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Decision Making Model for the Adoption of Cloud Computing in Turkish Organizations: A Conjoint Analysis

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ABSTRACT

Cloud computing became the most efficient resource for following the business processes of companies and providing the required ICT capability for the last 10 years. It is a well-known fact that different cloud computing services help firms to orient themselves effectively to their functional goals. Because many additional issues such as budget, human power, time, personnel training required to use resources will automatically be handled by service providers. However, the reality of storing organizational data outside the company causes prejudiced and skeptical thoughts in top manager's mind for cloud computing adoption from the point of security and privacy. But, the companies will be using this technology ultimately since its cost and competition efficiency will become more important as data production grows all over the world and every field. In this study, we will identify the different service options of cloud computing in the companies and analyze the factors that affect these choices in the light of their decisions. Orthogonal experimental design is applied to identify choices based on seven attributes: economic values, cloud advantage, security and privacy concern, reliability, control, compatibility and features. Afterwards, conjoint analysis is implemented to rank the criteria of the alternatives from the choices gained from orthogonal experimental design.

Keywords: *Cloud Computing, ICT Adoption, Decision Making, Orthogonal Experimental Design, Conjoint Analysis*

Introduction

Technology plays an important role in various sectors in businesses. With a web-based architectural concept, cloud computing has become a phenomenon over the last decade for IT

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departments of business organizations by offering internet based services such as software, hardware infrastructures, platforms within different deployments (public, private, hybrid and community cloud). However, the cloud users also have several challenges on perception, attitude and adoption of cloud computing (Lin & Chen, 2012). Businesses and cloud providers have additionally deep concerns over weak regulation and competitive pressure on cloud computing adoption. Although there are several issues on adopting cloud computing, the characteristics such as resource pooling, broad network access, rapid elasticity, measured service and on demand self-service of cloud computing adoption are very broad and overwhelming (Mell & Grance, 2011).

Cloud computing offers a wide range of services for businesses to conduct sustainable IT solutions with reasonable costs. While the software and hardware are delivered by data centers of cloud providers, the applications are also delivered as services over the internet. Even though cloud technology is a new paradigm but has been previously in use separately in terms of four IT technologies: grid computing, utility computing, virtualization and autonomic computing (Zhang, 2010). Prior to cloud computing, in-house computing, the traditional term, has been applied to manage ICT operations. It includes fully owned servers, hardware, and business software and these computing resources are needed to be purchased, updated and maintained by company's own IT department. On the other hand, cloud computing operates virtual servers, hardware and business software as a service without company's property that forms only a few IT personnel while the experienced users are in different departments of the company. Under these circumstances, companies should have a decision making process for their IT departments to apply whole company's business operations by considering what services are certainly required.

The decision making approach of companies to adopt cloud computing should be very carefully taken into consideration. The decision making process criteria for companies are;

- knowing business workflows of companies,
- regulating contract policy well between cloud providers and companies,
- trust of cloud providers
- educated employees to IT alignment

This study aims to understand the perceived idea of cloud computing adopters what they have experienced so far. This can also improve non-adopters' interaction with companies who are involved in the Cloud computing experience and tend to remove any vagueness surrounding this type of technology. Conjoint analysis has been applied to understand choices of companies by deriving combinations with an orthogonal design. This combinations have been ranked by IT decision makers and top managers to find out what Turkish companies expectations on various attributes of Cloud computing adoption adopted from Rogers (1995)'s theory of Innovation Diffusion.

Rogers (1995)'s theory of Innovation Diffusion is selected as an adoption theory as this theory is likely to apply for perceived characteristics of the innovation of new product and service development at macro level. The other theories such as Tornatzky & Fleisher (1990)'s Technological, organizational and environmental (TOE) Framework deals with at geographical

level of cloud computing from environmental perspective. Davis (1989)'s Technology acceptance model (TAM) also examines the adoption process at micro (individual) level.

The paper highlights cloud computing, issues in cloud computing, adoption issues and theories of cloud computing and derived methods to apply for cloud computing adoption in literature review, methodology. In the next section the methodology covers research design, data collection, data analysis and findings, discussion and suggestion for future research.

Literature Review

CLOUD COMPUTING

There are various definitions of cloud computing (CC) but the general popularly known is that *"cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction."*(Mell & Grance, 2011; 6). Bento & Bento (2011) also stated that there are also narrow and broad definitions of CC. The narrow definitions usually are the technical purposes. You need to explain or give examples of some narrow definitions. Cagle (2008) defined CC as grid computing just mentioned the use of a distributed network of servers. The broad definitions usually are the user oriented purposes. Fingar (2009) described cloud computing as an endless computer made up of networks of computers. Miller (2008) defined cloud computing as the computers and applications linked with internet with accessibility from everywhere at any device. In addition, there are several definitions of CC that have been made in business field. Armbrust (2010) expressed CC as applications delivered as application, software and hardware services over internet in datacenters in the cloud. Yang & Tate (2012) also expressed that CC provides on-demand computing power for decreasing cost with the contribution of quick implementation, low maintenance, less IT staff. As a result, from technical and business perspective, the enterprises have no need to deploy their own applications, resources, services or IT staff, which then allows customers to focus strictly on their jobs within the business market.

CC can also present many disadvantages. There are major technological and business concerns over cloud computing. The main business issues are cost, pricing, legal issues, ethical problems, trust, privacy and adoption (Yang & Tate, 2012). There are some researches focusing on it. For instance, Walker (2009) developed a model to monitor costs for cloud services. Hsu et al. (2014) created a price mechanism model of cloud providers. Charlebois et al. (2016) made a genomics research to understand the ethical and legal issues. Alsanea and Wainwright (2014) created a model to measure trust. Misral & Mondal (2011) focused on return of investment (ROI) model to build a decision making approach. Tarmidi et al. (2014) explored the level of awareness of accounting practitioners and their adoption of CC. Okan et al. (2013) expressed perception of cloud computing adoption issues in Turkish IT sector. Preciado et al. (2012) emphasize on the hardware, software and IT personnel costs issues of cloud computing adoption in small and medium enterprises. As a result, researches about various concerns are widespread. The researches show that cloud computing has advantages as well as disadvantages but this technology is inevitable because the

total of data center traffic grow of cloud data center is expected to increase from 85% to 92% by 2020, whereas, the total of data center traffic grow of cloud data center is expected to decrease from 16% to 8%.

Cloud Computing Adoption

There are several CC adoption studies, consisting of mainly three types of analysis: qualitative, quantitative and both qualitative and quantitative. There is a wide range of researches about qualitative analysis but the most important studies are Charlebois et al. (2016)' s CC adoption in biology labs and Gustaffson & Orrgren (2014)'s CC adoption in Swedish SMEs that have semi structured interviews to CC decision makers. The quantitative analysis researches are more extensive. Oliviera et al. (2014) and Gangwar et al. (2015) concerned with CC adoption of manufacturing and service sectors of developing countries. Gutierrez et al. (2015) made a CC adoption study for UK companies Senyo et al. (2015) dealt with CC adoption of Ghana that enlightened developing countries. Nkhoma et al. (2013) examined the drivers and barriers of cloud computing adoption from cloud providers' view. Lian et al. (2014) and Almubarak (2017) investigated the factors that impact the adoption for hospital. Mohammed et al**.** (2016) made an in-depth research on CC adoption of e-government implementation. Job (2016) concerned with CC adoption of private and public sectors in developing countries. The last research analysis is both qualitative and quantitative that Alshamaila et al. (2013), Alismaili et al. (2016) and Alhammadi (2016) are one of the mixed methods that Alshamaila et al. (2013) investigated factors affecting CC adoption of SMEs in North East of England. Alismaili et al. (2016) made a mixed method research about understanding CC adoption in Australian SMEs. Alhammadi (2016) conducted a research to measure the determinants of CC adoption from a knowledge management perspective.

A Market Technic: Conjoint Analysis

Conjoint analysis (CA) is one of the most significant methods to elicit preferences of respondents. It is also a marketing technique that has some researches of Huertas-Garcia et al. (2013) on B2B marketing, Hermelbracht & Koeper (2006) on development of new library services, Castel& Tsuji (2015) on web-based systems. All of researches are different but all common aim is to distinguish attributes and levels of analysis to find out attributes and levels of model. In short, conjoint analysis is mainly applied for new product development or services by considering the users' perceived ideas of use of products or services. (Hermelbracht & Koeper, 2006). There is another fuzzy technics that are multi criteria decision making technique called Analytical hierarchy process (AHP) developed by Johnson (1987). AHP technic is different from conjoint analysis in that there is a comparison inconsistency, ranking changing possibility, and large number of attributes. Hence, in small numbers of attitudes and levels, conjoint analysis is the most productive method to find utility values of attributes and their levels.

Adoption Issues and Theories of Cloud Computing Adoption

Diffusion is an adoption theory, which exhibits certain innovations diffuse in social systems (Innovators, Early adopter, Early Majority, Late majority and Laggards) that contains five stages in the innovation decision process that are knowledge, persuasion, decision, implementation and confirmation (Rogers ,2003). Knowledge is the early stage that it examines the characteristics of decision making unit that includes socioeconomic characteristics, personality variables and communication behaviour. The second of the stage is the persuasion that contains relative advantage, compatibility, and complexity and trial ability in perceived characteristics of the innovation. The third stage is the decision that has a decision making capability to accept or reject the technology. The fourth stage is the implementation of technologies in order to monitor whether technical equipment adopts business workflows after accepted. The fifth and the last one is the confirmation. The usage of this adoption can be adaptable to understand new technological ideas, products or systems of decision makers' perception over the old one.

Technological, organizational and environmental (TOE) Framework is another adoption theory that is appeared to understand physical, social and economic factors by means of the external environment. From technological aspects, this adoption theory concerns with business operations, quality of operation, specific tasks perform and business productivity. From organizational aspects, this adoption theory deals with scope, size and managerial structure. From environmental aspects, this adoption theory matters industry, competitors and governments behaviour. Technological and Organizational aspects usage in TOE framework are taken as a basis from the underlying innovation diffusion theory and has been developed with environmental extensions (Oliviera & Martins, 2011).

Technology acceptance model (TAM) is another adoption theory that examines the adoption of ICT as an individual basis for end users. This model concerns with IT decision makers' capability, users' capability and system usefulness. This theory predicts attitudes toward the use of ICT. Hence, the usage of TAM is easy to reach individuals, but it is not likely to embrace social and human factors (Durodolu, 2016).

A solution of a further detailed cloud computing adoption issues are considered by *Rogers (1995)*'s theory of Innovation Diffusion, Tornatzky et al. (1990)'s Technological, organizational and environmental (TOE) Framework, Davis (1985)'s Technology acceptance model (TAM), and Lacovou et al. (1995)'s model. Firstly, Innovation Diffusion theory measures relative advantage, compatibility, complexity, trialability and observability attributes of CC adoption to assess technical issues of adoption. This model drives the decision making approach to accept or reject the adoption by taking into account of cost effectiveness, level of security, complexity, compatibility of underlying system. Secondly, Technological, organizational and environmental (TOE) Framework concerns with technological attributes to detect the availability of infrastructure of companies. It also deals with organizational attributes to determine size and communication processes of companies. Moreover, it concerns with competitive environment characteristics, government regulation of countries and technology support infrastructure of companies to determine which cloud computing providers might be trustworthy for the customers, how business

processes can be compared with competitors, and how the data protection laws are in different countries. Thirdly, Technology Acceptance Model (TAM) concerns with questioning of technology acceptance of users towards cloud computing with two factors: usefulness and ease of use.

Rogers (1995)'s theory of Innovation Diffusion handles the perception of CC adoption as being better than its predecessor (in-house computing). It also investigate the vulnerabilities of cloud computing systems as being consistent with past experiences. In addition, the studies about innovation diffusion theory are used to answer which cloud computing services may be right for companies, how companies prepare for their own cloud migration, how their business strategy change when they are in the cloud and what tools they need to run for their business processes. This theory aims to specify cost, secure, complex, compatibility of system to suit the objectives of enterprises. Tornatzky et al. (1990)'s Technological, organizational and environmental (TOE) Framework addresses technical, organizational and environmental issues for organization. The studies about TOE framework use is also to find out how their business strategy can be adapted to the social system. This theory aims to determine which technological, organizational and environmental factors affect the adoption of Davis (1985)'s Technology acceptance model (TAM) copes with cloud decision makers and cloud system. The studies about TAM are to consider cloud computing ease of use, cloud computing usefulness. Hence, these adoption theories can alone have advantages and drawbacks that innovation diffusion theory, TOE framework and TAM can be integrated to eliminate the drawbacks of CC adoption as the examples shown in the next paragraph.

There are also integrated approaches to measure cloud computing adoption. There is a combined Innovation Diffusion Theory (DOI) and TOE model. Gustaffson & Orregren (2014) investigated SMEs of CC adoption as a case study research of cloud providers. Nkhoma et al. (2013) concerned with cloud provider-company interaction of CC adoption involving large-scale survey of IBM. Mohammed et al**.** (2016) worked on viability and fit of CC adoption. Lian et al. (2014) and Almubarak (2017) dealt with human factors of CC adoption. There is an integrated DOI, TAM, TOE Model. Yuvaraj (2016) explored factors of CC adoption as a case study research of organizations and cloud providers. Park& Kim (2014) considered mobile cloud services adoption. The results of this mobile cloud services adoption of online games and data storage systems is that perceived mobility, connectedness, security, quality of service and system, and satisfaction hugely affects the user acceptance of cloud computing adoption. Arpacı (2017) examined the effects of CC adoption on knowledge management. The other combined adoption model is Lacovou et al. (1995) model and TOE Model. Alsanea & Wainwright (2014) applied it for government adoption. The rest of researches has no model but assessed the perception, advantages and disadvantages of cloud computing adoption. Okan et al. (2013) explored cloud computing adoption in Turkish IT Sector. Marin et al. (2017) examined environmental effects of CC adoption.

Methods to Apply for Cloud Computing Adoption

The methods of applying cloud computing adoption are varied but there are three multi methods to apply for CC adoption that are(1)confirmatory factor analysis and partial least square, (2)factor analysis and multivariate statistical techniques (e.g. logistic regression) and (3)multi-regression analysis and conjoint analysis and AHP technics with multi case study. The first method is confirmatory factor analysis and partial least square that are applied by the researches of Nkhoma et al. (2013), Oliviera (2014), Gangwar et al. (2015), Sabi et al. (2016). The second method is factor analysis and multivariate statistical techniques (e.g. logistic regression) that are used by Alshamaila (2012), Tehrani (2013), Gutierrez et al. (2015). The third method is multi-regression analysis and conjoint analysis and AHP technics with multi case study that are implemented by Alsanea & Wainwright (2014).As a result, confirmatory factor analysis and partial least square are aimed to test the existing factors from literature of CC adoption to reach an effective model of research. Factor analysis and a logistic regression are aimed to build the factors of CC adoption to contribute to the literature. The goal of multi-regression analysis and conjoint analysis and AHP technics with multi case study is to analyze attributes and levels of factors to understand the perceived ideas of CC adoption.

Methodology

The research question is what Turkish companies' expectations are on various attributes of Cloud computing adoption. The research consists of four main parts: research process, data collection, data analysis, findings, discussion and implications and suggestion for future research.

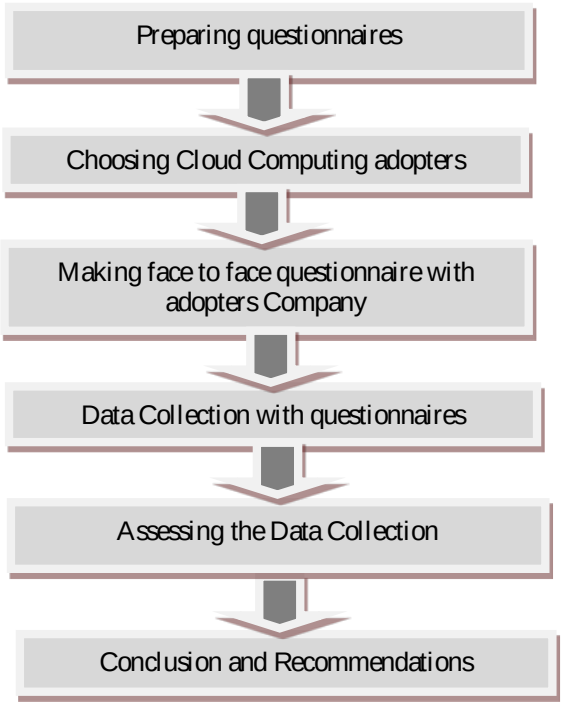

Figure 1. Research Design Source: Edited by author

Research Design

This research is a quantitative study that focuses on a company which has already adopted cloud computing technology. The design of research is primarily to collect data from this type of companies for the market analysis. The method to apply for cloud computing adoption is conjoint analysis. Attributes of cloud computing adoption is derived from secondary data. The attributes of research are selected from the persuasion phase of innovation diffusion theory. Face to face questionnaire has been applied to 47 respondents. The data analysis has been made by SPSS 21.0 software by applying orthogonal design in conjoint analysis. Finally, it ends with the findings and discussion by applying important implications and suggestions for further research. The main research design of study is shown below.

Data Collection

Data is collected from 47 out of 58 with a respondent rate of nearly 81 with a set of two questions: Type of industry (service or manufacturing) and ranking the seven attributes with three levels of cloud computing adoption. Sample size is specified by Orme (2010)'s formula approach shown below.

$$\text{Sample Size} = 3^* (N-n+1)$$

N (total attributes), n (levels)

Data collection is made by purposive sampling technic that is selected on purpose so in this research. Non-cloud owners are not selected as sample. Unit of scale is IT Managers or Decision makers of Organizations in local area, the third largest city of Turkey, İzmir. Primary data is collected from quantitative research with face to face questionnaires. This process takes time but avoids unbiased answers of respondents.

The structure of data is discrete data that consist of 7 attributes with 3 levels, Economic Values and Cloud advantages are shown as examples in figure 2. In the next section, data analysis has been done.

Table 1

Profile cards of Orthogonal design Source: Edited by author

Conjoint analysis has been applied to understand to what extent each component (factor) contribute to the total utility of a decision making of CC adoption.

The full design consists of 3x3x3x3x3x3x3=2.187 different combinations that is hard to specify the preferences. Orthogonal design method has been used in conjoint analysis to obtain

consistent preferences. This method normally derives 16-18 cards from 2 or 3 level and around 6-8 attributes. This research generates 18 cards from 7 attributes and 3 levels with SPSS 21 as shown in table 1.

Data Analysis and Findings

There are two phases of data analysis that are averaged important scores of attributes and estimation of utility value. In table 1, 18 profile cards have been ranked by 47 IT managers or decision makers and are wanted to order them from the most preferred choice (1) to the least preferred choice (18). Afterwards, importance values and their utility estimates of each is calculated in table 2, and figure 4, respectively.

In table 2, our findings is that "security and privacy concerns" (17,846) is the most important factor of decision making approach to CC adoption, "compatibility"(14,632) is the second factor, "cloud advantages"(13,841) is the third factor, "control"(13,723) is the fourth factor, "economic values"(13,505) is the fifth factor, "reliability"(13,467) is the sixth factor, "features"(12,987) is the least factor of decision making approach to CC adoption.

Table 2
Averaged Important Values

Economic_Values	Cloud_Advantages	Security_Privacy Concerns	Reliability	Control	Compatibility	Features	Card
High	Good	High	Average	Moderate	Good	Good	1
Low	Weak	High	Average	Low	Average	Average	2
High	Average	High	Excellent	Low	Average	Excellent	3
Medium	Weak	High	Good	High	Good	Excellent	4
High	Weak	Medium	Good	High	Average	Good	5
Low	Good	Medium	Good	Low	Good	Average	6
Medium	Good	High	Excellent	High	Excellent	Average	7
High	Average	Medium	Average	High	Excellent	Average	8
Low	Weak	Medium	Excellent	Moderate	Excellent	Excellent	9
Low	Average	Low	Average	High	Good	Excellent	10
High	Good	Low	Good	Low	Excellent	Excellent	11
Medium	Weak	Low	Average	Low	Excellent	Good	12
Low	Good	Low	Excellent	High	Average	Good	13
High	Weak	Low	Excellent	Moderate	Good	Average	14
Medium	Average	Medium	Excellent	Low	Good	Good	15
Low	Average	High	Good	Moderate	Excellent	Good	16
Medium	Average	Medium	Excellent	Low	Good	Good	17
Medium	Good	Medium	Average	Moderate	Average	Excellent	18

Importance value of Cloud Computing Adoption	
Economic_ Values	*13,505*
Cloud_ Advantages	*13,841*
Security_ Privacy concerns	*17,846*
Reliability	*13,467*
Control	*13,723*
Compatibility	*14,632*
Features	*12,987*

In table 3, in economic values factor, respondents consider that economic value of CC adoption is "high" (1,028). The least respondents believe that economic value of CC adoption is "medium".
-In cloud advantages factor, respondents consider that cloud advantages of CC adoption is "weak" (0,231). The least respondents believe that cloud advantages of CC adoption are "good".
-In security and privacy concerns factor, respondents consider that security and privacy concerns of CC adoption are "medium" (0,532). The least respondents believe that security and privacy concerns of CC adoption are "low".
-In reliability factor, respondents consider that reliability of CC adoption is "average" (0,472). The least respondents believe that reliability of CC adoption is "excellent".
-In control factor, respondents consider that control of CC adoption is "high" (1,088). The least respondents believe that control of CC adoption is "moderate".
-In compatibility factor, respondents consider that compatibility of CC adoption is "good" (0,083). The least respondents believe that compatibility of CC adoption is "average".
-In features factor, respondents consider that features of CC adoption are "average" (0,884). The least respondents believe that features of CC adoption are "good".
As a result, constant of all factors are 9,500 so CARD 8 is the highest total utility with 13,689 as calculated below.
CARD 8: 9,5+1,028 Economic values (high**)**+0,231 Cloud advantage (average)+ 0,532 Security and privacy concern (medium)+0,472 Reliability of CC (average**)** +1,088 Control of CC (high**)** +0,083 Compatibility of CC (excellent) +0,884 Features of CC (average)= 13,68

Table 3
Total utility of each level

		Utility Estimate	Std. Error			Utility Estimate	Std. Error
Economic Values	Low	-.250	,387	Control	Low	-,352	,387
	Medium	-,778	,387		Moderate	-,736	,387
	High	1,028	,387		High	1,088	,387
Cloud Advantages	Weak	,231	,387	Compatibility	Average	-,681	,387
	Average	,102	,387		Good	,597	,387
	Good	-,333	,387		Excellent	,083	,387
Security Privacy Concerns	High	,407	,387	Features	Average	,884	,387
	Medium	,532	,387		Good	-,542	,387
	Low	-,940	,387		Excellent	-,343	,387
Reliability	Average	,472	,387				
	Good	-,181	,387				
	Excellent	-,292	,387				
(Constant)		9,500					

In table 4, the value of R square is 0,957 (0,000) and Kendall's Dau value is 0,752 (0,000) which the research model is highly significant

Table 4
Correlation among ranking

	Value	Sig.
Pearson's R	,957	,000
Kendall's Tau	,752	,000

Discussion

The discussion of the findings is that companies think that economic value of CC is high as this technology can decrease overall IT and manpower costs of company. The companies consider that cloud advantage is average as this technology may not meet the business requirements of business processes which in-house computing alone can be reasonable for productivity, functionality, performance of business for companies. Companies believe that security and privacy concerns of CC adoption is medium, which CC can bring threats over data loss in data centers as data is stored outside of company or inside of company that is controlled by cloud service providers. In-house computing can also cause threats as companies store data in the building that can be stolen. Reliability is average so trust can be a barrier for cloud computing adoption of companies. Cloud computing adoption starts with building trust between companies and cloud service providers.

Service level agreements (contracts) should protect the company's rights in case of data threats. Companies consider that control is high. This technology enables companies to be dependent on a single provider and data migration cannot be easily made. Companies believe that compatibility is excellent which means that the technology is consistent with the existing values, past experience. Business processes excellently can be fit with in-house technology. IT can be aligned with IT infrastructure and business operations and processes of companies. Company considers that feature is average so characteristics of cloud computing can be least important. Ease of use Interface of cloud applications for end users might not be so important.

Conclusion and Findings

Conjoint analysis is one of the most important decision analysis technics for decision making approaches to IT. Especially, the importance factors and the utility value of its levels can easily be calculated with conjoint analysis. This analysis specifies the most preferred combinations and transforms verbal values to the numerical values to interpret factors and its levels. The result of decision making approach to CC adoption will be an important pathway to the non-cloud adopters. The results show that security and privacy concerns are the most significant factor of CC adoption, whereas feature is the least significant factor of CC adoption.

Suggestion of research is that the research firstly focused on the local, not Turkey's every city. Secondly, the research focused on the views of adopting managers, which lower level employees neglected. Thirdly, Environmental attributes can be added to the research model such as regulatory support and competitive pressure. These attributes can be applied to different adoption theories such as the expectation–confirmation model, the technology acceptance model, the theory of planned behavior, and flow theory.

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