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Cloud Computing Fitness for E-Government Implementation: Importance-Performance Analysis

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ABSTRACT The means through which governments deliver services and the way they operate may be considerably enhanced through cloud computing. It can help to address e-government implementation challenges and revolutionize e-government systems in terms of cost savings and the professional use of resources. The aim of this paper is to analyze the importance and performance of the factors that influence the fitness of cloud computing for e-government implementation. This paper integrates the task technology fit model with the diffusion of innovation theory to address this issue. Yemeni public institutions were identified as sources for data collection and 292 information technology employees participated as sample respondents for a structured questionnaire. Security, compatibility, relative advantage, and tasks were the variables found to affect the fitness of cloud computing for e-government activities. However, no impact was seen from the standpoints of trialability and complexity of the technology. In terms of assessing the fitness of cloud computing for e-government services, a greater understanding among policy formulators was sought through the importance-performance matrix analysis (IPMA). The results of IPMA can help identifying areas for strategic focus to assess cloud computing as an alternative technology to implement e-government services.

INDEX TERMS Cloud computing, DOI, e-government, importance-performance matrix analysis, TTF.

I. INTRODUCTION

Governments all over the world have recognized the potential opportunities offered by information communication technology (ICT) to increase efficiency in internal processes and offer better services to citizens by implementing e-government systems. As a result, significant competitive disadvantages may be incurred by governments that overlook the strengths of emerging ICT technologies. Many developing countries are facing an array of governance challenges, such as corruption, poor public management, lack of appropriate transparency and responsibility in public decision-making powers, and the provisioning of public services [1]. E-government can be utilized as a tool to improve government processes in order to meet these challenges [1]–[4]. Nevertheless, as Ebrahim and Irani [5] noted, a robust technical system and proficient technical capabilities are necessary for introducing e-government technology, which itself entails significant hazards and expense. Moreover, as Gant [6], Kanaan [7], and Al-Rashidi [8] emphasized, poor literacy and education level, a deficiency in ICT capabilities, insufficient technology systems, and scarce resources are all difficulties faced by developing states. Therefore, for developing countries, specifically countries in the early stages of development or those that have not yet initiated an e-government project, there is an increasing need to exploit the opportunities created by the new emerging ICT technologies as they invest in ICT to implement e-government systems. Cloud computing is one such innovative technology that can extend services in an economical manner, as well as provide considerable opportunities to offer user-centered services.

Cloud computing can provide a good basis to address some of the aforementioned challenges faced by governments. It has the potential to revolutionize e-government systems in terms of cost saving and the actual and professional use of resources [9]–[11]. Further, cloud computing has recently created a revolution in the way ICT is used by organizations and individuals. Tripathi and Parihar [12] explained that in terms of fulfilling the unanticipated requests for resources, strong performance has been established with regard to state sector utilization of cloud-based services.

Many researchers have studied cloud computing in the context of e-government implementation [9]–[11], [13]–[21]. Moreover, it has been found that only 12% of the proposed models investigate the variables affecting e-government utilization of cloud computing, while 88% of the reviewed models propose integrating cloud computing in the process of e-government implementation [22].

Furthermore, Rai *et al.* [23] conducted a systematic review of cloud computing adoption factors and concluded that cloud adoption research is currently in the seminal stage and requires further studies to mature.

The decision to adopt new technology to implement a system may involve some risk. Therefore, developing a model that can examine the fitness of this technology for the context requirements is valuable. The choice of whether to employ cloud computing may be shaped by a consideration of variables influencing the fitness of cloud computing to the specific needs of the e-government of a developing state. Therefore, the choice of whether to provide e-government services through the utilization of cloud computing may be facilitated based on the model proposed in this research. By analyzing the importance and performance of these factors, insight and derived recommendations are provided for government policymakers and Information Technology (IT) managers to measure the fitness of cloud computing as an alternative technology for e-government services.

The following section reviews the related literature. In the subsequent section, a theoretical background is established, the model is presented, and hypotheses are proposed. Then, the methodology followed in this study is described. The next section presents the data analysis and results. Finally, an importance-performance analysis is conducted and a discussion is presented on the findings of the study.

II. RELATED WORK

Since 2009, within the Information System (IS) context, attention has been paid to e-government and the potential for utilizing cloud computing within it. In terms of strategic IT development and the potential utilization of cloud computing for an institution, relevant variables were determined through the conceptual model developed by Ross [13]. Cost effectiveness, need for cloud computing, reliability, and perceived security effectiveness were considered. Furthermore, the U.S. Department of Defense (DoD) was assessed to determine the viability of cloud computing for the introduction of e-services by Killaly [14]. The acceptance of cloud computing by the DoD was investigated by proposing a Viability-Willingness Model (VWM), which was built based on the Fit-Viability Model (FVM). Acceptance of cloud computing was found to be shaped by viability, which in turn is formulated through perceived technological appropriateness, organizational inertia, and cost.

In research conducted by Hailu [15], the cost-effectiveness, reliability, organizational need, and security effectiveness of cloud computing were assessed in relation to the perspectives of IT experts (in developing states) on the utilization of cloud computing. The advocating of cloud computing tool adoption by the IT experts was found to be positively related to their views on cost effectiveness, reliability, organizational need, and security effectiveness. Additionally, the implementation of cloud computing by government bodies was investigated by Shin [16]. The influence of key characteristics of cloud computing on behavioral intention was considered, and a theoretical acceptance model was proposed to explore the factors influencing user perception of cloud computing. The model was developed by integrating TAM with specific influencing factors, such as availability, access, security, and reliability. The model was empirically verified by investigating the perception of users working in public institutions. The results showed that user intention and behavior are influenced by the perceived features of cloud services.

The utilization of cloud computing by big corporations and governments was the focus of the model developed by Trivedi [17]. Research on the Technology Organization Environment (TOE) model, as well as various case studies, was considered by Trivedi to identify significant variables. The TOE framework was applied to identify technological, organizational, and environmental factors. The proposed model helps organizations to understand what capabilities they need to develop to be able to adopt cloud computing. Further, Li *et al.* [18] analyzed the current situation of e-government in China and the cloud computing services and discussed the potential of implementing cloud computing for e-government. By considering the challenges arising from the application of cloud computing for e-government service delivery, the variables affecting e-government introduction could be assessed. Determining the variables shaping cloud utilization was conducted via the Gil-Garcia model.

The variables that influence the introduction of cloud computing in an institution in an effective manner were analyzed by Suo [24]. The impact of cloud computing on the IT capabilities of an institution was explored through the qualitative interviews. Two different cloud models were subjected to a case study exploration. An array of variables was discovered to affect IT capabilities as a consequence of cloud utilization, on the basis of the data obtained through a grounded theory approach. These factors include the role and functionality of IT departments, IT leadership, skills and jobs, IT staffing, formal structure, and workplace culture. Cloud utilization was identified as being shaped by two variables-based models developed by Kuiper *et al.* [19]. In order to assess the case of state sector cloud implementation from the position of the European Commission, a system diagram model was devised, alongside a general diffusion of an innovation-theory-based model. Ultimately, state sector utilization of cloud computing was found to be affected by risk and innovative variables such as trialability, observability, complexity, compatibility, and relative advantage, alongside other variables like definitional perspectives of ''cloud,'' security and legal challenges, persuasion of IT heads, auditability and traceability, and cooperation.

Abeywickrama and Rosca [20] investigated how cloud computing can enhance the value of public service delivery. Case study research on the Moldova central public administration was conducted. A success model based on the DeLone & McLean (D & M) model was proposed and factors related to system quality, information quality, service quality, intention to use, use, and user satisfaction were examined. In the context of state bodies in Malaysia, potential variables affecting the choice to utilize cloud computing were investigated by Sallehudin *et al.* [21]. A model was developed by integrating the DOI theory and IT personnel characteristics. Improvements in service provisions in the state sector of Malaysia through cloud computing was investigated in relation to influential variables through the devised model. The implementation of cloud computing in this context was found to be shaped by human variables, such as the understanding of IT employees, as well as innovation characteristics like compatibility and relative advantage. Table 1 summarizes the context, theoretical background, methodology, and examined factors in the previous studies. The variables that shape the utilization of cloud computing in e-government environments have been assessed in various literature along with their devised models, and are illustrated in Table 1. Different perspectives and theories were applied to propose the models and examine the influencing factors. Quantitative methodology utilizing questionnaires was mostly used to verify the proposed models, and various factors were examined. These factors include technological, organizational, environmental, economic, and human factors. However, adoption of a technology does not enhanced the performance of an organization unless this technology fit the organizations' requirements [25]. Previous studies ignored measuring the fitness of cloud computing to the tasks of e-government implementation in developing countries.

Furthermore, a number of research studies reviewed the concept of cloud computing in the e-government environment by focusing on identifying e-government challenges, as well as the benefits and barriers of e-governance on the cloud [26]–[28]. However, these studies surveyed the benefits and barriers of cloud computing based on its characteristics, with an absence of an empirical fieldwork. As a means of identifying the major impetuses behind the utilization of cloud computing across state sector institutions, various states and examples were explored by Mohammed and Ibrahim [29], posing an alternative approach. The transition of service provision to cloud systems by state sector bodies was determined to be shaped by scalability and economization requirements as major and pervasive variables. Also by reviewing the cloud adoption drivers, Rai *et al.* [23] concluded that cost savings, optimum resource utilization, unlimited scalability of resources, and less maintainability are the most common drivers. Aligning these drivers with common e-government implementation challenges (ICT infrastructure, human resources and financial resources) shows that cloud computing may fit with the e-government implementation requirements in developing countries.

III. THEORETICAL FOUNDATION

According to Baas and van Rekom [30], the linkage of technology to performance in IS research resulted in two main streams: the task-technology fit (TTF) model, and adoption- and utilization-focused models. Previous studies focused on cloud utilization in the context of e-government. The perspectives of IT employees and managers on cloud computing and its impact are considered by existing literature to shape the utilization of cloud computing. However, technology adoption is not always voluntary, and thus the performance impact is dependent on the supportive and instrumental value of the technology, rather than the degree of utilization [30]. Therefore, as Goodhue and Thompson [25] argue, if the adopted technology does not fit the requirements, higher utilization will not increase productivity. Hence, considering these two main streams can contribute to investigate the fitness of a technology to specific requirements toward adoption of this technology while ensuring higher productivity. Accordingly, this research proposes integrating two dominant theories: TTF and DOI. TTF identifies the factors that predict technology usage and performance [25], [30], [31]. Nevertheless, as Lee *et al.* [32] explained, in terms of technology diffusion studies, DOI is considered to be an important theoretical model that is widely applied by analysts in studies on the utilization of innovative technologies.

A. TASK TECHNOLOGY FIT

The TTF model matches the capabilities of the technology to the demands of the task. It measures the ability of a technology to support a task [25]. TTF model has four key constructs, task characteristics, technology characteristics, task technology fit and performance/utilization. Task characteristics and technology characteristics together affect the task technology fit, which in turns affects performance or utilization as a dependent construct. The TTF model implies that technology is used if the available functions support the activities of the user. If no sufficient benefits exist, the technology is less frequently utilized [33]. Cloud computing characteristics may support e-government implementation tasks and thus can be used for implementing more effective e-government services. Accordingly, this research applies the TTF model to measure the effect of the fitness of cloud computing to e-government implementation tasks.

B. DIFFUSION OF INNOVATION THEORY

As Lee *et al.* [32] noted, a foremost and pervasively utilized model in relation to innovative technology utilization

TABLE 1. Literature of cloud computing adoption in the E-government context.

Study	Context	Theory	Methodology	Factors
Ross [13]	Decision Making Managers	Conceptual Model	Survey (Questionnaire)	Cost Effectiveness, Need, Reliability Security Effectiveness
Shin [16]	Users working in public institutions in Korea	TAM	Survey (Questionnaire)	Availability, Access, Security, Reliability
Killaly [14]	E-services in the Department of Defense (DoD) in US.	FVM	Survey (Questionnaire)	Cost, Organizational Inertia, Fit
Trivedi [17]	Governments and large enterprises in developing countries	TOE	Survey (Questionnaire)	Technological, Organizational, Environmental
Hailu [15]	IT leaders in developing countries	Conceptual Model	Survey (Questionnaire)	Security Effectiveness, Organizational Need, Reliability, Cost-Effectiveness
Li et al. [18]	E-government in China	Gil-Garcia model	-	Security, Complexity, Skills, Business Needs, Maturity of Existing Systems, Project Size, Implementation Difficulty, Managers' Attitudes, Ordinary People's Attitude, Business Function, Privacy Concerns, Management Ability, Informatization Plan, Existing Informatization Level, One Year Budgets, Autonomy of Units, Laws and Regulations, Policy and Political Pressures, Development State Abroad, Degree of Public Support, Push of Superior Departments, Push of Departments
Suo [24]	Organizations in several industries in US (including government agencies)	Grounded theory	Interviews – Case Study	Role and Functionality, IT Leadership, Skills and Jobs, IT Staffing, Formal Structure, Workplace Culture
Kuiper et al. [19]	European Commission perspective on public sector cloud adoption.	DOI, system diagram	desk research, survey	Collaboration, Traceability and Auditability, Convincing IT Managers, Security and Legal Issues, Perception of The Term Cloud, Risk, Relative Advantage, Compatibility, Complexity, Observability, Trialability
Abeywickrama and Rosca [20]	Moldova central public administration	DeLone & McLean model	Case Study	System Quality, Information Quality, Service Quality, Intention to use, Use, User Satisfaction
Sallehudin et al. [21]	Malaysian public agencies	DOI and IT personnel characteristics	Survey (Questionnaire)	Relative Advantage, Compatibility, IT Personnel Knowledge

is the DOI theory developed by Rogers and Shoemaker [34]. The DOI theory is used to explain the mechanism of the adoption and assists in predicting whether a new invention will be successful. The theory postulates that certain attributes of an innovation can influence its adoption and at the same time affect the rate of acceptance of the innovation. According to Rogers, these characteristics include relative advantage, compatibility, complexity, trialability, and observability. There are a number of studies that tested the DOI model in the context of cloud computing adoption [35]–[43]. Although cloud computing innovation comes with new characteristics compared to previous generations of computing, its adoption has not been fully understood in the context of e-government [22], [23].

IV. PROPOSED MODEL AND HYPOTHESES

The TTF model is specifically adapted to help determine whether cloud computing is a suitable option for implementing e-government tasks. It is measured by identifying e-government related tasks and requirements, and assessing the impact of cloud computing by using DOI factors. Accordingly, various constructs have been identified in the context of cloud computing fitness for e-government implementation. Fitness is defined by Goodhue and Thompson [25] as the extent to which technology functionality matches task requirements. Lippert and Forman [44] also defined the fitness as the extent to which a technology provides features and fits the requirements of the task. According to Liang *et al.* [45], fitness measures the extent to which the characteristics of a technology matches the needs of the task. In the context of the current study, fitness is defined as the extent to which cloud computing is consistent with the specific requirement of e-government implementation. On the other hand, task characteristics refer to the task requirements within the organization [45]. Task requirements can be defined as ability or behavior requirements [46]. In the current study, the task construct assesses the government-related requirements and actions that are performed to provide e-services. In other words, the computational requirements of government bodies in relation to the utilization of e-government services are explored. UN report [47] and Krishnan and Teo [48] explained that in order to replicate the ability to undertake activities that would typically occur offline, e-government infrastructure must be introduced and enhanced to provide internet-based public-sector services.

Therefore, this research proposes the following hypothesis:

H1: *The e-government-related task requirements positively influence cloud computing technology fitness for e-government services implementation.*

In addition, by considering the technological factors influencing cloud computing adoption in the literature [35], [38], [40], [43], [49], relative advantage, compatibility, complexity, trialability, and security are proposed to measure the technology aspect of the fitness of cloud computing for e-government services implementation.

The extent to which an innovation is considered superior to the concept that it supplants was characterized by Rogers [50] as relative advantage. As Nuseibeh [39] and Tehrani and Shirazi [43] explained specifically in relation to cloud computing utilization research, the extent that decision makers consider cloud systems as superior to different computing paradigms characterizes relative advantage. Many studies examined relative advantage as a factor that positively influences cloud computing adoption decision making [35], [38], [51]. In addition, the relative advantage impact on the fitness of information technology was examined in different contexts [52], [53]. In the context of this research, relative advantage can be seen as one of the factors that influence cloud computing fitness to e-government implementation. Therefore, this study postulates the following hypothesis:

- ***H3:*** *Relative advantage positively influences the fitness of cloud computing to the computing needs of an organization to implement e-government services.*

Compatibility is the extent to which the value of the innovation is consistent with existing values, beliefs, and the needs of the context [50]. Morgan and Conboy [38] and Tehrani and Shirazi [43] explained that compatibility is concerned with the degree to which the present requirements, capabilities, and technology of an institution are compatible with cloud computing. Compatibility was widely used to study the diffusion of cloud computing adoption [35], [37]–[39], [41], [42], [51]. Further, several research studies examined compatibility as a factor to measure task–technology fitness [25], [31], [52], [54]. Furthermore, Lam *et al.* [52] demonstrates the relationship between the perceived compatibility of an IT system and the fitness of this system for task characteristics. E-government adoption and the effect of compatibility on the fitness of cloud computing is assessed in this research, with the subsequent hypothesis devised in this respect:

- ***H3:*** *Compatibility positively affects the fitness of cloud computing to the computing needs of an organization, in order to implement e-government services.*

The extent to which a new concept or item is considered to be challenging to comprehend and utilize was the definition that Roger and Shoemaker [34] initially gave for complexity (as a DOI variable). Multiple studies examined complexity as a factor that negatively influences cloud computing adoption [35], [38], [39], [42], [43], [51]. Further, Goodhue and Thompson [25] defined complexity as a factor of the TTF. In addition, Lee *et al.* [54] examined complexity as one of the factors used to measure the fitness of technology for specific tasks. This study tests the effect of the perception of complexity by the IT staff on the fitness of cloud computing on the context of public sector organizations. Therefore, this study proposes the following hypothesis:

- ***H4***: *Complexity negatively influences the fitness of cloud computing to the computing needs of an organization to implement e-government services.*

Furthermore, as Rogers [55] suggested, trialability is the extent to which a restricted trialing of an innovation can be undertaken and how it affects the diffusion of an innovation. Trialability is an important factor in cloud computing [43]. Tehrani and Shirazi [43], Morgan and Conboy [38], and Alshamaila [35] examined this factor in the context of cloud computing. Further, Dishaw *et al.* [33] examined the influence of trialability on TTF. The degree of fitness of cloud computing for e-government adoption can be determined based on the utilization of hybrid, private, or state models of particular e-services to assess the following cloud services: software as a service, platform as a service, or infrastructure as a service. Hence, this study aims to re-examine trialability to measure cloud computing fitness to implement e-government services. Therefore, the following hypothesis is proposed:

- ***H5:*** *Trialability positively influences the fitness of cloud computing to the computing needs of an organization to implement e-government services.*

Security can be defined as the ability to prevent unauthorized access or modification to information in storage, processing, or transit [56]. Conklin [57] noted that one of the primary issues for governments in relation to cloud computing platforms is data confidentiality and security. Lian *et al.* [36] also suggested that significant apprehension exists regarding confidentiality and security of data on cloud computing platforms. Therefore, there are limits on which applications can be safely transferred to the cloud. As a result, an organization must carefully assess the pros and cons of transferring various applications and data to the cloud [13]. Thus, it is important to understand whether the security concerns significantly influence the fitness of cloud computing to e-government implementation requirements. Therefore, this study proposed the following hypothesis:

- ***H6:*** *Security negatively influences the fitness of cloud computing to the computing needs of an organization in the implementation e-government services.*

Fig. 1 represents the proposed research model.

V. RESEARCH METHOD

To verify the proposed model, data were collected from a public sector organization in Yemen. The data sample includes IT staffs in public sector organizations who are responsible for implementing, maintaining, and managing e-government projects. The survey is used to collect quantitative data. Based on the proposed constructs of the model and the literature of e-government context, the study designs and develops an instrument. To develop the instrument, the definition of each construct is reviewed based on the theories and the

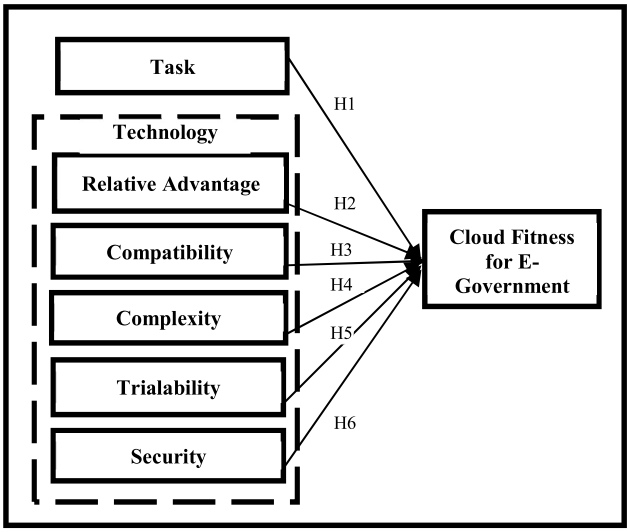

FIGURE 1. The research model.

literature. Then, the dimensions of each construct are identified. To measure each dimension, one item or more is adapted from the literature by considering the subject under investigation (cloud computing) and the context (e-government). Constructs' dimensions, number of items and related references are illustrated in Table 2. For the detailed list of items used in the instrument see the Appendix. All items that address constructs in the model are based on a five-point Likert scale where 1 represents strongly disagree and 5 represents strongly agree. A nominal scale is used in the demographics section.

Because organizations associated with different types of services may have different characteristics and different levels of experience with e-services provisions, the study intentionally targeted a variety of organizations. This makes the sample less biased and more representative. Fifty organizations were identified and contacted. The researcher visited each organization and explained the questionnaire to the manager and the IT staff before distributing it to them. At the end of the data collection journey, the study managed successfully to distribute approximately 380 questionnaires and collected 296, thus achieving an overall response rate of 77.9%.

TABLE 2. Instrument development.

Construct	NO. of Items	Dimensions	Reference
Task	4	Servicing citizens - Internal operations - Exchanging and sharing information	Killaly [14] and Liang et al. [45]
Relative advantage	4	Cost – Quality – Access to latest technology	Alshamaila, [35], Espadanal [58], Moore and Benbasat [59], Ross [13] and Tehrani [43]
Complexity	4	Ease of Implementation – clarity – Easy to learn - Time	Alshamaila [35], Espadanal, [58], Ifinedo [60], Moore and Benbasat, [59], and Tehrani [43]
Compatibility	4	Fit with work norms – Integrating with existing systems – Requiring for technical changes	Alshamaila, [35], Espadanal [58], Moore and Benbasat [59], Ross [13] and Tehrani [43]
Trialability	3	Trialing before actual use – adequacy of testing time – availability for trial	Alshamaila, [35], Moore and Benbasat [59] and Tehrani [43]
Security	5	Adequacy of security techniques – Data Protection – Data privacy and confidentiality	Hailu [15] and Tehrani [43]
Cloud Fitness for E-Government	5	Task requirements alignment – Systems adaptability – Alignment with computing needs	Baas and van Rekom [30], Goodhue [61], Killaly [14], Zigurs and Buckland [46]

VI. RESULTS

A. DESCRIPTIVE STATISTICS

The statistics analysis shows that 78.1% of the participants have a bachelor's degree, 16.8% have a master's degree, 4.5% have a diploma degree, and 0.3% have a PhD degree (0.3 is missed data, in which the respondent did not provide any information). With respect to the field of subjects, the results showed that 35.6% of participants have an IT background, 34.9% have a computer science background, 20.5% have an engineering background, and the rest hold an information systems and management background. With respect to the job position of the participants, approximately 29.8% of them are network engineers, 27.4% are IT managers, 16.1% are technicians, 12.3% are system analysts, and the rest have different roles such as consultation, programming, and database administration. Lastly, the study found that 35.6% of the respondents have 1–5 years of experience, 31.2% have 5–10 years of experience, and 29.8% have more than 10 years of experience.

TABLE 3. Reliability and validity results.

	Item Loading	AVE	Composite Reliability	Cronbach's Alpha
Relative Advantage	0.739	0.589	0.851	0.768
	0.795			
	0.723			
	0.809			
Complexity	0.549	0.588	0.848	0.754
	0.819			
	0.807			
	0.853			
Compatibility	0.735	0.582	0.848	0.761
	0.796			
	0.811			
	0.706			
Fitness	0.709	0.522	0.845	0.772
	0.745			
	0.748			
	0.666			
	0.742			
Security	0.832	0.692	0.918	0.888
	0.865			
	0.790			
	0.844			
	0.826			
Task	0.812	0.651	0.848	0.733
	0.821			
	0.787			
Trialability	0.860	0.630	0.835	0.742
	0.800			
	0.714			

B. MODEL ANALYSIS

To verify the model, partial least squares (PLS) was used for the data analysis. Structural equation modelling using PLS follows two-stage analytical procedures, measurement model assessment, and structural model assessment [62]. In the measurement model assessment, the reliability and validity of the constructs are examined. Structural model assessment aims to verify the model hypotheses.

1) MEASUREMENT MODEL

The measurement model is analyzed to verify the reliability and validity of the measurement. To examine the reliability of the item, three indicators can be used [63]: internal consistency by item loading, composite reliability, and Cronbach's Alpha. As shown in Table 3, all of the item loadings are above the minimum cut off point of 0.50 [64], which indicates satisfactory internal consistency. In terms of composite reliability, all values were above 0.7, which satisfies the criteria [63], [65], [66] as shown in Table 3. Cronbach's Alpha also exceeds the minimum criteria of 0.7 [67] for all constructs (see Table 3). Hence, the measurement model provided sufficient evidence in terms of reliability.

With respect to validity, convergent validity and discriminant validity should be assessed. In terms of convergent validity, the average variance extracted (AVE) values meet the minimum criteria of 0.50 [63], [65] (Table 3), which means that for each construct, the items share more than 50 % of their variance. For discriminant validity (see Table 4), the square root of AVE for each construct is greater than the inter-correlations of the construct with other constructs in the research model [65], [66], [68]. This indicates that each construct is distinct and captures phenomena not represented by other constructs. Thus, the measurement model is satisfactory and in terms of reliability and validity.

2) STRUCTURAL MODEL

The structural model is assessed using the significance of the path coefficients, which indicates the strengths of the relationships between the dependent and independent variables, and the R^2 value, which represents the amount of variance explained by independent variables. The R^2 values for the dependent variable (Fitness) is 0.54 (See Fig. 2). This value reveals that the innovation factors with task characteristics explain approximately 54% of the fitness of cloud computing for implementing e-government services. To test the hypotheses, the significance of each path is estimated using a PLS bootstrapping method that utilizes 5,000 resamples [69]. Table 5 presents the results of the hypotheses testing, which includes t-values and p values in addition to the path coefficients. The results showed that hypotheses H4 and H5 are rejected while the rest are accepted.

VII. IMPORTANCE-PERFORMANCE MATRIX ANALYSIS

The Importance-Performance Matrix Analysis (IPMA) extends the results of the measurement and structural models by adding a dimension that considers the performance of the latent variables. It is carried out in order to identify the possible areas that need to be addressed and improved with management activities [70]. The IPMA contrasts the total effects representing the importance of the predecessor constructs in shaping a certain target construct, and their index values indicate their performance [71]. When conducting an IPMA on the indicator level, the mean value of an indicator represents its average performance. To facilitate the interpretation and comparison of performance levels, the IPMA rescales indicator scores on a range between 0 and 100, with 0 representing the lowest performance and 100 representing the highest performance. The rescaling of an indicator i proceeds via the following formula [70]:

$$X_i^{rescaled} = \frac{(x_i - Minscale[x])}{(Maxscale\,[x] - Minscale\,[x])}.100$$

xi represents ith data (latent variable score), Minscale [x] represents the lowest, and Maxscale [x] the highest value in the x data [70]. The mean values of all latent variable scores are rescaled with the higher values indicating better performance.

TABLE 4. Discriminant validity results.

	Relative Advantage	Complexity	Compatibility	Fitness	Security	Task	Trialability
Relative Advantage	**0.767**						
Complexity	0.493	**0.767**					
Compatibility	0.313	0.494	**0.763**				
Fitness	0.601	0.496	0.549	**0.723**			
Security	0.424	0.402	0.266	0.412	**0.832**		
Task	0.502	0.323	0.200	0.430	0.276	**0.807**	
Trialability	0.252	0.232	0.192	0.268	0.135	0.246	**0.793**

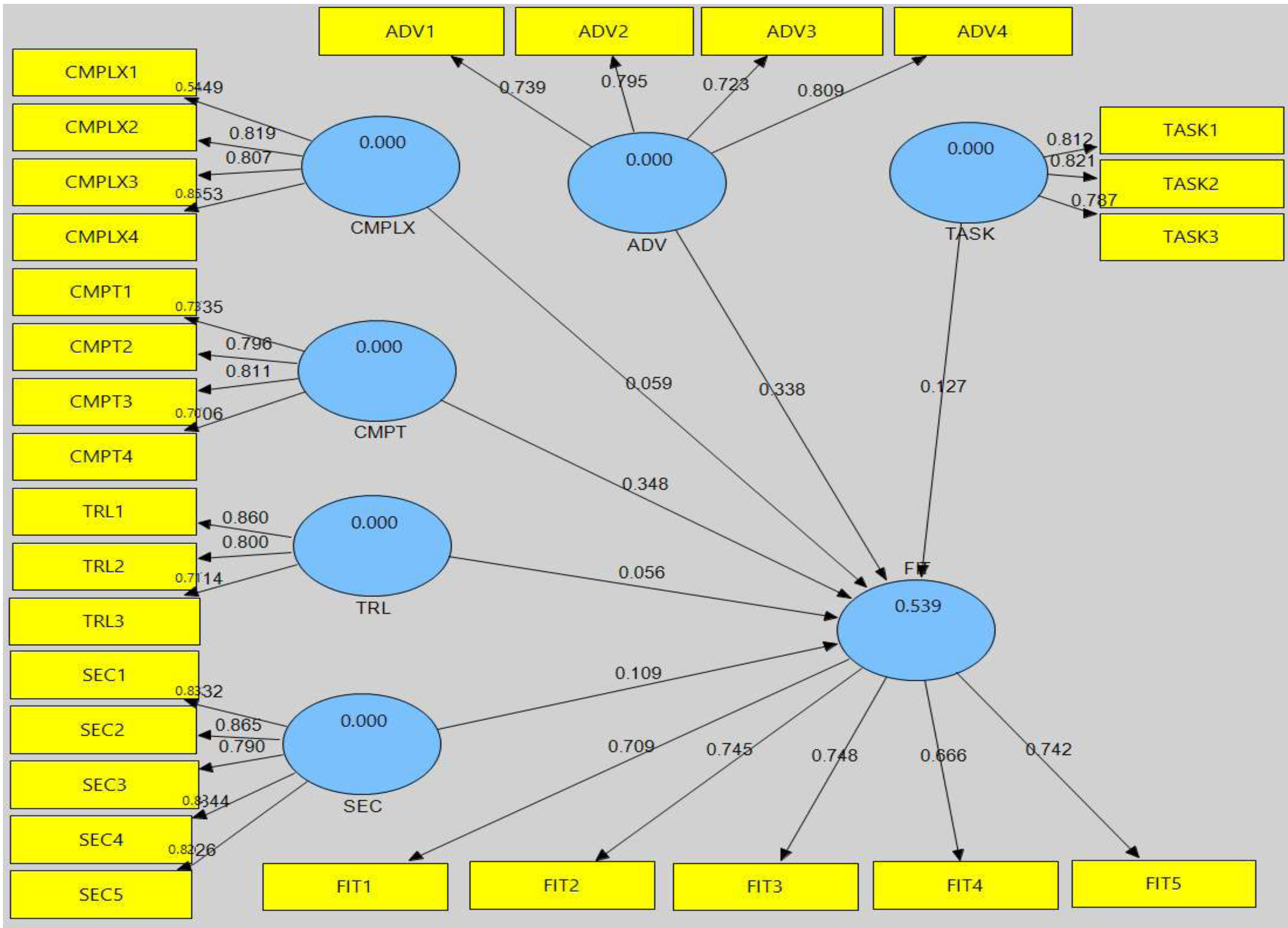

FIGURE 2. PLS algorithm results.

The IPMA of path modelling for cloud government fitness was carried out. By measuring the total effect (i.e., importance) and index values of the latent variables (i.e., performance). The latent variables with relatively low importance and relatively low performance on the fitness of cloud computing for e-government implementation are identified to provide managerial insights. First, the total effect (direct and indirect effects) of the relationships between the constructs was obtained. Next, by rescaling the latent variable score values for each observation on a scale of 0 (lowest) to 100 (highest) the performance values are obtained. In this research, the importance and performance of the task, relative advantage, compatibility, trialability, and security for the fitness of cloud computing for e-government were measured. The results are illustrated in Table 6 and visualized in Fig. 3. The results show that relative advantage exhibits high values

TABLE 5. Hypotheses testing results.

Hypothesis	Relation	Path Coefficient	T-Statistics	P Values	Supported
H1	Task -> Fitness	0.127	2.964	0.003	YES
H2	Relative Advantage -> Fitness	0.338	6.013	0.000	YES
H3	Compatibility -> Fitness	0.348	7.792	0.000	YES
H4	Complexity -> Fitness	0.059	0.952	0.341	NO
H5	Trialability -> Fitness	0.056	1.195	0.232	NO
H6	Security -> Fitness	0.109	2.248	0.025	YES

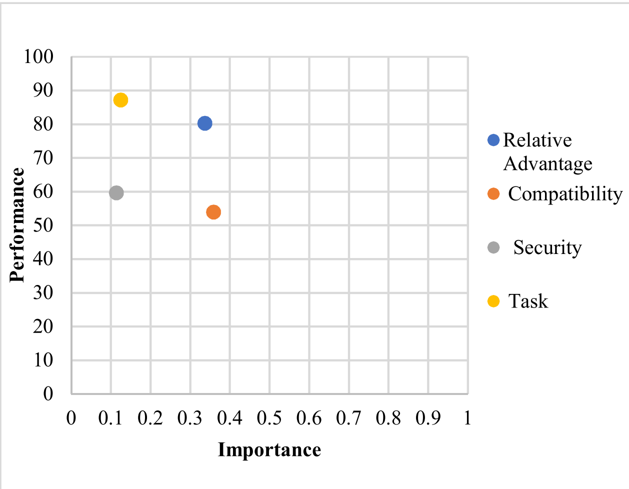

FIGURE 3. IPMA of the factors influencing the FIT construct.

TABLE 6. IPMA results.

Factor	Importance	Performance
Relative Advantage	0.337	80.2575
Compatibility	0.359	53.8725
Security	0.114	59.61
Task	0.125	87.15

in term of importance-performance, whereas the security exhibits the lowest value of importance and a relatively low level of performance. Further, despite the fact that task identification has a low value of importance, it has the highest value of performance. On the other hand, compatibility exhibits the highest value of importance, but it performs poorly compared to other factors in assessing the fitness of cloud computing to the tasks of e-government implementation.

VIII. DISCUSSION

Prior research demonstrated that cloud computing has advantages that, if exploited, can revolutionize e-government services provisions [9], [45], [72]–[74]. However, developing countries still face major barriers in the development of e-government initiatives, such as IT infrastructure, costs, and lack of resources. Therefore, this study proposes a model to examine the factors that influence the fitness of cloud computing for e-government implementation. The variables that must be assessed in order to determine the fitness of cloud computing to deliver e-government services in state sector institutions are identified through the devised model. The proposed model hypothesized that the fitness of cloud computing to implement e-government is influenced by the tasks of e-government from one side, and the innovation factors of cloud computing from the other side.

Based on the results of this study, the fitness of cloud computing to introduce e-government services is shaped by the tasks that must be executed in relation to it. The related hypothesis is supported at the 0.01 level with p value 0.003, which indicates that specifying the tasks to be performed using cloud computing has an important role as a predictor of the fitness of cloud computing for e-government implementation. This finding is relevant to the original model of TTF and related studies. Further, the results show that the path coefficient of the related relationship is 0.127, which is above the criterion of 0.100 [75]. Therefore, the fitness of cloud computing for e-government tasks appears to be influenced by the task features themselves. Additionally, the fitness of cloud computing for e-government tasks is shaped by security, compatibility, and relative advantage as technology variables. While compatibility and relative advantage positively influence the fitness of cloud computing for e-government implementation, security has negative effect. This reflects that security of information on the cloud is a significant area of concern for governments. Therefore, governments should pay more attention when using cloud computing to process information that is critical to national security, to citizens' privacy, or to manage critical government operations. The related hypotheses were supported at level 0.01. The related path coefficients also show the high effect of these factors on the fitness of cloud computing to e-government tasks. These results are consistent with the related literature [31], [52]–[54].

On the other hand, the hypotheses related to the complexity and trialability were not supported. The results of the empirical investigation show that the p value of the relationship between complexity and fit is 0.341, which significantly exceeds the significant value at level 0.1. This means that this study does not support the existence of a relationship between the complexity of cloud computing and its fitness to implement e-government services. Regarding the relationship between the complexity and technology fitness for specific tasks, Lam *et al.* [52] confirms this relationship in the context of IT adoption by a hotel employee. However, Lee et al. [54] rejects that the complexity of a personal digital assistant (PDA) affects its fitness for insurance industry tasks. In the context of cloud computing, the results of the study by Low *et al.* [37] shows that the effect of complexity on cloud computing adoption is not supported. Further, Stieninger and Nedbal [76] demonstrates that due to simple administration tools, high usability, and high degree of automation, experts do not consider cloud computing as a very complex technology to implement. This is consistent with the finding of this research. Furthermore, IT experts believe that it is not essential to be able to try out cloud services for long enough to measure its fitness for organization tasks. This interprets the result of this study in regarding to the trialability (Hypothesis 6). The output of the empirical analysis shows that this hypothesis is not supported (with p value 0.232). In addition, a path coefficient value of 0.056 represents a weak relationship [63]. The outcome is in accordance with Tehrani and Shirazi [43] and the current research.

To assign priority to management-oriented measures, IPMA has been conducted. Based on the results, the relative advantage of cloud computing is highly relevant to measuring its fitness for e-government implementation tasks, due to its significant impact. This dimension scored a high index value of importance; however, the minor potential for a further increase of performance can be applied. Efforts should be directed at maintaining or expanding the performance level of this area. With regard to compatibility, nearly the same strategies can be applied to performance, although the index value is significantly lower than the relative advantage. In order to determine the fitness of cloud computing for undertaking e-government tasks, compatibility characteristics must attain and sustain a particular degree of performance. For the dimension of task identification, results indicate that this factor has a high level of performance while scoring a low importance value. In addition, security has a low impact and scoring a relatively low index value of performance, which imposes a relatively substantial potential for further improvements.

IX. CONCLUSION

The main features of cloud computing, measured services, elasticity, and resource pooling may make it an ideal solution to e-government implementation challenges, which include cost, lack of compatibility, and insufficient IT skill. However, before applying this technology, the factors that influence the fitness of this technology for e-government tasks should be investigated. Therefore, TTF was selected to be the foundation for this research model. It was integrated with DOI theory to measure the fitness of cloud computing (as an innovation) for e-government implementation tasks. Hence, this study contributes to the literature by extending the TTF to measure the fit regardless of the specific attributes of a technology, as well as empirically examining the model on new technology (cloud computing). Consequently, this study contributes to the understanding of cloud computing the context of e-government.

Moreover, the choice of whether to utilize cloud computing may be expedited by designing and verifying a cloud computing fitness model in relation to e-government tasks. The degree to which expenditure and time spent can be limited through cloud computing determines its fitness in relation to different technologies. In addition, adopting cloud computing depends on its compatibility for the specific requirement of the e-government project, as well as the security and privacy requirements and the controls that can be provided by cloud computing technology. Therefore, this study model can help policy makers and those who supervise e-governments to evaluate this modern technology as they design the roadmap for e-government.

For future research, studies can be conducted for investigating cloud computing adoption for e-government implementation by applying different methodologies. A case study with a qualitative approach can be applied for a specific e-government project. A specific cloud model (Public, Private, Community or Hybrid) can be examined to be adopted for a specific type of e-government services.

APPENDIX
THE INSTRUMENT ITEMS

Task

- E-government ensures providing effective services to citizens.
- E-government enhances the internal operation performance of the organization.
- E-government helps facilitate effective exchanging and sharing of information between organizations.

Relative advantage

- Providing e-services over the cloud will lower costs.
- Using cloud computing makes it easier for organizations to implement e-government services.
- Cloud computing allows for the utilization of the latest versions of technology.
- Using cloud computing would improve the quality of the work performed by organizations.

Complexity

- It is easy to get cloud computing services to do what organization officials want them to do.
- Interacting with cloud computing services is not clear and is difficult to understand.
- Learning to operate on cloud computing services is not easy for employees.

- It takes too much time for IT staff to use cloud computing to perform their normal duties.

Compatibility

- Using cloud computing fits well with the way the organization usually performs.
- The cloud can easily be integrated into existing IT infrastructure.
- Cloud computing is compatible with the systems that are already in use.
- Using cloud computing services does not require many technical changes.

Trialability

- Before deciding to use any of cloud computing services, it can be tested properly.
- It is essential to be able to try out cloud services properly before deciding whether it fits with the tasks of an organization
- It is essential to be able to try cloud services (on a trial basis) for a certain amount of time to evaluate its capability.

Security

- Cloud computing provides sufficient security controls.
- The security systems built into cloud computing services are strong enough to protect organization data.
- Cloud providers maintain the privacy and confidentiality of organization data.
- The servers and data centers of cloud providers are secure.
- Overall, cloud computing technology is more secure than traditional computing methods.

Fitness

- The computing task requirements of an organization to implement e-government services closely align with cloud services.
- Cloud computing will satisfy the computing needs of an organization to implement e-government services.
- Cloud Computing would be a good way to share and exchange information between organizations.
- Current e-government applications can be easily adapted to the cloud.
- It seems that cloud computing fits well with organization requirements to provide e-government services.

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