit and implicit both) that underlie a given domain or problem". Companies that specialize in new product development (NPD) might profit from knowledge collecting by growing and increasing the quality of their offerings. These partnerships take place among multiple sources of information in order to improve their technological skills and achieve competitiveness. Knowledge can provide a competitive edge in product development organizations, as can the adoption of knowledge-sharing techniques. Some of the most significant obstacles to knowledge sharing are concerns of collaboration and coordination among distributed team members. Non-trustworthy behavior and knowledge vaporization result from a lack of direct communication. Another issue raised in research is the absence of sufficient documentation in both agile and traditional software development, which many organizations experience [18–22]. They assert that source code test files store a great deal of knowledge, and outdated, partial, omitted, or abstract documents are often exchanged [18–20,23]. Knowledge evaporation is another major issue in DSD. Recovery of much of the knowledge that resides in digital media such as e-mails and chats is difficult due to a lack of face-to-face conversation [18,21,22]. This is due to the fact that teams must stay current with the latest software development approaches and strategies.In light of these considerations, the goal of this research is to see how knowledge management (KM) strategies affect cloud-based software services (SaaS) uptake in different cultures.

The rest of the paper is organized as follows: Section 2 presents the related work, the theoretical foundation, proposed research model, and proposed research hypotheses are discussed in Section 3. Section 4 presents the method and measurement used in the study. Section 5 discusses results, and Section 6 discusses the impact of acceptance of KM practices and cloud computing services in research and practice. Section 7 concludes with the conclusion, limitations, and future work.

2. Related Work

Many prior studies on cloud-based solutions have used the case study method to qualitatively assess the benefits and drawbacks of the cloud [24–27], or have proposed frameworks to better operations in cloud design, deployment, and services [28]. While the available literature offers a fundamental understanding of cloud computing, empirical studies [29–33] used survey data to study the factors that influence cloud adoption. Furthermore, it was discovered that several existing cloud adoption studies had not used any ground theory to guide their data and outcomes analysis. In the past, scholars have sought to quantify technological uptake by investigating the adoption of various theoretical models. A few examples include the diffusion of innovation (DOI) [34], the theory of reasoned action (TRA) [35], the technological acceptance model (TAM) [36], the technology-organization-environment framework (TOE) [37], and the unified theory of acceptance and use of technology (UTAUT) [38]. Among them, TAM and TOE are the most extensively employed techniques. The TOE framework has grown to look at the adoption of various IT products and services at the company level in a comprehensive way. It was also recommended that it be paired with existing systems (TAM-TOE, DOI-TOE, and TRA-TOE) as well as new constructs (such as technology readiness, security, trustworthiness, marketing initiatives, organization size, and financial profitability) to explain adoption variation. The bulk of studies that leverage the TOE paradigm to study cloud adoption identify technological context in terms of the innovative technology's attributes.

The adoption of a new technique or technology is a multi-criteria decision-making process depending on how knowledge management practices and cloud services fit best to the structure, strategy, and goals of the company. Knowledge acquiring, management, and transfer involve technology, processes, and people [39,40], serving both exploration (creating innovations) and/or exploitation. According to knowledge generation [41], knowledge storage/retrieval, knowledge transmission, and knowledge application are all aspects of knowledge management framework. In this era of digitization, where digitization technologies such as the internet of things, cloud computing, blockchain technologies, assist collection, sharing, and use of information to support KM practices within organizations [42]. Researchers have related KM with digitization [42–44] to support the decentralization of information sharing and automation. Digitization combined with information systems such as cloud computing and blockchain technology presents a great opportunity to organizations for improved performance; often dependent on the actual users' readiness to accept and approve the available technology. In a separate study [45], authors proposed a fuzzy decision-making process that enables assessing the degree of knowledge and KMS alignment in an enterprise. In their work, they provide remedial measures and adoption techniques for KMS to enhance KM alignment. In the work presented in [46], authors presented the theoretical framework created to distinguish between outside-in, inside-out, and coupled Open Innovation processes. In their work, they identifies specific cultural barriers affecting each process and suggests which intermediary types might be better suited to support businesses going through the chosen processes. The framework aids businesses in opening up their internal R&D initiatives so they can select the intermediary type best suited for cultural adaptation and get beyond any potential barriers. A systematic study thorough analysis of KMSs and an analytical overview of how they promote creative kinds of knowledge translation that take place in cooperative settings is presented in [47]. Three perspectives—unit of analysis (LCs, SMEs), stages of the KM process (adoption, translation), and topic area—were used to analyze a sample of 129 publications (KM Practices, KM Tools, KMSs). Their findings identify five knowledge management (KM) literature gaps: (1) the role of KM practices in supporting knowledge translation; (2) the influence of KM practices alignment with firm complexity, dimension, and culture on the KM process; (3) the impact of KM tools on the KM process; (4) the variety of KMSs utilized in both LCs and SMEs; and (5) the alignment between organizational structure and information systems in the KM context.

To date, various technologies acceptance models have been proposed and investigated; however, the technology acceptance model [36] is the most widely used and is considered to be the most influential and model to describe user acceptance for a technology. Past studies have successfully employed TAM and shown favorable results to explain the acceptance of software development processes including improvement initiatives and measurement programs [48]. This results in carrying out a holistic analysis of understanding issues, constraints, and challenges in using cloud-based systems [46]. Previous research has focused on the elements that influence new technology adoption, such as the ability to share, functionalities, complexity, general perception, security and privacy, strategic planning, and so on [3–7,49]. The majority of the research focuses on providing a fundamental understanding of the adoption of cloud services, their deployment, and security concerns from a technological point of view, rather than rigorously examining the factors empirically for their positive or negative impact of adoption [50,51].

A few researchers have performed quantitative analysis using survey data to examine cloud adoption concerns on binary cloud adoption [52–54]. Furthermore, in order to analyze technology adoption, researchers have tried to investigate the adoption of several theoretical models. Diffusion of innovation (DOI), theory of reasoned action (TRA), technology acceptance model (TAM), technology-organization-environment (TOE) framework, and unified theory of adoption and application of technology are some of these [55]. The TOE framework has advanced to take a more complete look at the adoption of various IT products and services at the management level. It was also suggested that it be combined with current models (TAM-TOE, DOI-TOE, and TRA-TOE) as well as new constructs (such as technology readiness, security, trust, marketing effort, organization size, and financial performance) to explain adoption variation [55].

3. Theoretical Framework and Proposed Research Hypotheses

According to the literature, a growing number of researchers have looked at the success factors and effects of using cloud computing services. None of these studies, however, looked at the differences in knowledge management techniques and cloud computing, or SaaS, between cultures. More recently, researchers are now investigating moderating effects to enhance the power of TAM [56]. As a result, the focus of this study is on the moderating role of culture in the relationship between knowledge management methodologies and TAM for cloud-based service adoption. In light of these considerations, the key hypothesis driving the presented empirical research is that, if a software-based change occurs in a company's innovation operations, the company is more likely to support dispersed development and innovation techniques. Additionally, the investigation of the impact of knowledge management methods on the adoption of cloud computing services, notably SaaS, across cultures is also reported. TAM paired with TOE is used in this study as a crucial predictor of technology adoption behavior by merging perceived usefulness (PU) and perceived ease of use (PEOU). The interaction between knowledge management techniques and cloud computing services is investigated in this research, with a focus on regional (cross-cultural) differences. Figure 1 depicts the suggested research model, and Table 1 lists the proposed expanded TAM, TOE, and KM components, as well as the research hypotheses.

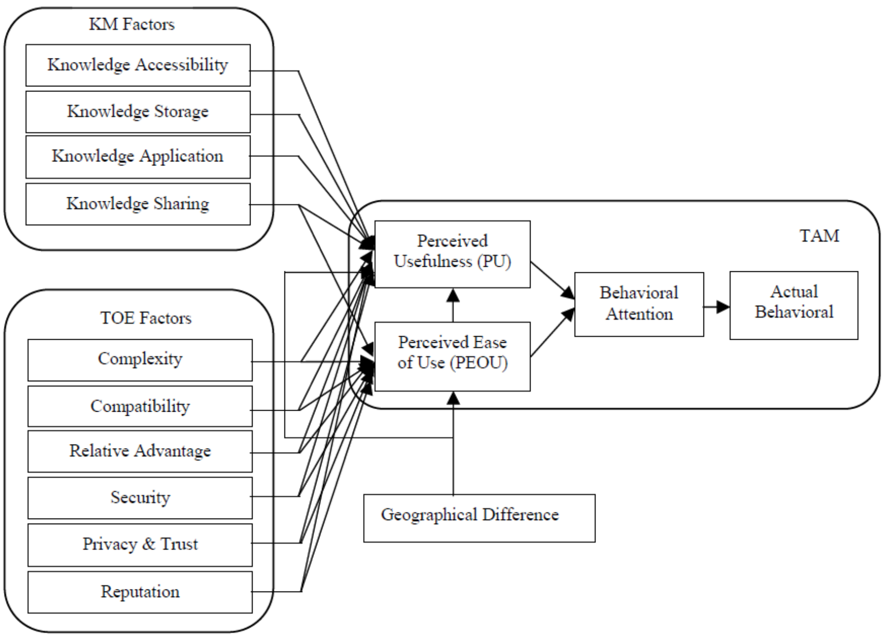

Figure 1. Proposed research model.

Table 1. Proposed extended TAM and proposed research hypotheses.

Construct	Description
KM Factors [40,49] and Proposed Hypotheses	
Knowledge Accessibility	refers to the retrieval of data, information, and knowledge from a specific system. H1: Knowledge accessibility would have a substantial and positive impact on the PU.
Knowledge Repository	refers to a data, information, and knowledge archive capable of storing and retrieving a wide range of data, information, and knowledge. H2: Knowledge repository would have a substantial and positive impact on the PU.
Knowledge Platform	refers to the smooth access to efficient storage and retrieval. H3: Knowledge platform would have a substantial and positive impact on the PU.
Knowledge Sharing	refers to the readiness to share knowledge and data as an attribute of technological innovation, acceptance, and adoption. H4a: Knowledge sharing would have a substantial and positive impact on the PU. H4b: Knowledge sharing would have a substantial and positive impact on the PEOU.
TOE adoption factors [56] and proposed hypotheses	
Relative Advantage	relates to the extent to which people believe the innovation is superior to other existing or competing technological possibilities. H5a: Relative advantage would have a substantial and positive impact on the PU. H5b: Relative advantage would have a substantial and positive impact on the PEOU.
Compatibility	refers to the degree of ease between the innovation and the expectations/needs. H6a: Compatibility would have a substantial and positive impact on the PU. H6b: Compatibility would have a substantial and positive impact on the PEOU.
Complexity	refers to the degree of difficulty corresponding to the use of the innovation H6a: Compatibility would have a substantial and positive impact on the PU. H6b: Compatibility would have a substantial and positive impact on the PEOU.
Security	refers to able to protect data from tampering and unauthorized access. H8a: Security would have a substantial and positive impact on the PU. H8b: Security would have a substantial and positive impact on the PEOU.
Privacy & Trust	refers to an individual's or an organization's ability to protect sensitive personal information. H9a: Privacy and trust would have a substantial and positive impact on the PU. H9b: Privacy and trust would have a substantial and positive impact on the PEOU.
Reputation	refers to the image or face value of the company affected by the specifics of adopting cloud solution. H10a: Reputation would have a substantial and positive impact on the PU. H10b: Reputation would have a substantial and positive impact on the PEOU.
TAM factors [36] and proposed hypotheses	
Perceived Ease of Use (PEOU)	refers to the amount of ease or effortless use of innovation a person believes while using the particular innovation. H8a: PEOU would have a substantial and positive impact on the PU. H8b: PEOU would have a substantial and positive impact on the BA.
Perceived Usefulness (PU)	refers to the amount of enhancement in job performance while using a particular innovation. H9: PU would have a substantial and positive impact on the BA.
Behavioral Attention and Actual Behavior	refers to the overall satisfaction of using the innovation. The behavioral intention has direct implication in actual usage behavior. H10: BA would have a substantial and positive impact on actual behavior (AB).
Geographical Difference	refers to the degree of the applicability of adopting cloud-based software systems in geographically distributed software development. It will help in understanding, examining, and providing insight into the cross-cultures differences. H11a: The relationships between TOE and KM practices with cloud computing service acceptance would have a moderating impact on PU. H11b: The relationships between TOE and KM practices with cloud computing service acceptance would have a moderating impact on PEOU.

4. Methodology

4.1. Participants and Data Collection

A total of 983 professionals participated in the research investigation. All of the participants work in the software development and distributed innovation business and had prior experience with software development and distributed innovation. The participants have varying levels of experience, with 40% with fewer than five years of experience, 36% having a minimum of 5 to 10 years experience, and 24% with more than ten years of expertise. The participants in the research study were from Canada (16%), Asia (30%), European Union (26%), America (14%), the United Kingdom (12%), and Australia (8%). There are 66% males and 34% females among the participants. Purposive and snowball sampling strategies were combined to choose the participants (non-probabilistic sampling).The convenience sampling approach was carried out by sending e-mails to potential respondents, who were also asked to forward it to their coworkers, using the respondent-driven sample method. The e-mail included a summary of the study's objectives as well as a link to the survey. Additionally, participants in our network of contacts were also invited to participate and provide referrals to help us find new research study participants. The non-response bias was measured using the *t*-test. At the 0.05 significant level, there were no significant differences between the early (n = 678), and late (n = 305) responders. Furthermore, 83% of participants reported that they have used cloud computing services on one or more projects (partially or fully) for software development activities in past. The participants were contacted for their voluntary involvement by mailing the questionnaire (see Table 2) and informed consent form to them. The findings show that perceived ease of use, perceived usefulness, and knowledge management practices all have a significant and favorable impact on the actual use of cloud-based software services. More specifically, coordination and communication issues are examined, which are the backbones of successful development and innovation.

Table 2. Descriptive statistical analysis and reliability.

Variables	Items	Loading Factor	CR	AVE	Cronbach's Alpha (α)
Knowledge Accessibility	*KA1*: It provides anytime and anywhere access.	0.962	0.931	0.817	0.893
	KA2: It makes it easier to do my work.	0.859			
	KA3: It enhances my work performance.	0.888			
Knowledge Repository	*KR1:* It allows access to the stored data easily.	0.965	0.950	0.863	0.923
	KR2: It enhances the quality of collaboration and coordination.	0.889			
	KR3: It makes it easier to do my work.	0.932			
Knowledge Platform	*KP1:* It enables me to exchange information easily.	0.908	0.915	0.781	0.861
	KP2: It provides easy and ubiquitous access to stored data and information.	0.845			
	KP3: It increases my productivity.	0.898			
Knowledge Sharing	*KSH1:* It allows easy exchange of data and information.	0.911	0.923	0.801	0.925
	KSH 2: It enables better and faster decision-making.	0.875			
	KSH 3: It enhances coordination and coordination.	0.898			
Complexity	*Comp1:* It provided easy access.	0.819	0.916	0.785	0.876
	Comp2: I was able to use the system seamlessly.	0.956			
	Comp3: I enjoyed my work and I was able to enhance my productivity.	0.878			
Compatibility	*Cmp1:* It provides a seamless interface with the other legacy applications.	0.951	0.932	0.820	0.799
	Cmp2: It provides relevant and required application support.	0.865			
	Cmp3: It faced no problems of system unexpected behavioral issues.	0.899			
Relative Advantage	*RA1:* It helps in better coordination and communication.	0.934	0.943	0.768	0.769
	RA2: It enhances my performance.	0.876			
	RA3: It provides flexibility.	0.932			
	RA4: It enhances learning and sharing.	0.843			
	RA5: I find it useful and believe that it will increase productivity.	0.787			
Security	*S1*: It helps in the secure storage of my data.	0.923	0.891	0.733	0.831
	S2: It ensures data protection so that it cannot be manipulated by hackers outside the organization.	0.843			
	S3: It also ensures protection of usage of official data by cloud providers for their commercial benefit.	0.787			

Table 2. *Cont.*

Variables	Items	Loading Factor	CR	AVE	Cronbach's Alpha (α)
Privacy & Trust	PT1: I trust privacy measures of the adoption of cloud computing.	0.896	0.912	0.775	0.894
	PT2: I am sure my data is kept private.	0.843			
	PT3: Cloud services are trustworthy.	0.901			
Reputation	R1: The service provider has a good name in the market.	0.777	0.87	0.691	0.915
	R2: It increases customer satisfaction because of the brand name.	0.903			
	R3: It helps in gaining confidence in the vendor.	0.809			
Perceived Ease of Use (PEOU)	*PEOU1:* I believe that it is easy to use.	0.974	0.947	0.82	0.902
	PEOU2: I have no trouble sharing facts and information.	0.957			
	PEOU3: It relieves a lot of mental strain caused by the abundance of data and information.	0.889			
	PEOU4: It enhances coordination and coordination.	0.789			
Perceived Usefulness (PU)	*PU1:* It prevents knowledge vaporization.	0.898	0.927	0.762	0.888
	PU2: It reduces documentation issues.	0.932			
	PU3: It improves coordination and coordination.	0.876			
	PU4: It improves job productivity and accessibility.	0.777			
Behavioral Attention (BA)	*BA1:* I would like to continue using the system in the future.	0.957	0.95	0.826	0.912
	BA2: Iwould keep using the system for my job-related activities.	0.931			
	BA3: I would use the system for accessing and sharing data and information in the future with my peers.	0.899			
	BA4: Overall, I am satisfied with all functions of the systems.	0.843			
Actual Behavior (AB)	*AB1:* I use cloud services on a regular basis.	0.826	0.917	0.734	0.859
	AB2: I use it to share and access data and knowledge.	0.922			
	AB3: How much do you rely on cloud-based systems?	0.831			
	AB4: I use cloud-based systems to minimize team-related issues.	0.843			
Geographical Difference (GD)	GD1: It reduces cross-cultural issues of coordination.	0.923	0.924	0.803	0.801
	GD2: It reduces language barriers and time zone problems.	0.889			
	GD3: It enhances team spirit and knowledge sharing.	0.876			

4.2. Participants Response

Items were selected from prior research studies and tailored for this study in the first edition of the survey questionnaire prepared for this study. There were two major components to the final survey questionnaire. The first section of the survey was comprised of questions aimed at gathering demographic and organizational data from respondents, such as their job title, number of employees, and turnover. In the second section, the measures of the theoretical constructs of the suggested research model were provided. The hypotheses are investigated using 51 questions to measure 14 components in the study model offered. The constructs in this study were evaluated using a five-point Likert scale ranging from "strongly disagree" (1) to "strongly disagree" (5). The initial questionnaire was evaluated by academics and industry specialists to identify any potential concerns with clarity and accuracy. In response to expert feedback, the wording of a few items was altered. Table 2 contains the final questionnaire items.

5. Results

5.1. Model Analysis

Both SEM and confirmatory factor analysis (CFA) were employed for analysis. IBM SPSS (version 25) and IBM AMOS (version 23) were used to analyze and report the findings of the data analysis. The summary of the Goodness fit model is presented in Table 3 and suggests an adequate model fit to the data with TLI = 0.94 and CFI = 0.95 indicating good fit. The value of RMSEA = 0.049 and [LO90 = 0.064, HI90 = 0.075] indicating good fit.

Table 3. Summary of fit indices for goodness.

Measure	Acceptance Fit Level [57]	Value
Chi-square (χ^2)	<3.5 to 0 (perfect fit) and (o > 0.01)	922.203
Normed Chi-square	Value should be greater than 1.0 and less than 5.0	3.583
Root-Mean Residual (RMR)	Close to 0 (perfect fit)	0.034
Goodness of Fit (GFI)	GFI $\geq$ 0.95	0.98
Adjusted Goodness of Fit (AGFI)	AGFI $\geq$ 0.90	85
Standardized Root Mean Square Residual (SRMR)	SRMR < 0.08	0.033
Incremental Fit Index (IFI)	The value should be larger than or equal to 0.90.	0.95
Tucker Lewis Index (TLI)	The value should be larger than or equal to 0.90.	0.94
Comparative Fit Index (CFI)	The value should be larger than or equal to 0.90.	0.95
Root mean square error of approximation (RMSEA)	Value below 0.10 indicates a good fit and below 0.05 is deemed a very good fit.	0.049 and [LO90 = 0.064, HI90 = 0.075].

5.2. Results of Reliability and Validity

Table 2 presents descriptive statistical analysis and reliability coefficients. With Cranach's alpha values ranging from 0.769 to 0.923, all scales have sufficient internal consistency, as shown in Table 2. A reliability Cranach's alpha value of 0.70 or higher is regarded good for internal consistency. The convergent validity test is used for composite reliability (CR) and average variance extracted (AVE). Results signify that KM factors, TOE factors along cross-cultural geographical differences are significantly associated with the attitudes toward using cloud-based software services for developing software systems. Average variance extracted was used to evaluate the average variance shared by a construct and its measures in order to examine Discriminant validity. The average variance extracted from the construct should be greater than the variance shared by the construct and other constructs in the study model (i.e., the squared correlation between two constructs).For acceptable Discriminant validity, the square root of average variance retrieved should be larger than the inter-correlations in the relevant rows and columns. Results in Table 4 suggest that the Discriminant validity is ascertained with the observed square root of AVE values (off-diagonal elements, highlighted in bold) higher than all other cross-correlations.

5.3. Results of of Hypotheses Testing

The majority of hypotheses with *p*-values between 0.001 and 0.05 are accepted, as shown in Table 5. It can be seen that KM practices, knowledge accessibility, knowledge storage, and knowledge application have path value, *t*-value, and *p*-value of 0.107, 0.213, 0.011, 0.133, 0.110, 0.009, 0.102, 0.012, and 0.022, respectively, which indicates the acceptance of H1, H2, and H3 hypotheses having had a substantial and positive impact on perceived usefulness of adoption of cloud services. Hypotheses representing knowledge sharing, H4, on the other hand, are accepted and show that they have a substantial and positive impact on perceived usefulness and ease of use. Other factors of TOE also indicate acceptance of their corresponding hypotheses having a substantial and positive impact on perceived usefulness and perceived ease of use except for H5a, H8b, H10b with *p*-values greater than 0.001. The geographical difference in the hypothesized relationship (H14) also indicates a substantial and positive impact on perceived usefulness and perceived ease of use. These results suggest that there are no significant differences for accepting cloud services for software development where teams are geographically distributed, confirming acceptance and support for hypothesis H14.

Table 4. Convergent and Discriminant validity correlation matrix.

	Knowledge Accessibility	**Knowledge Storage**	**Knowledge Application**	**Knowledge Sharing**	**Complexity**	**Compatibility**	**Relative Advantage**	**Security**	**Privacy & Trust**	**Reputation**	**Perceived Ease of Use**	**Perceived Usefulness**	**Behavioral Intention**	**Actual Behavior**	**Geographical Difference**
Knowledge Accessibility	**0.945**														
Knowledge storage	0.629	**0.961**													
Knowledge application	0.646	0.583	**0.928**												
Knowledge sharing	0.776	0.336	0.546	**0.962**											
Complexity	0.334	0.308	0.616	0.532	**0.936**										
Compatibility	0.428	0.636	0.643	0.659	0.517	**0.894**									
Relative advantage	0.791	0.424	0.367	0.541	0.651	0.518	**0.877**								
Security	0.656	0.583	0.524	0.529	0.713	0.439	0.429	**0.912**							
Privacy and trust	0.613	0.732	0.572	0.723	0.432	0.231	0.373	0.360	**0.956**						
Reputation	0.636	0.499	0.683	0.625	0.539	0.378	0.529	0.489	0.756	**0.957**					
Perceived usefulness	0.834	0.610	0.711	0.643	0.636	0.433	0.340	0.223	0.561	0.439	**0.950**				
Perceived ease of use	0.628	0.745	0.639	0.726	0.562	0.712	0.541	0.522	0.648	0.473	0.479	**0.942**			
Behavioral Attention	0.832	0.683	0.436	0.329	0.402	0.611	0.540	0.571	0.451	0.469	0.389	0.463	**0.955**		
Actual Behavior	0.723	0.632	0.287	0.761	0.438	0.459	0.423	0.462	0.633	0.531	0.283	0.456	0.573	**0.927**	
Geographical difference	0.802	0.684	0.611	0.452	0.539	0.632	0.327	0.355	0.271	0.573	0.338	0.643	0.623	0.476	**0.896**

Table 5. Hypotheses testing results.

#	Relationship	Path	*t*-Value	*p*-Value	Decision
H1	Knowledge Accessibility → PU	0.107	0.213	0.011	Supported *
H2	Knowledge storage → PU	0.133	0.110	0.009	Supported *
H3	Knowledge application → PU	0.102	0.012	0.022	Supported *
$H4_a$	Knowledge sharing → PU	0.121	0.060	0.007	Supported *
$H4_b$	Knowledge sharing → PEOU	1.030	0.141	0.011	Supported *
$H5_a$	Complexity → PU	−1.669	1.143	0.991	Not supported
$H5_b$	Complexity → PEOU	0.135	1.041	0.013	Supported *
$H6_a$	Compatibility → PU	1.061	1.211	0.006	Supported *
$H6_b$	Compatibility → PEOU	0.356	0.132	0.002	Supported *
$H7_a$	Relative advantage → PU	1.141	1.013	0.011	Supported *
$H7_b$	Relative advantage → PEOU	1.105	1.805	0.021	Supported *
$H8_a$	Security → PU	1.060	0.132	0.016	Supported *
$H8_b$	Security → PEOU	0.045	1.743	0.672	Not supported
$H9_a$	Privacy and trust → PU	0.142	0.373	0.011	Supported *
$H9_b$	Privacy and trust → PEOU	−1.376	1.876	0.864	Not supported
$H10_a$	Reputation → PU	0.342	1.833	0.015	Supported *
$H10_b$	Reputation → PEOU	−3.765	0.907	0.675	Not supported
$H11_a$	Perceived Ease of Use → PU	1.021	0.140	0.091	Supported *
$H11_b$	Perceived Ease of Use → BA	0.104	1.202	0.004	Supported *
H12	Perceived Usefulness → BA	0.214	0.252	0.009	Supported *
H13	Behavioral Attention →AB	1.015	0.132	0.001	Supported *
$H14_a$	Geographical difference → PU	0.632	0.132	0.006	Supported *
$H14_b$	Geographical difference → PEOU	1.105	0.043	0.015	Supported *

Note: * indicates the obtained *p*-value is less than 0.05.

6. Discussion

Results of Implication of Research and Practice

The conclusions of this study have a variety of theoretical and practical consequences for organizations that use software-centric processes in a dispersed environment, cloud service providers, and academic researchers. User-behavior analysis, such as the one we employed in this study, is necessary for a better understanding and success of knowledge management strategies linked with cloud benefits. The current study illustrates a user-centered decision process using an improved framework based on structural equation modeling. The presented acceptance model, which identifies key psychological factors that greatly impact the adoption pattern of cloud services as well as knowledge management in global software engineering, is validated by excellent fit indices between the model and the collected sample data, as well as confirmations of the hypothesized causal paths.

The presented solution can be used to ascertain the positive outcome of adopting KM practices with cloud computing adoption to reduce the problems faced in software development and innovation utilizations. The results indicate that KM practices–knowledge accessibility, repository, platform, and sharing along with TOE factors (complexity, compatibility, and relative advantage) have a substantial and positive impact on the relevance of cloud computing in the designing and developing systems. A good knowledge-sharing environment can help in solving issues related to coordination, information vaporization, and documentation. This can help the developer's access information and solve problems fast by fostering a document management system with the usage of knowledge repositories. The findings of the study revealed that relative advantage, compatibility, and complexity are critical factors in determining cloud computing adoption intentions, with perceived ease of use and perceived utility serving as mediating variables. Furthermore, the results depict the acceptance of moderating role of geographical (cross-cultural) differences in examining the impact of KM practices and cloud computing services.

The implication is that the integrated use of knowledge management and cloud services are crucial to the service's success or failure, prompting the software companies to invest more in providing solid, reliable software that ensures improved performance, coordination, knowledge vaporization prevention, documentation difficulties reduction, and satisfaction. In the long run, the industry should consider new ubiquitous settings and platforms for the industry 4.0 future by answering the following questions:

(A) How is the integration of knowledge management and cloud services critical to the service's success or failure, encouraging the software industry to spend more time and money building stable, dependable software that improves performance, coordination, prevents knowledge vaporization, and reduces documentation problems and increases satisfaction in DSD?
(B) How concerned are software companies about whether or not to implement knowledge management methods and cloud computing services?

From a practical viewpoint, the results of integrated model and key constraints can be used by the industry to establish strategic strategies for the success of their solutions. While most cloud service providers presently offer their services for free, their long-term goal is to break into conventional software development and maximize earnings. In order to do this, service providers should pay close attention to how user attitudes and behaviors are shaped. The importance of perceived utility and system quality in determining user intention was confirmed in a recent study, suggesting that the industry should strive on improving consumers' general psychological opinions of both factors. More importantly, cloud service providers should establish an effective and dependable connection.

7. Conclusions

This work investigates and reports the acceptance of multi-site software development valuing knowledge management practices combined with cloud computing services. This study helps to utilize the rich research available in the domain of technology adoption literature by combining components like belief in the benefits of an invention with the TAM and TOE model. The empirical findings offer substantial support for the proposed research model. In the sphere of technology adoption, perceived usefulness has a positive impact on attitude and behavioral intention. While perceived ease of use influences attitude, it has no influence on perceived usefulness. Decision makers may have a variety of options for upgrading with adoption of emerging technologies and services, but the findings of this study will aid them in making better system adoption decisions. Decision-makers who believe in the advantages of cloud computing and knowledge management methods are more likely to adopt new technologies and services. The study model enables researchers to comprehend and evaluate the relative impact of knowledge management strategies and cloud computing adoption on software development. The creation of successful software design guidelines and standards will be based on knowledge of the relative influences of elements. Moreover, the appropriateness of research models should not be determined merely by the direct association between these factors and adoption intentions or commercial value measurements. Examining important mediating variables linked to beliefs and attitudes, such as usefulness, ease of use, and behavioral intention, as defined in TAM, may aid in a better understanding of such relationships. The proposed research paradigm will be used to build a basis for further reasoning and testing of such concepts. It emphasizes the crucial importance of the components of the integrated model. The creation of a strategy for predicting and interpreting the mediating effects of distinct components follows the discovery and evaluation of alternative models. From the above discussion, considering the previous work studies above, have investigated the success factors and consequences of adopting cloud-based software services (SaaS) with KM practices. None of this research, however, has looked into how cross-cultural differences affect DSD and distributed innovation for coordination processes and information transparency.

Although the findings of the current study are helpful in understanding the adoption of knowledge management methods and cloud services, there are a few issues that need to be addressed in future research on the topic. First, the survey respondents' individual differences were not investigated in this study. Individual characteristics (gender, age, and race) as well as social influences (performance and effort expectancy, voluntariness, and subjective norms) have a substantial impact on a user's attitude toward and intention to use a particular technology. Second, the responses of respondents were collected through questionnaire surveys only. Further attempts for gathering responses through qualitative methods such as focus groups/interviews can be explored to confirm the quantitative results. Additionally, more specific constructs and items to analyze the acceptance behavior of a particular country or subcontinent can be considered to analyze the acceptance of the model in a close offshore environment. We intend to continue this work as part of our future efforts to analyze the acceptance of TAM with other technology acceptance models for analyzing cross-cultural studies in more depth with an attempt to cover wider perspectives.

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