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A SEM-STELLA approach for predicting decision-makers' adoption of cloud computing data center

Nasrin Badie[1] · Ab Razak Che Hussin[1] · Elaheh Yadegaridehkordi[2] · Dalbir Singh[2] · Arash Habibi Lashkari[3]

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Abstract
Cloud computing is the next generation of on-demand information technology services and products that deliver various applications over the Internet. Cloud computing is often adopted as a superior alternative by data centers to replace their current system. However, cloud computing services are still accompanied by many issues which hinder their adoption in data centers. Therefore, this study proposed a Cloud Computing Data Center (CCDC) adoption model for administration activities in higher education institutions. Technology Organization Environment (TOE), Diffusion of Innovation theory (DOI), and Institutional theory were considered as theoretical bases of CCDC model. A new Structural Equation Modelling (SEM)-STELLA method was applied to examine the proposed model and simulate it like a real system to investigate the respondents' interest in adopting cloud by passing the time. A questionnaire instrument was designed, and data were collected from 204 decision-makers at Malaysian universities. The results showed that eight out of ten factors, namely relative advantage, Complexity, compatibility, top management support, policy and standardization, competitive pressure, outage, and security influenced CCDC adoption. Finally, STELLA simulated the value changing of some factors or sub factors on the level of interest in adopting CCDC. Results showed that security and policy play the highest influence on the adoption of cloud computing. This research contributes to a theoretical understanding of factors that influence CCDC adoption. Meanwhile, it provides a better understanding of changes in users' behavior during the adoption of cloud computing services.

Keywords Cloud computing adoption · Data center · Structural Equation Modelling · STELLA

✉ Elaheh Yadegaridehkordi
yellahe@gmail.com

Extended author information available on the last page of the article

1 Introduction

The importance of cloud computing is rising as a medium for increasing productivity, effectiveness, and reducing cost (Ali et al., 2020). cloud computing has increasingly become a common platform for software developers considering its cost-effective and user-friendly characteristics (Aman et al., 2020). This computing methodology depends on several existing technologies, such as the Internet, virtualization, grid computing, Web services, etc. The delivery of this service in a pay-on-demand approach over (mainly) the widespread medium of the Internet makes this service distinctive (Armbrust et al., 2010). cloud computing is a computing service that uses ubiquitous resources for executing users' typical applications such as e-mail, office software, and Enterprise Resource Planning (ERP) software. Moreover, cloud computing services can be shared by business employees or trading partners. Providing the data center services is one of the important benefits of cloud computing (Badie & Yadegaridehkordi, 2013; Badie et al., 2015; Zhang et al., 2010). Data centers are the central piece of today's Internet infrastructure which has become critical for any organization and educational institution (Ibrahim et al., 2018). In addition, the data center is needed for universities; academic institutions often have many requirements that have unique characteristics. These must be considered carefully to fit the needs of different kinds of students.

Technology can quickly become outdated with limited IT resources and heavy workloads for administrative, teaching, and learning activities (Deem, 2020). The increasing demand of universities for computer resources leads to considerable growth in the number of data center servers and doubles the energy usage (Sovacool et al., 2022). Recently, data centers have gained notable attention as a cost-effective infrastructure for storing large volumes of data and presenting large-scale service applications (Qi et al., 2022). However, the traditional data center has some problems such as energy consumption, flexibility, power management, and cost. By using cloud computing, universities can administer their existent server resources more efficiently. They can simplify their data center administration and integrate resources into a coherent system (Mohammadzadeh et al., 2021). Meanwhile, cloud computing can solve the problem of energy costs in the current data centers (Canali et al., 2018).

The cloud computing data center adoption evaluation shows that universities use cloud-based applications offered by service providers and enable their users/students to conduct academic work. However, despite the significant benefits of cloud computing, many universities have not deployed all their critical applications in the cloud computing environment (Al Rawajbeh et al., 2019; Ali, 2018; Abba Ari et al., 2020).

The aim of this study was to identify the factors impacting decision-makers' interest for adoption of Cloud Computing Data Center (CCDC) in universities. The proposed model was evaluated by using Structural Equational Modelling (SEM). Then, all contributing factors were given as inputs to the STELLA simulator to get an idea from the system dynamic to investigate how the interest of IT decision-makers will be changed by using the model in higher education institutes. Using such method supports researchers (Ahani et al., 2017; Nilashi et al., 2016; Yadegaridehkordi, et al., 2018a) who advised using a combination of SEM with other complimentary analysis methods to enhance theory building and testing. Meanwhile, using such a two-step methodology will help researchers to get benefit from the advantage of both approaches.

Moreover, when the findings reach maturity, researchers try to go beyond a simple explanation of the cause and effect of the two variables and can understand what bridges the causal relationship and how the magnitude or causal ratio changes something. Mediators and moderators are two tools that engage with these puzzles. Mediation and moderation are concepts of sanitizing and considerate a causal relationship (Iranmanesh et al., 2019). They, essentially, are researchers' theories about how a cause leads to an effect. Unfortunately, the effects of mediation and moderation are less explored in cloud computing literature. Therefore, this study tried to find the mediator and mediation effect between factors in additional findings.

Thus, the contributions of this study are:

1. Combining the Technology-Organization-Environment (TOE), Diffusion of Innovation theory (DOI), and Institutional theory as a theoretical base and incorporating new factors such as policy and standardization, security, outage, etc. to develop CCDC adoption model. This model can provide a comprehensive direction for higher education institutions to make critical decisions regarding CCDC adoption.
2. The utilization of a two-step methodology (SEM and STELLA) can help researchers to get benefit from the advantages of both methods. Meanwhile, it provides a better understanding of changes in users' behavior during the adoption of cloud computing services.
3. Evaluating moderating and mediating relationship and Standardization between policy and security can provide new insights in CCDC adoption for decision-makers in higher education institutions.

2 Literature review

Nowadays, Cloud Computing involves the data centers' processes in the world. A customer can benefit from many resources in a cloud or data center, such as processing time, network bandwidth, disk storage, and memory. Thus, big organizations such as Yahoo, Google, IBM, and CISCO replaced cloud computing as a cheaper alternative for the current data center. Especially, cloud computing is a great alternative for educational institutions that are under the lack of funds. The principal difference between cloud and internal data center is that a cloud computing is an off-premises form of computing or storage that stores data on the Internet. In contrast, a data center refers to the on-premise hardware that stores the data on an organization's local network (Jansen & Grance, 2011). However, focusing on the technology's maturity is one of the main concerns of using the cloud computing services. It is possible to highlight that, vendor lock, performance, latency, security, privacy, and reliability are the most critical concerns here.

The Literature review indicates that many studies were carried out on the use of cloud computing by universities and education institutes based on the student requirements in the learning and teaching process and their perceptions about cost reduction, ease of use, sharing, and collaboration (Yadegaridehkordi et al., 2018b). However, the security and privacy of cloud computing is still an issue (Basu et al., 2018).

Table 1 reveals that many studies have been conducted on the use of TOE, DOI, and Institutional theory in different contexts related to the adoption of new technologies. Many studies are available to assess the various innovations at the firm level based on the TOE framework (Awa et al., 2016, 2017; Azarnik & Shayan, 2012; Chembessi et al., 2022; Mitra et al., 2022). Meanwhile, a combination of TOE, DOI, and Institutional theory has successfully predicted the adoption of new technologies (Baig et al., 2021; Dimitrova, 2020). Different technological, organizational, and environmental factors have been considered to comprehensively assess the adoption of different technologies in different contexts. Therefore, based on the TOE Tornatzky et al. (1990), DOI Rogers (1983), and the Institutional theory DiMaggio and Powell (1983), this research proposes a four-dimensional model. Technological dimension refers to relevant internal and external technologies to a firm, including equipment and processes. The organizational dimension includes many specifications and the firm resources such as formalization's degree, managerial structure, human resources, the number of slack resources, and linkages among employees. In addition, the environmental dimension refers to an environmental condition that a firm operate s such as firm's competitors, macroeconomic context, and regulatory environment.

This research aims to design and evaluate a new adoption model for CCDC in higher education based on the TOE, DOI, and Institutional theory. Therefore, factors influencing the adoption of cloud computing have been summarized under technology, organization, environment, and technology-organization dimensions in Table 2. According to this table, Relative Advantages (RA), Compatibility (CMB), Complexity (CMX), firm size, Outage (O), Top management support (TMS), Policy and standardization (PS), Competitor pressure (CP), Trading partner pressure (TPP), and security (S) are significant factors influencing cloud computing adoption.

In 2015, a survey paper was conducted using Fuzzy AHP to determine the most important factors affecting CCDC adoption (Badie et al., 2015). Results of this study also supported the importance of the factors mentioned above in predicting CCDC adoption.

2.1 Conceptual model and hypotheses development

The research model unites the four technology, organization, environment, and technology-organization contexts. Hypotheses of each context have been developed in the following sections.

2.1.1 Technology context

According to Rogers (1983), Relative Advantages, Compatibility, and Complexity are technology-related factors predicting an innovation adoption. More recent studies related to the cloud computing also supported this claim (Baig et al., 2021;

Table 1 Combination studies between TOE, DOI, and Institutional theory

Theoretical Model	Factors	Context	Authors
TOE and DOI	Relative advantages, top management support, firm size, competitor pressure, and tpp	Cloud Adoption	(Chen et al., 2021; Ooi et al., 2018; Watson, 2021; Youssef & Mostafa, 2019)
TOE and DOI	Relative advantages; compatibility; complexity. Expectations of market trends; competitor pressure, trust; information distribution; information interpretation	Collaborative commerce	(Ahmad et al., 2019; Beshdeleh et al., 2018, 2020; Salah et al., 2021)
TOE and DOI	Technology readiness; technology integration Firm size; global scopes; trading globalization; Managerial obstacles. Competition intensity; regulatory environment	E-Business	(Ali & Soar, 2018; Asadi et al., 2021a, b; Beshdeleh et al., 2018, 2020; Oliveira & Martins, 2011; Sun et al., 2018)
TOE, DOI and institutional theory	Relative advantages, compatibility, organizational size, organizational readiness, top management support, mimetic pressure, coercive pressure, normative pressures	Cloud adoption	(Asadi et al., 2021a, b; Ayong & Naidoo, 2019; Qasem et al., 2020; Tweel, 2012)
TOE, DOI and institutional theory	Relative advantages; complexity; compatibility Financial slacks; top management support External pressure; external support; government promotion	E-procurement	(Dimitrova, 2020)
TOE and DOI	Relative advantages, complexity, compatibility, Top management support, firm size, technology competence, competitor pressure, tpp; information intensity	RFID	(Lee et al., 2009)
TOE and Institutional theory	Technology resources, perceived benefits lack of organizational compatibility Financial resources; firm size; external pressure; government promotion; legislation barriers. Industries (distribution, finance, and manufacture)	E-commerce	(Oliveira & Martins, 2011)

Table 2 Success factors for adoption of cloud computing services

	Author / Factor / Construct	Sub-construct (items)	(Kim et al., 2009) (Khayer et al., 2020)	(Cai & Chen, 2021) (Chutipong & Hitoshi, 2012)	(Ireland, 2012), (Tanveer et al. 2022)	(Bramante et al., 2010), (Helali & Omri, 2021)	(Adam, 24), (Aug 2012), (Adedokun, 2021)	(Low et al., 2011) (Sayginer & Ercan, 2020)	(Khajeh-Hosseini et al., 2012) (Greenwood et al., 2011, Khayer et al., 2020)	(Feuerlicht & Margaris, 2012), (Khayer et al., 2020)	(Cloud Security Alliance (CSA), 2014), (Hansch, 2020)
Technology	Relative advantage	Profitability and cost reduction	*	*	*	*	*	✓	*	*	*
		Easy implementation									
		No up-front capital investment									
	Complexity	Internal skill-sets and governance	*	*	✓	*	*	*	*	*	*
		Flexibility	*	*	✓	*	*	*	*	*	*
		Data storage and extraction	*	*	✓	*	*	*	*	*	*
		Performance	✓	*	*	*	*	*	*	*	*
		Web site Usage Factors	*	✓	*	*	*	*	*	*	*
		Perception of Difficulties in ICT Usage	*	✓	*	*	*	*	*	*	*
		Integration	✓	*	*	*	*	*	*	*	*

Table 2 (continued)

	Author / Factor / Construct	Sub-construct (items)	(Kim et al., 2009) (Khayer et al., 2020)	(Cai & Chen, 2021) (Chutipong & Hitoshi, 2012)	(Ireland, 2012), (Tanveer et al. 2022)	(Bramante et al., 2010), (Helali & Omri, 2021)	(Adam, 24), (Aug 2012), (Adedokun, 2021)	(Low et al., 2011) (Sayginer & Ercan, 2020)	(Khajeh-Hosseini et al., 2012) (Greenwood et al., 2011, Khayer et al., 2020)	(Feuerlicht & Margaris, 2012), (Khayer et al., 2020)	(Cloud Security Alliance (CSA), 2014), (Hansch, 2020)
organization	Top management support	Cost and commercial consideration	✓	*	*	✓	*	✓	✓	✓	*
		Energy Consumption									
		Analysis Cost modeling									
		Responsibility Modeling									
	Firm size	Number of employees	*	✓	*	*	*	*	*	*	*
	Policy and Standardization	Risk-mitigation	*	*	*	*	*	*	*	*	✓
		Risk-evaluation	*	*	*	*	*	*	*	*	✓
		Optimizing the current ICT environment	*	*	*	*	*	*	*	*	✓
		Infrastructure & Virtualization and wireless Security	*	*	*	✓	✓	*	*	*	✓
		Technical challenges assessment	*	*	*	*	*	*	*	*	✓
		Identity & Access Management	*	*	*	*	*	*	*	*	✓
		Policies and Procedures Security Incident Management	*	*	*	*	*	*	*	*	✓
		Legal Preparation	*	*	*	*	*	*	*	*	✓
		data confidentiality	*	*	*	✓	✓	*	*	*	✓
		Sharing data policy	*	*	*	*	*	*	*	*	✓
		Supply Chain Management, Transparency and Accountability	*	*	*	*	*	*	*	*	✓
		Third Party Assessment	*	*	*	*	*	*	*	*	✓
		Awareness	*	*	*	*	*	*	*	*	✓
		Supply Chain Metrics	*	*	*	*	*	*	*	*	✓
		Governance and Risk Management	*	*	*	*	*	*	*	*	✓
		Policy Enforcement	*	*	*	*	*	*	*	*	✓
		Business Continuity Management & Optional Resilience	*	*	*	*	*	*	*	*	✓
		Governance and Risk Management	*	*	*	*	*	*	*	*	✓
		Policy Reviews									
		Data center Security Policy	*	*	*	✓	✓	*	*	*	✓
		Unauthorized Persons Entry risk-mitigation	*	*	*	*	*	*	*	*	✓

Table 2 (continued)

Factor	Construct	Sub-construct (items)	(Kim et al., 2009) (Khayer et al., 2020)	(Cai & Chen, 2021) (Chutipong & Hitoshi, 2012)	(Ireland, 2012), (Tanveer et al. 2022)	(Bramante et al., 2010), (Helali & Omri, 2021)	(Adam, 24), (Aug 2012), (Adedokun, 2021)	(Low et al., 2011) (Sayginer & Ercan, 2020)	(Khajeh-Hosseini et al., 2012) (Greenwood et al., 2011, Khayer et al., 2020)	(Feuerlicht & Margaris, 2012), (Khayer et al., 2020)	(Cloud Security Alliance (CSA), 2014), (Hansch, 2020)
Environment	Competitive pressure	Competitors are currently /will be adopting	*	*	*	*	*	✓	*	*	*
		Benefiting									
		Perceived favorably in our industry/ by their customers									
	Trading partner pressure	Intends Policy And Standardization to adopt /Already adopt /Will adopt cloud	*	*	*	*	*	✓	*	*	*
Technology-Organization	Outage	Contingency planning monitoring	✓	*	✓	*	*	*	*	*	*
	Security	Data Privacy	✓	*	✓	✓	*	✓	*	*	*
		Data Availability	✓	*	✓	*	*	✓	*	*	*
		System availability	✓	*	✓	*	*	✓	*	*	*
		Data privacy and protection	✓	*	✓	*	*	✓	*	*	*

Yadegaridehkordi et al., 2020). Relative Advantages was defined as the level to which a technology provides greater benefit for the firm and have been better than the idea it supplants (Rogers, 1983). It means organizations should be concerned about the benefits of adopted innovations. cloud computing is an Internet-based technology that offers many benefits to enterprises, industries, and universities. So, by adopting cloud computing, companies can benefit from more optional efficiency, more accurate access to real-time data, computational power, and the ability to save costs (Atieh, 2021; Gaur et al., 2019; Hassani & Silva, 2018; Mani et al., 2020). However, as the cloud computing technology is relatively new, organizations are not still sure about it (Alam et al., 2018; Hurwitz & Kirsch, 2020; Njenga et al., 2019). Complexity of innovation relates to the barriers and difficulties of using the new technology. Compatibility refers to the fitting level of new innovative technology with the existing values, past experiences, and needs of potential adopters (Garay et al., 2019; Wang & Lin, 2021; Yuen et al., 2021). Thus, it is hypothesized.

H1: Relative advantages has influence on interest for adoption of cloud computing.
H2: Complexity has influence on interest for adoption of cloud computing.
H3: Compatibility has influence on interest for adoption of cloud computing.

2.1.2 Technical –Organizational context

Some researchers believed that security and outage are two factors under the technology context and the rest assigned these factors under the organizational context (Belzunegui-Eraso & Erro-Garcés, 2020; Cobb et al., 2018; Merhi et al., 2019). Therefore, a new category, namely technical–organizational has been added to the model (Almaiah et al., 2020; Caiado et al., 2021; Masood & Egger, 2019; Taherdoost, 2018). One of the principal concerns for cloud adoption is security, which is cited as one of the key inhibitors to cloud adoption (Caiado et al., 2021). The security can become an inhibitor to accepting cloud data centers. It depends not only on the nature of services that will operate in the cloud, but also on the deployed model and the level of security policy developed in the organization. One obvious solution for security concerns is for users to encrypt the data residing in the cloud, which is sufficient for data storage (Jaeger et al., 2008). Consumers should not worry about security concerns. Because security can be guaranteed for users by providers as government surveillance and data collection activities (Al-Issa et al., 2019; Tabrizchi & Kuchaki Rafsanjani, 2020).

H4: Security has influence on interest for adoption of cloud computing.

A permanent outage occurs when a cloud service provider service is suddenly interrupted. Suddenly disconnecting the cloud computing service is unavoidable. It may happen several times in a year and may take a few hours, or about one full day or even more, each time (Alashhab et al., 2021; Nouri et al., 2019). It is critical to plan for potential cases to control the outage, especially in situations where control of all systems is transferred to a cloud provider. It is important to understand the probable situation in place and the failure of responsibility for these arrangements (Jansen & Grance, 2011).

H5: Outage has influence on interest for adoption of cloud computing.

2.1.3 Organizational context

The attributes such as size, quality of human resources, and Complexity of the firm's managerial structure are related to the organizational context (Hong & Zhu, 2006). Policy And Standardization covers a set of instructions that ensure users do not lose privacy, security, interoperability among cloud platforms, and transparency protections by moving data to the cloud (Al-Issa et al., 2019; Farahzadi et al., 2018; Galiveeti et al., 2021; Le & Lei, 2019; Puklavec et al., 2018; Shi et al., 2020).

H6: Policy and Standardization has influence on interest for adoption of cloud computing.

In cloud computing adoption, supports of top management play a substantial role as it creates a supportive environment and provides the appropriate essential resources (Ilyas et al., 2020; Puklavec et al., 2018). Top Management Support can provide a vision and commitment to sending positive signals to all firm employees as the Complexity and sophistication of technologies increase (Bellini et al., 2020; Bertrand et al., 2021; Gettman, 2019; Luciano et al., 2018). The senior management allocates the resources required to adopt an innovation after accepting its benefits. Then they encourage members of the organization to realize changes.

H7: Top Management Support has influence on interest for adoption of cloud computing.

Firm size is defined in terms of the workforce employed (Domini et al., 2021; Fritsch et al., 2019; Gaubert, 2018) which is often stated that large firms tend to adopt more innovations because of their greater flexibility and capability to take the risk (Brous et al., 2020; Ravichandran, 2018; Sturgeon, 2021).

H8: firm size has influence on interest for adoption of cloud computing.

2.1.4 Environmental context

The environmental context refers to the area that a firm is conducting to industry or competitors, accessing of resources provided by others, and dealing with the government (Utterback, 1971). To the extent which the environment affects the company's decision can be examined with two variables called Competitor Pressure and TPP Which refer to the level of pressure felt by the company from competitors in the industry (Wang et al., 2018; Won & Park, 2020; Wu et al., 2021).

H9: Competitor Pressure has influence on interest for adoption of cloud computing.
H10: Trading partner pressure has influence on interest for adoption of cloud computing.

Figure 1 shows the developed model.

Based on previous studies, the correlation between the security risk and the level of cloud computing adoption is not positive. On the other hand, the policy, outage, and Relative Advantages are affecting the security, and consequently, that will decrease the security risk of CCDC adoption (Do Chung et al., 2014; Dong et al., 2014). There is a strong relationship between security-policy, security- outage, and security- Relative Advantages. Therefore, it is hypothesized that:

H11: There is mediator relationship between security and security-policy, security- outage, and security- Relative Advantages

3 Research methodology

A survey questionnaire was designed to examine the hypotheses and evaluate the proposed model in this study. The questionnaire has been developed based on (Tornatzky et al., 1990) study, however, some changes have been made to meet CCDC adoption requirements. The questionnaire has ten main parts. The research questionnaire began with a memo, which described the purpose of this questionnaire. The first part of the questionnaire (Section A) is devoted to the demographic details of the respondents. The second part of the questionnaire (Section B to J) covers questions related to the constructs (constructs such as relative advantages, top management support, compatibility, competitor pressure, complexity, firm size, interest in

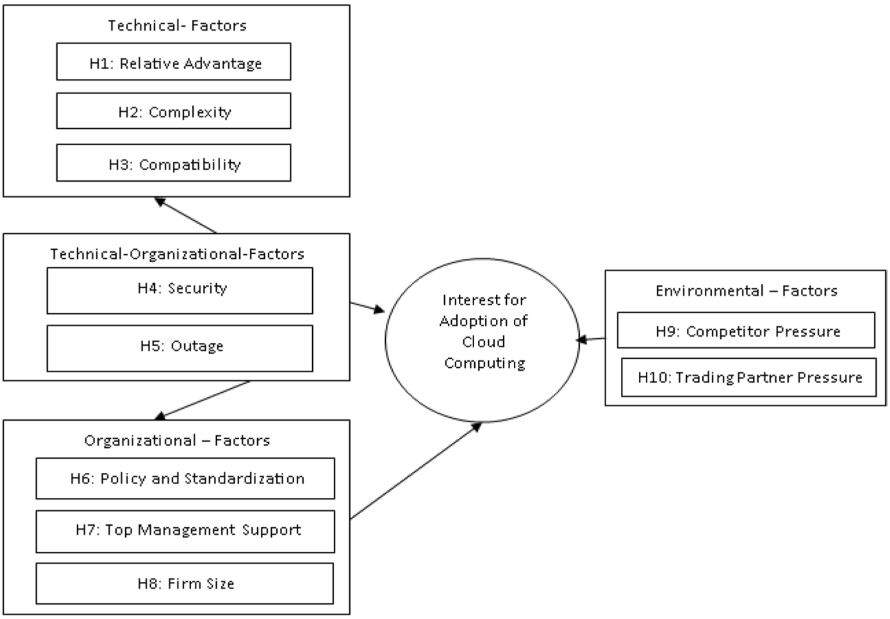

Fig. 1 The conceptual model

the adoption of cloud computing, outage, policy and standardization, security, and trading partner pressure). All the variables are reflective (Benlian & Hess, 2011; Gupta et al., 2013) except the Policy and Standardization and security, which are formative constructs (Aleixo et al., 2020; Brutschin et al., 2021; Hanus et al., 2018). Each variable was measured using a 5-point Likert scale, with values Ranging between 1 (strongly disagree) and 5 (strongly agree). The list of indicators' details with definitions and sources are explained in Appendix Table 14.

3.1 Data collection procedure

Before making the final and official survey, the pre-instrument validation was conducted, including face validation, content validation, and pilot study as recommended by (Anderson, 2019). For the validation process in the early stage of model development, small samples can be used to develop and test explanations. Same as previous studies in this study for the validation process with small samples in early validation step a panel of experts is chosen (Hsu et al., 2014; Oliveira et al., 2014). The validation process continues with the pilot study. In a pilot study, the questionnaire was distributed to a small number of samples. The past research recommended 10 to 50 respondents for the pilot study of the questionnaire instrument (Khan & Alhusseini, 2015). Pilot studies are an important element of good survey design, increasing the likelihood of success.

Finally, the case study method is chosen for the final evaluation. Since it allows the researcher to explore and understand complex issues. Since education institutes today, such as any other organization are becoming completely dependent on Information technology for delivery, communication, and collaboration. Having servers, storage, and software in universities, colleges and schools are very robust, but cloud computing is an Internet-based computer system, so shared resources, software, and information are required for computers and devices based on demand, such as the electricity grid (Abidin & Husin, 2018; Choi et al., 2021; Othman et al., 2020).

This study chooses 10 most active public and private universities in Malaysia for a case study. The expert panel in this study comprised of twelve experts from IT, deputy and cloud project directors of the chosen universities, as well as experts of cloud service providers of higher education institutions in Malaysia MYREN employed during the validation process (Hsu et al., 2014; Oliveira et al., 2014). Experts are then asked to review the potential scale items and validate the indicators of each of the constructs. The feedback received about the quality of new and extended measures from the experts of the sample organizations helped define the fundamental objective criteria to evaluate each case and contains suggestions for improving measures (Tamjidyamcholo et al., 2014). Experts' responses helped identify meaning, readability, ease of response, and content validity problems. After incorporating the minor changes for questionnaire evaluation, a pilot study was run among the 50 IT officers of the universities who were experts in the data center, security, policy, and IT professionals who were familiar with cloud computing. The results revealed that the scale is reliable and valid. Based on this result, the final survey questionnaire was formulated and ready to send a larger sample to collect data for the research model.

Some criteria have been developed to decide who the appropriate respondent is and increase the content validity in this study. The purpose of this measure was to ensure the respondents have the potential to meet the research requirement.

- The organization is from the higher education institute
- The organization is in Malaysia
- The organization has experience in cloud computing and data center

After the organization was selected, this study determined the respondents. The criteria for employees are:

- Employees are working in Malaysian higher education.
- Employees meet the requirements of knowledge about cloud computing and data centers.
- Employees have experience implementing cloud computing and worked with data centers and cloud-based applications.

Meanwhile, criteria for experts in cloud computing data center are 1) having experience of more than five years in his field and 2) having a position in their organization such as supervisor, manager, head of the division, head of the department, manager, director, and IT professional.

To have a comprehensive list of those organizations that meet the criteria, the researcher has a meeting with the higher education cloud provider in Malaysia called MYREN. It is an organization under the Ministry of Education whose mission is to provide cloud services for higher education in Malaysia.

The proper respondents in this study were IT staff of higher education institutes (public and private universities) who have experience working with cloud-based applications and implementing cloud computing and data centers. Ten universities in the Malaysian public and private universities were negotiated and accepted to participate in this study. These universities are among the most active and reputable ones in the cloud computing research field. After that, an official email clarifying the purpose of the survey, data confidentiality, participant anonymity, and time requirement was forwarded to the respondents. Moreover, the online version of the questionnaire was attached to this email.

The detail of the respondent's characters is shown in Table 3. To estimate the minimum sample size, power analysis method is used. In this method, the statistical power of 0.8 is considered the researcher's lowest acceptable value (Houser, 2007). For ten variables of this study using power analysis, the value of 0.05 should be used to calculate a medium effect size of 0.15. The result of calculating power analysis showed that to achieve the desired power level of 0.80 the minimum required sample for this study was 118 subjects. Also, the statistical power of the sample is calculated via Post-hoc Statistical Power Calculator for Multiple Regression with a minimum sample size of 118, for ten predictors, Observed R2 was larger to 0.25,

and Probability level 0.05 became 0.99499509 which was greater than desired power level 0.8 (Anderson, 2020; Chung et al., 2019; Misra et al., 2021). Moreover, this study uses the rule of thumb of the SEM technique to define the sample size.

Table 3 Sample characteristics ($N=204$)

Question	Categorize				Number	Percentage
Job Position	IT Manager (Director and deputy Directors)				52	25.6
	IT Professional				125	61.3
	Programmer				20	9.8
	Hardware				7	3.4
Expertise	Main Expertise		Secondary Expertise		Third Expertise	
	Number	Percentage	Number	Percentage	Number	Percentage
cloud computing	32	15.7	0	0	0	0
Distributed Computing (grid and cloud)	12	5.9	20	9.8	3	1.5
Data Center	31	15.2	4	2.0	3	1.5
Security	28	13.7	0	0	1	0.5
Networking	29	14.2	4	2.0	4	2.0
Policy	12	5.9	5	2.5	0	0
Data Base	10	4.9	8	3.9	7	3.4
Programming	29	14.2	26	12.7	7	3.4
Data Analysis	8	3.9	1	0.5	8	3.9
System Analyzer	13	6.4	11	5.4	2	1.0

Data was collected during 7-weeks. From 500 requests, totally about 220 positive replies responded positively. Out of this 220, 204 questionnaires were completely answered and valid, meeting the necessary conditions of sample size. The estimated response percentage of the universities and the sample size are reported in Table 4.

Independent samples t-tests were conducted to test the non-response bias (Sabbatinelli et al., 2021). In particular, 132 responses were considered initial responses and 72 were deemed late responses. The mean of the responses in the main study was compared between the early and late replies and there was no substantial variation between the two group ($P<0.05$) (Tweel, 2012). Respondents were qualified individuals (see Table 3), representing good data quality. The Harman Factor test was used to test the conventional method (Podsakoff et al., 2003) and the results showed that there is no significant common method bias in the data set (Oliveira et al., 2014).

4 Data analysis

4.1 SEM

SEM has been used in this study to test the relationship between ten independent variables and interest for the adoption of cloud computing. In this study,

Table 4 Respondent percentage

Organization	Number of respondent	Percent	Organization	Number of respondent	Percent
University 1	51	25.0%	University 6	11	5.4%
University 2	36	17.6%	University 7	10	4.9%
University 3	30	14.7%	Higher education Cloud Provider	4	2.0%
University 4	26	12.7%	University 9	12	5.9%
University 5	14	6.9%	University 10	10	4.9%
			Total	204	100.0

Partial Least Squares (PLS) method was used, since PLS is a statistical method that bears some relation to principal components regression which normally is used for accomplishing SME-based analysis (Chin, 1998). More recently, PLS statistical approaches have been considered actively in IS research to sort out perceived and hidden information systems artifacts in complex datasets.

Both reflective and formative measurement models can be handled by the PLS method. Meanwhile, it does not require a large sample or normally distributed data for dependent prediction (Chin et al., 2020; Xu et al., 2019). This is a suitable method for evaluating theories in the early stages of their formation (Zaim et al., 2019). The suggested model of the study was tested by Smart PLS performing (1) evaluation of measurement models, including reliability and discriminate validity of the measures, and (2) Structural model assessment, which includes path coefficients and values of R2. A distinction between reflective and formative models have been done to evaluate the measurement model (Karahoca et al., 2018; Ortega-Gutiérrez et al., 2021)).

4.1.1 The measurement model

The research model of this study is mixed of 8 reflective and two formative constructs. For reflective constructs, internal consistency was examined as a reliability test (Tamjidyamcholo et al., 2014). Composite reliability and Cronbach's alpha have been used to assess the internal consistency of structures. The constructs are considered adequate when the Cronbach Alpha scores are above the recommended minimum value of 0.60 and above the 0.70 are acceptable as the cut-off for composite reliability (Berthevas, 2021; Tamjidyamcholo et al., 2020).

In this study, composite reliabilities were above 0.774 and Cronbach's Alpha was above 0.6135, both exceeding the acceptable values of the threshold (see Table 5). Except for Policy and Standardization and security which are formative constructs and the composite reliabilities and Cronbach's Alpha are 0 (Kopp et al., 2021). In this section, the average variance extracted (AVE) has been investigated (see Table 6), to ensure sufficient convergence validity (Gupta et al., 2013; Oliveira et al., 2014; Tamjidyamcholo et al., 2014). The AVE value of 0.50 and above represents a consistent level of convergent validity (Chen & Hung, 2010).

Table 5 Reliability of constructs

Item	Composite reliability	Cronbach's Alpha	Item	Composite reliability	Cronbach's Alpha
RA	0.8251	0.6906	TMS	0.8024	0.6135
CMX	0.8355	0.827	FS	1	1
CMB	0.8899	0.7809	CP	0.774	0.5426
S	0	0	TPP	0.7912	0.6262
O	0.9251	0.8794	Interest in adoption of cloud computing	0.837	0.8679
PS	0	0			

Relative advantage (RA), Top management support (TMS), Competitor pressure (CP), Trading partner pressure (TPP), Complexity (CMX), Compatibility (CMB), Policy and standardization (PS), Security (S), Outage (O), Firm size (FS)

Finally, two criteria, namely Fornell–Larcker criteria and cross-loadings, have been evaluated for the discriminant validity of the constructs (Fornell, 1981). For the first criterion, the average square root of AVEs should be higher than the correlation with the other latent variables (Table 7) (Rahi et al., 2018; Yusoff et al., 2020).

The cross-loadings as the second criterion offer another check for discriminate validity: If the correlation of an indicator with another latent variable is higher than the correlation with the respective latent variable, then the appropriateness of the model should be reconsidered (Hanafiah, 2020) (Table 15, Appendix).

The loading and cross-loading tables (Table 15 See Appendix) show that the cross-leading is lower than the loading patterns, but both measures are satisfied. The Policy and Standardization and security constructs have been measured formatively because their measurement items are not parallel. When dealing with the formative measurement model, the outer weight of the model (not outer loadings), convergent validity, and collinearity of the indicators have been analyzed (Götz et al., 2010). Multicollinearity is an essential assessment for any formative model. The literature proposes different approaches for dealing with multicollinearity (Diamantopoulos & Winklhofer, 2001).

Several authors suggest variance inflation factors (VIF) as a standard approach for calculating multicollinearity without an apparent threshold (Sulaiman et al., 2021). Meanwhile, a traditional rule of thumb says that multicollinearity is a concern if the VIF is higher than 10; however, scholars mentioned that of formative measures, this value should not be over-valued about 5 to be considered in the model (Tamjidyamcholo et al., 2014). The maximum VIF value for our formative indicators came in 4.711, which is well below the threshold of 5. Also, the tolerance values for the security construct were located above the cutoff value of 0.1, ranging from 1.232 to 3.333 (Tables 16 and 17 see Appendix). The next step to validate the formative construct is checking based on the below algorithm (Hair et al., 2013):

From the formative construct of security, two indicators (S1 and S14) break the rules and both outer weight and their outer loadings are less than the satisfactory value. In policy also, some indicator has a small outer weight, but just policy and standardization 11 and policy and standardization 18 compromise the rules for outer loading (bigger than 0.5), so they should be removed (Hair et al., 2013) (Tables 16 and 17 see Appendix).

Table 6 Correlations and average variance extracted (AVE)

Item	AVE	Item	AVEs
RA	0.6127	TMS	0.5849
CMX	0.6748	Firm size	1
CMB	0.5059	CP	0.612
Security	0	TPP	0.5624
Outage	0.8049	Interest in adoption of cloud computing	0.8833
PS	0		

Relative advantage (RA), Top management support (TMS), Competitor pressure (CP), Trading partner pressure (TPP), Complexity (CMX), Compatibility (CMB), Policy and standardization (PS), Security (S), Outage (O), Firm size (FS)

Table 7 Square root of AVEs

Items	TMS	CMB	CP	CMX	FS	TMS	O	PS	RA	S	TPP
TMS	0.77	0	0	0	0	0	0	0	0	0	0
CMB	0.45	0.83	0	0	0	0	0	0	0	0	0
CP	0.54	0.47	0.79	0	0	0	0	0	0	0	0
CMX	0.33	0.4	0.33	0.72	0	0	0	0	0	0	0
FS	0.02	0.07	0.13	0.08	1	0	0	0	0	0	0
TMS	0.55	0.56	0.49	0.26	0.08	0.94	0	0	0	0	0
O	0.14	0.24	-0.1	0.29	0.08	0.23	0.94	0	0	0	0
PS	0.24	0.28	0.18	0.29	0.07	0.56	0.52	0	0	0	0
RA	0.28	0.29	0.29	0.68	0.12	0.37	0.33	0.33	0.79	0	0
S	0.15	0.1	-0.03	0.2	0.04	0.37	0.54	0.4	0.33	0	0
TPP	0.76	0.45	0.61	0.37	0.1	0.45	0.14	0.23	0.36	0.13	0.75

Relative advantage (RA), Top management support (TMS), Competitor pressure (CP), Trading partner pressure (TPP), Complexity (CMX), Compatibility (CMB), Policy and standardization (PS), Security (S), Outage (O), Firm size (FS)

4.1.2 The structural model

In this phase, the relationship among the hypothetical constructs have been assessed by the Structural model. To verify the hypotheses, we used the statistical importance of the path coefficients verification based on calculating the t-statistics by Bootstrap. The number of samples in this calculation was 500 (Götz et al., 2010; Hair et al., 2012).

The path coefficients represent the strength of the associations between the dependent/independent variables, and assessments of the R2 values signify the quantity of variance in the dependent variable elucidated by the independent variables (Asadi et al., 2021a, 2021b). In the Structural model, the estimated values for path relationship can be evaluated in terms of the sign, magnitude, and significance (Hair et al., 2012, 2013) and the significant usage level of the standardized parameter

```
If the outer weight of an indicator is less than (n= number of indicators)
    Then
        If outer loading is bigger or equal than 0.5
            It should remain
        Otherwise
            It should be deleted
```

Algorithm 1

estimates between the constructs in this test has been shown by the corresponding t-values. The statistical decision criterion is 5% significance level, which means p should be less than 0.05 ($P < 0.05$) (Fisher, 1992). The results are summarized in Tables 8 and 9 which show that eight have supported out of the ten hypotheses.

Ten hypotheses were evaluated for this study. The bootstrapping test is run to calculate the t value and p-values. Moreover, DF in this study was 203, equal to N-1 and N is the number of respondents. The hypotheses and results have been described below:

Hypothesis 1: has evaluated the relationship between Relative Advantages and interest for the adoption of cloud computing. T value for this hypothesis is $t = 3.167$, p value is less than 0.05 ($p = 0.0018$) and ß=0.200. Therefore, the relative advantages is significantly related to the interest in the adoption of cloud computing.

Hypothesis 2: suggests that the Complexity influences interest in the adoption of cloud computing. Supporting the hypothesis, the research model demonstrated a negative, but significant influence of Complexity on interest for adoption of cloud computing (t-value = 3.328, $p = 0.001039$, and ß = -0.232).

Hypothesis 3: The empirical study supports research hypothesis 3 in that there is a significant statistical relationship between compatibility and interest in adopting cloud computing. The t value for this hypothesis is 5.417, where p was less than $0.0000002 < 0.05$. This is in accordance with H3 expectations (path coefficient = 0.337).

Hypothesis 4: The variable defined in this analysis as security has evaluated the relationship between security and interest in the adoption of cloud computing. The t value for this hypothesis is $t = 3.251$. Moreover, the p value was $0.001357 < 0.05$. Therefore, based on the result, the security is significantly related to the interest in the adoption of cloud computing. It is consistent with the expectation of H4 (path coefficient = 0.236).

Hypothesis 5: suggests that the outage influences interest in the adoption of cloud computing. Supporting the hypothesis, the research model demonstrated a negative, but significant influence of outage on interest for adoption of cloud computing (t-value = 3.396, $p = 0.000823$, and ß = -0.201). The result shows that integration efficiency is significantly related to the effectiveness of the integration of knowledge.

Hypothesis 6: it was suggested that the policy has a relationship with interest for the cloud computing adoption. The policy had a highly significant posi-

Table 8 Hypotheses testing

	Original Sample	Sample Mean (M)	(STDEV)	T Statistics
Relative advantages⟶Interest in adoption of cloud computing	0.22	0.2	0.06	3.59
Complexity⟶Interest in adoption of cloud computing	–0.25	–0.2	0.07	3.7
Compatibility⟶Interest in adoption of cloud computing	0.32	0.3	0.06	5.24
Security⟶Interest in adoption of cloud computing	0.27	0.25	0.07	3.84
Outage⟶Interest in adoption of cloud computing	–0.21	–0.15	0.07	3.23
Policy⟶Interest in adoption of cloud computing	0.38	0.38	0.07	5.62
Top management support⟶Interest in adoption of cloud computing	0.38	0.34	0.11	3.66
Firm size⟶Interest in adoption of cloud computing	0.03	0.02	0.05	0.61
Competitor pressure⟶Interest in adoption of cloud computing	0.22	0.2	0.07	3.17
Trading partner pressure⟶Interest in adoption of cloud computing	–0.19	–0.16	0.1	1.82

Table 9 Hypotheses testing result

Hypotheses testing result	Hypotheses	ß	T	P-value	Result
H1	Relative advantages—> Interest in adoption of cloud computing	0.200	3.167	0.0018	Supported
H2	Complexity—> Interest in adoption of cloud computing	−0.232	3.328	0.001039	Supported
H3	Compatibility—> Interest in adoption of cloud computing	0.337	5.417	0.0000002	Supported
H4	Security—> Interest in adoption of cloud computing	0.236	3.251	0.00134639	Supported
H5	Outage—> Interest in adoption of cloud computing	−0.201	3.396	0.000823	Supported
H6	Policy—> Interest in adoption of cloud computing	0.395	6.503	$P < 0.0000001$	Supported
H7	Top management support—> Interest in adoption of cloud computing	0.346	3.602	0.0004	Supported
H8	Firm size—> Interest in adoption of cloud computing	0.013	0.332	0.74	Not Supported
H9	Competitor pressure—> Interest in adoption of cloud computing	0.190	2.831	0.005107	Supported
H10	Trading partner pressure—> Interest in adoption of cloud computing	−0.166	1.710	0.088794	Not Supported

tive influence on interest in adoption of cloud computing (t-value = 6.503, $p < 0.0000001 \approx 0$). The value of P explains that the policy has a significant relationship with the interest in cloud computing adaption. The results of the PLS path model showed that the policy factor (path coefficient = 0.395) had a much more significant effect on the interest in adopting cloud computing compared to the other constructs, Top Management Support (path coefficient = 0.346), compatibility (path coefficient = 0.337), and security (path coefficient = 0.236).

Hypothesis 7: has evaluated the relationship's Top Management Support between and interest in the adoption of cloud computing services. The t value for this hypothesis is t = 3.602 where p value is less than 0.05 ($p = 0.0004$). Therefore, based on the result, the Top Management Support is strongly related to the interest in the adoption of cloud computing. This is in line with the expectation of the H7 (path coefficient = 0.346).

Hypothesis 8: has evaluated the relationship between firm size and interest for the adoption of cloud computing. The t value for this hypothesis is t = 0.332 where the p value test shows that the p value is bigger than 0.05 ($p = 0.74$). Conventional criteria can summarize it, and this difference is not statistically significant. It is consistent with the expectation of H8 (path coefficient = 0.013).

Hypothesis 9: has evaluated the relationship between competitor pressure and interest for adoption of cloud computing. The t value for this hypothesis is 2.831, where p is equal to 0.005107 which is less than 0.05 and ß = 0.190. Therefore, the competitive pressure is significantly related to the interest in the adoption of cloud computing.

Hypothesis 10: has evaluated the relationship between trading partner pressure and interest for the adoption of cloud computing. The t value for this hypothesis is t = 1.710 where the p value is bigger than 0.05 ($p = 0.088794$) and ß = -0.166. Output from the p value calculation of the two-tailed test shows the p value is less than 0.6334. Therefore, this H was not supported.

As presented in Fig. 2, the model constitutes 67.1% ≈ 70% of the variance in interest for the adoption of cloud computing. Except for the hypothesis H8 and H10, all hypotheses are supported.

Another logical metric to judge the structure (or inner) model, the coefficient of determination of endogenous variables (R2). Correlation of determination (R-square) of each endogenous variable in general is the total fitness degree of model or percentage of variance explained by the model. Chin (1998) defined R2 values in the PLS path models as 0.67, 0.33, and 0.19, which are shown substantial, moderate, and weak values. The R^2 in the study was $0.671 > 0.67$, which was a substantial level. R2 for any Latent Variable (LV) can be the starting point of PLS analysis of the structure model, since the PLS interpretation is like a traditional regression. Previous researchers also advised that the change in R2 can be surveyed to see how a specific independent variable impacts the dependent variable known as effect size (f^2). Following the recommendations of China (1998b), the effect size can be calculated as follows:

$$\text{Effect size}: f^2 = (R^2\text{include} - R^2\text{excluded})/(1 - R^2\text{include}) \tag{1}$$

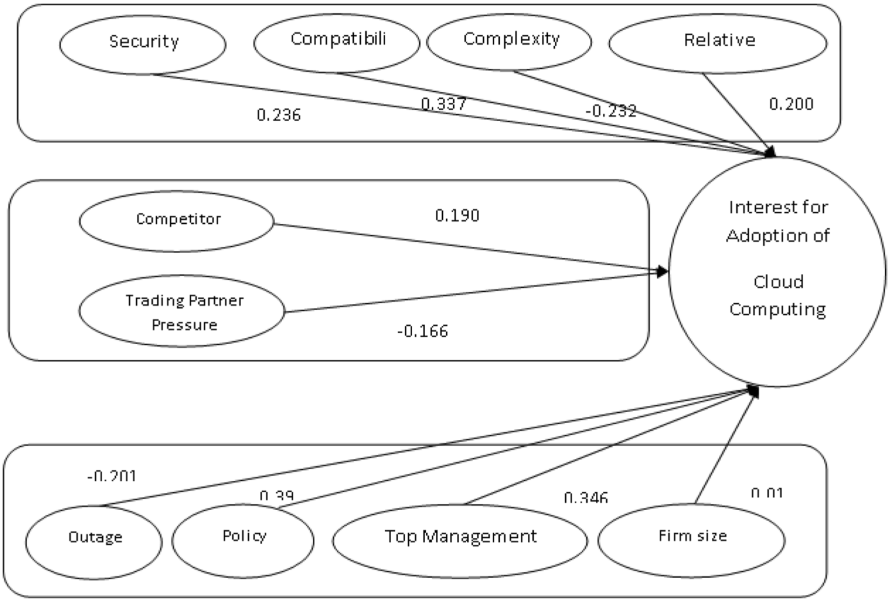

Fig. 2 Path coefficient

F2 from 0.02, 0.15 and 0.35 can be interpreted as a small, medium, or large predictor of LV at the Structural level (Püschel et al., 2010).

Table 10 shows that f^2 value of all factors in this study are more than 0.15 so the effect of all constructs of the model is medium except policy with 0.39633 which is more than 0.35 and its effect is substantial. After Policy, compatibility with 0.31243, Top Management Support with 0.28323, security with 0.27642, and Outage with 0.21533 are the essential factors. In this study, all factors affect the dependent variables (more than 0.15).

The medium to large effect sizes (f^2) indicate that the proportion of the multivariate variance in the study is medium to high; thus, the relationship between independent construct and interest for adoption of cloud computing identified in this study are substantive and have significant theoretical and practical implications. This result adds reliability to the analysis and findings of the current study.

4.2 Simulation process and result

Simulation modeling, creating and analyzing a prototype, is a model for predicting its performance in the real world (Shannon, 1975). Simulating the adoption model aims to provide a computer tool that help organizations know by changing the value of each sub-factor how the value of interest for adoption of cloud computing services will be changing. Moreover, to determine which sub-factors are more critical in predicting cloud computing adoption based on the respondent's opinion. For instance, the security factor as a formative factor includes any sub-factors

Table 10 Effect Size

Included/ Excluded Item	f2	Included/ Excluded Item	f2	Included/ Excluded Item	f2
Relative Advantages	0.19867	Security	0.27642	Top Management Support	0.28323
Complexity	0.21933	Outage	0.21533	Firm size	0.003
Compatibility	0.31243	Policy	0.39633	Competitor Pressure	0.18967
Trading partner pressure	0.16067				

(indicators) that each of them, even with a small amount of contribution, should be considered. Moreover, it can be recognized for increasing the security of cloud computing which sub-factor is more effective. Therefore, the system dynamic method and STELLA simulation is used. System Dynamic (SD) was chosen in this study because Forrester designed system dynamics in 1969 to simulate social and specific management problems applied in the design of complex systems and information system studies (Chang & Chou, 2011). In addition, system dynamics are used to represent the sequence of events to show how decision-makers interrelate to influence an organization (Brailsford, 2014). STELLA (Systems Thinking, Experimental Learning Laboratory with Animation; also marketed as iThink) is a flexible computer modeling package with an easy and intuitive user interface that allows users to model dynamic models and realistically simulate biological systems developed by Richmond and Goldberg (1985). STELLA simulation engine is chosen because it is used in IT diffusion adoption process successfully. To simulate the proposed model in this study, after validating the model by distributing questionnaire the data is entered in an Excel file and used as an initial value for simulation (Fig. 3). To calculate the value of each factor (flow) each indicator such as ITMI 2 get its initial value from an Excel file, then the Average of the respondent's answer to each variable is calculated, for example for the variable of HAS as:

$$\text{HSA} = \text{SUM(ITIM2)}/\text{Number of Respondent} \tag{2}$$

And then, the sum of all indicators is calculated as the value of each factor

$$\text{Fn} = \text{Sum of all its indicators} \tag{3}$$

Moreover, the level of changes in interest for adoption can be perused by changing each factor in the final prototype. For example, by changing the level of access control via prototype, you can see how the security and consequently the interest in adoption will be influenced. To do this, the slider impute device element should be used. Based on 5-point Likert scale minimum value for each variable was 1 and the maximum was 5. By changing the value of access control from 1 to 5, the security level increased in this test and subsequently interest is changed from 2782 to 2834.

The data used for this model's simulation is based on data collected for cloud computing services adoption throughout 2013 to 2014. The data is imported to the model by using excel software. The layer model is structured based on TOE theory as Technological, Organizational, and Environmental, interests of IT

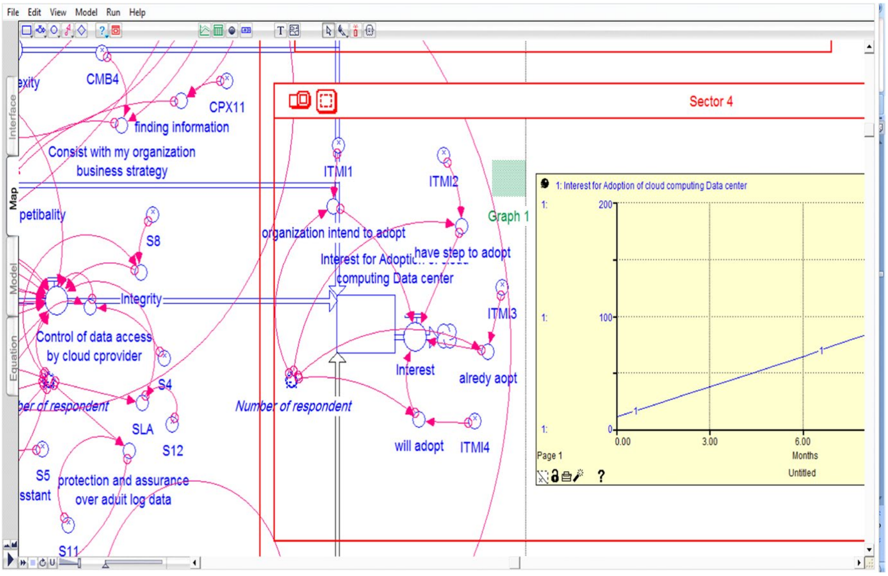

Fig. 3 A sample from simulation model by using STELLA

managers for the adoption of cloud computing services. Figures 4, 5, and 6 show the structure of the model, which includes 153 variables. The initial inputs for the variable come from questionnaire answers in an excel file. Delta Time (DT) chosen for simulations is 0.25 (quarter of a year), a time interval between the calculations. This interval is optimal because it is small enough not to miss any interesting changes between the step and large enough to allow the computer to run the simulation fast.

Figure 4 shows that the technological subgroup consists of four main factors of Relative Advantages, Complexity, Compatibility, and security and some sub factors for each factor. For each factor, a flow and for each indicator a convertor is defined. Each indicator consists of an average of the response of responding to one of the questions for example; profitability is the average of the response to Relative Advantages 1. Moreover, each factor (flow) value is equal to the sum of the value of all its indicators (convertors) is dedicated to it.

Figure 5 shows the organizational subgroup, including outage, policy, Top Management Support, and firm size as main factors and their indicators. Same as technical session here also for each factor a flow and for each indicator a convertor is defined. Each indicator value is also calculated as the same as the technical session. The average of the response of responding to the each of the questions is equal to the indicated value and for, each factor (flow) the sum of the value of all indicators (convertors) is calculated.

Finally, Fig. 6 shows the environment subgroup, which includes two factors of competitive pressure, TPP, and the result of the simulation model which is interested in adopting cloud computing that stock shows it. The output of all three technical, organizational, and environmental subgroups is entering this stock.

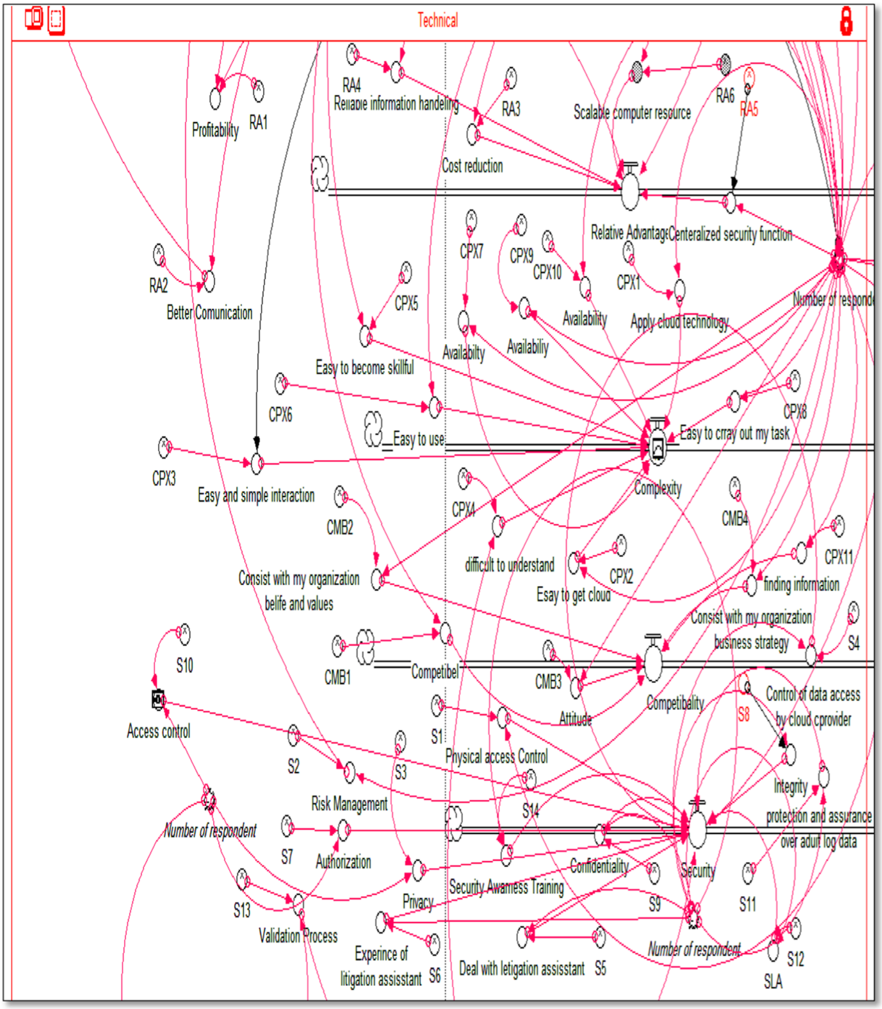

Fig. 4 Technical session of structural model in STELLA simulator

In addition, a prototype is developed based on the result of the evaluated model. The prototype is designed to build a general understanding of cloud computing services adoption through customizing simulations. As presented in Fig. 7, the prototype includes two main parts: the parameter adjustment and the simulation outcome. The parameter adjustment is used to change the key support factors (assumption) affecting the interest in the adoption of cloud computing. Changing the value of assumption causes a change in the value of interest for the adoption of cloud computing. For example, for the access control, which falls under "Security Factor," a user can select a value between one and five. By setting its value to 5, the security will be increased and interest for the adoption of CC services (see appendix Fig. 8).

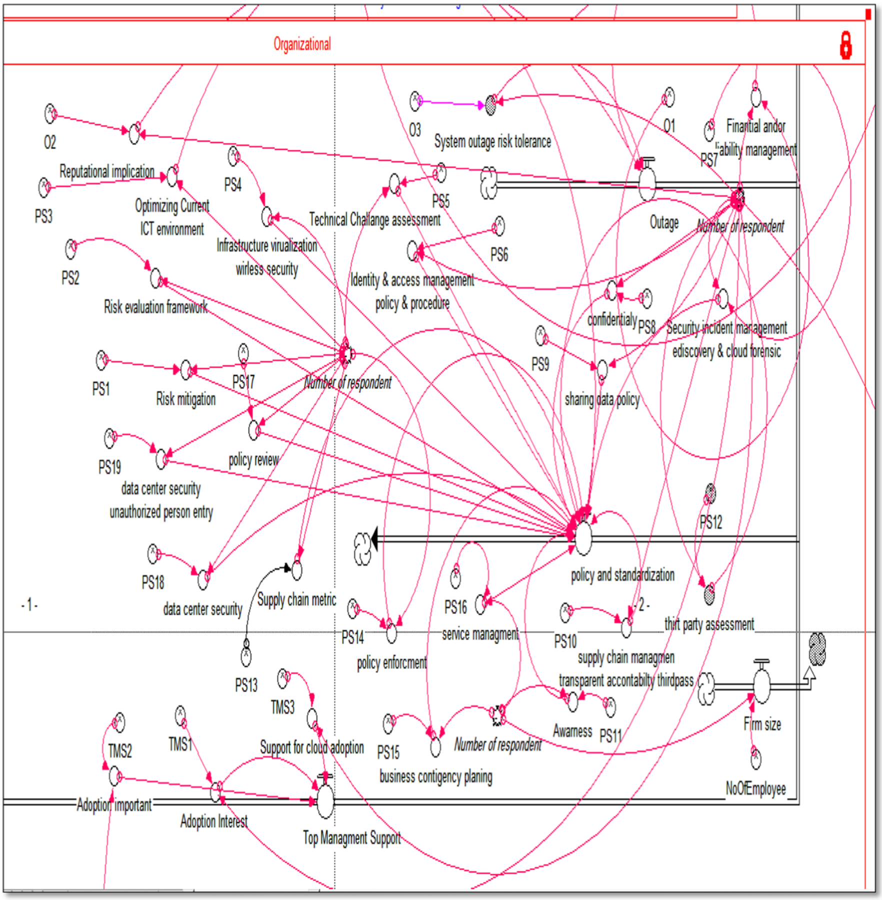

Fig. 5 Structural model in stella simulator: Organizational session

Under the proposed scenario, the interest of IT decision-makers for the adoption of cloud computing services increase from 2,614 in the pilot study, to 2,842, in the period of 1-year. The prototype shows that the value of interest for adoption increases from 2,614 to 2,821 in round 1 and 2,842 in the final round. During the pilot study, the number of respondents was 38 and their answers to a questionnaire showed that their level of interest for using cloud computing services in the pilot university is 2,614. By starting the main survey, in the first round of data gathering the number of respondents increased to 138 as a result the level of interest for adoption of cloud computing increased to 2,821. In the final round of data gathering, the number of respondents reached 204. Therefore, the level of interest for the adoption of cloud computing increased to 2,842. Finally, the simulation environment for the base run was developed based on a university with 204 full-time IT decision-makers in universities. Figure 7 presents selected graphical outputs of the simulation.

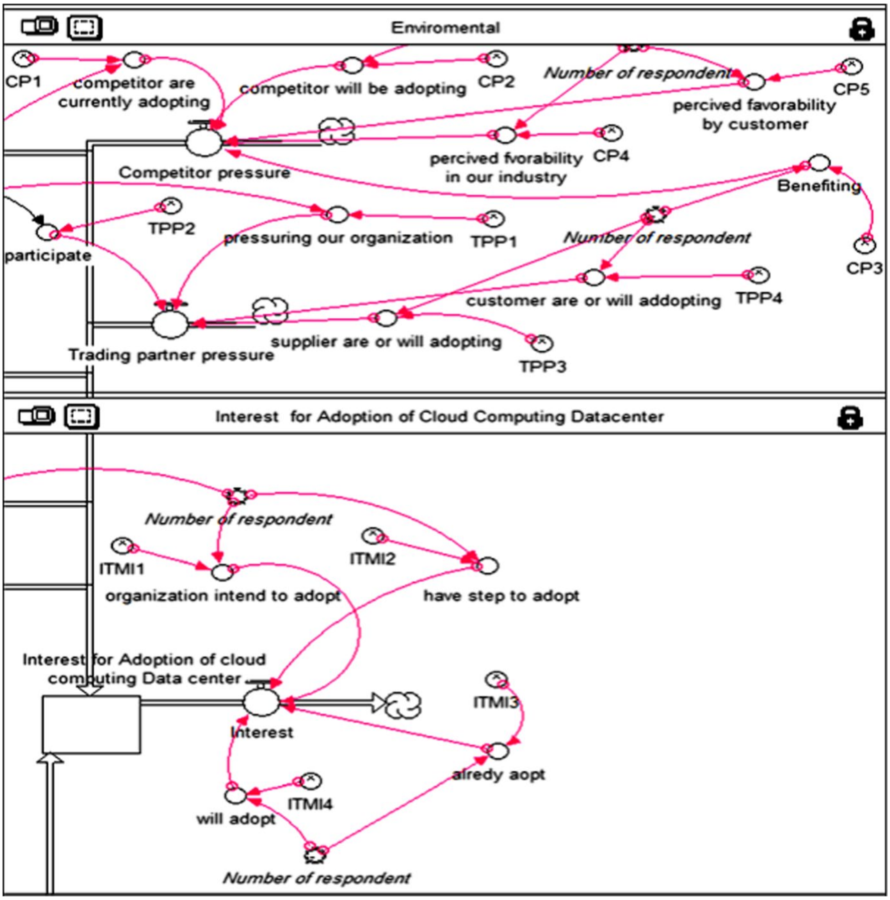

Fig. 6 Environmental and interest session of structural model in STELLA simulator

In Fig. 7, the X-axis represents the time in months, while the Y-axis represents the amount of interest of IT decision-makers for the adoption of cloud computing services. In addition, it is` linear' since the constant proportionality between the stock and its flaws gives rise to the term linear, which refers to the algebraic form of the flow equation. The system is called first order since only one stock is involved. In this comparative graph, three factors are compared together. The blue line shows the level of interest for the adoption of cloud computing during the pilot study, which has said before it was 2,614. The red line shows the amount of interest for the adoption of cloud computing in the first round of data gathering. The level of interest for the adoption of cloud by Malaysian university was 2.821 in this round. Finally, the green line shows the level of interest in the final round of data gathering which was 2,842. This means the proposed model is valid and the interest of users for the adoption of cloud computing services has been increased by around 8% = (100- ((2,614 * 100) / 2,842) = 8.023) in the 1-year period, which is a significant growth in this time.

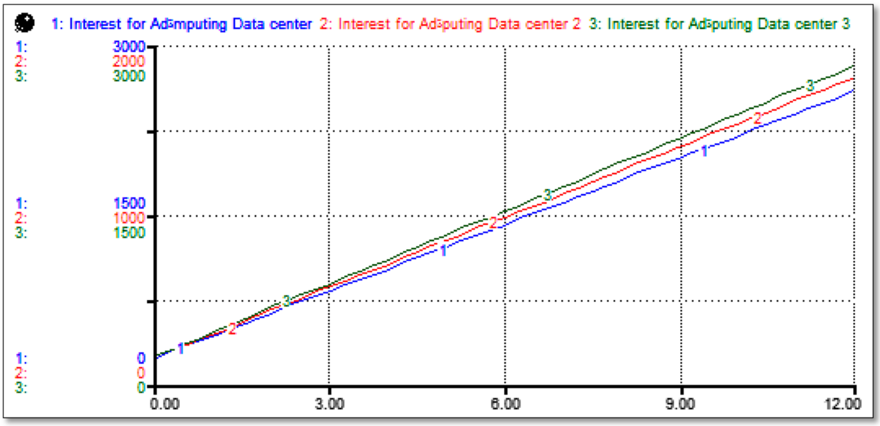

Fig. 7 Graphical output base run simulation: Interest for adoption of cloud computing services

4.3 Additional findings

To determine the effect of policy on security, both mediating and moderating effects were examined. To examine the moderating effect, the product indicator approach has been deployed (Chin, 1998). SmartPLS exhibits three criteria to verify the strength of the moderating effect, including path coefficient, the significance of the path coefficient, and effect size (f2) of the interaction term (Henseler et al., 2009). The results showed that the interaction term (policy and security) had a path coefficient of -0.308 and t-value of 2.848, which were statistically significant at $p = 0.00485 < 0.05$ for two-tailed. In addition, the path coefficient of the main effects is reduced, but the coefficient of determination (R2) has increased from 0.671 to 0.697. Also, to determine the power of interaction, "size of effect" is considered (Chin, 1998)

$$\text{f2} = (\text{R2 model with moderator} - \text{R2 model without moderator}) / (\text{R2 model with moderator})\text{f2} = (0.697 - 0.671)/(0.697) \approx 0.05$$

The significant interaction in our experiments has an effect size of 0.05, which indicates a small interaction effect. However, even minor effects using the product indicator approach represent important relationship (Lowry & Gaskin, 2014).

Since in comparison with the alternatives, e.g. Sobel test, there is a significant advantage for bootstrapping that the previous scholars acclaimed (MacKinnon et al., 2004), in the next step, we used bootstrapping to calculate the mediating effect of policy on security,

One of the main advantages of using bootstrapping is strongly protecting the test against type II errors. The significance of the effect of security on interest was examined in two cases: with the intervening variables, which was the policy, and directly between them per sue.

Baron and Kenny (1986) followed formal step to examine mediating relationship includes: (a) the independent variable should affect the dependent variable; (B) the

Table 11 Test criteria

Total effect	Standard error	Relationship	
0.8647	0.021	Policy	Security
0.5275	0.1253	Interest	Policy

independent variable must influence the variable intervention; and (c) the intervention variables must influence the outcome, after controlling the independent variable. To create a full mediation, the total effect of the independent variable on the result (path C) should not be significant in the presence of the C (C) variable, while its indirect effect is significant.

Partial mediation is established when the C route remains significant, but it is considerably reduced and its indirect effect is significant. Finally, the effectiveness values have been calculated to express the total effect, as described by indirect effects via the mediator(s) (Mikalef et al., 2020). The analyses are potentially facilitated during the experiments by maximizing effect sizes between intervention and controls (Goldberg et al., 2022).

The results showed the effect of policy on the relationship between security and interest. On the other side, after ignoring the policy, the security strongly affects cloud computing adoption interest. For the Sobel test, the standard error, the total effect of IV to M, and M to DV, and their path coefficient are extracted using SmartPLS (their t-value also can be used alternatively), which shows in Table 11.

Due to the result of Sobel test, the indirect effect value of security on interest via policy is 4.18806376, and p- value is 0.00002813, which means there is a significant effect. Moreover, the result of the path coefficient, total effect and t-value analysis of the relationship between mediating analysis between police and security is summed up in Table 12.

With a highly positive indirect influence between security and policy (0.8650), policy and interest (0.528) for the adoption of cloud computing data center, there is a significant correlation between security and policy at the 0.05 level ($\beta = 0.865$, t-value = 41.098, $p < 0.00001$). However, the direct effect of security and interest after adding this relation became insignificant ($\beta = 0.225$, $t = 2.051$, $p = 0.0753$). Therefore, based on the definition of mediator, the policy could not be a mediator of security (Baron & Kenny, 1986; Judd et al., 2014) (Baron & Kenny, 1986). Since, the policy changed the direction and strength of the relationship of security and the interest of IT decision-makers, the policy has a moderating effect on security (Hair et al., 2013; Hu et al., 2021; Judd et al., 2014).

Besides, the results of the path coefficient analysis for the relationship between outage-monitoring-contingency planning and security showed positive influence (path coefficient of 0.730) between outage and security, the relationship was significantly correlated at 0.05 level ($\beta = 0.730$, T-value = 19.782, $p < 0.00001 \approx 0$). In other words, through a well-established outage contingency planning, the organization's security risk will be decreased.

It is also possible to find a positive and significant influence between security and Relative Advantages from the outcome of the path coefficient analysis with a substantial relationship value of ($\beta = 0.408$, T-value = 5.659, $p < 0.00000005$). This study also approved that central security is one of the benefits of cloud

Table 12 Total Effect of Direct and Indirect Effect of Security on Interest

p-value	T value	Direct effect	Total effect	To	From
< 0.00001	41.098	0	0.865	Policy	Security
< 0.00001	4.210	0.236	0.528	Interest	Policy
0.0753	2.051	0.395	0.225	Interest	Security

computing. This item was one of the questions of Relative Advantages (RA 5), which most of the respondents strongly agreed with it.

Therefore, it can be said that while it has a series of specific security concerns, but it solves some traditional security concerns such as eavesdropping attacks (Vaquero et al., 2011). Moreover, referring the results of the discussion with MYREN, and some reports, it could be concluded that some solutions, e.g. key management, can help the customers to keep their data privately, and control the data access. Thus, as finding of this study showed security in some aspect is Relative Advantages of cloud computing. However, there is still some security concern regarding the cloud computing.

5 Discussion

The finding of the research model has been discussed in this section. This study's conceptual framework revealed a link between the interest of IT managers to cloud computing adoption and the independent variables, i.e. Top Management Support, compatibility, competitor pressure, Complexity, outage, policy, Relative Advantages, security, TPP, and firm size. The interest of the IT managers in adopting cloud computing is the only dependent variable in this study. The results of the data analysis provided support for the proposed model. Moreover, the results supported the majority of the hypothetical relationship. This study yielded some interesting results. Except for competitor pressure and firm size, rest of the factors had a significant relation with interest to CCDC adoption. Policy had the most contribution in predicting the universities' for CCDC adoption. Though the security has been introduced as the most important concern for cloud computing adoption, compared to the other factors, i.e. policy, compatibility, and Top Management Support is influence on cloud computing adoption is not remarkable. The findings discuss in detail in the following sections.

5.1 Technology context

Through data analysis, the researcher found out that Relative Advantages is one of the influencing factors of IT managers' interest in CCDC adoption in Malaysian higher education. Also, some scholars have introduced the Relative Advantages as one of the best predictors of diffusion of innovation in adoption (Muda et al., 2019; Nartey, 2021). Finally, the Relative Advantages measures the extent of decision-makers' tent to adopt an innovation due to the expecting improvement over existing technologies (Al Hadwer et al., 2021; Qasem et al., 2020).

The relationship between Relative Advantages and interest were positive and statistically significant. The positive effect of Relative Advantages in this study supports previous findings in the literature (Ra et al., 2018; Sallehudin et al., 2020; Wilson et al., 2020). While previous studies asserted cost reduction, scalable computing resources, profitability, and better communication as the advantages of cloud computing (Farahnak et al., 2020; Kiely et al., 2019), this study highlighted the centralized security function and the reliable information handling as the other important benefits for cloud computing.

The findings revealed that Complexity of new technology like cloud computing can influence the decision of IT professionals for adoption of cloud computing data center. The results showed a significant relationship between Complexity and interest for the adoption of cloud computing. However, the path coefficient was negative, which means by increasing the Complexity of cloud computing, the interest in adopting cloud data center will reduce. This result is consistent with the previous studies finding that Complexity has a negative effect on the adoption of new technology and is one of the critical factors for adopting new technology (Darban & Polites, 2020; Romero-Hernandez et al., 2021). Users need a long time to understand the technology because of the Complexity and it can act as a barrier to the implementation of new technology. Moreover, this study's findings showed cloud computing is becoming more and more popular, especially in the context of Malaysian universities. The reasons were easy to learn, easy to get cloud technology to perform job functions, interaction would be clear and straightforward, easy to become more skillful, easy to use, availability, and productive.

Compatibility is the next factor that influences IT decision-makers' interest in adopting CC data center in the context of the Malaysian higher education institute. This finding of hypothesis 3 showed that (p=0.0000002 and=0. 337) it has a strong positive relationship with the dependent variable. Moreover, the Compatibility was the second most significant factor in this study after policy with a strong path coefficient. This means that it causes to about 0. 34 percent of the variation of interest in adopting cloud computing data center. These findings confirm the result of previous studies (Nuryyev et al., 2020; Qasem et al., 2021). When a technology has been recognized as compatible with an individual's job responsibilities, business organizations are more likely to adopt that technology (Mohammed & Ferraris, 2021; Talukder et al., 2020). The current study's findings also supported that if the CCDC is compatible with an organization Information Technology (IT) infra structure, belief and values, and business strategy, universities are more interested in adopting it.

The influence of security, on IT decision-makers' interest in the adoption of cloud computing data center, was posed in Hypothesis 4. The model for CCDC adoption data analysis result shows that security had a $p = 0.0013$, which means the relationship is statistically significant. Moreover, the path coefficient of 0.236 indicated that security has a strong positive effect on cloud adoption, but it has a weaker influence compared to policy, Compatibility, and Top Management Support. This finding supports the previous studies that assert the security challenges as one of the critical constraints of cloud computing adoption (Buyya et al., 2010); however, its strength is considerable. Also, as discussed in the relative advantages factor, central security is one of the benefits of cloud computing (Hung, 2019; Wimmer et al., 2020).

5.2 Technical –Organizational context

Outage and monitoring were the other important factors that affected IT managers' interest in CCDC adoption. The results of this study illustrated a direct and significant effect of outage on the managers' interest. The cloud services will confront the outage, whether temporarily or permanently. However, cloud providers acclaim several advantages of cloud-based services, i.e. trustingly availability and assure computational integrity; mutually, they can fail, collapse, or be attacked (Bhushan et al., 2021; Kim et al., 2009; Sultan, 2010).

Therefore, Outage and monitoring are very important factors that cloud customers should consider. They should provide good contingency planning for outage time to avoid serious harm. The measurement of this study declared that the important item should be regarded as deducting the outage disadvantage as follows: financial and/or liability management implications of a service outage, reputational implications of a service outage, and policy and standardization should have system outages within acceptable risk tolerances.

Moreover, as discussed, the security has a direct, positive, and statistically significant relation with Relative Advantages, which means, in some aspects security could be one of the Relative Advantages s of the cloud. Published annual reports and standards for cloud security via governments of different countries report some techniques such as key management, which help to deduct cloud computing security risk and increase control over accessing data (Begemann et al., 2020; Mora et al., 2019). Further, this study provided a list of items that can convince the IT decision-makers of Malaysian universities about the security of the cloud computing. Referring to final measurement model of this study, these items are risk management, recovering rights of data, e-Discovery right of data, deal with litigation assistance in the contract or supporting corporate policy documents, experience of litigation assistance, authorization of persons who have search capability, Cloud Service Provider (CSP), sufficient security measures, customer level of access to audit the log data, protection and assurance over audit log data, Service Level Agreement (SLAs), application validation process for testing the device, and security awareness training program. Finally, based on the result of this study security was classified under the technical factors.

This research also exhibited the policy as a significant factor contributing to CCDC adoption. Some cloud adoption studies have mentioned an established policy for cloud computing. Moreover, some reports acknowledged that the CC risk would be reduced with a good and established policy. However, some other studies pointed out that policy and organizational obstacles may prevent companies from adopting cloud computing services (Rao et al., 2022; Yeboah-Boateng & Essandoh, 2014).

5.3 Organizational context

Universities have some concerns such as security, policy, standardization, and privacy about the cloud computing adoption. The current study also confirmed these concerns. However, considering the additional finding of this study that shows the policy is a moderator, from the moderation effect of policy on security, it can be concluded that the security issue is guaranteed by including policy in cloud computing technology. In the other hand, consideration to policy causes in increasing IT decision-maker interest in CCDC adoption. Therefore, the policy has a twofold role. It affects both interest and security risk, doubling the interest of IT manager to CCDC adoption.

The result showed a significant correlation between Top Management Support and CCDC adoption. The findings asserted that Top Management Support could contribute to adopting the newest technology by providing a creative environment and supplying resources. Additionally, the Top Management Support is a widely accepted condition for successful technology implementation as mentioned in previous research (Aremu et al., 2021; Borgman et al., 2013; Low et al., 2011; Tweel, 2012).

Firm size measured based on the number of employees ($ß=0.013$, $p=0.74$) was insignificant in this study. This result is supported by previous studies (Low et al., 2011; Tweel, 2012; Zheng, 2021). However, this study showed that small universities also have the same interest in adopting cloud-based data center as big universities.

5.4 Environmental context

Competitor pressure showed a strong relationship with the adoption of cloud computing. This finding is in line with the results of studies conducted by (Baig et al., 2021; Qasem et al., 2021). The TPP does not show an impact on the adoption of cloud computing. This result may relate to the culture of the Malaysian universities.

5.5 Moderator and mediator effects

Finally, the meditation and moderation effects between security, outage, Relative Advantages, and policy have been checked (H11). With a highly positive indirect influence between security and policy (0.8650), policy and interest (0.528) for adoption of CCDC, and in addition, considering to that the policy changed the direction and strength of the relationship of security and interest of IT decision-makers, based on moderator definition the policy has a moderating effect on security (Hair et al., 2013; Judd et al., 2014). The literature review showed that a Relative Advantages re study examined the mediating and moderating effect on the adoption of cloud computing. Besides, there is not any study that investigated the moderating or mediating effect of policy on security for cloud computing (Abied & Ibrahim, 2021; Liang et al., 2017).

6 Research contribution

The research contributions are listed from two different perspectives, theoretical and practical.

6.1 Theoretical contribution

In the theoretical part, this study contributed to enriching the knowledge about the interest of IT decision-makers in technology adoption. Especially in finding the critical success factors influencing IT decision-makers for the adoption of CCDC. The considerable point of this research is identifying factors that affect the CCDC adoption. Even, some studies (Ali et al., 2018; Arpaci, 2019) focused on the usage of cloud computing for educational purposes for students, there is no comprehensive study that investigates the adoption of CCDC in the higher education institutes (Gupta et al., 2022; Jones et al., 2021).

This study developed and empirically tested a model for CCDC adoption in public and private universities in Malaysia. An integrated conceptual research model based on TOE, DOI, and Institutional theory was developed for CCDC adoption. The integrated conceptual model reviewed the related factors to CC adoption and extracted factors from the adoption theories. This research finds three new critical success factors including outage, policy, and security and 36 indicators for these factors contribute to interest of CCDC adoption. In addition to finding the new policy factor, the items related to this factor are added as indicators to measure the policy for cloud computing data center adoption based on the opinion of expert and related references. Then the instrument reliability and validity test via pilot and during the main study. The additional result of our study that in the prior studies was not investigated is testing the relationship between security with policy, outage and Relative Advantages. Moreover, since the security and outage construct category was unclear referring to previous studies, this study categorized these factors under the technology and organization category.

6.2 Practical contributions

For the practical part, the results can help cloud providers to evaluate the interest of the organizations for adoption of CCDC. Using the developed instrument in this study they can evaluate the organizations' readiness for CCDC adoption. The following questions refer to measuring the readiness of the organizations:

Q3- Optional cost reduction,
Q40- Improve quality of decision-making,
Q2 and Q6- Improved Service to Customers,
Q15- Productivity Improvement,
Q57, 22, 31, 44- Improved Access to Information,
Q61-66- Improved Competitiveness,
Q20- Attitude of Top management toward adoption of technology, and
Q22-Q35 Security

By calculating the average of responses to these questions, cloud service providers can calculate the level of readiness of the organizations. Moreover, based on results of this study, the cloud provider knows which factors are considerable for increasing the organization's interest for the adoption of CCDC. Furthermore, this study's results can help providers control the security risk of cloud adoption.

Table 13 The recommended area for establishing a policy based on the research questionnaire

	Policy area	Variance	Importance		Policy area	Variance	Importance
1	Risk-mitigation	0.532	53.2%	10,11,12	SCM, TAA, TPA	0.468	46.8
2	Risk-evaluation framework	0.423	42.3%	13	SCM, TAA Supply Chain Metrics	0.507	50.7
3	Optimizing the current ICT environment	0.389	38.9%	14	Governance and Risk Management Policy Enforcement	0.409	40.9
4	Infra structure & Virtualization Security Wireless Security	0.515	51.5%	15	Business Continuity Management & Optional Resilience Equipment Power Failures	0.521	52.1
5	Technical challenges assessment	0.529	52.9%	16	Service management	0.473	47.3
6	Identity & Access Management Policies and Procedures	0.446	44.6	17	Governance and Risk Management Policy Reviews	0.482	48.2
7	SIM, E-Discovery & Cloud Forensics Incident Response Legal Preparation	0.561	56.1	18	Datacenter Security Policy	0.447	44.7
8	Confidentiality of Data	0.632	63.2	19	Datacenter Security Unauthorized Persons Entry	0.535	53.5
9	Privacy of Sharing Data Policy	0.515	51.5				
11	Awareness	0.517	51.7				

Furthermore, the survey questionnaire of this study can be used as a list. Management of organizations can use the results of the list as the foundation for developing policy and strategy to enhance the probability of successful CCDC adoption. Furthermore, the policymakers can consider the policy indicator, which is used as a policy measurement, as input when extending or trying to commit to optimal rule. These elements can help organizations to establish a well-structured and well-formulated policy for cloud computing data center adoption. An example of the areas and items that should be considered during the policy-making process are summarized in Table 13. This table consists of the results of the study and each item's importance based on respondent opinion. Although, still more investigation is required to explore more areas.

Table 16 Validity test for formative constructs –variance inflation factor (VIF)

Items	Tolerance	VIF
PS 1	.318	3.145
PS 2	.370	2.705
PS 3	.359	2.784
PS 4	.285	3.508
PS 5	.288	3.470
PS 6	.305	3.281
PS 7	.235	4.255
PS 8	.376	2.661
PS 9	.229	4.376
PS 10	.313	3.199
PS 11	.236	4.231
PS 12	.212	4.711
PS 13	.350	2.857
PS 14	.361	2.766
PS 15	.251	3.978
PS 16	.326	3.066
PS 17	.333	3.002
PS 18	.312	3.210
PS 19	.380	2.632
The Construct of Security		
Items	ToleRelative Advantages nce	VIF
S1	.575	1.741
S2	.423	2.365
S3	.379	2.635
S4	.797	1.255
S5	.399	2.503
S6	.466	2.144
S7	.501	1.995
S8	.492	2.033
S9	.340	2.938
S10	.360	2.781
S11	.812	1.232
S12	.300	3.333
S13	.432	2.314
S14	.426	2.348

7 Conclusions and future research directions

The cloud computing is built on virtualization, distributed computing, and utility computing. cloud computing is a promising technology because of its intrinsic potential to provide flexible, configurable, cost-effective services with low IT implementation costs. This study investigated the factors affecting the interest of the IT decision-makers in Malaysian universities toward CCDC adoption. Thus, a theoretical model was proposed based on the DOI, TOE, and institutional theory. In evaluating the proposed model, 204 IT decision-makers have been selected from Malaysian universities. The main contribution of this study was in proposing a new research model based on critical success factors of CCDC. The CCDC model is supposed to be used in universities' administrative activities. This model examines the effect of each independent variable on the sole dependent variable, which is the interest of IT managers in adopting CCDC. The two new factors, namely policy and outage were added to this model to measure the amount

Table 17 Validity test for formative -constructs outer weight, outer loading

	Item	Outer Weight	Outer Loading
Policy and Standardization (PaS)= (1/19) = 0.267261	PS 1	-0.8112	0.2409
	PS 10	-0.5335	0.3382
	PS 11	0.1421	0.3934
	PS 12	0.258	0.5973
	PS 13	0.252	0.5562
	PS 14	0.0373	0.5368
	POLICY AND STANDARDIZATION 15	0.0235	0.5129
	PS 16	0.7121	0.727
	PS 17	-0.1728	0.5851
	PS 18	0.0829	0.5383
	PS 19	-0.2008	0.5788
	PS 2	0.0778	0.5485
	PS 3	0.0709	0.5953
	PS 4	0.6641	0.6757
	PS 5	-0.0098	0.5984
	PS 6	-0.4201	0.5617
	PS 7	0.5369	0.5983
	PS 8	-0.0134	0.3728
	PS 9	0.0604	0.5929
Security (S) (1/14)= 0.229415734	S1	-0.0412	0.47
	S10	-0.4614	0.379
	S11	-0.1138	0.1344
	S12	0.2965	0.6105
	S13	0.1614	0.5347
	S14	0.3257	0.6049
	S2	0.5802	0.7201
	S4	0.003	0.2011
	S3	-0.2901	0.2472
	S5	-0.2979	0.3436
	S6	0.5275	0.5607
	S7	-0.3874	0.1533
	S8	0.3337	0.6068
	S9	0.1171	0.5343

of interest in cloud computing adoption more accurately. Since some studies stated that there is a relationship between security and policy, outage and Relative Advantages which can reduce security risk, these relationships were also examined as moderators in this study. The results confirmed significant relationship of all the factors with interest in the adoption of cloud computing. However, it was noticed that there was no meaningful relationship between firm size, Trading partner pressure and interest in cloud computing adoption. The results indicate that the most critical factors are policy followed by Compatibility, security, outage, and Top Management Support.

Moreover, to get benefit from the advantage of both approaches, besides testing causality by using SEM, simulation was also used to evaluate the output of the SEM. The simulation results showed that during the three relationships of data gathering using the proposed model the interest of IT decision-makers increased in the adoption of cloud computing.

Although this study contributes to both theory and practice, the study still has limitations that must be considered. One of the aspects that can be considered a limitation of the current study is data collected from IT decision-makers. Therefore, the study can be continued by collecting data from IT research group in universities, which would consequently be expected to enhance the output quality. The findings from this study suggest some recommendations for further research and advancement. For example, researchers can extend this study to other higher education institutes.

Finally, since this research showed that the policy has a moderating effect on security, future studies might focus on developing a high-quality policy for cloud computing data centers. Moreover, some previous studies mentioned that policy's impact on risk reduces cloud computing adoption (Do Chung et al., 2014; Dong et al., 2014). Therefore, proposing new strategies and policies that help organizations to reduce the security risk of cloud computing adoption is open an opportunity for further research. Meanwhile, it has a positive impact on the economy.

It is recommended that further study is conducted on the direct and indirect relationship between security and policy (Do Chung et al., 2014; Dong et al., 2014), outage and security (Srinivasan, 2015; Sultan, 2014) and security and relative advantages (Oliveira et al., 2014). As the current study was a cross-sectional design, it recommended the interrelationship among the factors investigated using a longitudinal study. That approach may provide a better explanation of mediating effects and outcomes.

Furthermore, theoretical development may consider further important factors based on the related studies. Future research could consider other potential factors influencing CCDC adoption in organizations. Moreover, the current research has been accomplished in public and private universities. The higher education institutes comprise of colleges and high schools. Thus, the generalization of this model for higher education institutes is beyond this study's result.

The survey was conducted only in one type of organization. However, in future studies, different categories of organizations could be considered. Investigations in various organizations can validate the model and instrument as they have not been developed for only one specific organization. Moreover, future studies are recommended to conduct on post adoption stage of cloud computing by focusing on end-users (students and academic staffs) to disclose more findings about cloud computing as an educational technology.

8 Appendix 1

Table 14 Questionnaire map

Item	Question	References
RELATIVE ADVANTAGES (RA)		
RA 1	Profitability	(Bisong & Rahman, 2011; Tweel, 2012)
RA 2	Better communication	(Leavitt, 2009; Tweel, 2012)
RA 3	Cost reduction	(Leavitt, 2009; Tweel, 2012)
RA 4	Reliable information handling	(Marston et al., 2011)
RA 5	Centralized security function	(Yarter, 2012; Ross, 2010)
RA 6	Scalable computing resources	(Leavitt, 2009)
Complexity (CMX)		
CMX 1	Apply cloud technology easy	(Ekufu, 2012) (Subashini & Kavitha, 2011)
CMX 2	Easy to get cloud	(Ekufu, 2012)
CMX 3	The interaction would be clear and simple	(Ekufu, 2012)
CMX 4	The technology is difficult to understand	(Hoover, 2003)
CMX 5	Easy for me to become more skillful	(Ekufu, 2012)
CMX 6	Easy to use	(Ekufu, 2012)
CMX 7	Easily available	(Hoover, 2003)
CMX 8	Productivity	(Ekufu, 2012) (Hoover, 2003)
CMX 9	Easily available	(Ekufu, 2012) (Zhang et al., 2010)
CMX 10	Easily available	(Ekufu, 2012)
Compatibility (CMB)		
CMB 1	Compatible	(Ekufu, 2012)
CMB 2	Consistent with my organization's belief and values	(Ekufu, 2012) (Hoover, 2003; Lin, 2006)
CMB 3	Attitude	(Ekufu, 2012)
CMB 4	Consistent with my organization's business strategy	(Ekufu, 2012)

Table 14 (continued)

Item	Question	References
S1	Physical access control	(Ireland, 2012)
S2	Risk management	(Ireland, 2012)
S3	Privacy	(Ireland, 2012)
S4	control of the Cloud provider	(Ireland, 2012)
S5	Deal with litigation assistance	(Ireland, 2012)
S6	Experience of litigation assistance	(Ireland, 2012)
S7	Authorization	(ENISA, 2013)
S8	Integrity	(Ireland, 2012)
S9	Confidentiality	(Ireland, 2012)
S10	Access control	(Ireland, 2012)
S11	Protection and assurance over audit log data	(Ireland, 2012)
S12	SLAs	(Ireland, 2012)
S13	Validation process	(ENISA, 2013)
S14	A security awareness training program	(ENISA, 2013)
Outage (O)		
O1	Financial and/or liability management	(Ireland, 2012)
O2	Reputational implications	(Ireland, 2012)
O3	System outages risk tolerances	(Ireland, 2012)
Policy and Standardization (PS)		
PS 1	Risk-mitigation	(cloudsecurityalliance(CSA), 2013; ENISA, 2013)
PS 2	Risk-evaluation framework	(cloudsecurityalliance(CSA), 2013; ENISA, 2013)
PS 3	Optimizing the current ICT environment	(cloudsecurityalliance(CSA), 2013; ENISA, 2013)
PS 4	Infra structure & virtualization security Wireless security	(cloudsecurityalliance(CSA), 2013)
PS 5	Technical challenges assessment	(cloudsecurityalliance(CSA), 2013)

Table 14 (continued)

Item	Question	References
PS 6	Identity & access management Policies and procedures	(cloudsecurityalliance(CSA), 2013)
PS 7	SIM, e-discovery & cloud forensics Incident response legal prepaRelative Advantages tion	(cloudsecurityalliance(CSA), 2013)
PS 8	Confidentiality of data	(cloudsecurityalliance(CSA), 2013)
PS 9	Sharing data policy	(cloudsecurityalliance(CSA), 2013)
PS 10	SCM, TAA, TPA	(cloudsecurityalliance(CSA), 2013)
PS 11	Awareness	(cloudsecurityalliance(CSA), 2013)
PS 12	SCM, TAA, TPA	(cloudsecurityalliance(CSA), 2013)
PS 13	SCM, TAA, Supply Chain Metrics	(cloudsecurityalliance(CSA), 2013)
PS 14	Governance and Risk Management Policy Enforcement	(cloudsecurityalliance(CSA), 2013)
PS 15	Business continuity management & optional resilience Equipment power failures	(cloudsecurityalliance(CSA), 2013)
PS 16	Service management	(cloudsecurityalliance(CSA), 2013)
PS 17	Governance and Risk Management Policy Reviews	(cloudsecurityalliance(CSA), 2013)
PS 18	Data center Security Policy	(cloudsecurityalliance(CSA), 2013)
PS 19	Data center Security Unauthorized Persons Entry	(cloudsecurityalliance(CSA), 2013)
TOP MANAGEMENT SUPPORT (TMS)		
TMS 1	Adoption interest	(Ekufu, 2012)
TMS 2	Adoption important	(Ekufu, 2012)
TMS 3	Support for CC adoption	(Ekufu, 2012)
Competitors Pressure (CP)		
CP 1	Competitors are currently adopting	(Ekufu, 2012)
CP 2	Competitors will be adopting	(Ekufu, 2012)
CP 3	Benefiting	(Ekufu, 2012)

Table 14 (continued)

Item	Question	References
CP 4	Perceived favoRelative Advantages bly in our industry	(Ekufu, 2012)
CP 5	Perceived favoRelative Advantages bly by their customers	(Ekufu, 2012)
Trading partner pressure (TPP)		
TPP1	Pressuring our organization	(Ekufu, 2012)
TPP2	Participate	(Ekufu, 2012)
TPP3	Suppliers are currently adopting/will	(Ekufu, 2012)
TPP4	Customers adopting/will	(Ekufu, 2012)
Interest for Adoption of CC Services(ITMI)		
ITMI1	Intends	(Ekufu, 2012)
ITMI2	Step to adopt CC in the future	(Ekufu, 2012)
ITMI3	Already adopt cloud	(Ekufu, 2012)
ITMI4	Will adopt cloud	(Ekufu, 2012)

Table 15 Cross-loadings

Indicators	RELATIVE ADVANTAGES	COMPATIBILITY	COMPLEXITY	O	TOP MANAGEMENT SUPPORT	FS	COMPETITOR PRESSURE	TPP	IT TOP MANAGEMENT SUPPORT
RA 2	0.77	0.17	0.52	0.34	0.21	0.06	0.2	0.18	0.31
RA 4	0.72	0.25	0.59	0.17	0.27	0.15	0.26	0.33	0.19
RA 5	0.87	0.27	0.52	0.25	0.2	0.09	0.23	0.36	0.34
CMB 1	0.51	0.59	0.49	0.26	0.32	0.12	0.29	0.37	0.4
CMB 2	0.18	0.87	0.35	0.15	0.34	0.11	0.45	0.34	0.44
CMB 3	0.12	0.9	0.24	0.2	0.42	0.01	0.39	0.4	0.46
CMB 4	0.19	0.91	0.27	0.2	0.38	0.01	0.39	0.37	0.51
CMX 10	0.48	0.34	0.8	0.17	0.23	-0.01	0.3	0.28	0.23
CMX 2	0.63	0.26	0.76	0.23	0.28	0.12	0.18	0.24	0.23
CMX 5	0.3	0.3	0.62	0.07	0.35	0.06	0.25	0.41	0.07
CMX 6	0.42	0.33	0.69	0.19	0.35	0.07	0.34	0.47	0.07
CMX 8	0.45	0.27	0.7	0.31	0.14	0.05	0.23	0.18	0.18
O1	0.38	0.26	0.3	0.92	0.11	0.11	-0.05	0.16	0.23
O2	0.26	0.21	0.23	0.93	0.15	0.07	-0.08	0.13	0.21
O3	0.23	0.17	0.25	0.85	0.12	0.01	-0.01	0.05	0.17
TPM 1	0.07	0.32	0.15	0.06	0.54	0.09	0.29	0.16	0.38
TPM 2	0.3	0.37	0.32	0.15	0.85	-0.03	0.43	0.48	0.39
TPM 3	0.26	0.34	0.28	0.11	0.87	-0.02	0.49	0.7	0.48
FS	0.12	0.07	0.08	0.08	0.02	1	0.13	0.1	0.08
CP 1	0.11	0.08	0.07	0.06	-0.04	0.06	0.09	0.02	0.07
CP 4	0.27	0.45	0.29	-0.06	0.53	0.13	0.97	0.59	0.5
CP 5	0.27	0.44	0.35	-0.05	0.5	0.1	0.95	0.59	0.43
TPP1	0.19	0.23	0.24	0.03	0.44	0.13	0.43	0.61	0.18
TPP2	0.31	0.39	0.27	0.09	0.4	0.15	0.54	0.79	0.38
TPP3	0.3	0.37	0.32	0.15	0.58	-0.03	0.43	0.84	0.39
ITMI1	0.38	0.46	0.19	0.24	0.5	0.06	0.41	0.4	0.95
ITMI2	0.32	0.58	0.29	0.18	0.55	0.09	0.51	0.44	0.94

RA Relative Advantages, *CMB* Compatibility, *CMX* Complexity, *O* Outage, *TPP* TOP MANAGEMENT SUPPORT, *FS* Firm Size, *CP* Competitor Pressure, *ITMI2* Interest for adoption of CC

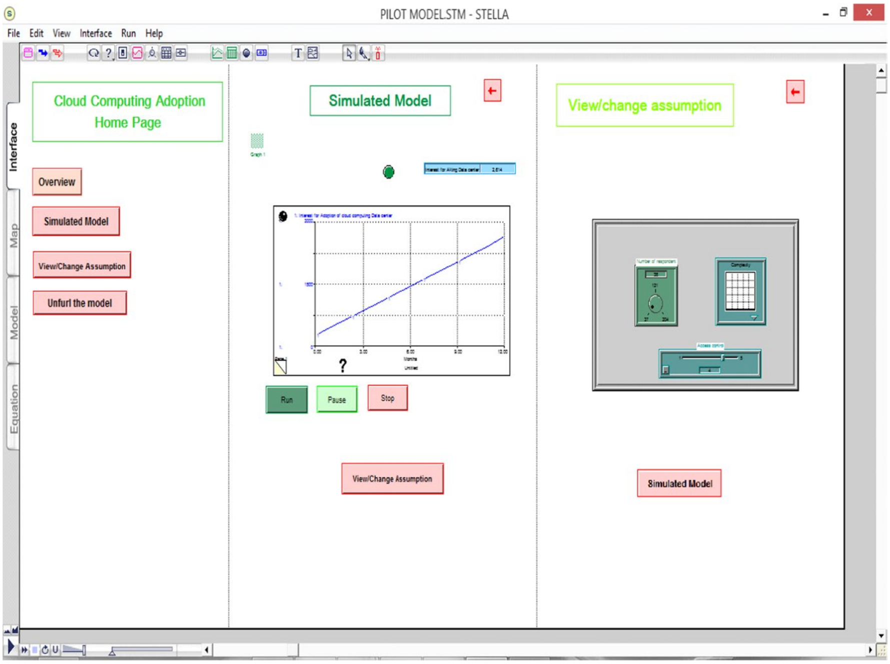

Fig. 8 Simulation interface (prototype)

Data availability Data will be available on reasonable request.

Declarations

Conflict of interest None.

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Authors and Affiliations

Nasrin Badie[1] · Ab Razak Che Hussin[1] · Elaheh Yadegaridehkordi[2] · Dalbir Singh[2] · Arash Habibi Lashkari[3]

[1] Azman Hashim International Business School, Universiti Teknologi Malaysia, Johor Bahru, Malaysia

[2] Center for Software Technology and Management, Faculty of Information Science and Technology, Universiti Kebangsaan Malaysia (UKM), 43600 Bangi, Selangor, Malaysia

[3] School of Information Technology, York University, Toronto, Canada