# Investigating the Determinants Influencing Cloud Computing Adoption in Public Sector Organizations of Pakistan

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**Abstract**— Cloud computing is one of the latest technological trends that deals with consolidating, sharing and standardizing IT infrastructure and applications through a central facility. Although cloud computing provides many benefits to the organizations including cost reduction and disaster recovery etc., at the same time, its adoption faces many challenges due to interoperability issues and slow adoption rate. Cloud computing adoption is even more challenging in public sector organizations (PSOs) than their private counterparts due to contextual differences between the two sectors. Prior research mainly focused on cloud computing adoption in private sector and less research has been conducted in PSOs e.g. Pakistan remained unexplored. Therefore, it is imperative to investigate the determinants influencing cloud computing adoption in PSOs especially of a developing country. This study investigated the determinants influencing cloud computing adoption in Pakistani public sector organizations (PakPSOs). More specifically, this study investigated the effect of nine determinants of technology adoption grouped into four categories based on technology-organization-environment (TOE) i.e. human, technological, organizational and environmental factors on cloud computing adoption. Quantitative research approach was applied to test the proposed model. Sample data was taken from 96 respondents in 22 PakPSOs and analyzed through PLS-based SEM. Consequently, nine hypotheses were tested and analyzed. The results demonstrated that IT personnel knowledge and innovation and government support were among the potential determinants influencing the cloud computing adoption in this environment. The study provides several implications for the practitioners and academicians. Public managers and policy-makers can use the results to recognize the potential determinants for prioritizing limited resources and updating their IT related plans. Theoretically, this study enhances the scope of the determinants influencing cloud computing adoption in PSOs of a developing country. The study also provides a new avenue for future research.

**Index Terms**— Cloud computing, IT adoption, public sector innovativeness, technology-organization-environment (TOE), PLS-based SEM



## 1 INTRODUCTION

PUBLIC sector organizations (PSOs) around the world are striving for more efficient and cost-effective public service delivery due to escalating demands and expectations of citizen. This has also been accelerated due to emerging trend of e-government for more efficient, transparent, responsive and accountable government. However, e-government domain to transform or change the public sector is much complex and challenging. Introducing new or latest technologies in this domain faces many challenges like interoperability issues [1], slow rate of adoption and variability of stakeholders [2], and bureaucratic and political influence [3]. Nevertheless, the advent of cloud computing technology has created the new opportunities for all types of organizations and PSOSs are no exception. Cloud computing technology is one of the latest IT innovations that is mainly based on the concept of consolidating, standardizing and sharing IT resources through a centralized facility or infrastructure in and across organizations [4]. It provides many advantages including reduction in hardware and software costs, disaster recovery, increased collaboration and security concerns etc.

Many studies have been conducted to identify the determinants influencing cloud computing adoption in the private sector organizations ranging from large to small and medium organizations [5], [6], [7]. However, less research has been conducted especially in PSOs and even PakPSOs remained unexplored. Moreover, adoption of the cloud computing services and resources depends on the specific context of the organizations and other related determinants such as human, technological, organizational and environmental determinants which may be different in different countries [8], [9], [10], [11]. Therefore, it is paramount to identify the determinants that influence the cloud computing adoption in PakPSOs through a contextualized study. This study attempts to bridge this gap by having insights into the relevant determinants influencing the cloud computing adoption in PakPSOs.

## 2 LITERATURE REVIEW AND THEORECTICAL BACKGROUND

### 2.1 Cloud Computing

The concept of cloud computing was appeared in the academic literature even before the emergence of Internet. First time, Prof. Chellapa presented the concept of cloud computing in 1997 by describing it as “cloud computing is a new computing paradigm where the boundaries of computing will be determined by economic rationale rather than technical limits alone". However, Salesforce.com took the lead and practically implemented the cloud computing first time for delivering services through Internet. After this, cloud computing has attracted more attention of the industry and academia as compared to other computing technologies such as grid computing and cluster computing. With the passage of time, cloud computing has drastically evolutionized. Many researchers and practitioners have provided various concepts, aspects and definitions of cloud computing including its advantages and disadvantages in many journals and peer-reviewed conferences papers. For instance, Zhang et al. [12] argued that cloud computing consists of a combination of three fundamental computing technologies. These fundamental computing technologies are grid computing, cluster computing and parallel computing. Moreover, Armbrust et al. [13] described that IT industry has been revolutionized by the potential of cloud computing. However, Geelan [14] provided 21 definitions of cloud computing and concluded that it is a phenomenon that can be represented by multiple and varying concepts and perceptions.

## 2.2 Cloud Computing in Public Sector Organizations

Cloud computing facility creates value for PSOs. Governments in the developed countries like United States, European Union, Japan and Australia are considered to be as pioneers regarding the adoption of cloud computing facility in the PSOs. Various governments have decided to use shared technologies for enhancing public sector efficiency [15], ensuring increased responsiveness, providing improved service quality and enabling green IT [16]. However, Wyld [3] argued that the public sector managers and policy-makers should consider cost savings, improved collaborative capabilities, operational advantages and especially security, privacy and reliability related issues before adopting cloud computing facility. Cloud computing adoption in the PSOs is not so much easy and straight forward as it is in their private counterparts where CEO decision matters. Busch et al. [17] described that the PSOs face a complex array of problems and challenges including complex decision-making process, regulations and other legal requirements. They further added that such organizations must ensure availability, security and privacy at national level while adopting a cloud computing facility. Furthermore, they argued that high sensitive public data hosted into cloud may face cyber security threats which may harm national security or citizen' security. Wyld [3] demonstrated that more governments around the globe are adopting new technologies but public sector characteristics create an interesting blend between technologies and governance. Moreover, the adoption of cloud computing facility is even more challenging in the PSOs of developing countries due to higher level of political intervention, corruption, informality and poor economic conditions which adversely obstruct decision-making in this environment. Therefore, more care should be taken while adopting a cloud computing facility in this environment.

## 2.2 Theoretical Background

Technology-organization-environment (TOE) framework has been applied by many researchers to investigate the phenomenon of IT adoption in the organizations. It is an organizational level framework that is considered to be one of the prominent frameworks to investigate the new technologies. Martins, Oliveira and Popovič [18] stated that "the TOE framework as originally presented, and later adapted in IT adoption studies, provides a useful analytical framework that can be used for studying the adoption and assimilation of different types of IT innovation". The TOE framework was developed by Tornatzky and Fleischer [11] and consisted of three domains: technological, organizational and environmental domains. Technological domain deals with the internal and external effects of the technology on the organization. Organizational domain deals with the factors that can influence the technology adoption in the organization. Environmental domain deals with the factors related to the structure of industry, competition and other external factors. The TOE framework claims that the factors from these three domains influence the innovation adoption in organizations. However, Premkumar [10] argued that factors from individual and task domain can also join technological, organizational and environmental domain. Moreover, Thong and Yap [19] revealed that human factors in terms of CIO characteristics are determinants of IT adoption. Therefore, this study has developed a TOE framework with four domains: technological factors, organizational factors, environmental factors and human factors. More specifically, this study has extended the TOE framework adapted by Low et al. [15] with an additional domain named human domain.

A research model is developed based on the aforesaid four domains. The research model is shown in the Figure. It consists of human, technological, organizational and environmental factors as independent variables and cloud computing adoption as dependent variables. It is reasonable to believe that all independent variables positively influence cloud computing adoption in PakPSOs. A total of nine hypotheses were developed based on the research model.

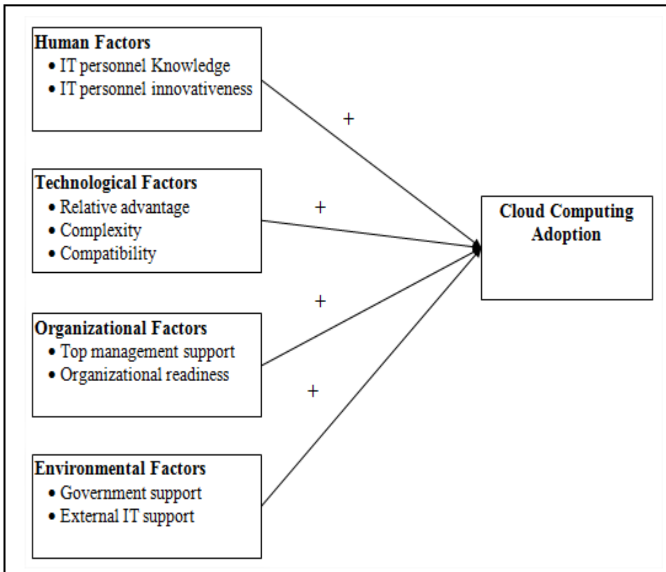


Fig. Research Model.

*Human Factors:* These factors refer to the characteristics of IT personnel in organizations such as IT personnel knowledge and IT personnel innovative effectiveness [6]. Human context represents IT people's related knowledge, skills and innovative capabilities to implement and adopt new technologies in organizations. The IS innovation model of Thong and Yap [19] argued that CIO characteristics are important for adoption innovation in organizations. According to Sallehudin [6], human factors play a vital role in PSOs for IT innovation implementation. Hence, this leads towards the following hypotheses.

H1a: IT personnel knowledge positively influences the cloud computing adoption in PakPSOs.

H1b: IT personnel innovativeness positively influences the cloud computing adoption in PakPSOs.

*Technological Factors:* These factors refer to the characteristics of technological innovation in organizations such as relative advantage, complexity and compatibility which influence adoption decisions [15]. Technological context represents existing technologies in organizations to determine scope and limit of change which organizations accept and market technologies to understand how organizations evolve through the adoption of new technologies. Rogers [20] advocated that technological factors positively impact the innovation implementations in organizations. Thus, the following hypotheses are formulated.

H2a: Relative advantage positively influences the cloud computing adoption in PakPSOs.

H2b: Compatibility positively influences the cloud computing adoption in PakPSOs.

H2c: Complexity positively influences the cloud computing adoption in PakPSOs.

*Organizational Factors:* These factors refer to the characteristics of structure and system of organizations such top management support and technological readiness for adopting new technologies [21]. Organizational context represents current issues and problems identified at organizational level for implementing new technologies. Many studies have supported that organizational factors are important for the adoption of IT innovations [6]. Hence, this leads towards the following hypotheses.

H3a: Top management support positively influences the cloud computing adoption in PakPSOs.

H3b: Organizational readiness positively influences the cloud computing adoption in PakPSOs.

*Environmental Factors:* These factors refer to the characteristics the environment in which the business is run by organizations such as government support and external IS support to adopt new technologies [6]. Environmental context represents the operating environment of organizations in which they perform and contribute and create need and ability to adopt and implement new innovations. Rogers [20] emphasized that a conducive environment is paramount for adoption of innovation. Therefore, the following hypotheses are formulated.

H4a: External IS support positively influences the cloud computing adoption in PakPSOs.

H4b: Government support positively influences the cloud computing adoption in PakPSOs.

## 3 RESEARCH METHODOLOGY

### 3.1 Research Approach

Research approach deals with the conception that whether a research study is inductive or deductive. Inductive approach is appropriate for qualitative research whereas deductive approach is appropriate for quantitative research [22]. In deductive approach, theoretical categories and frameworks are built from the literature and then tested. It is usually involved formulating and testing of hypotheses based on a conceptual framework or research model using independent and dependent variables. Therefore, due to the quantitative nature of this study and involvement of independent and dependent variables, deductive approach is selected for this study.

### 3.2 Research Strategy

Research strategy deals with general plan of how a researcher answers the research questions [22]. The commonly used research strategies include experiment, survey, case study, action research, grounded theory, ethnography and archival research. All these strategies have advantages and disadvantages over each other. However, survey research strategy enables the researcher to learn about opinions, attitudes, expectations and intentions of the participants. Survey research strategy is a feasible and popular strategy in business and management research [22]. It is used to answer who, what, where, how much and how many questions. Survey is a more economical way to collect large amount of data and gives the researcher much control over the research process. Therefore, survey research strategy is adopted in this research study.

### 3.3 Data Collection Methods

Data can be primary and secondary. However, this study uses primary data. Primary data contains information collected directly from the respondents using interviews and/or questionnaires. Questionnaires are written list of questions which may be open-ended and/or closed ended. These are distributed among the respondents to record their answers. Survey questionnaires are most popular because they are highly economical and allow the collection of standardized data from a population [22]. In survey questionnaires, all the respondents are asked the same set of questions in the same format. In this study, closed ended survey questionnaires are used to get meaningful data from the respondents.

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### 3.4 Population and Sample

The study population consisted of Ministries, Divisions and Agencies (MDAs). As the cloud computing facility is at early stages in PakPSOs and a very few MDAs are using or planning to use this facility in the near future, therefore, only those PakPSOs formed the study population which are partially using or planning to use cloud computing facility in the near future. The sampling frame was the government of Pakistan website (www.pakistani.gov.pk) which provided contacts for MDAs. The further detail of MDAs which were involved in cloud computing adoption was taken from National Information Technology Board (NITB) which is the principle body for executing e-government projects in the country. In this way, a list of 22 MDAs was obtained from NITB. Therefore, the real study population consists of 22 MDAs. The minimum sample size was calculated based on guidelines provided by Marcoulides and Saunders [23] and found to be 70. However, the researcher sent 180 questionnaires to the respondents expecting a response rate of 50 percent. The respondents were mainly heads of IT, Directors/Deputy Directors IT, IT Project Directors/Managers/Coordinators, IT Administrator and potential IT users and support personnel. The unit of analysis was individual.

### 3.5 Measurements

Whenever possible, the researcher adopted previous validated scales. However, some items were slightly modified by the two experts in PakPSOs to match the context of the study. The questionnaire consists of 38 items including relative advantage (5 items), compatibility (4 items), complexity (5 items), top management support (4 items), organizational readiness (6 items), IT personnel innovativeness (4 items), IT personnel knowledge (5 items) and cloud computing adoption (5 items). The items were mainly adopted from Moore and Benbasat [24], Featherman and Pavlou [25], Aziz and Yusof [26], Lian, Yen and Wang [27]. All the items were measured on a five point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

### 3.6 Data Analysis Approach

Data were analyzed using PLS-based SEM which is capable to develop and test hypotheses. A variance based SEM technique known as Partial Least Squares (PLS) was applied. More specifically, smart PLS (V. 3.2.7) is applied due to its simplicity and ease of use. It is also suitable for small sample sizes where data is not normally distributed.

## 4 Results

### 4.1 Sample Characteristics

All possible endeavours were made to increase the response rate. Two reminders were sent to the respondents who were not responded after the original request and the first reminder. Consequently, 96 respondents returned the completely filled questionnaires. This resulted into a response rate of 53.33%. This is in line with Urbach and Ahlemann [28] who recommended a sample size of 30 to 100 cases. The sample characteristics are shown in Table 1. Sample characteristics show that the most of the respondents (36. 46%) were IT Project Directors/Managers/Coordinators followed by IT Administrators (26.04%) and Potential IT users and support staff (16.67%). Similarly, the participation of Directors/Deputy Directors IT was 15.63%. However, heads of IT represented 5.20% of the sample which might be due to their busy schedules. With respect to the experience, the average (median) experience acquired by the respondents was 7 years. As for as the qualification of the respondents concerned, 58 possessed master degree, 27 possessed bachelor degree and 11 possessed under bachelor degrees. The representation of the respondents by age is also is given in Table 1. Moreover, Table 1 shows that 81 respondents were male and 15 were female. In conclusion, the overall sample was the representative sample.

TABLE 1
SAMPLE CHARACTERISTICS

| Role in organization (n=96) | Frequency | Percentage |
|---|---|---|
| Heads of IT | 5 | 5.20 |
| Directors/Deputy Directors IT | 15 | 15.63 |
| IT Project Directors/Managers/Coordinators | 35 | 36. 46 |
| IT Administrators | 25 | 26.04 |
| Potential IT users and support staff | 16 | 16.67 |
| Experience | Median | |
| Experience (in years) | 7 | |
| Qualification | | |
| Master degree | 58 | |
| Bachelor degree | 27 | |
| Others | 11 | |
| Age (in years) | | |
| Below 25 | 0 | |
| 25 to 30 | 22 | |
| 31 to 40 | 45 | |
| 40 to 50 | 20 | |
| Above 50 | 9 | |
| Gender | | |
| Male | 81 | |
| Female | 15 | |

### 4.2 Testing the Measurement Model

Two measures are applied to test the measurement model: convergent validity and discriminant validity. Convergent validity is tested through item loading, Cronbach's alpha coefficient, composite reliability and average variance extracted (AVE). First of all, we tested the item loading. The analysis of item loading resulted into the reduction of many indicators of the latent constructs due to the low item loading. More specifically, one indicator (ITKn1) was removed from the construct IT personnel knowledge and one indicator (ITIn5) was removed from the construct IT personal innovativeness due to their item loading below 0.7 as suggested by Hair et al. [29]. Moreover, two indicators (RAd1 & RAd5) were removed from the construct relative advantage due to their low item loading below the minimum threshold of 0.7. Similarly, three indicators (Cplex3, Cplex4 & Cplex5) were removed from the construct complexity and two indicators (Cpat1 & Cpat5) were removed from the construct compatibility due to their item loading below 0.7. Moreover, four indicators (OR1, OR4, OR5 & OR6) were removed from the construct organizational readiness due to their low item loading. Furthermore, two indicators (EISS4 & EISS5) were removed from the construct external IS support and two indicators (GS1 & GS2) were removed from the construct government support and two indicators (CCA1 & CCA5) were removed from the construct cloud computing adoption due to their item loading below the minimum threshold of 0.7. The remaining indicators for each of the constructs were the subject for further analysis. Subsequently, we applied PLS algorithm on the remaining indicators to examine the convergent validity of the measurement model. The results of item loading, Cronbach's alpha coefficient, composite reliability and average variance extracted (AVE) are shown in Table 2. The results showed that the item loading of all the indicators is above the minimum required value of 0.7 [29]. Cronbach's alpha coefficient is above the minimum required value of 0.7, composite reliability is larger than the required value of 0.5 and AVE is also greater than the minimum required limit of 0.5 [30]. The values of all these measures indicated that the convergent validity has been ensured in this study.

Discriminant validity is tested by two methods. 1) item loading of the latent constructs are examined on its own constructs and on other constructs. If items loading of the latent constructs on its own construct are greater than loading on other constructs then the discriminant validity is established [30]. 2) square root of AVE between constructs and its measures are examined. If square root of AVE between constructs and its measures is greater than the other constructs then the discriminant validity is established [31]. Discriminant validity was tested by using the two methods as discussed above. The results are shown in Table 3 and Table 4. The results in Table 3 show that the items loading on their own constrcuts are greater than the loading on other constructs. The results in Table 4 indicate that the square root of AVE (shown by bold) between constcucts and their measures are greater than the other constcucts. Hence, discriminant vailidity has been ensured in this study.

### 4.3 Testing the Structural Model

Three measures are used to test the structural model. These measures are variance (R2), path coefficient strength (β) and their significance (t-values). The structural model is used to test hypotheses. The results of Smart PLS bootstrapping are shown in Table 5 and Table 6. The results in Table 5 show that 61.7 percent variance in the cloud computing adoption is explained by the nine independent variables which is higher than the required threshold of 50 percent [29]. The results in Table 6 show the path coefficient strength (β) and their significance (t-values).

The result revealed that IT personnel knowledge demonstrated the highest positive impact on cloud computing adoption (β = 0.394, t = 2. 480) followed by the IT personnel innovativeness (β =0.387, t = 2.688). These impacts are also significant (t>1.96 at 5% significant level). Therefore, hypotheses H1a and H1b were supported. Moreover, government support showed positive impact on cloud computing adoption (β = 0.275, t = 2.632). This impact is also significant (t>1.96 at 5% significant level). Therefore, hypothesis H4b was also supported. Compatibility showed weak path coefficient strength for cloud computing adoption (β = 0.120, t = 1.008) but this impact is not significant. All other hypotheses were not supported in the study environment due to their low path coefficient strength and/or insignificance. The summary of the results is given in Table 6. The discussion on the results and their interpretation are made in the next sub-section.

TABLE 2
CONVERGENT VALIDITY

| Latent constructs | Items | Item loading | Cronbach's Alpha | CR | AVE |
|---|---|---|---|---|---|
| IT personal knowledge (ITKn) | ITKn2 | 0.817 | 0.807 | 0.871 | 0.630 |
| | ITKn3 | 0.819 | | | |
| | ITKn4 | 0.706 | | | |
| | ITKn5 | 0.826 | | | |
| IT personal innovativeness (ITIn) | ITIn1 | 0.747 | 0.818 | 0.878 | 0.643 |
| | ITIn2 | 0.852 | | | |
| | ITIn3 | 0.839 | | | |
| | ITIn4 | 0.766 | | | |
| Relative advantage (RAd) | RAd2 | 0.815 | 0.877 | 0.922 | 0.797 |
| | RAd3 | 0.938 | | | |
| | RAd4 | 0.920 | | | |
| Complexity (Cplex) | Cplex1 | 0.893 | 0.713 | 0.874 | 0.777 |
| | Cplex2 | 0.870 | | | |
| Compatibility (Cpat) | Cpat2 | 0.861 | 0.890 | 0.921 | 0.795 |
| | Cpat3 | 0.834 | | | |
| | Cpat4 | 0.975 | | | |
| Top management support (TMS) | TMS1 | 0.838 | 0.733 | 0.814 | 0.530 |
| | TMS2 | 0.789 | | | |
| | TMS3 | 0.717 | | | |
| | TMS4 | 0.729 | | | |
| Organizational readiness (OR) | OR2 | 0.729 | 0.808 | 0.902 | 0.660 |
| | OR3 | 0.855 | | | |
| Government Support (GS) | GS3 | 0.841 | 0.708 | 0.837 | 0.632 |
| | GS4 | 0.813 | | | |
| | GS5 | 0.727 | | | |
| External IS support (EISS) | EISS1 | 0.813 | 0.755 | 0.832 | 0.623 |
| | EISS2 | 0.726 | | | |
| | EISS3 | 0.826 | | | |
| Cloud computing adoption (CCA) | CCA2 | 0.820 | 0.746 | 0.855 | 0.664 |
| | CCA3 | 0.854 | | | |
| | CCA4 | 0.768 | | | |

TABLE 3
CROSS LOADING

| | ITKn | ITIn | RAd | Cplex | Cpat | TMS | OR | GS | EISS | CCA |
|---|---|---|---|---|---|---|---|---|---|---|
| ITKn2 | 0.817 | 0.376 | 0.563 | 0.588 | 0.437 | 0.247 | 0.451 | 0.251 | 0.351 | 0.551 |
| ITKn3 | 0.819 | 0.323 | 0.428 | 0.456 | 0.334 | 0.385 | 0.407 | 0.503 | 0.109 | 0.501 |
| ITKn4 | 0.706 | 0.202 | 0.231 | 0.526 | 0.559 | 0.356 | 0.618 | 0.618 | 0.318 | 0.618 |
| ITKn5 | 0.826 | 0.411 | 0.520 | 0.462 | 0.433 | 0.268 | 0.550 | 0.550 | 0.350 | 0.650 |
| ITIn1 | 0.249 | 0.747 | 0.240 | 0.373 | 0.367 | 0.432 | 0.366 | 0.566 | 0.566 | 0.366 |
| ITIn2 | 0.115 | 0.852 | 0.433 | 0.514 | 0.533 | 0.216 | 0.467 | 0.467 | 0.567 | 0.267 |
| ITIn3 | 0.369 | 0.839 | 0.253 | 0.443 | 0.386 | 0.367 | 0.572 | 0.372 | 0.372 | 0.472 |
| ITIn4 | 0.315 | 0.766 | 0.513 | 0.348 | 0.310 | 0.276 | 0.476 | 0.376 | 0.376 | 0.376 |
| RAd2 | 0.552 | 0.374 | 0.815 | 0.447 | 0.394 | 0.240 | 0.593 | 0.293 | 0.393 | 0.393 |
| RAd3 | 0.444 | 0.283 | 0.938 | 0.513 | 0.489 | 0.329 | 0.361 | 0.561 | 0.361 | 0.461 |
| RAd4 | 0.272 | 0.211 | 0.920 | 0.366 | 0.522 | 0.304 | 0.236 | 0.236 | 0.236 | 0.236 |
| Cplex1 | 0.511 | 0.193 | 0.365 | 0.893 | 0.566 | 0.610 | 0.363 | 0.363 | 0.263 | 0.363 |
| Cplex2 | 0.366 | 0.199 | 0.324 | 0.870 | 0.490 | 0.321 | 0.402 | 0.440 | 0.540 | 0.540 |
| Cpat2 | 0.206 | 0.144 | 0.357 | 0.283 | 0.861 | 0.364 | 0.508 | 0.508 | 0.308 | 0.308 |
| Cpat3 | 0.311 | 0.273 | 0.291 | 0.556 | 0.834 | 0.390 | 0.628 | 0.528 | 0.328 | 0.528 |
| Cpat4 | 0.275 | 0.114 | 0.342 | 0.388 | 0.975 | 0.318 | 0.563 | 0.563 | 0.463 | 0.563 |
| TMS1 | 0.252 | 0.125 | 0.336 | 0.484 | 0.385 | 0.838 | 0.361 | 0.336 | 0.336 | 0.536 |
| TMS2 | 0.336 | 0.266 | 0.536 | 0.564 | 0.325 | 0.789 | 0.230 | 0.339 | 0.239 | 0.539 |
| TMS3 | 0.228 | 0.343 | 0.382 | 0.247 | 0.339 | 0.717 | 0.366 | 0.466 | 0.366 | 0.466 |
| TMS4 | 0.249 | 0.210 | 0.386 | 0.314 | 0.220 | 0.729 | 0.359 | 0.559 | 0.359 | 0.559 |
| OR2 | 0.363 | 0.301 | 0.362 | 0.357 | 0.262 | 0.561 | 0.729 | 0.329 | 0.529 | 0.329 |
| OR3 | 0.321 | 0.542 | 0.376 | 0.405 | 0.574 | 0.340 | 0.855 | 0.333 | 0.358 | 0.555 |
| GS3 | 0.417 | 0.350 | 0.155 | 0.553 | 0.568 | 0.557 | 0.628 | 0.841 | 0.569 | 0.369 |
| GS4 | 0.376 | 0.386 | 0.192 | 0.248 | 0.554 | 0.330 | 0.223 | 0.813 | 0.554 | 0.354 |
| GS5 | 0.332 | 0.38 | 0.373 | 0.173 | 0.333 | 0.227 | 0.386 | 0.727 | 0.233 | 0.433 |
| EISS1 | 0.211 | 0.286 | 0.342 | 0.218 | 0.546 | 0.543 | 0.513 | 0.254 | 0.813 | 0.569 |
| EISS2 | 0.306 | 0.355 | 0.380 | 0.559 | 0.630 | 0.515 | 0.313 | 0.633 | 0.726 | 0.554 |
| EISS3 | 0.254 | 0.133 | 0.254 | 0.554 | 0.354 | 0.554 | 0.554 | 0.646 | 0.826 | 0.533 |
| CCA2 | 0.333 | 0.539 | 0.233 | 0.633 | 0.433 | 0.533 | 0.333 | 0.330 | 0.412 | 0.820 |
| CCA3 | 0.346 | 0.546 | 0.346 | 0.446 | 0.446 | 0.346 | 0.461 | 0.317 | 0.255 | 0.854 |
| CCA4 | 0.330 | 0.330 | 0.530 | 0.330 | 0.330 | 0.330 | 0.540 | 0.259 | 0.488 | 0.768 |

TABLE 4
INTER-CORRELATION OF CONSTRUCTS AND THE CORRESPONDING SQUARE ROOT OF AVE

| | CCA | Cpat | Cplex | EISS | GS | ITIn | ITKn | OR | RAd | TMS |
|---|---|---|---|---|---|---|---|---|---|---|
| CCA | 0.815 | | | | | | | | | |
| Cpat | 0.132 | 0.892 | | | | | | | | |
| Cplex | 0.251 | 0.171 | 0.881 | | | | | | | |
| EISS | 0.419 | 0.230 | 0.385 | 0.789 | | | | | | |
| GS | 0.426 | 0.297 | 0.385 | 0.767 | 0.795 | | | | | |
| ITIn | 0.756 | 0.020 | 0.327 | 0.379 | 0.331 | 0.802 | | | | |
| ITKn | 0.684 | 0.081 | 0.265 | 0.393 | 0.335 | 0.661 | 0.794 | | | |
| OR | 0.413 | 0.278 | 0.261 | 0.546 | 0.512 | 0.422 | 0.495 | 0.813 | | |
| RA | 0.170 | 0.658 | 0.007 | 0.133 | 0.280 | 0.115 | 0.280 | 0.195 | 0.893 | |
| TMS | 0.311 | 0.694 | 0.244 | 0.375 | 0.410 | 0.285 | 0.439 | 0.426 | 0.518 | 0.728 |

TABLE 5
VARIANCE $R^2$

| | R Square | R Square Adjusted |
|---|---|---|
| Cloud Computing Adoption | 0.617 | 0.577 |

TABLE 6
STRENGTHS AND SIGNIFICANCE OF PATH COEFFICIENTS

| Constructs | Path coefficient (β) | t-values (t) | Hypothesis Support |
|---|---|---|---|
| ITKn → CCA (H1a) | 0.394 | 2. 480 | Supported |
| ITIn → CCA (H1b) | 0.387 | 2.688 | Supported |
| RAd → CCA (H2a) | -0.085 | 0.802 | Not supported |
| Cpat → CCA (H2b) | 0.120 | 1.008 | Not supported |
| Cplex → CCA (H2c) | -0.068 | 0.764 | Not supported |
| TMS → CCA (H3a) | -0.046 | 0. 411 | Not supported |
| OR → CCA (H3b) | 0.026 | 0.264 | Not supported |
| EISS → CCA (H4a) | -.0.133 | 1.233 | Not supported |
| GS → CCA (H4b) | 0.275 | 2.632 | Supported |

### 4.4 Discussion

After the process of data analysis, it was revealed that only three hypotheses H1a, H1b and H4b were supported and rest of the hypotheses were not supported in the PakPSOs. The hypothesis H1a demonstrated the highest positive support for the cloud computing adoption in PakPSOs. It means that IT personnel knowledge is the most crucial determinant influencing the cloud computing adoption in PakPSOs. This might be due to the fact that cloud computing adoption success depends on the competitive IT professionals' knowledge and skills in PakPSOs. Skilled and trained professionals are the assets of the organizations and PakPSOs are no exception. Therefore, organizations should attract, develop and retain IT personnel who are knowledgeable and skilled without which cloud computing adoption is a nightmare. IT personnel knowledge counted as an essential determinant regarding the cloud computing adoption in organizations. The need is even coupled in the PSOs of developing countries which largely influenced by the various political pressures at various levels. The hypothesis H1b also showed positive support for the cloud computing adoption in PakPSOs. It means IT personnel innovativeness is also crucial for the success of cloud computing adoption in PakPSOs. Innovative employees bring changes in the organizations and are considered as big sources of competitive advantage for the organizations. They are knowledgeable of the new technological changes in the market place and introduce new implementation concepts and plans for the successful implementations of new technologies in organizations. The need is also felt in PakPSOs because it is a difficult task to attract, retain and develop IT personnel innovativeness in PakPSOs due to lack of IT cadre in the public sector. However, they perceive that IT personnel innovativeness is an essential determinant of cloud computing adoption in this environment. The hypothesis H4b also demonstrated positive support for the cloud computing adoption in PakPSOs. This might be due to the fact that top management provides necessary resources for the cloud computing adoption in their respective organizations. Top management support is also vital for acquiring additional resources in crisis. Without the support of top management, new technological changes cloud not be implemented in the organizations. Not only the support of the top management is required but also their active engagement is required in this regard. The other six hypotheses were not supported in the study environment i.e. PakPSOs. This was not only the contradictory result of this study with the previous studies but also the surprising result. There might be two reasons behind this. First, cloud computing adoption is at its early stages in PakPSOs due to which the respondents might not have deep insights regarding its adoption in PakPSOs. Second, some or all of the determinants might have interaction effect (moderating effect) with other variables on the cloud computing adoption or these might be the moderators themselves. Similarly, some variables might have mediation effect with other variables on the cloud computing adoption or these might be the mediators themselves. In either case, these determinants should not be ignored at all. Investigating the moderating or mediation effect with these variables would be the motivating area for future researchers.

## 5 Conclusion

This study investigated the determinants influencing the cloud computing adoption in PakPSOs. A research model was developed based on the TOE framework which is most cited and widely accepted framework to implement technological innovations in the organizations [9]. Various determinants influencing the cloud computing adoption were found and grouped into four categories of the TOE framework i.e. human factors, technological factors, organizational factors and environmental factors. Consequently, nine hypotheses were developed and tested using sample data of 96 respondents from 22 PakPSOs. Smart PLS (V. 3.2.7) was applied for data analysis.

The results of the study revealed that three hypotheses were supported in the study environment. IT personnel knowledge, IT personnel innovation and government support positively influenced the cloud computing in PakPSOs. Rest of the hypotheses was not supported in the study environment. The results also showed that PakPSOs are weak in many areas which need to be improved. In terms of TOE framework, the results indicated that human related factors are more important than other factors regarding the implementation of cloud computing in the public sector of a developing country. Moreover, government support is also vital in the public sector environment without which technological innovations like cloud computing cloud not be turned into success story.

However, the other determinants which were not supported might also be of importance. These determinants might have moderating or mediating effect with some other determinants. Therefore, these determinants should not be ignored at all. The study sheds light on adopting technological innovations in the PSOs of a developing country through the use of emerging technology especially cloud computing adoption in this environment. The study possesses value in the sense that cloud computer adoption enables organizations to use IT infrastructure and application more cost-effectively resulting into synergistic gains and quality public service delivery. PSOs can create and share links in and across organizations not only in a cost-effective way but also in a sustained, improved and reliable way. Therefore, determining the effective determinants of cloud computing adoption is paramount for focusing on areas which require immediate attention.

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