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a case study of Jordan

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Adoption of Cloud Computing Technology in Higher Education Institutions: A Case Study of Jordan

By

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ABSTRACT

The extensive use of cloud computing is changing ways of dealing with information and communication technology. Cloud computing is an emerging paradigm designed to deliver numerous computing services through networked media such as the Web. It offers several benefits in dealing with software services and hardware infrastructure by increasing the scalability and reliability of virtual resources. Some benefits are seen immediately, for instance, allowing students to share information easily and to discover new experiences within the education system. However, cloud computing also introduces several challenges such as security and privacy, as well as the configuration of resources in shared environments.

In developing countries, higher education (HE) institutions cannot escape from the growing adoption of cloud computing. Despite the comprehensive literature on Western, developed countries, there is still limited research and related publications on practical and managerial issues that influence its adoption in developing nations. Jordan is one such country, with HE establishments that continue to seek opportunities to rationalise how they manage their resources.

The aim of this study is to develop a framework which considers the key factors affecting the adoption of cloud computing, to help Jordanian HE institutions (JHEIs) to implement the technology effectively. By adapting the Diffusion of Innovation (DOI) and Technology Acceptance Model (TAM) theories, and the Technology, Organisation and Environment (TOE) framework, this research proposed a framework for the adoption of cloud computing by JHEIs. The proposed framework, named Technology-Organisation-Environment-Quality of Cloud Computing adoption (TOEQCC), extends these original theories and models to enhance understanding of the factors affecting the adoption of cloud computing in the context of JHEIs. It also suggests a roadmap for adopting cloud computing in JHEIs. A pilot study was conducted in three JHEIs before the actual study took place to discover any possible weakness or ambiguity. Fieldwork involving eleven universities in Jordan was conducted in order to specify the actual factors determining the design of the TOEQCC framework. An interpretive paradigm using triangulation methods was applied to collect qualitative data, conducting thirty-one semi-structured interviews with major stakeholders in Jordanian universities, including professors in cloud computing and information technology, university vice-chancellors, IT managers, heads of departments, and deans of schools. The researcher

also held three focus groups and distributed 100 surveys to Jordanian students as well as collecting documents and reports from the Jordanian Minister of Higher Education (JMHE) and the Jordanian Higher Education Accreditation Commission (JHEAC). The data was analysed using NVivo software, and based on the three-step process recommended by Miles and Huberman (2014): data condensation, data display and drawing/verifying conclusions. Microsoft Excel was used to present information relating to frequencies or statistics (e.g. in the form of tables, pie charts, bar charts and column charts).

Thirty-three factors influencing the adoption of cloud computing in JHEIs were identified and incorporated in the TOEQCC framework to explain the correlations between them. The TOEQCC framework was validated and tested by three Jordanian universities. Ethical approval was received from the University of Coventry's ethics panel before the field study was started.

Keywords: Cloud computing adoption, higher education, developing countries, Kingdom of Jordan, quality of higher education, NVivo.

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For My Parents

Dr Mousa Odeh

Prof Nadia Qozmar

My Brother

Dr Mohanad Odeh

My Sister

Dr Dana Odeh

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LIST OF ABBREVIATIONS

ICT	Information and communication Technology
ENIC	Electronic Numerical Integration and Computer
HE	Higher Education
HEQ	Higher Education Quality
JHEIs	Jordanian Higher Education Institutions
CCEA	Cloud Computing Educational Applications
DOI	Diffusion of Innovation
TAM	Technology Acceptance Model
T-O-E	Technology-Organisational-Environmental Model
IT	Information Technology
MIT	Massachusetts Institution of Technology
ASP	Application Service Provision
SaaS	Storage-as-a-Service
DBaaS	Database-as-a-Service
INaaS	Information-as-a-Service
PRaaS	Process-as-a-Service
AaaS	Application-as-a-Service
PaaS	Platform-as-a-Service
IGaaS	Integration-as-a-Service
IaaS	Infrastructure-as-a-Service
BoT	Board of Trustees
JEI	Jordan Education Initiative
ERfKE	Education Reform for Knowledge Economy
WEF	World Economic Forum
PU	Perceived Usefulness
PEOU	Perceived Ease of Use
ATT	Attitude Towards Technology
BI	Behavioural Intention
JMHE	Jordanian Ministry of Higher Education
JHEAC	Jordanian Higher Education Accreditation Commission
AQCCJHE	Accreditation and Quality Control Commission for Higher Education Institutions in Jordan
SLA	Service Level Agreement
TOEQ	Technology-Organisation-Environment-Quality Model
TOEQCC	Technology-Organisation-Environment-Quality of Cloud Computing Framework
APIs	Applications programming interface

RELATED PUBLICATIONS

- Odeh, M., Garcia-Perez, A and **Warwick, K.** (2017). Adoption of cloud computing in higher education institutions: A case study of Jordan. *International Journal of information management-Elsevier*. (In Progress)
- Odeh, M., Garcia-Perez, A and **Warwick, K.** (2017). Towards a new framework to adopt cloud computing at higher education in developing countries. *International Journal of information management-Elsevier*. (In Progress)
- Odeh, M., Garcia-Perez, A and **Warwick, K.** (2017). Cloud Computing Adoption at Higher Education Institutions in Developing Countries: A Qualitative Investigation of Main Enablers and Barriers. *International Journal of Information and Education Technology*, 7(12), 921-927. (The University of Cambridge/ Clare collage conference 2017). (Published)
- Odeh, M., **Warwick, K.** & Garcia-Perez, A. (2015). The impacts of cloud computing adoption at Higher Education institutions: a SWOT analysis. *International Journal of Computer Applications*, *127*(4), 15-21. (Published)
- Odeh, M., **Warwick, K.** & Cadenas, O. (2014). Major Differences of Cloud Computing Adoption in Universities: Europe vs. Middle East. *Journal of Emerging Trends in Computing and Information Sciences*, *5*(12), 948-952. (Published)

1 INTRODUCTION

Research into the ways that information and communication technology (ICT) can be used to support educational institutions is not a new topic. Limited research, however, has been conducted regarding the use of ICT based on cloud computing by higher education (HE) institutions in developing countries, especially in Jordanian universities. This research is intended to assist Jordanian higher education institutions (JHEIs) in adopting cloud computing technology, by defining the main motivators and barriers to adoption. A theoretical framework to achieve this was designed and evaluated.

Recently, considerable literature has emerged around the theme of cloud computing, although there have been limited studies on the role of cloud computing in improving the quality of HE academic outcomes in Jordanian universities. This absence in the literature may be due to the modernity of cloud computing technology.

Given the limited attention paid to the factors influencing the adoption of cloud computing technology by JHEIs and the role of cloud computing technology in improving the quality of educational outcomes, the lack of research that suggesting a conceptual framework for adopting innovative technology such as cloud computing is not surprising. Therefore, investigating the main factors influencing the adoption of cloud computing at JHEIs as well as developing a conceptual framework based on these factors considering quality factor appears a worthy subject for research to suggest adaption roadmap for cloud computing in JHEIs.

As the starting point of the thesis, this chapter presents the context of the research, the research problem associated with educational quality in Jordanian universities, and the solution proposed.

1.1 An introduction to the research

This study addresses the adoption of cloud computing in JHEIs. It focuses on the adoption process itself, as well as the role of cloud technology in improving the quality of education outcomes. This research, therefore, will study the problems related to using the latest ICT, cloud computing applications, and their association with education quality in Jordanian universities. According to Al-Jaghoub, Al-Yaseen, Hourani and El-Haddadeh (2009), there are many indicators that demonstrate the inefficiency of HE in Jordan; for example, the high unemployment level of graduates and the low rate of return to HE. One of the key factors contributing to these shortcomings is the failure to adopt the latest information technologies in HE programmes.

Benefits from JHEIs adopting cloud computing technology include:

- The students will become familiar with the cloud computing technology, which is currently being used extensively in local and global markets.
- Providing new creative and different methods of teaching and learning as alternatives to traditional classroom methods.
- Providing more flexibility in terms of reaching documents from any place and at any time.
- Expanding collaboration and knowledge sharing among students beyond the classroom.

This research has been undertaken to gain a better understanding of the problems associated with adopting cloud computing services at HE institutions, as well as its role as one of the potential solutions that may help in solving the quality problem of Jordanian universities' outcomes and decreasing the gap between these and the requirements of the labour market. The literature review explains the role of this technology in improving the education sector, and the main barriers and enablers in its adoption, in order to develop a framework built on these factors. This involved an exploration of diffusion and innovation theories and technology adoption frameworks. During the fieldwork, the researcher studied the best possible approaches to adopting cloud computing in Jordan's universities, and took into account feedbacks and suggestions from education and technology experts, and decision makers.

This chapter presents the background and motivation that constitute the foundation of this study. It describes the general background to the roles of information technology and cloud computing in the education sector. It then moves on to outlining the research problem, aims, and objectives and the context of the research. It concludes with the structure of this thesis and the proposed approach to addressing the research topic.

1.2 Research Context

1.2.1 The importance of higher education quality in social and economic development

In acquiring a relative advantage, HE institutions may adopt ICT, and universities in developing countries such as Jordan could improve the quality of HE by increasing their use of cloud computing (Pardeshi, 2014; Stein, Ware, Laboy, & Schaffer, 2013). Adopting the latest technology, such as cloud computing, may improve the mechanism of education, reduce costs and enhance knowledge sharing, and simplify the process of learning and teaching (Sabi, Uzoka, Langmia, & Njeh, 2016).

Efforts to improve the quality of HE incorporate a variety of approaches. For example, Lomas (2004) identified quality assurance and quality enhancement. The former describes efforts to prevent low-quality products, while the latter aims to improve the level of students within the educational process. The impact of quality outcomes in HE is very important, as every nation's education affects its own economy and the global economy in general. Harman and Meek (2000) believe that in most cases social and economic development is directly linked to HE outcomes.

In order to understand the quality of HE in this study and how cloud computing may enhance it within the educational context, it is important to define the term quality. This study adopts the definition provided by Harvey and Knight (1996, p.13):

> *The excellence, standards, perfection, conformance to requirements, fitness for purposes and value for money of the educational technology services level and higher education institutions outcomes.*

1.2.2 The concept of cloud computing

Cloud computing is a new paradigm which provides applications and services that can be accessed through the Internet with the ability to share, manage and store data hosted on remote servers instead of using in-house servers or personal machines (Foster, Zhao, Raicu, & Lu, 2008). Cloud computing provides advances in technology, such as high processing speed, distributed and grid computing, and high storage capacity. In addition, through its use the common problems of limited computational power and limited physical data storage can be ameliorated (Sultan, 2013a). This synthesis integrates hardware, software, networks, and storage options to deliver shared computing solutions in which applications and other services are provided over the Internet (Mahmood, 2014).

Cloud computing is a modern technology considered to provide user-friendly services, reliable applications and fast processing response time. It is commonly assumed that human nature always prefers something reliable and simple, and it is this that is found in cloud computing technology (Velte, Velte, & Elsenpeter, 2009).

Cloud computing has four deployment models: public, private, community and hybrid. According to Chou (2015), the public cloud is the most popular model, with service providers such as Google, Amazon, and IBM offering inexpensive or even free cloud computing services (Stein et al., 2013). However, despite the low cost and broad availability of public cloud services, it is widely believed that this model has less security protection than other models (Sultan, 2013a). In addition, the shared resources pool provided to users has limited physical capacity and processing performance unless the customer agrees to pay more for premium promotion (McDonald, 2010). In the public cloud model, the service provider does not allow the client to control the physical resources at any level. Therefore, sharing physical servers might allow other clients to access an organisation's critical data unintentionally (McDonald, 2010).

As opposed to the public cloud, the private cloud model enables the client to have control over the physical resources, by leasing or owning control of the cloud infrastructure. This infrastructure is operated solely for a specific client by the service provider (Linthicum, 2009).

The cost of adopting the private cloud model is obviously more expensive than the public cloud. Integration between public and private cloud models usually offers the benefits of both while avoiding their limitations. Such integration is called the hybrid cloud (Sultan, 2013a). Finally, the community cloud model enables organisations that have similar concerns, such as security, mission and policy, to share the same cloud infrastructure (Linthicum, 2009).

Cloud computing can also be categorised according to the service models, such as software as a service (SaaS), platform as a service (PaaS), hardware as a service (HaaS) and infrastructure as a service (IaaS). Further discussion about cloud computing categories and service models is found in chapter two.

In the context of education, several studies have revealed that such users of cloud computing are considered as "late adopters", in comparison with other sectors such as government and healthcare (Katz, Goldstein, & Yanosky, 2010). This delay in cloud technology adoption could be due to the factors influencing the decision to implement cloud computing in universities, which may differ from those in other sectors.

1.2.3 Using cloud computing technology in the higher education system

Cloud computing in the HE infrastructure of developed countries has been integrated to provide better services in teaching and learning activities, and in improving knowledge sharing between students (McCREA, 2009; Sultan, 2010), and has been found to improve the quality of education (N. M. Rao, Sasidhar, & Kumar, 2012).

Many universities and other educational institutions in developed countries have already accepted the potential of using cloud computing to improve education quality, rather than continuing with traditional computing technology (Pardeshi, 2014; Stieninger, Nedbal, Wetzlinger, Wagner, & Erskine, 2014). For instance, Google Apps has been adopted by several HE institutions in the UK, such as the University of Westminster, the University of Glamorgan, Leeds Metropolitan University, and the University of Aberdeen (Sultan, 2010). Many colleges and universities in Commonwealth countries have introduced a collaborative system named Virginia Virtual Computing Lab, which enables them to reduce their IT expenses by eliminating the requirements of software updating and licensing by using cloud computing services instead (Wyld, 2010).

A recent study by Mircea and Andreescu (2011) suggested that about 70% of IT leaders in HE recommended cloud computing over traditional computer technologies, stating that improving IT services is the most crucial factor in their decision. In addition, it is expected that using cloud computing technology at any institution may reduce the total operational cost by up to 25 to 30% (Hugos & Hulitzky, 2010). Cloud computing has become common in HE because of its role in providing a serious step across the educational industry and the opportunity to improve structural efficiency, stimulate innovation, decrease spending on technology, and increase agility (Sosinsky, 2010; Pardeshi, 2014; Stieninger et al., 2014).

As a result, the importance of cloud computing in HE has increased rapidly with the passage of time, and it is obvious that its use and importance will continue to grow in the future (Mircea & Andreescu, 2011; Sultan, 2010), as a result of its benefits in teaching and learning, among other aspects (Chou, 2015). Unfortunately, despite the positive role of cloud computing in the educational sector it is still underutilised in the majority of HE institutions in developing countries, for several reasons including lack of awareness about the benefits of this technology, lack of professional training for both students and staff, budgetary limitations, and other barriers which will be discussed in more detail in chapter two.

Jordan, the context of this research, is a developing country in the Middle East; it still under-utilises cloud computing technology in the educational sector (Hashim & Othman, 2014; Masadeh, Al-Lozi, & Darawsheh, 2015).

1.2.4 Jordan the context of this study

Jordan is a developing country located in the heart of the Middle East. Since the first public university was established in 1962, there has been a significant effort by the government to establishing universities (Al Jabery & Zumberg, 2008), resulting in a current total of 10 public and 21 private universities. Although there is intensive support from the government towards the development and growth of universities, there is a notable lack of adopting and implementing the latest ICT such as cloud computing in these universities (Al-Adwan & Smedley, 2012).

The majority of Jordanian universities have exceeded their maximum allowance of student numbers, and they have limited resources, staff and facilities (See appendix 6). In particular, the high cost of upgrading software and hardware is a challenge facing all JHEIs.

In addition, continuous maintenance of university infrastructure, as well as in-house devices such as servers, is another pressure on Jordanian universities' limited budgets. Furthermore, using traditional methods of learning and teaching without adopting new technologies may have a negative effect on graduate students, especially in schools that depend heavily on information technology (e.g. engineering, computer science, and management information systems). These effects spill over into Jordan's society and economic development. Cloud computing technology may enable many of the JHEIs to reduce total costs and improve the level of information technology services for students and staff, avoiding continuous updating and upgrading of hardware and software (Sultan, 2013a).

The high level of cloud computing power could serve all university students and staff, especially the scientific schools and their advanced research projects (Pardeshi, 2014). Wide availability of information technology services at a relatively low cost may also enhance Jordanian social and economic development. The need to implement cloud computing technology in JHEIs is discussed in more detail in chapters two, five and six.

Despite the benefits of cloud computing to the increasingly complex environment of JHEIs, certain measures must be taken regarding to cloud computing adoption. These measures include the introduction of the cloud services, proportionate to the university budget; the need to implement a compatible infrastructure to host the cloud computing technology; and the ability to reduce total costs while managing the highest level of privacy, updating security, and ensuring the capacity to accommodate growing numbers of students (Odeh, Warwick, & Garcia-Perez, 2015).

1.3 Research Problem

1.3.1 The definition of the research problem

As already discussed, the quality of any country's HE plays a significant role in its response to social and economic development needs (Breivold & Crnkovic, 2014; Pardeshi, 2014; Sultan, 2010). Many researchers have observed that the quality of education in JHEIs is not keeping up with global trends, which may affect the place of Jordan in the global knowledge economy, in alignment with current and future social and developmental needs (Al-Adwan, Al-Adwan, & Smedley, 2013; Al-Hadrami, 2012; Al-Khasawneh, 2012; Al-Mobaideen, 2009; Qudais, Al-Adhaileh, & Al-Omari, 2010).

However, it has been observed that Jordanian universities are still using traditional methods in teaching and learning. The lack of usage of technological innovation such as cloud computing could be one of the reasons holding back JHEIs. This need a further investigation about the factors influencing the adoption of innovation technology in JHEIs and suggest a solution to increase such adoption. Introduction of a framework for the adoption of cloud computing would help JHEIs to adopt this technology as one of the potential solutions to improve the HE quality in Jordan.

1.3.2 The research questions

<u>The primary research question</u>

How can higher education institutions in Jordan effectively adopt cloud computing technology in the learning and teaching process?

The researcher was already aware of the current limitations and gaps in using cloud computing education applications (CCEA), which defined the problem that led to the primary research question. The limitations of using cloud computing in JHEI suggest research into a number of secondary research questions, as follows:

1. How can Jordanian universities benefit from the adoption of cloud computing technology?
2. What are the main factors influencing the adoption of cloud computing in JHEIs?
3. What are the motivators for and barriers to cloud computing adoption by JHEIs?
4. What are the main phases for the effective adoption of cloud computing technology in JHEIs?

1.4 The research proposition

After defining the main research question and investigating the background literature, the research proposition was formulated:

> *Development of a framework that considers the key factors influencing the adoption of cloud computing would help Jordanian higher education institutions to adopt cloud computing technology effectively.*

1.5 Research aim and objectives

This research will focus on ICT in general and cloud computing technology in particular, which can be used in Jordanian universities as one of the potential solutions helping to improve the output quality. Based on the previous sections, which defined the research problem and research questions, the main aim of this study is:

> *To develop a framework considering the key factors affecting the adoption of cloud computing that will help Jordanian higher education institutions to implement cloud computing effectively.*

In order to achieve this aim, the following objectives were established:

- To understand ICT adoption theories and frameworks and how they can be implemented by the individual, the organisation and its context.
- To study the factors that influence the adoption of cloud computing in JHEIs (influencing factors).
- To produce and validate a framework that helps Jordanian universities to use cloud computing in an effective way.

1.6 Research scope

- The research focuses on ICT adoption in general and cloud computing adoption in particular.
- The research context is the JHEIs environment including both public and private universities.
- The research focuses on developing a conceptual framework, which includes factors affecting the adoption of cloud computing technology in Jordanian universities.
- The research is concerned to help Jordanian universities to adopt cloud computing as one of the potential solutions that may improve the quality of HE.

- The qualitative approach conducted in this research enables the researcher to develop a conceptual framework, supported by suggestions from interviews with education and technology experts in Jordan, focus groups, student surveys, direct observation, and secondary data collected by the researcher.

1.7 Research contribution

Although the adoption of cloud computing in the education sector has been examined in many developed countries, there is a notable lack of such studies in the Middle East region (Truong, Pham, Thoai, & Dustdar, 2012; Sabi et al., 2016; Shirazi, Gholami, & Higón, 2009). As such, Jordan has a different level of economic, education, technology, and industrial development compared with developed countries.

The review of previous literature has revealed few studies providing conclusive evidence regarding the adoption of cloud computing in Jordanian universities. In the Middle East in general and Jordan in particular, a limited number of studies in cloud computing adoption and diffusion within the educational sector have been done. Accordingly, diffusion theories that cover the individual, organisational and environmental contexts have been found to be a good approach to span the body of this research. Such theoretical frameworks provide a better understanding regarding consumer concerns and acceptance levels of new technology.

This study attempts to fill this gap in the literature by demonstrating how introducing cloud computing in Jordanian universities can help to align the quality of learning outcomes with current and future needs for social and economic development. This study also aims also to provide JHEIs with a clear image of cloud computing technology in the field of education.

This research therefore attempts to study the main factors affecting the implementation of cloud computing at JHEIs by collecting and analysing primary and secondary data from several Jordanian universities. Studying such factors will be the cornerstone for developing a framework for adopting cloud computing technology in JHEIs. This framework would be one of the potential solutions that may contribute to strengthening the education system in Jordan, as well as enhancing the quality of academic output that is essential for the process of economic growth and development. Furthermore, the framework will help to provide a practical roadmap to guide Jordanian universities in cloud computing adoption.

Finally, the findings of this research are expected to be applicable not only to Jordanian society but also to other developing countries that have a similar culture and situation, particularly other countries in the Middle East.

1.8 Research motivation and context justification

The extensive use of new technology such as cloud computing in the educational sector worldwide, and the competitive nature of HE institutions, motivates universities to find better solutions by adopting new technology. Such adoption may improve the quality of the educational process and outcomes.

In Jordan, HE institutions are considered as one of the most important sectors where the circle of economic development starts, providing the labour market with manpower, through graduate students. In addition to local universities and colleges, Jordan is home to several renowned international universities (Akhorshaideh, 2013). Ciborra (2005) stated that "Jordan is a textbook case for its vision to become the Singapore or Bangalore of the Middle East in the adoption of new information and communication technologies". Therefore, Jordan appears to be among the best candidates in the Middle East to introduce cloud computing technology to share knowledge and improve the quality of HE. It has one of the highest adult literacy rates in the Middle East and some 2,000 researchers per million people (Sami El-Khasawneh, 2012). Moreover, Jordan could be a good example to the Middle East countries, which share common denominators such as culture, language, economy, attitude toward using cloud technology, behavioural intention to use new technology, and level of ICT use.

The limitation of previous studies on Arab World universities in general and in Jordanian universities in particular, motivated the researcher to study the adoption of cloud computing technology in JHEIs. The lack of a framework for adopting cloud computing is one of the problems faced by Jordanian universities, and suggesting a suitable framework for JHEIs may help to fill this gap.

The expected contribution to knowledge for this research is both theoretical and practical. On theoretical level, the study aims to extend the technology adoption theory by adding new factors influencing the adoption of cloud computing in the education sector. On the practical level, it involves both public and private universities in Jordan in developing and validating a cloud computing adoption framework.

1.9 Theoretical foundation of this study

This study explored the main factors influencing the adoption of cloud computing in Jordanian universities, as well as developed a framework to support this adoption. The aim and objectives of this study were achieved through applied two theories and one framework to develop a new framework relevant to the research context.

These theories are the Diffusion of Innovation (DOI) model (Rogers Everett, 1995; Rogers, 2003; Rogers, 2010), the Technology Acceptance Model (TAM) (Tornatzky, Fleischer, & Chakrabarti, 1990) and the Technology-Organisation-Environment (T-O-E) framework (Davis, 1989).

Initially, the researcher identified the adoption framework factors from the literature review, enabling understanding of the challenges of ICT adoption by HE institutions, and of the most popular theories and frameworks in technology adoption. The methodology chapter explains the approach to collecting and analysing the requisite data.

However, it is important to mention that several theories beyond DOI, TAM and TOE have been considered and excluded by the researcher for several reasons related to the topic of this research. For example, Theory of Reasoned Action (TRA), which concerns studying individual behaviour in the adoption of innovation technology, was developed by Fishbein and Ajzen (1975). However, its main limitation is that illogical decisions in accepting or rejecting innovation technology, or any unpredictable behaviour by individuals, are not considered by this theory.

Since cloud computing technology is a relatively new phenomenon in the context of HE in Jordan irrational behaviour in rejecting or accepting cloud technology could exist, especially in security and privacy concerns. This is because cloud computing technology has a different concept in providing innovation technology as the customer data and operations will be hosted on the service provider side rather than using the in-house technology hosted on the customer’s local machines. Therefore, TRA theory has been rejected for this study because it is important to study both illogical and logical decisions of individual behaviour regarding the adoption of cloud computing. Furthermore, TAM, which originated from the Theory of Planned Behaviour, already covers individual behaviour in the adoption of innovation technology and addresses the weakness of TRA theory.

Another example of an innovation theory that has been addressed and excluded in this study is the Web Adoption theory developed by Teo and Pian (2004), which examines the various levels of adoption of institutions' websites. It comprises four levels of adoption. Level 0, the lowest, states that the institution only using emails and has no effective websites. In Level 1, institutions decide to develop a website, but it is still in the process of implementation. By Level 2, institutions are providing useful information for customers such as news, events and innovation products. Finally, at Level 3, there is business integration where customers have a direct connection with the institution through the website.

However, the Web Adoption Model only targets institutional websites without providing a comprehensive vision of the adoption of innovation technology, such as considering the HEI's technical infrastructure (e.g. servers, networks and storage devices). It can be argued that it is still too early for JHEIs to consider Web Adoption Theory which focuses only on their websites. The aim of this study is to develop a framework to help JHEIs to adopt cloud computing technology effectively, and Web Adoption Theory fails to consider fully cloud computing technology and its factors (e.g. cost, compatibility, security, privacy and scalability).

1.10 Thesis structure and summary of contributions

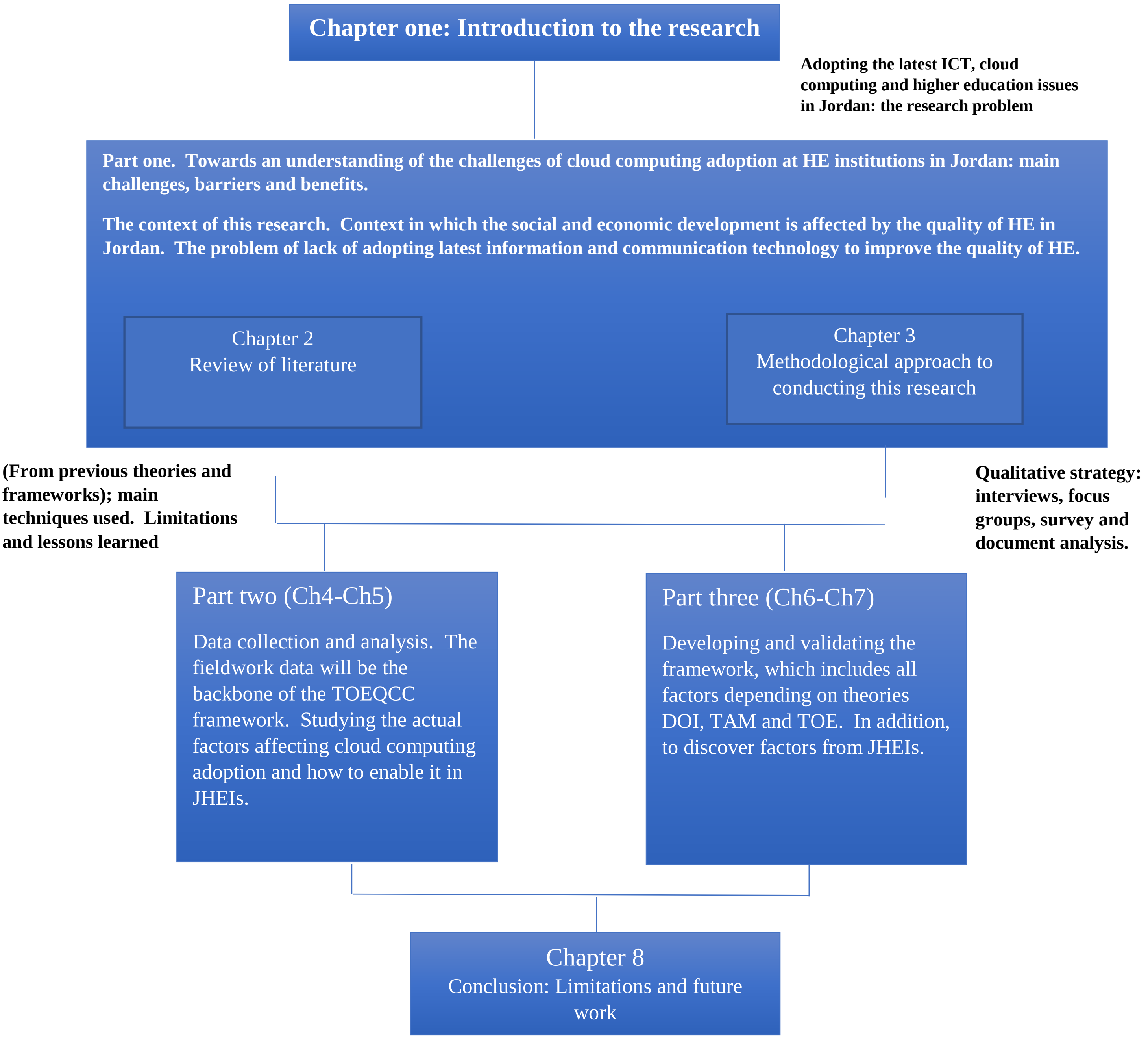

Figure 1-1 Thesis structure

First part of thesis (chapters one, two and three)

The first part comprises the introduction, literature review and research methodology chapters.

The introduction presents the context of the research, the research problem associated with HE quality in Jordanian universities, the research questions, aim and objectives, the scope, contribution and motivation of the research, justification of the context, and the solution proposed. In order to set the research context, chapter two reviews the most important studies in the field of information technology (IT) adoption in the education sector. It provides a brief description of Jordan, the context of this study. It also discusses the technology's limitations and benefits, the barriers and enablers of ICT adoption, the concept of cloud computing, and the most popular theories and frameworks in the field of technology innovation and the adoption of a conceptual framework. Chapter three details the methodology selected to carry out the data collection and analysis. It addresses the research problem and justifies the methodology selected.

Second part of thesis (chapters four and five)

The second part of the thesis focuses on the collection and analysis from the fieldwork of the large volume of data from observation, document analysis, focus groups, surveys and interviews, during a case studies. It describes how the data set was reduced to make it manageable and understandable. The results of the data reduction and analysis are presented using tables to explain how the conclusions were drawn. The quality of the findings, internal and external validity, transferability, auditability, credibility and the ethical issues associated with the conduct of the research are also discussed in chapter four.

Chapter five presents the qualitative data analysis and results. Statistical frequencies are provided to support the qualitative results. Accordingly, chapter five answers the first research question: What are the main factors that influence the adoption of cloud computing by JHEIs?

Third part of thesis (chapters six, seven and eight)

Chapter six answers further research questions: How can JHEIs effectively adopt cloud computing technology in the learning and teaching process? What are the main motivators and enablers affecting the adoption of cloud computing in JHEIs? The theoretical framework is developed and illustrated. It is validated in chapter seven. Finally, the key contributions of the research are summarised in chapter eight, which also sets out areas that will benefit from further study.

2 LITERATURE REVIEW

Writing the literature review is one of the most substantial tasks in a thesis (Steane, 2004; Swanson, West, Carr, & Augustine, 2014). Reviewing the extant literature is an important phase that helps in establishing and categorising key issues in the research area, and discussing relevant resources (Cottrell & McKenzie, 2010; Hair Jr, Wolfinbarger, Money, Samouel, & Page, 2015; Malhotra, 2015).

This chapter addresses the current literature in the field of ICT in general and cloud computing within the educational context in particular. It first defines of key concepts used in this study, such as the quality of HE, cloud computing in education, and the concept of knowledge as a service in terms of cloud computing. It clarifies the role of the quality of HE in social and economic development.

This chapter critically reviews the most important published literature concerning cloud computing in developing countries in general and within the HE system in Jordan in particular. It also offers information about Jordan, the context of this research, and summarises the historical evolution of the use of ICT in HE institutions. Finally, it addresses the main theories and frameworks adopted in this study: The Technology Acceptance Model (TAM), the Technology-Organisation-Environment (TOE), and the theory of Diffusion of Innovations (DOI).

2.1 The focus of the literature review

Chapter one addressed the main research problem of this work. Section 1.2.1 discussed the important role of information technology and cloud computing in the education context, as well as the limitations of adopting cloud computing in JHEIs. This led to the research question and the aim and objectives of the research. The review of the literature in this chapter aims to:

- Establish and clarify the key concepts that led to the formulation of the research question.
- Identify the limitations of the existing adoption of ICT within higher education institutions in Jordan.
- Define the main concepts of this research and the relationship between these concepts.

- Present the conceptual frameworks that will help to inform the adoption of cloud computing technology in the HE context.
- Investigate the main barriers to and enablers of ICT adoption within an educational context.
- Trace the historical development of ICT and its role in the educational context.
- Investigate the most popular innovation and diffusion theories, and ways in which to successfully apply these theories in the implementation of cloud computing within the educational context of Jordan.

To achieve these aims, this literature review focuses on analysing the research topics, which include:

- Information technology, cloud computing, the quality of HE outcomes, and the unemployment gap.
- The use of technology to improve the quality of education in Jordan.
- The adoption of cloud computing technology to decrease the gap between labour market needs and education context outcomes.
- Cloud technology and knowledge sharing.
- Specific issues related to diffusion theories and their role in cloud computing adoption in the educational context, including:
    - Attitudes towards new technology adoption.
    - Technology Acceptance Model within a specific context.
    - Environmental factors, technology factors and organisational factors.
    - Diffusion of Innovations theory and the different classifications of innovation adopters,
- Technology adoption as the focus of the teaching and learning process, the role of technology in the classroom.
- Evaluating the current situation of technology adoption in Jordanian universities.

In order to address these issues, Section 2.2 begins by outlining the main context in which HE has been found to have an impact on economic development. Section 2.3 analyses key factors related to the definition of quality in the education context. Section 2.4 summarises the historical evolution of the role of ICT in HE institutions.

Section 2.5 defines the concept of cloud computing, while sections 2.6 and 2.7 discuses cloud computing service and deployment models. This is followed by sections 2.8 and 2.9, which discuss the use of ICT and cloud computing in developing countries, and the main enablers and barriers of the adoption of this technology. Section 2.10 provides a brief description of the Kingdom of Jordan, the context of this study.

Section 2.11 presents the theoretical framework, derived from the most popular diffusion and innovation theories and frameworks, to support the process of cloud computing technology adoption in JHEIs. The theoretical framework followed by the integrative conceptual model of this research is described in section 2.12. The chapter concludes with sections 2.13 and 2.14, which summarise the lessons learned from the literature and summarise the chapter.

2.2 Main contexts where higher education has been found to have an impact on economic development

In the last decade, there has been considerable debate over the role of HE in social and economic growth (Sakamoto & Chapman, 2012; Pardeshi, 2014). A number of studies have argued that it is considered to be a leading institution for promoting social and economic growth (Bloom, Canning, & Chan, 2006; Burkhalter, 1996; Cave, 1997; Morley, 2003). David (1997) argues that the role of universities is not only to create scientific research and to train minds, but also to play a significant role in economic growth. Therefore**,** the general perception that universities are only institutions for learning is fading away, as they are becoming an important engine in economic development and growth (Chrisman, Hynes, & Fraser, 1995). The quality of HE is particularly important in this role. Miller (2013), for example, states that it is an important driver in any country. From the perspective of economic experts, HE institutions are anchors in social and economic development, because they are the main source of an educated workforce (Layard, Nickell, & Jackman, 2005; Wolfe, 2005). In addition, universities act as leaders in the knowledge economy by creating innovative ideas and preparing the skilled workforce required for specific jobs.

According to Hanushek and Wößmann (2007), the growth of the economy in any country is affected by improvement in the quality of HE, which is linked directly with productivity. This link between HE and productivity could play a significant role in social economic growth for the individual as well as society as a whole.

On the other hand, HE plays a significant role in economic competitiveness. In a study conducted by Knight (2011), it was reported that HE institutions in the US are considered the main source of new knowledge, leading to the preparation and development of high-paying jobs in the innovation economy. The same study reported that ICT is one of the priorities in creating a new model for improving national growth rate.

Similarly, Kozma (2005) points out that HE has a significant role in economic development, through preparing a high quality workforce and providing professional connections between workforce development and labour market requirements. These connections match educational programmes with current and future market needs, supporting customised training services that fill the gaps between employee skills and current business operational requirements. In addition, HE institutions can provide advanced research in specific domains such as engineering projects, creating innovative technology, developing critical software for manufacturers, and providing customised solutions for transportation systems (Garcia-Perez, Shaikh, Kalutarage, & Jahantab, 2015).

Thus, HE institutions play a vital role in social and economic development, in addition to meeting the market's demands for a workforce. Unfortunately, despite this role, HE in Jordan suffers from a gap between universities' outcomes and labour market needs (Badran, 2014). This study attempts to examine the reasons for this gap, and put forward a framework for using innovative technology such as cloud computing as one of the solutions to reduce the gap. This study also attempts to provide a better understanding of the role of cloud computing technology in the educational context, and the main factors that may influence its adoption by JHEIs.

2.3 Quality in higher education context

In an attempt to define what the author understands as quality within the educational context this section revisits the concept of quality adopted from Harvey and Knight (1996, p.13) in section 1.2.1 of this thesis:

> *The excellence, standards, perfection, conformance to requirements, fitness for purposes and value for money of the educational technology services level and higher education institutions outcomes.*

This section emphasises the factors that can be derived from this definition as illustrated in Table 2.1. This research will study such factors in relation to ICT and cloud computing technology within JHEIs. Accordingly, the data analysis in chapter five will assess the issues related to each factor.

Table 2-1 Indicators of quality

Quality	Definition	Key Concepts
Excellence	Usually operationalised as exceptionally high standards of achievement (Harvey & Stensaker, 2008).	Exclusivity, exceeding high standards or fulfilling minimum absolute standards.
Perfection	Focuses on processes and sets specifications that it aims to meet (Harvey, 2007).	Zero defects via a quality culture emphasising 'right first time'.
Value for Money	Assesses quality in terms of return on investment or expenditure (Harvey & Knight, 1996).	Accountability via performance indicators or customer charters.
Fitness for Purpose	Judges quality in terms of the extent to which products or services meet stated purposes (Harvey & Green, 1993).	Meeting customer specification or fulfilling institution's mission.
Higher education institution outcomes	The gap between the universities' outcomes and the labour market, based on the learning and teaching process and outcomes (Harvey & Purser, 2006).	Enhancing or empowering the student's level through adopting innovative technology.

Table 2.1 indicates five factors that define quality. In the context of ICT, the first refers to the excellence of ICT services, and to achieving the minimum expectations of such services to improve the HE quality. The second refers to the perfection of ICT and the ability to avoid any anticipated limitations, such as service downtime, and delayed response time. The third factor is value for money, comparing it with the value of the benefits of services provided to the students and staff in improving the quality of teaching and learning. Fitness for purpose compares the ICT services with their suitability for the university's purposes. The final factor describes the quality of the HE institution's outcomes, and its role in fulfilling labour market requirements.

2.4 The role of ICT in higher education institutions: A summary of historical evolution

The role of ICT in improving education quality is not a new phenomenon. In 1946, the University of Pennsylvania developed the first electronic computer in the USA. The Electronic Numerical Integrator and Computer (ENIC) was developed to speed up complex calculations, allow multiple users to work at the same time, and finally to receive printed paper with results after inputting data into the program (Forest & Kinser, 2002). ENIC made the whole process, which included feeding the program using punch cards, waiting for completion of the process, and receiving results, very short compared with the more labour-intensive manual process.

From the 1950s until the 1960s, mainframe computers were available only in major research universities, with the aim of improving the field of computer science (Forest & Kinser, 2002). However, the use of mainframe computers was limited, due to their high cost, the large amount of space needed to house them, and the limited number of faculty and students who knew how to use this technology.

The evolution of computer networking was another major change in ICT. In the 1970s, Carnegie Mellon University and Massachusetts Institution of Technology (MIT) adopted two network projects, Andrew and Athena, whose aim was to create a new network that connected students, faculties, and staff. The first version was the distributed computing model, which connected different workstations and servers including different brands software and operating systems, such as IBM, and UNIX.

Although the distributed computing model was very expensive, most universities adopted it in the 1980s, as it created new concepts in sharing and communication, allowing users to communicate via an electronic mail system, and to share research documents in the university library and access information resources in an effective way.

The biggest leap in computing technology within the education sector was in 1981, when IBM introduced the personal computer, followed in 1984 by the Apple Macintosh personal computer. Personal computers allowed users to simplify the complex computing process with the same performance offered by mainframe computers, but at a lower cost. New software was introduced, such as word processing, spreadsheet and graphical interface programs, which constituted the major change for the education sector at that time (Forest & Kinser, 2002, P.653).

According to Westera (2004), ICT played a notable role in universities and schools around the world, which in turn were forerunners in improving educational quality through their extensive use of ICT (Chiu & Moss, 2007).

In the same context, Ensminger and Lewis (2010, p.30) argue that technology changed the face of HE, allowing students to access almost unlimited resources, and motivating universities to provide a creative learning environment. Moreover, technology improves students' research skills, and creates professional learners.

Forest and Kinser (2002, p.652) claim that policy makers considered technology to be a solution to many HE challenges, such as improving quality, decreasing costs, increasing creativity and productivity, and improving research cooperation.

In the 21st century, the evolution of smartphones, cell phones, tablets, online information communications, and new tools for education have increased research sharing and access to resources among students, researchers and learners (Parker, Lenhart, & Moore, 2011).

Several recent studies have demonstrated that students prefer learning methods supported by technology, rather than old learning methods (Milliken & Barnes, 2002; Tamim et al., 2008; Webster & Hackley, 1997). Accordingly, it is difficult to ignore the evolution of technology in education, even in developing countries. HE institutions must be aware of the best ways forward for education technology integration and communication. Therefore, the process of adopting the right technology in the best way is one of the most important methods for improving the quality of HE. For this reason, developing nations seeking better HE quality outcomes and improved economic growth, should be more familiar with education technology.

According to Dirksen (1999, pp.150-151), one of the key factors for the successful adoption of ICT is the cultural context. Accordingly, one of the main factors in this study is cultural issues, which play an important role in influencing the adoption of ICT in JHEIs.

Although it originated in the 1960s, cloud computing gained popularity in the 1990s, going through many phases including Grid, Software as a Service (SaaS) and Application Service Provision (ASP) (Dikaiakos, Katsaros, Mehra, Pallis, & Vakali, 2009). Cloud computing moves data and computers away from desktops and other portable computers and into large data centres. Therefore, applications may be delivered as services over the Internet from within the cloud infrastructure. Users can access this service or their data and files with a web browser from the servers of the cloud service provider (Kim, 2009). Another perspective of the cloud is that it is a type of computing where elastic and scalable IT-enabled capabilities are provided as a service to customers.

Cloud computing has created a new concept to deal with software services and hardware infrastructure. Some benefits are immediate, for instance, allowing students to share their information easily, and to experience the education system in new ways. However, this introduces more challenges, such as security and privacy, and the configuration of resources in shared environments.

Suggesting a suitable innovation technology such as cloud computing for adoption by JHEIs is considered as an important aspect of this research. Cloud computing technology is considered a suitable technology because it promises to reduce the total cost of ICT expenses as well as to improve the performance of the ICT operations. The high cost of the adoption of innovation technology is one of the most important challenges faced by JHEIs. In addition, the limited computational power and limited physical data storage in JHEIs can be ameliorated by using cloud computing technology. Furthermore, the cloud computing deployment models and service models provide a considerable number of options for JHEIs, to be selected according to current and future requirements.

Other technologies such as augmented reality, which is a combination of real-word and virtual objects (Billinghurst, 2002), has been excluded from this research because of its high cost. In addition, augmented reality requires advanced hardware and software, which could not be easily provided to students in HEIs. Another example of innovation that has been excluded is 3D printing technology, which enables students to design and print 3D sculpture models. Again, because of the limited budget and the lack of hardware and software, this technology has been excluded in this research.

Figure 2.1 shows the six phases recognised by Voas and Zhang (2009), from mainframe to cloud computing.

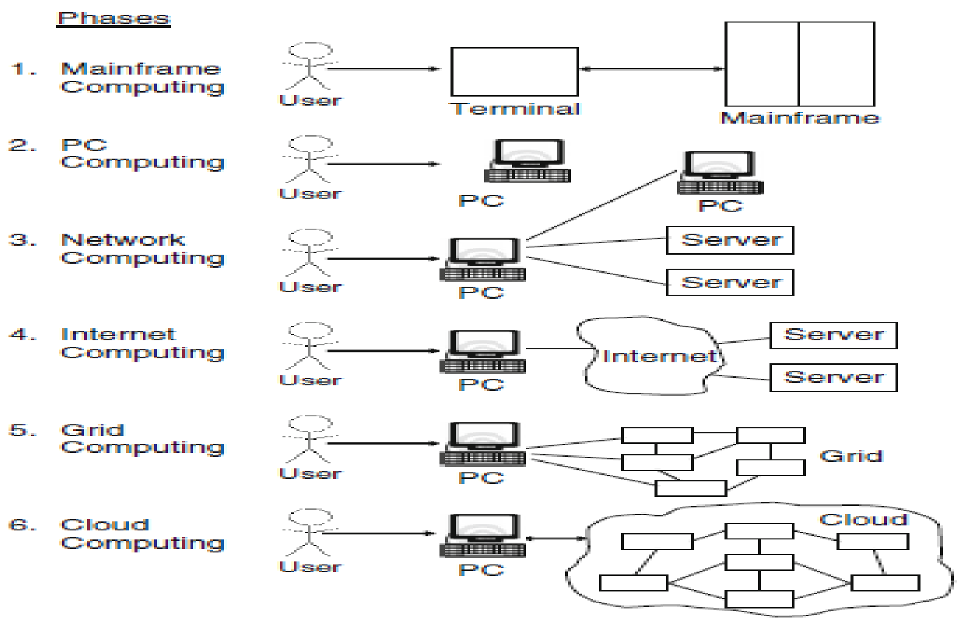

Figure 2-1 Six computing paradigms (Voas & Zhang, 2009).

2.5 Cloud computing definition

According to Voorsluys, Broberg and Buyya (2011) "Cloud computing is considered as an umbrella term to describe a category of sophisticated on-demand computing services initially offered by commercial providers such as Amazon, Google, and Microsoft". However, there seems to be no standard definition (Sultan, 2010). Several studies consider it to be a new phenomenon or a new paradigm of computing technology that provides on-demand access to ICT resources shared with other users (Pallis, 2010; Wang et al., 2010; Zhang, 2010).

However, other studies consider cloud computing as a technology that had already existed for some time. For example, Sultan (2014b) points out that in the 1930s some companies, such as IBM, specialised in offering a punch-card electronic machine to other organisations as a rented service. The customers brought their data for processing and the IBM electronic punch-card machine processed and retrieved the required information, being paid for the service. Such services can be considered as the initial pay-as-you-go cloud-computing concept. Table 2.2 presents definitions of cloud computing, as stated by different authors.

Table 2-2 Cloud computing definitions

Author	Definition
Jones (2015)	Cloud computing is considered as the newest Internet development, which offers external services such as data storage, data processing and customised applications from external service providers using network-hosted servers rather than local resources (e.g. hardware, software).
Lin & Chen (2012)	Cloud computing is a large shared pool of usable hardware and software resources that can be accessed through the Internet.
Stein et al. (2013)	The practice of use (on-demand resources) through remote servers that offer hardware, software, infrastructure, and platform applications, provided by service providers.
The National Institute of Standards and Technology (NIST)/ Mell & Grance (2011)	"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."
Velte et al. (2009)	Cloud computing is a construction of different resources that allows users to access services and applications hosted on the internet, which are located at the different place where the user, computer or device is located.

Buyya, Yeo, & Venugopal (2008)	“A type of parallel and distributed system consisting of a collection of interconnected and virtualised computers that are dynamically provisioned and present as one or more unified computing resources based on service level agreement established through negotiation between the service provider and customer.”
Sultan (2014a)	Cloud computing is defined as a new IT solution that uses the latest technology such as virtual machine grid computing, and remote access to resources. It also uses the pay-as–you-go business model to service the customers’ requirements through the cloud service provider.
Alabbadi (2011)	An emerging technology based on an Internet network that offers elasticity, scalability and on-demand services, using a pay-per-use business model.

In recent years, the evolution of cloud computing has been considered a key factor in computing technology, gradually improving information system services by providing real-time responses to user requirements (Kim, 2009).

In particular, cloud computing service providers offer pay-per-use options. This is considered a new business model, where customers pay only for the exact amount of resources they need. Cloud computing promises to deliver significant benefits, such as lower up-front service costs, and almost unlimited availability of resources (Staten, Yates, Rymer, & Nelson, 2009). According to Buyya et al. (2008), cloud computing payment methods are similar to traditional public utility services such as electricity, water and gas.

Furthermore, cloud computing offers flexible on-demand features, such as scalability and elasticity. Scalability is defined as flexibility in increasing the number of resources when the workload increases suddenly from the customer’s side, while elasticity is the ability to dynamically increase and decrease the resources, the quality of services, and the cost.

Cloud computing models can be classified according to service and deployment models. These classifications are based on computing requirements from the customer’s side. Service models consist of different layers, according to the architecture design of the cloud service providers. Accordingly, the cloud computing service model consists of three main types:

Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS). Cloud computing deployment models, on the other hand, are classified as follows: Public Cloud, Private Cloud, Hybrid Cloud and Community Cloud (Mell & Grance, 2011).

2.6 Cloud computing service models

The term services in cloud technology refers to the ability to reuse services' components through the vendor's network, widely described as "x-as-a-service". There is a lack of standards in cloud computing-related applications for HE institutions.

Cloud computing service providers offer a wide variety of services for educational purposes, an advantage in terms of simplifying the decision to adoption cloud computing. Difficulties arise, however, when HE institutions attempt to adopt a specific cloud technology service, and then find that they need to select and commit to one option rather than others from a large group of several services provided. In addition, most cloud computing services offer standard services for a large number of customers, not designed to fit non-customised needs.

According to Linthicum (2009, p.11), cloud computing may be categorised into eight types as follows:

1. Storage-as-a-Service
2. Database-as-a-Service
3. Information-as-a-Service
4. Process-as-a-Service
5. Application-as-a-Service
6. Platform-as-a-Service
7. Integration-as-a-Service
8. Infrastructure-as-a-Service

These services enable customers to access computing resources over the Internet without owning such resources. The key to adopting cloud technology is to understand which resources are widely available, the solutions that can be offered by cloud providers, and how this solution can fit with an institution's requirements. Therefore, it is very important to understand the institution's options in order to adopt the best cloud scenario available. This solution will be on-demand, and the pay-as-you-go business model. This model is mainly concerned with paying only for the required resources.

However, these models present different challenges, such as compatibility with the current systems in use within the institution, the level of usability, and the observability of benefits.

The section below provides more detail about the different cloud computing service models.

2.6.1 Storage-as-a-Service (SaaS)

SaaS is also identified as disk space on demand (Linthicum, 2009). It provides storage such as Storage Area Network (SAN), Network Attached Storage (NAS) and Direct Attached Storage (DAS), which are available at a physical location and accessible remotely through an application hosted logically at a different site (Schulz, 2011). Such services may assist HE institutions in their backup, lowering the cost and time needed for the backup process. Data is replicated at different geographic locations, which also avoids any loss of data in the event of a disaster at one physical location (Dikaiakos et al., 2009). Data privacy is still the main issue, as the cloud service provider's data centre stores the information that the university has traditionally stored on their local servers or storage machines (Dikaiakos et al., 2009).

One of the most popular solutions to improve privacy is data encryption, traditionally considered the first choice in safeguarding an organisation's sensitive information (L. S. Wang, Jung, Lee, Okuhara, & Yang, 2014). Since cloud service customers do not have full control of the cloud data centre, the data encryption method enables them to protect their information effectively. Before uploading data to the cloud storage device, local backup software generates a secret key from the customer side to encrypt the data. In the retrieval process, the local backup software decrypts the data when the customer recalls it (L. S. Wang et al., 2014).

However, data encryption methods in cloud computing are complex and troublesome (Mather, Kumaraswamy, & Latif, 2009), and customers sometimes have recourse to a third-party security provider called a cloud broker, rather than a cloud service provider (Ruan & Carthy, 2013). The cloud broker works as an intermediary between cloud computing service providers and cloud customers, acting as a kind of consumer watchdog (see Figure 2.2). Brokers also guarantee that cloud providers have no access to customers' sensitive information (Mehrotra, Srivastava, Banicescu, & Abdelwahed, 2014).

Figure 2-2 Cloud broker roles between consumer and service provider (Liu et al., 2011).

SaaS has many benefits. One advantage is its ability to expand disk space storage as a customer demands (Linthicum, 2009). This flexibility, based on the customer's demand, makes SaaS cost effective. Another advantage is that there is no need to worry about hardware maintenance or storage upgrade. Finally, cloud service providers provide plans for disaster recovery, usually at no additional cost (Linthicum, 2009).

However, there are many limitations in adopting SaaS. The service customer depends on an Internet connection to access storage (Linthicum, 2009), and if this is interrupted for any reason, no connection with the storage device is possible. If the data is considered to be time-critical not to be interrupted for any reason, then SaaS may not make sense (Linthicum, 2009).

Furthermore, there is a difference in performance between on-site storage and cloud storage services, the former possibly being much better. Therefore, if storage performance is considered to be a critical success factor for storage and applications, SaaS is not the best solution. Moreover, if the employee or applications are in the same physical building, then the location-independent benefits that SaaS provides will not be effectively employed. The loss of such benefits could affect the cost-effectiveness factor (Linthicum, 2009).

2.6.2 Database-as-a-Service (DBaaS)

DBaaS enables the consumer to load and store the data, and create tables through a remote database hosted on cloud computing servers. The database functions physically as if it were on the customer's local machines (Linthicum, 2009). Cloud consumers can create a new database very easily, without even buying any hardware or software, all on the same day, saving time. DBaaS users can manage and access all database functions remotely through the Internet at any place and any time using APIs (Raj, 2014). However, as with the SaaS, DBaaS has both benefits and drawbacks.

One benefit of DBaaS is that the cloud computing database service provider is responsible for the maintenance, management, backup solutions, database recovery and migration (Srinivasan, 2014). Such features enable HE institutions to avoid extra costs such as hiring database administrators. A second advantage is the ability to avoid the high cost which comes from hardware and software installations in the short term, and the need to upgrade in-house devices in the middle and long term (Linthicum, 2009). Finally, there is the potential to avoid doing bug fixes, on which database administrators usually spend a great deal of time. Cloud service providers ensure that customers have the latest bug-free version, and they handle any other problems or bugs appearing in the database (Linthicum, 2009).

However, DBaaS has a few drawbacks. First, the privacy and legal liability of data hosted in a remote cloud database could be an issue (J. Chen, Miyaji, & Su, 2014). In some cases, hiring a remote database for illegal types of data would render the service illegal. Such issues should be studied carefully before signing the SLA (Linthicum, 2009). Second, each DBaaS provider usually uses different application programming interfaces (APIs). Therefore, cloud customers need to understand and test such APIs for security considerations (Sosinsky, 2010). Finally, DBaaS providers offer standard features that are usually found in traditional databases hosted in-house, and some customers may find that they are missing features or other customised functions they had before (Linthicum, 2009).

2.6.3 Information-as-a-Service (INaaS)

This service offers useful hosted information to cloud customers via APIs such as online credit or debit verification, address validation, up-to-date stock market information, and weather information (Bento, 2012). INaaS may also offer statistical information for social websites such as Twitter and Facebook (Linthicum, 2009).

2.6.4 Process-as-a-Service (PRaaS)

This is a delivery model where cloud service providers perform backend processing tasks in order to decrease the cost and accelerate data processing (Bento, 2012), with better agility and higher scalability (Linthicum, 2009). This service model derived mainly from the business process outsourcing concept (BPO), where ICT companies and other institutions sent their tasks to be processed outside the institution (Bento, 2012). PRaaS binds many cloud computing resources together, hosted remotely in different locations, to provide several services at one virtual location (Linthicum, 2009).

2.6.5 Application-as-a-Service (AaaS)

AaaS also called Software as a Service, refers to any application delivered to the end user through a web platform using an Internet browser, such as Google Docs, Google Gmail or Microsoft Office online applications (Velte et al., 2009). This service has many benefits. First, cloud customers can use it directly without any installation needed on the local machines, since the application is executed through the web browser (Sitaram & Manjunath, 2011). Second, the independence possible with any device (e.g. laptop, home PC, work PC, tablet smartphone) improves the application availability and the intensity of use (Sitaram & Manjunath, 2011).

Third, the main advantage of AaaS is the cost (Linthicum, 2009), which benefits both cloud customers and cloud providers. On the customer's side, the pay-per-use business model ensures that the cost will be kept to a minimum. From the vendor's point of view, it is economically viable to create a cloud service application, rather than provide full software packages (Sitaram & Manjunath, 2011). Finally, this service avoids updates and new versions, simply because the service provider obliges the customer to use updated applications; old versions are no longer used.

There are, of course, many limitations in AaaS. First, privacy and security are still the main concern when using a cloud application service. Second, the customer has no control over when the service provider may decide to change or replace the service. Third, although AaaS is considered an economically viable solution for both the customer and the service provider, accessing the application may incur continuous running costs, unlike the situation where the customer pays for the software application once and then uses it frequently.

Therefore, the adoption of this cloud solution, and any potential short- and long-term effects, should be studied carefully by potential customers. In addition, if the institution has some very specific requirements it will probably not find the application available online through AaaS. Finally, AaaS has a "vendor lock-in" problem: the customer cannot easily move from one vendor to another, and if the customer tries to do so, the old vendor may charge excessive fees.

2.6.6 Platform-as-a-Service (PaaS)

PaaS is a cloud delivery service that supplies the customer with all the resources needed to build and develop web applications (Velte et al., 2009). There is no need to install or download any software for the application development process, as PaaS designs, builds, and tests customer applications (Linthicum, 2009). It enables cloud clients to control the software application; however, it is important that application developers know how to use the programming language provided by the vendor (Chou, 2015).

The main advantages of adopting PaaS are, first, the low cost, and second, the ability to access the enterprise environment, which allows developers to create enterprise applications. The disadvantage is that the service provider may lock the service on to a specific platform, which may result in technical difficulties in the case of changing provider. PaaS service providers have no standard programming language and interface; therefore, it is very difficult for customers to move from one service provider to another (Linthicum, 2009).

2.6.7 Integration-as-a-Service (IGaaS)

This service enables users to integrate different service applications, including their interface and design. It offers a solution for connecting different files and applications through a web interface (Linthicum, 2009). It must provide four main functions: transformation, routing, interface and logging. In transformation, the service converts information from one system to another, which means that the receiver system will fully understand the information from the sender system after the conversion process. Routing refers to the predefined logical connecting of information, which is also known as intelligent routing.

Through the interface in cloud service integration, the customer can connect with the target application or software despite differences in software interfaces. Finally, logging refers to the ability to access all integrated software, such as control messages. However, the customer may find it very difficult to integrate some customised applications.

2.6.8 Infrastructure-as-a-Service (IaaS)

IaaS offers virtual servers, virtual storage, and any virtual hardware instead of physical in-house resources; cloud customers can access any virtual hardware resources remotely (Landis & Blacharski, 2010). IaaS can deliver all other cloud services, and any resources in a traditional institution’s data centre. According to Aumueller (2010), the concept originated under the hardware-as-a-service umbrella, and later became IaaS.

IaaS can be used at universities to satisfy students’ and researchers’ specific requirements, such as simulation in engineering projects, which require high-specification hardware (Pardeshi, 2014). The first advantage of IaaS is that it enables cloud customers to access any expensive data centre, which may contain supercomputers (Linthicum, 2009). Customers may access these resources because they own them. The second advantage is that the cloud service vendor takes full responsibility for hardware maintenance, support and upgrades. Such advantages reduce concerns about maintenance, in addition to removing the need for a technical support team, which obviously lowers the cost.

Finally, since this service is hosted remotely on a network, the customer is able to access the resources outside the institution at any place and time. IaaS offers resource flexibility and scalability. Such features enable the cloud customer to upgrade resources in accordance with actual need, simply by adding additional CPU cycles or storage. IaaS also has flexibility to downgrade the resources at any time (Velte et al., 2009). This degree of simplicity with regard to infrastructure resources is almost impossible when using traditional hardware resources.

IaaS does, however, have many disadvantages. For example, cloud customers have no full control over physical resources, and in some cases the cost of these physical resources could be less than the cloud bandwidth payment. Therefore, it is important for institutions to assess whether or not they really need to move towards IaaS technology, according to their own requirements.

2.7 Cloud computing deployment models

Deployment models concern the physical environment of a cloud computing system (Hamdaqa & Tahvildari, 2012). This includes the physical location, the infrastructure facilities, and the cloud technology platform. Accordingly, cloud deployment is categorised by the service type provided by the cloud vendor: public, private, hybrid or community cloud (Chang, 2015).

2.7.1 Public cloud

According to a definition provided by Armbrust et al. (2010), the public cloud is “cloud made available in a pay-as-you-go manner to the general public”. That is, it is a general open model, in which the cloud service provider has full control and ownership of the service applications (Chang, 2015). The public cloud is considered a cost-effective solution for institutions, since it offers a wide range of applications.

However, the public nature of this service, which enables sharing resources among multiple organisations, might decrease security and privacy when compared with other deployment models (Hamdaqa & Tahvildari, 2012). Amazon, Google, and Microsoft are prominent examples of this model.

2.7.2 Private cloud

According to Armbrust et al. (2010), the private cloud is defined as the "internal data centre of a business or other organisation, not made available to the general public". It is an internal cloud that offers customers the options of owning or leasing a cloud service (Hamdaqa & Tahvildari, 2012).

In this model, the cloud infrastructure works solely within a single organisation, providing it with more control and management capabilities. Therefore, organisations can adopt their own policies in matters of privacy and security. Despite these benefits, the private cloud is an expensive option compared with other deployment models (Ngeru & Bardhan, 2015), but it is strongly recommended for organisations seeking high levels of privacy and full control over their data.

2.7.3 Community cloud

This model offers services to several institutions that share the same interests (Chang, 2015). The cloud community model enables one or more parties (cloud community members or third-party service vendors) to share the hosting of the cloud infrastructure (Nwobodo, 2016).

Accordingly, this model is considered to be more trustworthy than the public cloud and less expensive than the private cloud model. However, the fixed amount of resources that are shared between the same community members may reduce the performance or quality of services. The community cloud is considered a good option for large institutions that include many branches in scattered locations, but which share the same policies and rules (Nwobodo, 2016).

2.7.4 Hybrid cloud

Hybrid cloud systems consist of two or more cloud deployment models (Chang, 2015). Institutions may implement a hybrid cloud to fulfil different requirements. For example, they may use the public cloud for non-critical information, while maintaining control over sensitive information through adopting the private cloud model (Marston, Li, Bandyopadhyay, Zhang, & Ghalsasi, 2011). Such merging of models offers both cost benefits and the potential to improve security and privacy (Goyal, 2014).

However, hybrid clouds are considered more complex than other deployment models due to the nature of their composition, the implementation and management of which requires high-level technical skills (Rountree & Castrillo, 2013).

2.8 The use of ICT and cloud computing in developing countries

This section describes the use of ICT and cloud computing technology in developing countries and the importance of technology adoption. Developing countries have usually been left behind in the adoption and implementation of cloud computing technology (Sabi et al., 2016). Under-utilisation of such technology has negatively affected economic growth, knowledge sharing, and the quality of higher education.

According to Stein et al. (2013), cloud computing can increase efficiency in education, improve its quality, and reduce overall ICT costs. This has been observed in several education institutions in East Africa (e.g. the University of Nairobi, the Kigali Institute for Education, and the Kenyan Methodist University), which collaborated with Google to gain significant benefits from Google Cloud applications for both students and lecturers (Sultan, 2013a).

In Ethiopia Microsoft has supported education institutions by rolling out 250,000 laptops to lecturers. All of these laptops run Windows Azure, an operating system on PaaS (Sultan, 2010). Lecturers may use Windows Azure to upload and download curricula, and securely transfer students' records to the education system. These releases education institutions in Ethiopia from investing heavily in data centres or in the expensive hardware and software necessary for connecting such a large amount of transactions.

In a large longitudinal study, Shirazi, Gholami and Higón, (2009) investigated the impact of ICT on the economy of 11 countries in the Middle East (Jordan, Oman, Yemen, Saudi Arabia, Qatar, Syria, the United Arab Emirates, Bahrain, Iran, Kuwait and Lebanon). The study concluded that there is a strong correlation between economic growth and utilisation of ICT. It also showed that countries such as Jordan, Kuwait and Bahrain, which have flexibility in roles and policies, were able to achieve benefits from ICT such as improving social economy; other countries, such as Iran and Syria, were less advantaged by ICT because of government constraints and policies which prevented the growth of an ICT infrastructure.

In their excellent study of cloud computing adoption in Oman, Sharma, Al-Badi, Govindaluri, and Al-Kharusi (2016) were able to show that job opportunities are closely linked to the adoption of cloud computing at the individual level, as Omani firms prefer to hire employees who have experience in the new technologies. In addition, these employees are highly motivated to improve performance and their own skills in using innovative technology in future tasks. The same study concluded that other factors, such as perceived usefulness, self-efficacy and trust, positively influenced the adoption of cloud computing technology by organisational users.

Truong, Pham, Thoai and Dustdar (2012) argued that universities in developing countries face many challenges, which can be characterised as:

- A limited amount of resources compared to a high population rate. This leads to competition among students to secure a seat at these universities.
- Expensive, high-quality resources are unavailable. As a result, the technology currently available in universities lacks the capacity to solve complicated and advanced scientific problems. These resources can only assist in small projects.
- The universities' resources, such as computer labs, are unavailable outside class hours. Therefore, students are restricted to specific hours in which they can use university facilities.
- Lack of communication and knowledge sharing between lecturers and students outside the classroom.

In theory, cloud computing resources can be used in developing countries using the same approach as in developed countries (Sabi et al., 2016). Cloud computing promises to provide almost unlimited computational power at a low cost (Lin & Chen, 2012). These benefits may solve the problem of limited resources and difficulties in accessing advanced technology (Truong et al., 2012). However, utilising cloud-computing services in an effective way requires a well prepared infrastructure, such as high-speed Internet for uploading and downloading resources (Sultan, 2013a).

In developing countries, the barriers to adopting cloud computing in universities include cost and payment methods (Truong et al., 2012), problems with electric power stability and poor broadband infrastructure (Greengard, 2010), lack of awareness (Scholtz & Atukwase, 2016), security and privacy concerns (Sabi et al., 2016), and a lack of cloud computing technical experts (Truong et al., 2012).

- Cost and payment method: Although cloud computing ultimately reduces the cost of ICT through reducing physical infrastructure, it is still expensive for universities in developing countries. In addition, the service providers usually accept only electronic payment by credit or debit card. This payment method is a problem in developing countries, which still prefer traditional methods rather than online banking, due to the limitations of their online services. This lack of online payment services may hinder the adoption of cloud computing in HE institutions.

- Problems with electric power stability and poor broadband infrastructure: In many developing countries, the power supply might be shut down unexpectedly, disrupting the process of uploading and downloading, especially if there is a large amount of data that depends on automatic tasks (e.g. scheduled backups of student records).
- Lack of awareness: According to Rogers (2003), the first stage in new technology adoption is awareness about the technology. In a study to determine the reasons for the adoption of cloud computing in universities in developing countries, Sabi et al. (2016) found that awareness of cloud computing's benefits is strongly and positively correlated with its adoption. This study suggests that the level of awareness of the benefits of cloud computing is the main factor influencing the decision to adopt it at universities in developing countries.

  In the same vein, Truong et al. (2012) argued that increasing awareness in developing countries about the main benefits and challenges of cloud computing is fundamental. The education context is very different from that of developed countries in terms of culture, attitudes towards technology, individual behaviours, and resistance to new technology.
- Security and privacy concerns: A recent study by Alkhater, Wills and Walters (2014), which investigated the intention to adopt cloud computing services in Saudi Arabia, noted that security and privacy were the main concerns. However, the main weakness of the study was its failure to address precisely how these factors prevented the adoption, and to address other factors that could have affected it. Another study by Massadeh and Meslah (2013) found that security and privacy are the main barriers to adopting cloud computing at JHEIs.

Massadeh, Al-Lozi and Darawsheh (2015) concluded that universities in Jordan would benefit from the adoption of cloud computing. They argued that many of the factors relating to cloud computing adoption, such as compatibility, complexity, security and privacy, would not be a concern in the adoption process. The main weakness of Massadeh and Meslah's (2013) study is its failure to address the ways in which its findings relate to the adoption of cloud computing in the context of Jordanian education, or to distinguish between these factors. They argued that a hybrid cloud would be the best approach for Jordanian universities, but offered no justification for this recommendation. Finally, their paper would have been more convincing if the authors had described the methodology used in this study.

Accordingly, a serious weakness with Masadeh et al.'s (2015) study is that it is over-ambitious in its claims, since it failed to categorise Jordanian universities according to factors like size, budget, total number of students, total number of staff, and level of ICT adoption. Such factors may significantly affect the decision to adopt cloud computing (e.g. the Hashemite University is a wealthy academic institution, always looking to adopt new technological innovations, while the Applied Science University suffers from financial problems). Jordan has 31 universities in total, 21 private and 10 public. The sample in this study only consisted of public universities without any justification for excluding private universities.

Although the relative advantages, compatibility and complexity are clearly presented, there is little concern for participants and institutions. This is unsatisfactory because the adoption of cloud computing in all Jordanian universities is still in its infancy. Another weakness is the authors' failure to declare the full extent of the research context. Although they mentioned in the paper's abstract and introduction that the study scope was only public universities in Jordan, in the body of the paper they also referred several times to companies. Furthermore, the study failed to consider the barriers to cloud computing adoption within the Jordanian education context.

Weber (2011) argues that the main barrier to cloud computing adoption in the Middle East is the culture of privacy, giving the example of the negative consequences of releasing a female student's photograph to the public at one of the universities in Saudi Arabia. However, Weber does not take into account the significant increase in the use of social networking websites in the Middle East, where the majority of users uploaded their personal photos on websites such as Flickr.

From the above, it is clear that further investigation into the adoption of cloud computing at HE institutions in developing countries is needed. The literature failed to report the main factors influencing cloud computing in developing countries in general, and in Jordanian universities in particular, and how these factors significantly affect such adoption. In addition, much uncertainty still exists about how to adopt cloud computing in educational institutions in developing countries.

Unlike the study by Massadeh et al. (2015), this thesis will focus on both public and private universities in Jordan, and will detail the methodological approach taken. In addition, this research will analyse all the factors affecting the adoption of cloud computing in JHEIs, develop a realistic framework for its adoption, and take into consideration environmental factors related to the context of developing countries, specifically Jordan. It will also highlight new factors that may emerge from the study.

2.9 ICT adoption: Main enablers and barriers

A number of authors have considered the important role that ICT plays in delivering high-quality education (Mason, 2005; Sari, 2013; Tongkaw, 2013). Although the adoption of ICT in HE has a significant role in improving the quality of education and increasing economic growth, the implementation process faces considerable barriers. In a study to determine the main barriers and potential enablers of ICT adoption in Turkish educational institutions, Goktas, Yildirim and Yildirim (2009) found that the main barriers were training limitations, a shortage of software materials, a lack of hardware and infrastructure, weakness in technical support skills, and cost determinants**.** On the other hand, the same study suggested possible solutions: developing a professional plan for technology adoption, providing suitable training, offering professional technical support, and increasing the hardware and software budget. The study would have been more interesting if it had included a categorisation for each academic institution according to its ICT adoption level, which would enable the reader to understand the variety of academic institutions in relation to the level of ICT adoption.

Khan, Hossain, Hasan and Clement (2012) found that the main barriers to the implementation of ICT in the education context in developing countries were a lack of infrastructure, such as computer and network resources, a lack of skills and basic knowledge in technology, and insufficient funds available for education to adopt ICT. Finally, poor planning and a lack of clear vision from government and educational institutions, along with social and cultural factors, may be considered central barriers to ICT adoption.

Many authors have categorised the barriers to ICT adoption as extrinsic and intrinsic, according to different criteria. According to Ertmer (1999), the extrinsic barriers are considered first-order barriers, and include limitations in equipment, lack of time, and lack of training and support. The intrinsic barriers, on the other hand, which are considered as second-order, include teachers' beliefs regarding the teaching and learning process, attitudes towards technology, and practices in using technology. Possible solutions would involve utilising practical strategies to eliminate these barriers, encompassing more than just a basic knowledge of using technology. Instead, teachers need to design effective programmes to improve the use of technology by increasing their own basic IT skills to a professional level. These programmes should motivate students to use technology as an important resource in research, as well as improving collaboration and teamwork between students. However, to create such professional programmes for students, a professional training programme for teachers must be available first.

In another major study, Balanskat, Blamire and Kefala (2006) divided barriers into three levels. The first is teacher-level barriers, which include teachers' lack of ICT skills, feelings of doubt, a lack of confidence about using technology, lack of motivation and competence, and insufficient training programmes to enable them not only to learn basic skills but to transfer ICT into the classroom in a professional way. The second is school-level barriers, which include poor infrastructure quality (such as hardware and software), lack of access to ICT resources, and poor planning and experience in the adoption of ICT. The third level is system-level barriers, such as the inflexibility of the learning system, inflexibility of the organisational structure, and the inability to change the current curriculum for fear that changing current traditional systems to new systems may produce poor results.

In the same context, Chen, Tan and Lim (2012) examined adopting ICT in educational institutions by a comparative case study, observing teachers before and after using e-learning portals. The study concluded that the main barriers to ICT adoption were lack of time to prepare and plan for ICT-related lessons, low-quality infrastructure, and slow computers. Other barriers were lack of the software licences required, inflexibility of curricula which contained old content and traditional learning activities, and limited IT skills.

Reaching similar conclusions, Albugarni and Ahmed (2015) explored factors necessary for the successful adoption of ICT. They found that the main barriers were: lack of ICT planning and strategies, limitations in infrastructure and access to ICT resources, lack of training programmes for teachers and staff, limitations in access to technical support teams and, finally, attitudes, beliefs and behaviours which considered ICT systems as negative.

One large longitudinal study investigated the adoption of ICT in educational institutions in 26 countries. Pelgrum (2001) concluded that obstacles to ICT adoption could be placed in two categories, material and non-material. The main obstacles in the material category were a lack of computer availability, insufficient knowledge and skills, and a shortage of software, while the non-material category encompassed such obstacles as the difficulty of ICT integration in education curricula, insufficient teacher time, and problems with technical support teams.

A study conducted by Shadreck (2015) showed that the main barriers to adopting ICT in educational institutions included poor infrastructure, lack of equipment and resources, lack of training, and insufficient technical support. The same study recommended that governments, through the public and private sectors, should provide the necessary training and equipment to eliminate barriers to ICT adoption.

Based on the above literature, it is clear that researchers have reported similar enablers and barriers influencing the adoption of ICT. Since cloud computing is only a single element of ICT, different barriers and enablers may present themselves. For example, cloud computing overcomes the limitations of hardware, software licence, and technical team support by passing responsibility to the service providers. Additional barriers have arisen in cloud computing, such as security, vendor lock-in, compatibility with in-house technology, and observability of benefits. Further discussions of these enablers and barriers are examined in chapter five, and chapter six.

2.10 Jordan: The context of the research

This section provides background to the country that forms the focus of this study. The first part briefly reviews Jordan's geography and climate, basic education system, HE system, and economy. The second part discusses ICT in Jordan, the need to adopt technology, the relationship between ICT and economic development, cloud computing technology as an infrastructure solution for ICT, and the link between ICT and the quality of higher education.

2.10.1 Jordan: Overview, geography and climate

Jordan is a small country situated in the heart of the Middle East, and is considered a developing country (Stjernswärd et al., 2007). It is bordered on the north by Syria, on the east by Iraq, on the west by Israel, and by Saudi Arabia to the south and east, with the Gulf of Aqaba to the south (see Figure 2.3). The total area of Jordan is approximately 96,188 square kilometres (Al-Deseit & Al-Sharafat, 2009). The official language is Arabic, with English considered the first foreign language (Dweik, 2000).

In general, the country has warm, dry weather, with an average temperature of 12 to 25 degrees Celsius, rising in summer to as high as 40 degrees (Ghuzlan & Al-Khateeb, 2013). According to Patai (2015), Jordan is divided into three geographic zones. The first is to the west of the mountains in the Rift valley, which is located along the length of the country and continues 1,312 feet (400 metres) below sea level in the Dead Sea, the lowest point on earth. The second zone is the desert area, located in the south and west; covering two-thirds of the country, it is considered to be an extension of the Arabian Desert, although there is a small amount of rain which nourishes low plants (Al-Tabini, Al-Khalidi, & Al-Shudiefat, 2012). The final zone is the mountains, which extend from north to south. Many rivers cross these mountains, finally pouring into the Dead Sea or the River Jordan.

Figure 2-3 Map of Jordan (Lonely Planet, 2017).

2.10.2 The Education system

The education system was established in the early 1920s. From then until the present day, the government has aimed to support and improve it (Burke & Al-Waked, 1997). Its development has been dramatic. The continued increase of the population of Jordan encouraged the government to offer free education at both primary and secondary levels (Qablan, Abuloum, & Al-Ruz, 2009). To access the third level, HE, the student must successfully complete the primary and secondary levels, which last for 12 years.

HE in Jordan consists of two main stages: an undergraduate level of Diploma and Bachelor programmes, and a postgraduate level of Master’s and doctoral degrees. The Master’s degree requires a minimum of one year, with a two-and-a-half-year maximum, at the end of which students complete their study by writing a thesis or passing a comprehensive exam. The doctoral degree, unlike the Masters, takes three to four years to complete, and writing a thesis is mandatory. The number of postgraduate students in Jordanian universities is restricted, due to limitations in specialised programmes and places offered by universities.

Statistically, in 2014 310,606 students were enrolled at undergraduate level, with 14,783 masters and 2,362 PhD students. Overall, 29,379 international students were registered at JHEIs (Badran, 2014).

To improve the quality of higher education in Jordan, a major initiative by the government established the Higher Education Accreditation Council (HEAC). According to Badran (2014), quality assurance and accreditation in Jordanian universities expanded rapidly, as follows:

1. The Accreditation Council was established in 1990 to:
   - Set standards for both public and private universities.
   - Provide standard measures for quality assurance.
   - Create a monitoring system to ensure compliance with quality standards.
2. HEAC was established in 2007 to:
   - Replace the Accreditation Council.
   - Improve the quality of JHEIs.
   - Establish the National Centre for testing all HE specialisations.

   The vision of HEAC: To raise the standard of specialisations and faculty members in Jordanian higher education institutions to internationally recognised standards.

   Aims of HEAC

   - Setting standards for quality assurance and accreditation in Jordan.
   - Monitoring universities to ensure quality and accreditation standards.
   - Encouraging cooperation between HE in Jordan and international research centres through conferences and meetings.
3. An ad hoc committee was established in 2011, the main objective of which is to create a ranking system of Jordanian universities, based on student outcomes, research output, facilities, faculties, finance, and university programmes.

Despite the considerable efforts made by the government to improve HE, one of the most significant challenges to Jordan's education system is the gap between HE outcomes and labour market needs, especially in the field of technology (Mofleh, 2008). This gap has led to increased unemployment levels because of outdated teaching methodologies, a lack of training, and infrastructure limitations (Al-Omari, Rumman, Majali, & Shra'ah, 2012).

2.10.3 Higher education in Jordan

The first public JHEI, Jordan University (Jam'a Al Uordoniya) was established in 1962. It was followed by Yarmouk University in 1976, and within a short period nine more public universities. Amman University was the first private university in the country, established in 1990. Since then, another nineteen private universities have been established, bringing the total number of public and private universities to 31. In addition, there are 54 community colleges: 24 are private, 14 are public and 16 colleges are owned by the armed forces. These colleges offer professional two-year programmes in different areas, such as business, IT studies, education, hotel management and social work.

Both private and public universities have a board of trustees (BoT), Deans Council, Faculty Council and Department Council. In private universities, the BoT consists of a chairman and fourteen members, while public universities have twelve members and a chairman. In public universities, the BoT is appointed by royal decree, and in private universities by the Board of Higher Education.

The BoT is responsible for creating the general policy of the university, approving plans, appointing university vice-presidents and deans of schools, evaluating the university's performance, and evaluating the president of the university.

The Deans Council consists of the university vice-president and deans, who are responsible for appointing faculty members, approving the curricula of all the faculties, and monitoring and evaluating faculty members. The Faculty Council consists of all the vice-deans and heads of department. Finally, the Department Council consists of all academic staff members, and is considered the basic unit in the university academic structure. All academic members of staff participate in any decision within their department.

2.10.4 ICT in the Jordanian educational context

The government of Jordan has recognised the importance of ICT in ensuring and improving quality in the education sector (Abu-Samaha & Abdel Samad, 2007), and there has been increased interest in ICT adoption, training, and development throughout the country (Abuhmaid, 2011), especially in the education sector.

For example, in 2003 the government spent $380 million on the Education Reform for Knowledge Economy (ERfKE) programme, to improve the use of ICT in teaching and learning processes (Kubow, 2010). In the same year, the government established the Jordan Education Initiative (JEI), in partnership with the World Economic Forum (WEF), to motivate the use of ICT in education through public-private and global-local partnerships. The JEI project is supported by 17 global corporations, including Dell, IBM, Hewlett, Cisco Systems, Siemens, and Intel International, 17 Jordanian entities, and 11 government and non-government organisations, together with the backing of King Abdullah II and Queen Rania. The main principles of the JEI project are: improving the quality of education for students, providing high-level training for teachers, improving and evaluating innovative approaches, and building the public-private partnership model.

Accordingly, the JEI project has improved the curriculum by developing electronic curriculum content in subjects such as Mathematics, Arabic, Science, ICT and Physics. The Edu Wave portal was developed to enable students to use laptop computers to access electronic courses, and teachers were provided with laptops and the data necessary to present the electronic curriculum. The JEI project has been deployed throughout 100 schools, involving 80,000 students and 3,200 teachers, connected online and able to access the online curriculum.

According to the WEF (2003), the main aims and objectives of the JEI project may be summarised as follows:

1. To improve innovation in the education sector through developing creative learning solutions, with the support of international corporations.
2. To support the effective use and adoption of ICT in education through adopting a public-private model.
3. To achieve the vision of the Jordanian government in considering the education sector as a vehicle for social and economic development in Jordanian society by encouraging public-private partnership.

Through these measures, the government is concentrating on bridging the gap between HE outcomes and labour market needs, encouraging the adoption of ICT in teaching and learning processes in both public and private universities. However, despite these efforts, the gap between the educational sector and the labour market still exists, having a negative impact on Jordanian social and economic development (Al-Deseit & Al-Sharafat, 2009; Kardoosh & Al Khouri, 2005; Patai, 2015; Rajab & Baqain, 2005).

2.10.5 Jordan's economy

Although Jordan is located between oil-bearing countries, it suffers from a lack of natural resources such as oil, gas and water (Poul Alberg, Lund, & Mathiesen, 2014). It also faces many economic difficulties, such as a high unemployment rate, high population growth, poverty, and high government debt (Al Taleb & Al-Shubiri, 2011). The country has faced many economic crises over past decades; for example, in 1988 the Jordanian Dinar collapsed as a result of heavy borrowing (Harrigan, El-Said, & Wang, 2006). Another blow to the Jordanian economy occurred in 1991 with the Gulf Crisis (Swaidan & Nica, 2002). However, notable improvement in economic growth has taken place since 1996, due to new economic policies and the establishment of the Qualifying Industrial Zone (QIZ), and through trade agreements with other countries, such as the United States and Israel (Rosen, 2004). For example, in 1997, Jordan exported about $6.9 million in goods to the US, and both imports and exports in that year were about $395 million; by 2005, exports were about $1.1 billion, and imports about $1.7 billion (Twaissi, 2008).

More recently, however, the situation has again worsened slightly. Jordan's Minister of Planning and International Cooperation argued that the year 2012 was the worst economic year in the last twenty years, due to the global rise in the cost of energy and electricity (Akhorshaideh, 2013). Furthermore, the GDP growth of Jordan in 2002 was 5% compared with 3% in 1998. King Abdullah II seeks to promote economic development through a knowledge-based economy and the ICT industry, which may create thousands of jobs over time (Al-Jaghoub & Westrup, 2003).

The above discussion of Jordan's economy shows that a lack of natural resources has motivated the government to move towards focusing on education and investment in human resources. Therefore, improving the quality of HE through encouraging the use of technology may play a major role in national economic growth, and may decrease the gap between labour market needs and HE outcomes.

2.11 Theoretical framework

To explain the best approaches for the adoption of cloud computing, theories and frameworks from different publications have been examined (see Table 2.3). One of the most popular theories in technology adoption is the Technology Acceptance Model (TAM) developed by Davis (1989). The primary aim of TAM was to determine the main factors related to the adoption of technology at the level of an individual's behaviour (Lippert & Govindarajulu, 2006). The Technology-Organisation-Environment framework, developed in (1990) by Tornatzky and Fleischer, is also used here to study factors relating to the adoption of cloud computing in the context of JHEIs.

Another theory that has been widely used in several studies is Diffusion of Innovations (DOI), developed by Rogers (1995; 2010). The main aim of DOI is to provide a clear explanation of the process of adopting new technology. It is one of the most important theories to explain the propagation of innovative technology at organisational and individual levels in specific contexts, such as education.

Table 2-3 Theoretical frameworks

Theory/ Framework	Author(s)
Technology Acceptance Model (TAM)	(Davis, 1989)
Technology-Organisation-Environment (TOE)	(Tornatzky et al., 1990)
Theory on Diffusion of Innovations (DOI)	(Rogers Everett, 1995; Rogers, 2003; Rogers, 2010)

2.11.1 Technology Acceptance Model (TAM)

TAM is one of the most popular theories for studying the adoption and diffusion of new technology, such as cloud computing (Y. Y. Alshamaila, 2013; Sabi et al., 2016), at the individual level, and to clarify computer usage behaviour. Numerous studies have attempted to explain users' acceptance of new technology through TAM (Davis, 1989; Gefen, Straub, & Boudreau, 2000; Legris, Ingham, & Collerette, 2003).

TAM has been strongly validated in the field of individual predictions for new technology, receiving wide support through research on ICT adoption within different institutions (Kwee-Meier, Bützler, & Schlick, 2016; Tarhini, Hassouna, Abbasi, & Orozco, 2015; Venkatesh, Morris, Davis, & Davis, 2003; Venkatesh, 2000; Davis, Bagozzi, & Warshaw, 1989). Therefore, the model has been employed in this study to investigate the acceptance at the individual level of cloud computing adoption in JHEIs. TAM has been applied by several authors to understand ICT and cloud computing adoption within different contexts, and Table 2.4 presents some of them.

Table 2-4 Example of previous research in cloud computing based on TAM theory

Author(s)/ Context/ Study factors	**Methodology employed.**	**Summary of study**
Sabi et al. (2016). Educational context. Factors included relative advantage, complexity, compatibility, trialability, observability, cost, risk, security, age, usefulness, and ease of use.	Quantitative/Positivist	This study applied TAM to discuss the adoption and usage of cloud computing. It concluded that factors such as awareness; compatibility; cost; complexity; and risk to security have a great influence on the adoption of cloud computing within the educational context.
Militaru et al. (2016). Educational context. Perceived usefulness, perceived ease of uses, Students' attitude towards technology, risk perceived, and perceived value.	Quantitative/Positivist	The aim of this study was to examine the effects of perceived value and usefulness. The data was collected from University Politehnica of Bucharest, Romania. The findings stated that there are strong positive influences of perceived value and usefulness over the intention to adopt cloud computing technology. In addition, this study found that there is no significant effect of students' attitude towards using cloud computing over the adoption of this technology.
Gangwar, Date, & Ramaswamy (2015). Organisational context. Relative advantage, compatibility complexity, training & education top management support, perceived usefulness, and perceived ease of use.	Quantitative/Positivist	The study's purpose is to develop a conceptual framework by integrating the TAM model and TOE framework. The findings claim that competitive pressure and cloud computing service providers' support have directly affected the intention to adopt cloud computing.
Low, Chen, and Wu (2011). Organisational/ high-tech industry.	Quantitative/Positivist	This research investigates the main factors affecting the adoption of cloud computing within the high-tech industry. The study classified the factors into organisational, environmental, and technological aspects. The findings argued that relative advantages, the firm's size, and management support have a major effect on adoption. In addition, the study revealed that the influence of organisational and environmental factors on the adoption of cloud computing varied according to the study context.

Opitz, Langkau, Schmidt, & Kolbe (2012). Organisational context/ stock indexed companies. Factors included subject norm, image, experience, perceived usefulness, perceived ease of use, and intention to use.	Quantitative/Positivist	This study examined the acceptance of cloud computing through analysing data collected from stock indexed companies. The findings argued that factors such as usefulness, the image of the person who uses cloud computing technology, and perceived usefulness have a significant role in accepting the use of cloud computing. The study also suggests a structured approach that may help cloud computing service providers to improve their service.
Alharbi (2012). Government context. Factors included perceived usefulness, perceived ease of use, behavioural intention, gender, age, job domain, and education level.	Quantitative/Positivist	The aim of this study, conducted in Saudi Arabia, was to investigate the acceptance of using cloud computing at the individual level. Along with TAM, the author utilised additional factors to study the acceptance level, including the job domain, age of employee, educational level, and gender. The findings stated that all factors influenced the participants' attitude towards using cloud computing, except for gender.

As can be seen from Table 2-4, most of the previous studies that adopted TAM have employed a quantitative/positivist methodology. However, this study does not take a deductive approach, nor does it test an existing theory, as quantitative research does. The study focuses on the social reality of individuals and academic institutions and on the factors influencing the adoption of cloud computing.

TAM enables the study of the behaviour of individuals in JHEIs as well as addressing attitudes towards using innovation technology. To study such factors, it is important to gain an in-depth understanding of the factors that may influence the adoption of cloud technology as well as the behaviour of individuals regarding this technology. Therefore, this is one of very few studies adopting TAM with a qualitative methodology to develop a new framework for the adoption of cloud computing in JHEIs, through addressing the main factors of the adoption and explaining the relationship between such factors.

TAM postulates two main variables that affect users' decisions regarding new technology: perceived usefulness (PU), and perceived ease of use (PEOU). PU is "the degree to which a person believes that using a particular system would enhance his/her job performance", and

PEOU “the degree to which a person believes that using a particular system would be free from effort” (Davis, 1989, p.82).

As illustrated in Figure 2.4, attitude towards technology (ATT) affects individuals’ behavioural intention (BI) in term of adopting new technology. Although both PU and PEOU are assumed to be related to ATT, PU could be considered the more important factor, because after the adoption period, PEOU no longer affects intention, while PU continues to have a strong and positive effect (Gardner & Amoroso, 2004).

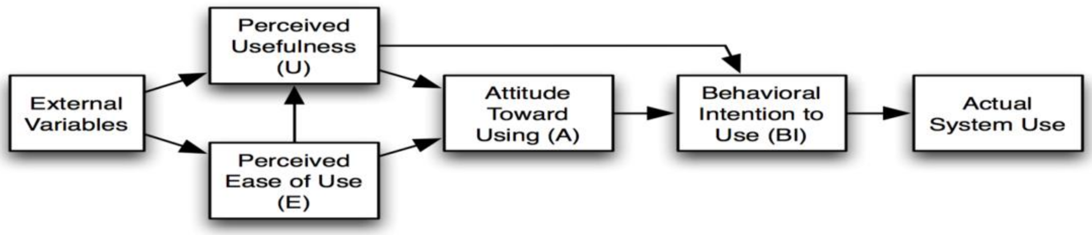

Figure 2-4 Technology Acceptance Model (Davis, 1989).

Attitude towards using technology (ATT)

ATT refers to the student's perception of using cloud computing technology in HE institutions (Khan et al., 2012). According to Harrison and Rainer (1992), a negative attitude towards technology is one of the main causes of its unsuccessful adoption in the classroom. Coffin and MacIntyre (1999, p.555) stated that as "students gain more experience with computers their attitudes towards computers should become more positive".

The study by Demiraslan and Usluel (2008) found that positive attitudes towards using ICT motivated students to use innovative technology in the learning and teaching process. Eltayeb and Dawson (2016) found that successful adoption of cloud computing in universities depends on students' attitude. In short, the individual's attitude towards using cloud computing technology plays an important role in his or her adoption of it.

Behavioral intention of use (BI)

BI is "the degree to which a student has formulated conscious plans to use or not use cloud services in the future" (Arpaci, Kilicer, & Bardakci, 2015, p.95). Chang (2008) showed that an individual's attitude towards using technology can have a positive effect on BI, while Arpaci, Kilicer and Bardakci (2015) found that BI has a positive and significant influence in using cloud computing services within the educational context. Sharing this opinion, Stantchev, Colomo-Palacios, Soto-Acosta and Misra (2014) found that students' BI is positively related to use of cloud computing SaaS tools such as Dropbox. Therefore, BI might affect the use of cloud computing at JHEIs, given the fact that it precedes actual adoption.

2.11.2 Technology-Organisation-Environment (TOE)

The TOE framework (Figure 2.5) depends on three main contexts of adopting and implementing new technology at the level of the organisation: technological, organisational and environmental (Lippert & Govindarajulu, 2006). According to Baker (2012), all these contexts strongly affect technological innovation. TOE can be used to investigate the adoption of innovative technology at the organisational and environmental levels, and has been applied in many studies, such as Alshamaila (2013); Gardner & Amoroso (2004); Lian, Yen, & Wang (2014); Low et al. (2011); Nkhoma, Dang, & De Souza-Daw (2013); Yeboah-Boateng & Essandoh (2014a); and Sabi et al. (2016), who investigated the adoption of cloud computing within different contexts.

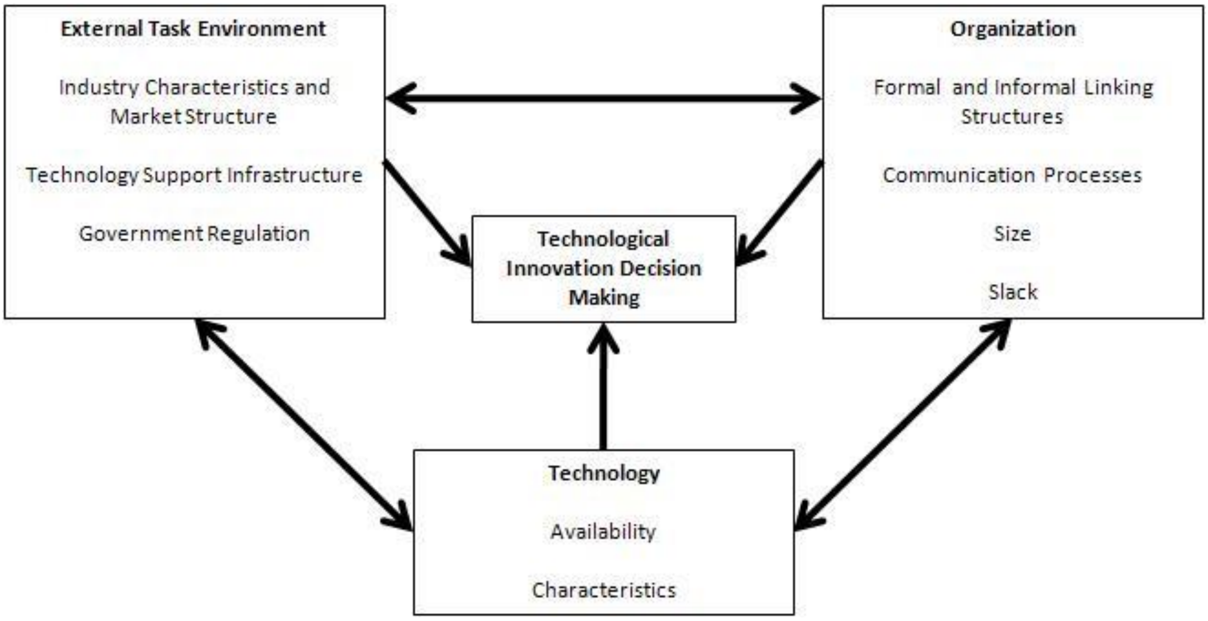

Figure 2-5 TOE framework (Tornatzky et al., 1990, p.154).

The Technological Context

The technology context refers to all internal and external technology currently in use "that might be useful in improving organisational productivity" (Lippert & Govindarajulu, 2006). Internal technology has already been adopted inside the firm, whereas external technology is available in the marketplace but has not yet been adopted by the firm (Baker, 2012).

External technology innovation may be classified into three main types: incremental, synthetic and discontinuous (Tushman, M., & Nadler, D., 1986). Innovations belonging to the incremental category introduce new versions or features to existing technology. The Microsoft Windows operating system is an example, where new versions include old versions' features, with new additional features. Computer monitors are another example of incremental technology; CRT monitors have been upgraded to LCD monitors, followed by LED technology (Baker, 2012).

Synthetic innovation refers to representing existing ideas or current technology in a novel way (Asheim, Coenen, Moodysson, & Vang, 2007), for example the presentation of educational curricula online. No new technology is used in this online content; rather, the same content is presented in a novel way, using online tools.

Discontinuous innovation refers to technology that represents a shift in concept or service (Veryzer, 1998); for instance, the shift from mainframes to PCs in companies throughout the 1970s and 1980s, or from grid computing to cloud computing technology in the early 2000s.

The Organisational Context

Tornatzky et al. (1990) stated that this refers to an organisation's internal characteristics and resources, such as institution size, available resources, its structure for adopting technological innovations, slack, and communication processes between employees. According to a definition provided by Lippert and Govindarajulu (2006, p.149), the organisational context is the "… resources available to support the acceptance of the innovation".

The organisational context varies from one sector to another, and HE institutions have characteristics that differ from other sectors, like the business or health. According to Pudjianto and Hangjung (2009), researchers who adopted the TOE framework have explained the various factors relating to organisational context such as the communication process within the organisation, the size of the organisation, and its structure.

The Environmental Context

The environmental context includes the industry structure, government, service providers and suppliers (Tornatzky et al., 1990). According to the definition of Lippert and Govindarajulu (2006), it is the "... setting in which the firm conducts business, and is influenced by the industry itself, its competitors, the firm's ability to access resources supplied by others, and interactions with the government". Therefore, the environmental context encompasses the effects of the external environment beyond the organisation's border. Organisational competitors, industry and sector type, external technology providers, and the availability of new technologies in the market are all factors that have a significant effect on decisions regarding the adoption of new technology within the organisation.

In sum, these three contexts, technological, organisational, and environmental, may present both enablers for and barriers to technological innovation at any institution. They may be considered as constraints and opportunities at the level of the firm (Tornatzky et al., 1990).

2.11.3 Theory of Diffusion of Innovations (DOI)

Everett Rogers was a Professor of Communication Studies who first expounded the DOI theory in his book *Diffusion of Innovations* in 1962. DOI is widely used in technology adoption studies, and by 2003 had reached its fifth edition.

Rogers examined the roots of DOI theory in his childhood family farm. Although neighbouring farms successfully adopted chemical innovations and reaped excellent benefits, Rogers' father at first rejected them, accepting their use only after eight years. This experience formed the core of DOI theory. Roger found a notable similarity in innovation diffusion in different contexts, such as education, health, marketing and business, as well as agriculture.

Many questions motivated Rogers to develop DOI: how does innovation spread in particular social systems? Why do some communities accept innovation while others reject it? What are the reasons for accepting or rejecting innovation diffusion? What are the types of innovation diffusion rejection?

The main aim of DOI theory is to help both organisations and individuals, whether in accepting or rejecting innovation (Fagan, 2001). Another aim is to provide clear estimates of how long it will take to adopt and accept an innovative technology (Fagan, 2001).

According to Rogers (2003, p.12), diffusion is defined as *"the process in which an innovation is communicated through certain channels over time among the members of a social system"*. This definition suggests four main elements in DOI theory: (1) the innovation, (2) communication channels, (3) time, and (4) the social system.

<u>DOI theory's main element</u>

1. **The innovation** is defined as "an idea, practice, or object that is perceived as new by an individual or another unit of adoption" (Rogers, 2003, p.62). The innovation does not need to be objectively new, and may vary from one individual or organisation to

another. If an idea appears new to an individual or organisation, it is an innovation (Rogers, 2003).

2. **Communication channels** refer to the process of creating and sharing information between individuals. As Rogers states: "the diffusion process is the information exchange through which one individual communicates a new idea to one or several others" (Rogers, 2005, p.18).
3. **Time**: There are three main aspects of the element of time in DOI theory. First is the innovation decision process, which has five stages, from the individual's first knowledge of the innovation, through to its adoption or rejection. Next, innovativeness refers to the earliness/lateness of a member's innovation adoption within the same system. Third comes the innovation rate, which is normally measured by the number of members who adopt the innovation in a particular period (Rogers, 2003).
4. **Social system**: This is "a set of interrelated units that are engaged in joint problem-solving to accomplish a common goal" (Rogers, 2003, p.37). These units could be individuals, groups, organisations, and/or subsystems. Sharing the same problem-solving process to reach the same targets can affect innovation diffusion, as can the structure and characteristics of the social system (i.e. social system units are not necessarily identical in their behaviour).

DOI theory's main stages

According to Rogers (2003), five main stages affect an individual's decision to adopt or reject innovation within a social system, from knowledge to implementation. The innovation decision process will vary from one individual to another. While some people need many years to adopt an innovation, others move rapidly from knowledge to implementation.

Table 2.5 provides a brief description of the adopting/rejecting decision process stages, as explained by Rogers (1995) through the Innovation–Decision Process Model (IDPM) (Figure 2.6).

Table 2-5 Adoption/rejection decision process stages

Stage	Description
Knowledge	The first stage, when the individuals or decision unit know about the existence of the innovation and have the opportunity to understand how it functions.

Persuasion	Consists of five characteristics: (1) relative advantage, (2) compatibility, (3) complexity, (4) trainability, (5) observability.
Decision	In this stage, the individual or decision unit decides to adopt or reject the innovation. They may continue adopting the innovation or discontinue it after a period. The decision to reject the innovation may result in continuing the rejection as a permanent decision, or deciding to adopt the innovation later.
Implementation	At the implementation stage, the actual use of innovation in real life will take place.
Confirmation	This is the final stage, where the individual or decision-making unit evaluates the outcomes of innovation. Based on these outcomes, the individual or decision-making unit finally decides to keep adopting the innovation or stop using it for some reason.

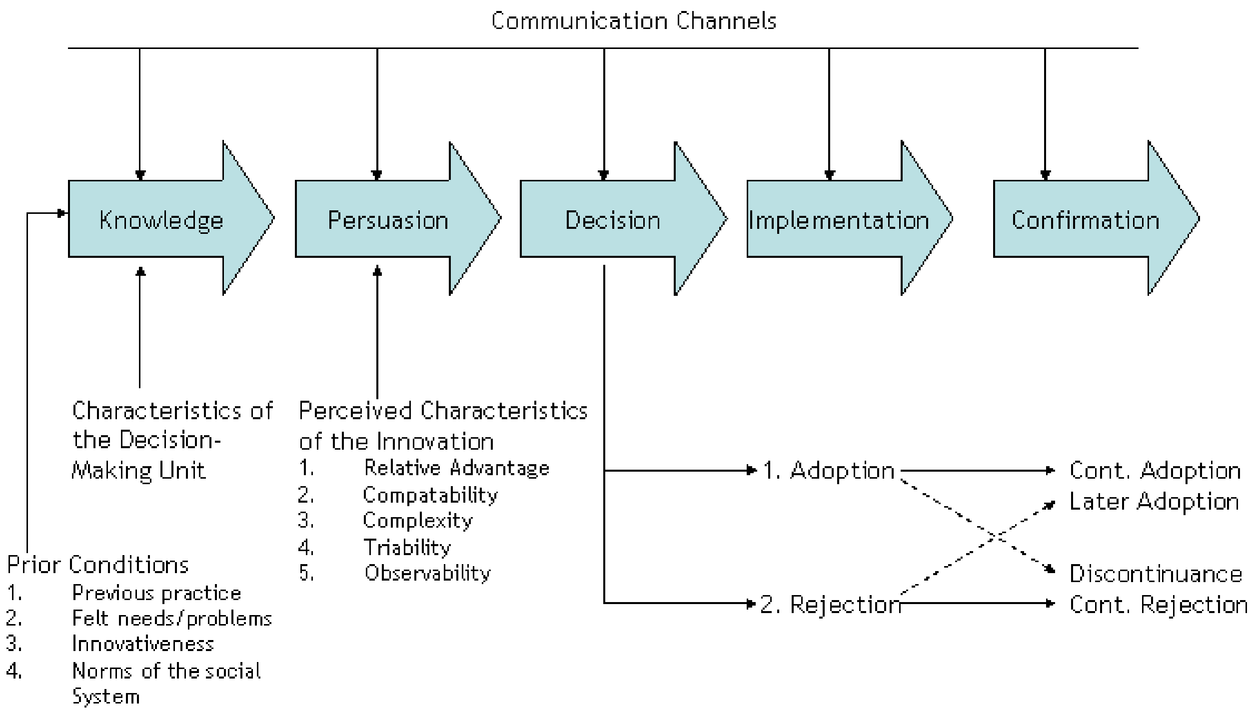

Figure 2-6 Innovation–Decisions Process Model (Rogers, 2003)

Innovativeness and adopter categories

Innovativeness is “the degree to which an individual or another unit of adoption is relatively earlier in adopting innovative ideas than the other members of a system” (Rogers, 2003, p.22). Rogers classified individuals or adoption makers according to five levels, relating to time, as seen in Figure 2.7.

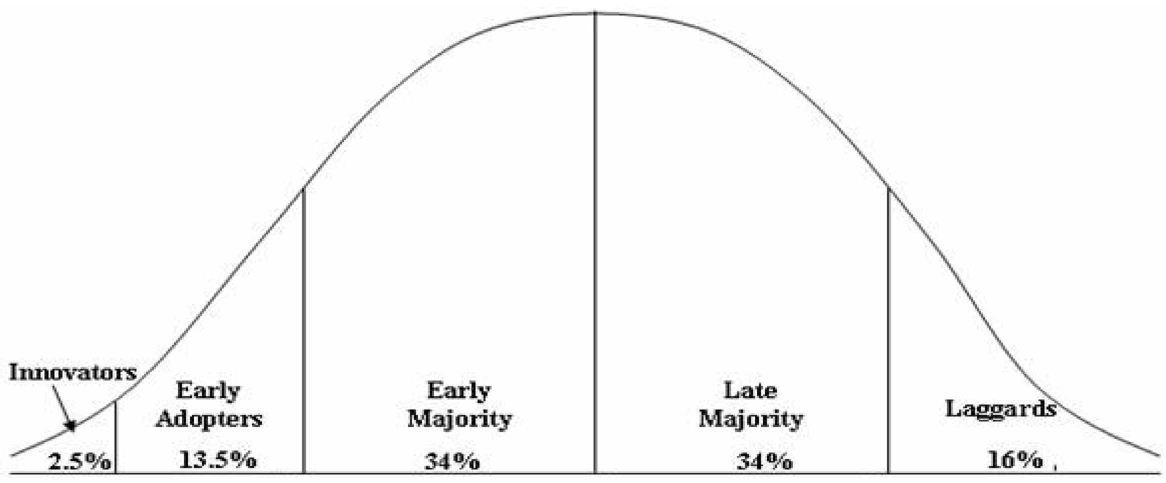

Figure 2-7 Adopters Classification of Innovation over Time (Rogers, 2003)

1. **Innovators:** Venturesome innovators may be considered risk takers. Usually they are interested and highly motivated to adopt the newest technology. According to Rogers' classification, innovators represent 2.5% of the total population; normally they have a high income and are highly educated. In addition, they have long-term vision and good awareness of the consequences of adopting the innovation.
2. **Early adopters*:*** This type of adopter is considered an opinion leader. They are usually in leadership positions, believe in change, and are always happy to adopt new ideas. Early adopters represent 13.5% of the whole social system. They are also able to provide information regarding innovation to others.

3. **Early majority:** The early majority represents 34% of adopters, who sit in the middle between early adopters and the late majority. They accept the innovation after they observe its reputation within the social system. They nevertheless accept the innovation before the population average.
4. **Late majority:** This type of adopter does not take any risks at all. Usually they have limited education levels and limited income. They take the innovation decision when the innovation level becomes higher than average. Late majority adopters represent 34% of adopters.
5. **Laggards:** The final group, who represent 16% of total adopters. They usually have the lowest income, and lowest education level, and adopt the innovation only when another innovation is taking place. They do not have sufficient confidence to accept new ideas until all other adopter groups have already accepted them.

Justification for using DOI theory in this study

The researcher has opted to use the DOI theory because it provides a clear explanation regarding the adoption process of innovative technology such as cloud computing (Oliveira, Thomas, & Espadanal, 2014; Uys†, Nleya, & Molelu, 2004). The theory is well known and proven and has been widely used in cloud computing adoption studies (Bharadwaj & Lal, 2012; Borgman, Bahli, Heier, & Schewski, 2013; Dwivedi, Papazafeiropoulo, Ramdani, Kawalek, & Lorenzo, 2009). Its main factors, such as time, social system, and communication channels, are important for understanding the adoption process of new ideas and technology by any HE institution.

In addition, DOI depends on five main attributes: relative advantage, compatibility, complexity, trainability and observability. These attributes are helpful in the case of cloud computing to enhance understanding about the factors that influence the adoption of this technology. Furthermore, these attributes can be used to explain the decision to accept or reject the technology from the perspective of HE institutions. DOI may also help in understanding how innovative technology can be transferred between different cultures, and why same innovations might be accepted in one culture and rejected in another.

Accordingly, this study has integrated the DOI theory in relation to cloud computing technology; more details are given in chapter four.

2.12 The Integrated Conceptual Model

Figure 2.8 shows the conceptual model designed for this research, which integrates the three models described above:

- Technological-Organisational-Environmental framework (TOE: Tornatzky et al., (1990), presented as an information system framework. It includes technological factors of cloud computing adoption, the organisational factors applied by HE institutions as an analysis unit, and the environmental factors based on the JHEI context.
- Information system theory presented by the Technology Acceptance Model (TAM: Davis, (1989), which focuses on factors from individuals' perspectives regarding the adoption of cloud computing technology.
- Diffusion of Innovations theory (DOI: Rogers, (2003), presenting several factors of cloud computing adoption as well as the implementation phases of cloud computing.

2.13 Summary of lessons learned from the literature

While several studies have investigated the adoption of cloud computing, only limited attention has been paid to addressing the ways in which computing technology can be implemented within the educational context in developing countries. Despite the fact that adoption theories are widely available, transferring them into practice requires further research, addressing how HE institutions can start the process.

In addition, the majority of studies assumed that technological factors are the only aspects that need to be covered. However, this results in the misguided notion that challenges to implementing cloud technology are restricted to the domain of technology. Although a few studies, such as Alshamaila (2013), have expanded their scope to include additional factors, there is still the need for further research in this respect.

From this review of the literature, four gaps may be noted:

1. There is a lack of literature that identifies potential benefits from the adoption of cloud computing technology in JHEIs.

2. There is a lack of literature relating to factors that influence the adoption of cloud computing in the context of JHEIs.

3. There is a lack of literature that identifies motivators for and barriers to cloud computing adoption in JHEIs.

4. The main gap is the limited number of available frameworks that would help HE institutions in developing countries in general and Jordan in particular to start the process of implementing cloud computing.

Accordingly, this study attempts to fill these gaps by carrying out an empirical study. It aims to provide a better understanding of all aspects of the research problem in the Jordanian higher education sector.

Therefore, the following action must be taken to address these issues:

1. Enriching the literature on cloud computing adoption by moving beyond the current limited parameters relating only to the technological domain, and extending it to further investigation of other aspects, such as implementation in the context of the educational sector of developing countries.

2. Providing a better understanding of the context of the Jordanian education sector and the reasons why this sector has under-utilised innovative information technology like cloud computing, along with investigating the main enablers and barriers to adopting cloud technology in this context.
3. A further practical study needs to be undertaken in the real world, covering the educational sector in the context of Jordan.
4. Developing a framework or model to help JHEIs implement cloud computing technology. Such a framework must include both practical and theoretical foundations, with a clear roadmap explaining the safe process of adopting cloud computing.
5. Addressing the weakness and limitations of this framework by testing it in some JHEIs, and making suitable recommendations.

2.14 Chapter Summary

This chapter reviewed the body of existing literature relevant to this study. It presented an overview of the main elements of this research: the quality of HE, cloud computing adoption within the educational context, social and economic development in Jordan, and cloud computing in developing countries.

The chapter also identified the gap between JHEIs' outcomes and the labour market, and showed that there was a lack of studies relating to the adoption of cloud computing technology in developing countries, and its effects on the quality of HE. It also suggested that there is a lack of theoretical frameworks regarding the adoption of cloud computing that could be applied to education in developing countries.

A theoretical framework has been presented, consisting of and justifying a combination of the Diffusion of Innovation (DOI) theory, the Technology Acceptance Model (TAM), and the Technology-Organisational-Environmental (TOE) framework. A combination of these theories was adopted in order to cover individual, organisational and technological levels. As a result, this literature review serves as the groundwork enabling the identification of gaps in the research that this study will attempt to fill.

3 METHODOLOGICAL APPROACH TO CONDUCTING THE RESEARCH

The previous chapter reviewed the literature relating to cloud computing technology within the context of education, and emphasised the need to develop a framework for its adoption by Jordanian universities. It highlighted a gap in the literature: the limited number of studies on the education sector in the Middle East in general, and Jordan in particular, in addressing the main factors influencing the adoption of cloud computing.

According to Zikmund (2003), research methodology refers to the research design, methods of data collection, techniques, fieldwork and data analysis. By conducting thirty-one interviews, three focus groups, 100 qualitative questionnaires, and content analysis, this research applied a qualitative methodology with an interpretive stance. The data was collected from eleven public and private universities in Jordan. To explain the research methodology, data collection procedures from the fieldwork, and data analysis, this chapter guides the reader through the methodology and research design, while chapter four presents the actual process of data collection.

This chapter, therefore, describes the methodologies that have been selected in accordance with the nature of the research problem and its context, already addressed in chapter one. It discusses the philosophies and methodological approaches employed to achieve the aim and objectives of the research.

3.1 The need for a methodology chapter

This chapter illustrates the methodology used to investigate the main factors influencing the adoption of cloud computing at JHEIs, and the approach for developing a framework to support the adoption. To understand how the research topic has been addressed, it is important to outline the overall strategy used for the collection of data and its analysis.

In accordance with Silverman (2013), this chapter will answer the following questions:

1. What are the theoretical assumptions that shaped the data collection and analysis reported in this dissertation?
2. What were the factors that made the researcher choose to work with this particular data?
3. How did the overall strategy adopted and the research design and technique used by the researcher affect the conclusions of the research?

Sections 3.3 and 3.4 answer the first question, sections 3.5 and 3.6 describe and justify the selected methodological approach to data collection and analysis, and section 3.7 explains the research design.

3.2 A definition of research

According to Hernon (1991, p.3), research can be generally defined as "an inquiry process that has clearly defined parameters and has as its aim the: discovery or creation of knowledge, or theory building; testing, confirmation, revision, refutation of knowledge and theory; and/or investigation of a problem for local decision making". Qualitative research is defined by Johnson and Christensen (2008, p.388) as "research relying primarily on the collection of qualitative data (non-numerical data, such as words and pictures)". Accordingly, qualitative research is an interpretive process, and an analysis of material that makes the world more visible (Miles, Huberman, & Saldaña, 2014). Qualitative research within the field of ICT may, however, be defined in a more specific way for this study, according to a definition provided by Gorman and Clayton (2004) as:

> *a process of enquiry that draws data from the context in which events occur, in an attempt to describe these occurrences, as a means of determining the process in which events are embedded and the perspective of those participating in the events, using induction to derive possible explanation based on observed phenomena*.

In this research, the context is the education sector and the event is the way in which IT is adopted and utilised in Jordanian universities. Therefore, the process of this event is the approaches to using cloud computing, as well as the need for more investigation of technology adoption in JHEIs. An explanation of the current situation requires fieldwork, observation, in-depth meetings, and document-tracking. The participants in this event are the students, lecturers, staff, technology experts, and other stakeholders in Jordan.

This research is qualitative in nature and is supported with statstical indicators. The data collection comes mainly from semi-structured interviews, focus groups, direct observation, secondary data analysis, case studies and a qualitative survey. The analysis will help to provide a realistic framework that depends on a deep understanding of the factors that influence the adoption of cloud computing by JHEIs.

3.3 Key concepts which support the conduct of this research

In order to define the study's theoretical assumptions as well as the main thoughts influencing the data collection and analysis processes, it is important to define some key terms, as shown in Table 3.1: the research *model;* its *concepts; theories* on which the study depends; *hypotheses*; *methodologies;* and *methods.* Silverman (2013) argued that these definitions provide a better understanding of the mechanisms of research. This section, therefore, aims to inform the reader how these terms relate to the context of this thesis. Figure 3.1 illustrates how the terms are connected.

Table 3-1 Basic research terms, adopted from Silverman (2013, p.112).

Term	Meaning	Relevance
Model	A general envisaging of the research framework that simulates the situation in reality.	Usefulness
Concept	A derived idea taken from the given research model.	Usefulness
Theory	A combination of concepts used together to explain a phenomenon.	Usefulness
Methodology	The approach chosen to study the research topic.	Usefulness
Method	A specific technique/tool to collect and analyse research data (e.g. interviews, surveys and focus groups).	Must have a proper logical relation with research terms: model, theory, and methodology.

Mental Models

The concept of the mental model was originally coined by a scholar from the University of Cambridge in 1943 in his book *The Nature of Explanation*, which describes how people represent the real word by using models (Craik, 1967). Since then, others have offered different definitions of mental models. For instance, Rouse and Morris (1986) defined mental models as “the mechanisms whereby humans are able to generate descriptions of system purpose and form, explanations of system functioning and observed system states, and predictions of future system states”. Accordingly, it is important to have a comprehensive understanding of the research problem in reality in order to describe the current system and to predict its future state. Similarly, Senge (1993, p. 487) defined a mental model as the “deeply ingrained assumptions, generalisations, or even pictures or images that influence how we understand the world and how we take action”.

A model can also be called a research paradigm (Silverman, 2013). The research paradigm provides a deep understanding of the research problem in reality, helps the researcher formulate the research questions, and develop a realistic framework to answer these questions. Models or research paradigms, therefore, can dictate the following:

- Research Ontology: According to Punch (2013), research ontology explains the nature of the reality of the research, and refers to what the reality is like. Johnson and Christensen (2008, p.14) defined ontology as the "study of knowledge, including its nature, how it is gained or generated, how it is warranted, and the standards that are used to judge its adequacy". Ontology is often used as a concept in metaphysics (Holden and Lynch, 2004). Therefore, it informs the researcher of what the reality looks like, and what the basic elements it may contain are. Here, the researcher provides different perspectives of technology adoption: the individual perspective, for example of the staff of JHEIs; the organisational perspective regarding the reality of technology use; and the organisational and environmental perspectives.

- Research Epistemology: The term epistemology is derived from the Greek words *episteme* (knowledge) and *logos* (reason) (Grix, 2002). Therefore, it refers to the reason of the knowledge, which describes what the researcher acknowledges in particular. It also concerns knowledge theory and its methods, as well as validation of gaining knowledge in social reality. Moreover, research epistemology refers to the nature of specific knowledge and the theory of such knowledge. Ontology is about understanding the knowledge, and epistemology provides the explanation of this knowledge.

In brief, ontologically the study considers the HE institutions as the unit of analysis. Epistemologically, for this exploratory nature of this research, a qualitative approach was considered appropriate as it provides deeper analysis of the highlighted factors.

Concepts

According to the definition provided by Silverman (2013, p.112), concepts in research are "clearly specified ideas deriving from a particular model". A concept could therefore be an idea or even words that represent the researcher's experience and observations (DePoy & Gitlin, 2015).

Theories

Again, according to Silverman (2013, p.112), theory is "an arrangement of sets of concepts which aims to define and explain some phenomenon". Using theories in any research plays a significant role in helping both researcher and reader to understand the previous research and studies (Myers, 2009). Silverman (2013) further argues that without theory, phenomena are considered as dead. Adopting theories, therefore, provides living entities for the research.

Methodology

Methodology refers to how the researcher will study the phenomenon. According to Adams, Khan, Raeside and White (2007, p.5), "research methodology is the science and philosophy behind all research". It refers to the researcher's choice regarding the methods that will be used for collecting and analysing the data. Moreover, methodology dives into the heart of research by providing the concepts of how to know and how to understand different approaches to answering the research questions (Adams et al., 2007, p.23).

Research Methods

Research methods "involve the forms of data collection, analysis, and interpretation that researchers propose for their studies" (Creswell, 2013, p.247). Accordingly, research methods explain the specific techniques and practical procedures that will be used for collecting and analysing the data. They can be classified as either qualitative or quantitative techniques.

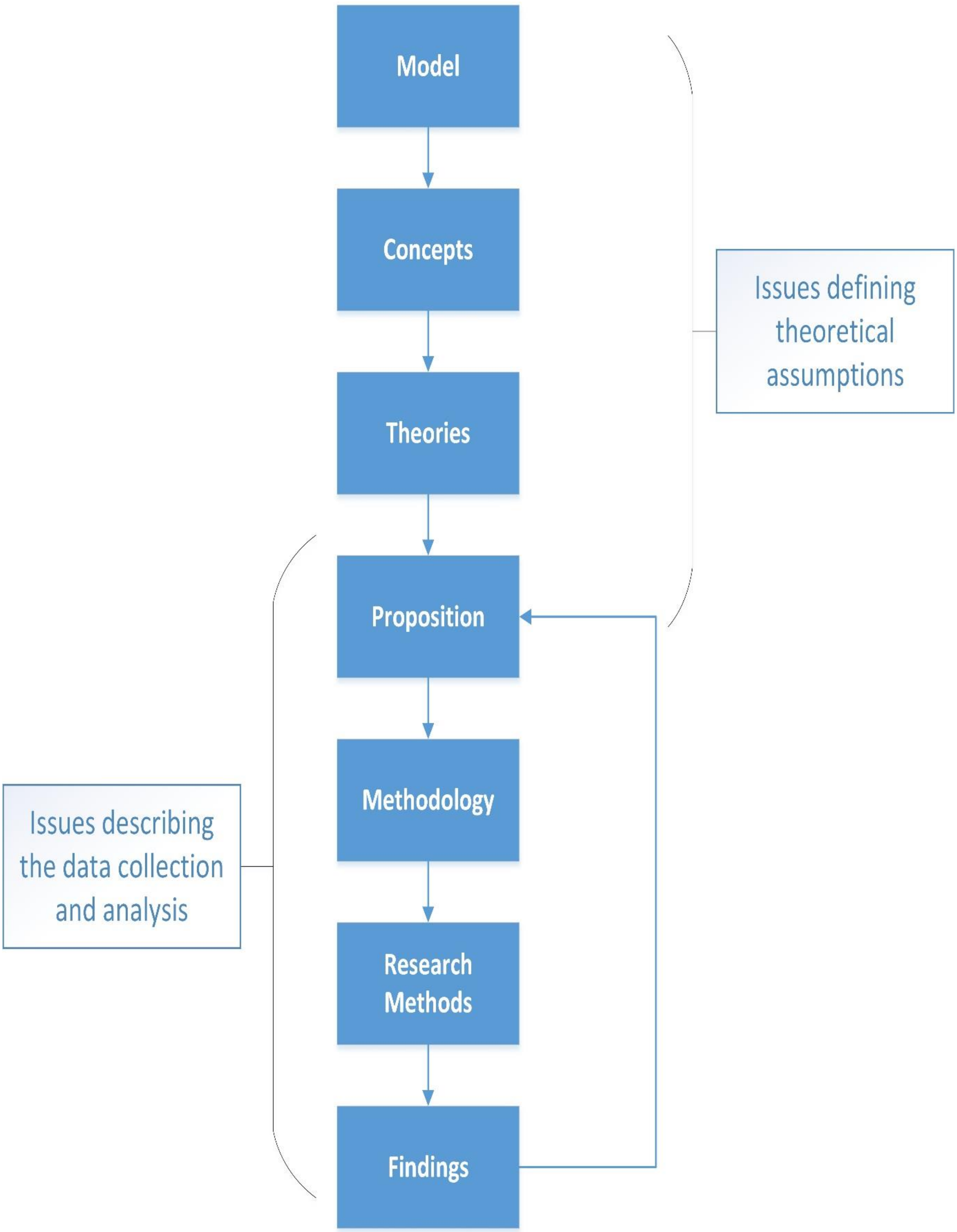

Figure 3-1 The relationship between different levels of analysis in research (Silverman, 2005, p.79).

3.4 Theoretical assumptions made in the conduct of the research

The theoretical perception implicit in this research was determined as follows:

- The research mental model

- The research ideas in the field of adopting cloud computing in the context of JHEIs, as a starting point for the research
- The concepts derived from research ideas
- The theories supporting research concepts that led to research hypotheses.

Accordingly, the section below defines theoretical perception of the research by identifying each component.

3.4.1. The research paradigm

According to Johnson and Christensen (2008, p.33), a research paradigm "is a perspective about research held by a community of researchers that is based on a set of shared assumptions, concepts, values and practices". There are three main research paradigms: positivist, interpretivist and critical analysis (Bryman, 2015).

Lincoln and Guba (1985) argued that positivist studies depend on several facts. First, the phenomenon investigated through a positivist paradigm is usually tangible and includes a clear description of each aspect. Second, the researcher is considered as an independent entity in explaining the phenomena. Third, the phenomenon's aspects have a fixed meaning and are considered to be precise, which provides the ability to generalise the findings of the study. Fourth, the methods used in the research are mainly concerned in testing hypotheses developed by the researcher during the early stages of the study, to be confirmed or rejected.

However, with respect to these facts these values are very difficult to achieve in this study, as in some areas of this research personal behaviour comes into play. For example, it would be difficult to understand participants' behaviour, such as their attitude towards using innovation technology and behavioural intention, and resistance of innovation in JHEIs, by employing a statistical approach. In addition, the researcher believes that he has a vital role in understanding the factors influencing the adoption of cloud computing and then developing a new framework for its adoption based on these factors. Furthermore, this study focuses on the adoption of cloud technology in a specific context, so generalisation of the findings could be difficult to justify without further research. Moreover, this research does not use a deductive approach, nor does it test a hypothesis as quantitative research does.

In contrast, the interpretive paradigm can be defined as "the fundamental assumption that people create and attach their own meaning to the world around them and to the behaviour they manifest in the world" (A. S. Lee, 1991). According to this definition it could be argued that an interpretive paradigm involves collecting data to understand the research phenomenon through engaging in real life (Myers, 2013). Therefore, the aim of employing the interpretive paradigm in the field of information systems could be "to produce an understanding of the context of the information system, and the process whereby the information system influences, and is influenced by, the context"

This research therefore employs the interpretive approach as a suitable paradigm to study the adoption of cloud computing in JHEIs. It operates at three levels: individual, organisational and contextual. Each of these levels has factors that will impact on how cloud computing may be adopted. Technology adoption at the organisational level is being studied from the standpoint of Rogers' (2003) DOI theory, which suggests that innovation adoption is affected by different factors such as compatibility, complexity, relative advantage, observability and trialability. The individual level is understood to depend mainly on TAM, while the environmental level is supported by TOE, which also covers the technological and organisational aspects. A further justification for the adoption of the interpretive paradigm is provided in section 3.7.1.

The third research paradigm is critical research, which aims to change social reality and enhance emancipation. (Corbin & Strauss, 2014). Myers (2013), argued that critical research is less common, but could be similar to the interpretive research. The key difference is that critical research is transformative, as it focuses on changing the current status, whereas the interpretive paradigm is explanatory and neutral in nature (Khazanchi & Munkvold, 2003).

3.4.2. Research ideas

In the early stages of this research, the researcher recognised the need to investigate the adoption of cloud computing by JHEIs through reviewing the body of existing literature relevant to the study. Additional ideas beyond this central one were derived from the gap between the labour market and HE outcomes, as well as the serious limitations of technology adoption in Jordanian universities. These ideas led to the formulation of the primary and secondary research questions as follows:

The primary research question:

How can higher education institutions in Jordan effectively adopt cloud computing technology in the learning and teaching process?

The secondary research questions:

1. How can Jordanian universities benefit from the adoption of cloud computing technology?
2. What are the main factors influencing the adoption of cloud computing in JHEIs?
3. What are the motivators for and barriers to cloud computing adoption by JHEIs?
4. What are the main phases in the effective adoption of cloud computing technology in JHEIs?

3.4.3. Research Concepts

According to these ideas, the key concepts of this research can be considered as: cloud computing adoption, enablers and barriers to cloud computing adoption, the HE context in Jordan, and relative advantages of cloud computing. These concepts were discussed in the literature review in chapter two.

3.4.4. Theories

This research focuses on combining the findings from the literature and empirical work on the topic of the adoption of cloud computing technology. In this regard, existing theories relating to the adoption of innovative technology were applied to support the research problem. Two major theories are most relevant: TAM and DOI. One framework, TOE, was also used. The empirical work collects relevant data from Jordanian universities to develop and validate a new framework for the adoption of cloud computing, and addresses the factors that influence such adoption.

3.4.5. Proposition

Informed by the research questions and relevant background literature, the following proposition was proposed:

> *Development of a framework that considers the key factors influencing the adoption of cloud computing technology would help Jordanian higher education institutions to adopt cloud computing effectively.*

3.5 Methodological approach to data collection and analysis

The aim of this section is to enable the reader to understand the approach taken in this research for both data collection and data analysis. More details regarding the actual process are provided in chapters four and five respectively.

3.5.1. Research techniques

To achieve the research aims, it is important to identify suitable tools and techniques. There are two main research techniques, quantitative and qualitative.

Quantitative research

According to Cornford and Smithson (1996, p.40), quantitative research can be defined as "research that relies on developing metrics (numbers) that can be used to describe the phenomena (objects and relationships) under study". It normally takes a deductive, theory-testing approach (Bryman, 2012), and involves measuring, comparing and analysing relationships between different variables (Denzin & Lincoln, 2011). Quantitative researchers, therefore, depend heavily on statistical data analysis to clarify their research results (Black, 1999). Quantitative researchers employ a variety methods for data collection to investigate a research question or research problem (Adams et al., 2007), as follows:

- **The quantitative survey** is usually used to collect research data from a large sample, that is the researcher asks the same questions to a large group of participants. The data collection process might be managed in person, through email, or by phone.
- **Structured interview,** in which the researcher asks questions starting with "how many" or "when". The interviewers usually use opinion polls or another selection type for gathering quantitative data.
- **Testing or measurement,** where the researcher asks questions that can be answered with "yes" or "no".

In quantitative research, the researcher is considered as an external part of the actual study. The results, therefore, are expected to be the same if the study is conducted repeatedly (Bryman, 2012). Furthermore, quantitative research uses a standard measurement to characterise the phenomena through studying factors that can be described in a comparable way (Creswell, 2013).

However, the quantitative research methodology suffers from many limitations. For example, it might not correlate with an interpretive approach, and it is not recommended for critical and in-depth study. The main aim of quantitative research is usually to prove or disprove a number of research hypotheses that the author has already established in the early stages of the research (Goodly, 2008).

Secondly, quantitative research is unable to study different social aspects of people. In addition, despite the large sample size, it tends to suffer from a low response rate (Vogt, 2007). Therefore, it is difficult to decide if the research sample can be considered as representative of a population.

Finally, misunderstandings of survey questions may not be easily discovered, since the process of data collection usually occurs within a limited time, due to the large sample size. Unnoted misunderstandings of survey questions by participants may lead to misleading results.

Qualitative research

According to Denzin and Lincoln (2011) several authors have championed the use of qualitative studies for understanding interpersonal relationships, human behaviour and daily activities. Qualitative research employs words rather than numbers, and is interpretive with the inductive approach (Gupta & Awasthy, 2015). It is suited to 'wordy' data, including interviews, focus groups, documents, and personal observations (Denscombe, 2014). It incorporates discussion, deep knowledge and understanding of the research context (Bryman, 2012).

According to Woods (2006, p.4), qualitative researchers within the academic field are mainly interested in the following: "how understandings are formed, how meanings are negotiated, how roles are developed, how a curriculum works out, how a policy is formulated and implemented, how a pupil becomes deviant". They seek reasons for individuals' or groups' experiences by observing research participants' behaviour (Gorman, Clayton, Rice-Lively, & Gorman, 2005). In addition, qualitative research utilises the inductive analysis approach, which enables researchers to develop frameworks and theories, and add new elements to the body of knowledge (Maxwell, 2012). Unlike quantitative research, qualitative research uses in-depth study to develop new approaches to solving real-life problems, rather than trying to prove hypotheses created by the researcher.

According to the literature, the characteristics of qualitative research can be summarised as follows:

- Qualitative research is descriptive. The qualitative researcher is interested in understanding the meaning of a real situation, identifying a process or processes, and analysing the phenomenon in depth, using field notes and observations (Stangor, 2014).
- The researcher's role in a qualitative study is to be the main instrument for data collection. No other "third party" instrument is required (Merriam, 1998).
- Qualitative research is evolutionary, emergent and flexible in design (T. W. Lee, Mitchell, & Sablynski, 1999). It focuses on interpretive human data because it considers subjective realities where the researcher endeavours to reconstruct knowledge (Merriam, 1998).
- The results of qualitative research are comprehensive, holistic, and provide the ability to develop theories as well as frameworks. Therefore, qualitative research is considered an endless creative process. To create a qualitative study, the researcher must take an interpretive approach (Dezin & Lincoln, 2003).
- In qualitative research, the sample is usually selective in nature, with a small, carefully chosen group of participants, whereas in quantitative studies the sample is usually random, with large numbers of participants (Merriam, 1998).
- When the research includes complex phenomena, the qualitative approach might be the best choice (Yin, 2013).
- According to Creswell (2013), research questions starting with "how" or "what" lead naturally to a qualitative approach. Therefore, for any study attempting to answer these types of question, the qualitative approach is considered the most appropriate choice (Merriam, 1998).

The main differences between qualitative are quantitative research are listed in Table 3.2.

Table 3-2 The differences between qualitative and quantitative research (Kanaan, 2009).

Qualitative research	**Quantitative research**
Inductive approach.	Deductive approach.
Selective sample.	Random sample.

Subjective.	Objective.
Focus on words.	Focus on numbers.
Focus on specific phenomena.	Focus on generalisation.
In-depth study to understand patterns and concepts.	Researchers develop hypotheses before starting the research.
What is X?	How many X?
Researcher aims to develop new theory, framework or compare patterns with existing theories.	Researcher aims to find the relationship between different variables.

The two main research approaches are applied differently. Researchers view the quantitative approach from a positivist stance, and the qualitative approach from an interpretive stance. The positivist school believes that researchers are external and independent factors in their study, and the results are usually presented numerically. On the other hand, the interpretive paradigm considers the researcher as an important variable in the research, and the findings attempt to present the viewpoints of participants based on the real word, usually by non-numerical data.

3.6 Research strategies

Case research

There are many approaches to conducting social research. One of the most popular methods is case research. While a variety of definitions of the term have been suggested, this research will use the definition of case research suggested by Benbasat, Goldstein and Mead (1987, p.370), as the examination of "a phenomenon in its natural settings, employing multiple methods of data collection to gather information from one or a few entities (people, groups, or organisations)".

Case research usually employs multiple data collection methods, such as interviews, direct observation, focus groups, annual reports and questionnaires (Bloor & Wood, 2006). An advantage of case research is that the variety of data collection methods enables comparison between cases for overall research validity (Dooley, 2002). Case research is highly recommended when the phenomena require deep understanding and field investigation.

Moreover, it enables researchers to develop new theories and frameworks through triangulating data collection techniques (Voss, Tsikriktsis, & Frohlich, 2002).

This researcher believes that applying case research to this study enables in-depth elucidation of existing issues in the JHEI context, while enhancing students', lecturers', stakeholders', consultants', and experts' understanding of the research topic. Furthermore, it enables the researcher to study the research factors in order to develop a proper framework.

Thus, case research was chosen as a research design. The decision was also based on the following four key issues (Voss et al., 2002; Yin, 2013):

- Case research provides the ability to collect data from a variety of participants.
- Case research enables the researcher to use multiple data collection methods.
- The explanatory nature and form of the research question, e.g.:
  "How can JHEIs effectively adopt cloud computing technology in the learning and teaching process?"
- The adoption of cloud computing in Jordanian universities can be studied within a real-life context, by accessing different resources from these universities and collecting data from people with different points of view, as well as from different locations where situations vary.

However, despite the benefits of the case study approach, Myers (2009) argues that there are concerns about validity and reliability. Yin (2009, p. 15) highlights additional concerns, including the significant length of time that case studies take and the huge amount of data produced. In order to overcome these challenges, the author applied the following criteria:

- Ability to demonstrate reliable research findings. In order to arrive at reliable, valid and replicable findings, the case study involves many of the JHEIs. As Yin (2013, p. 76) argues, "the evidence from multiple cases is often considered more compelling, and the overall study is therefore regarded as being more robust".
- Collecting consistent groups of data relevant to the purposes of the research. During the data collection process, the researcher sought to avoid anything which might inconvenience the participants. Furthermore, all the collected data was organised in records which included participants' contact details, dates, and the institution to which they belonged.

- Finding HE institutions that were aware of the role of technology in education, and were actively looking to improve the quality of education through implementing the latest information technologies and cloud computing. Such institutions were able to collaborate with the researcher to achieve the research aims.
- Engaging in successful collaboration with academic institutions, and making them aware of the benefits of the research and developing a framework designed to help them adopt IT effectively.

These challenges led the researcher to adopt the interpretive approach, which enables the researcher to recognise both technical and social factors (Stockdale & Standing, 2006). Moreover, the interpretive approach allows the researcher to reach a better understanding of the reality and to explore what happens in institutions, as well as understanding the behaviour of people and systems (Gupta & Awasthy, 2015). As Walsham (2006, p.320) stated, "The interpretive approach starts from the position that our knowledge of reality, including the domain of human actions, is a social construction of human actors". In brief, the interpretive approach enables the qualitative researcher in the field of information systems to understand human actions in both individual and organisational contexts.

3.7 Research design

3.7.1 The rationale of adopting qualitative methodology with an interpretive stance

The nature of the research problem associated with the epistemological and ontological orientations of this research argued that a qualitative methodology aligned with the interpretive stance would apply to this study. The arguments of Bryman (2012, p.36) justifies this:

- The research does not entail a deductive approach, nor does it test an existing theory, as quantitative research does. The emphasis is placed on the inductive approach, in which the research focuses on the generation of findings that are likely to contribute to the development of a new framework related to how cloud computing technology can be adopted and improved at JHEIs.
- The research focuses on the social reality of individuals and academic institutions, emphasising the actual factors affecting the decision to adopt cloud computing in an academic context.
- The research emphasises the factors affecting technology diffusion and adoption within JHEIs by studying both individual and organisational levels.

The adoption of cloud computing, both in general and within JHEIs in particular, is still a relatively new phenomenon (Hassan, Nasir, & Khairudin, 2017; Odeh et al., 2015; Sultan, 2014b). The implementation process of cloud computing in JHEIs is still in its infancy (see section 2.8), and there are limited studies about the factors that influence such implementation (Odeh, Warwick, & Cadenas, 2014). As a result, qualitative research is the appropriate choice for this research since qualitative research is recommended where little is known about the phenomena under study (Miles et al., 2014).

Merriam (1998, p.6) Stated that "Qualitative researchers are interested in understanding the meaning people have constructed, that is, how they make sense of their world and the experiences they have in the world". In this study, it is important to understand stakeholders' experience about the usage of ICT and the adoption of cloud computing in JHEIs in order to understand and determined the factors that influence such adoption.

The adoption of innovation technology such as cloud computing in JHEIs is considered as a complex phenomenon in terms of the security and privacy concerns, behavioural intention to use new technology, cost and budgets, attitude towards using new technology in Jordanian HE, the role of innovation technology in improving quality of higher education, and other factors (See figure 5.1). Qualitative research is, therefore, the appropriate choice when addressing phenomenon with such complexity.

Interpretive stance

The research aims can be achieved through interviewing HE stakeholders in Jordan, and through a qualitative survey, focus group, document analysis, and direct observation. Such methods enable the researcher to understand the meaning behind participants' views, and to investigate the actual factors that influence the adoption of cloud technology within the Jordanian education context (Bryman, 2015; Seidman, 2013).

As the adoption of the latest ICT, such as cloud computing, may influence and affect HE institutions' stakeholders, it is important to gain an in-depth understanding of actual technology usage and the vision for adopting information technology in this context, especially from the decision makers' points of view (Y. Y. Alshamaila, 2013; Bell, 2014).

This research is not interested in testing hypotheses to be accepted or rejected. The interpretive approach has been taken because it naturally enables the researcher to investigate in depth and uncover the main factors influencing the adoption of cloud computing technology in Jordanian HEIs.

Based on the above reasons, qualitative research with an interpretive stance was chosen as the most appropriate approach for achieving the aim of this study. Further justifications of the adoption of qualitative methodology, data collection methods, and data analysis will be discussed in detail in the next chapter.

3.7.2 Research methods

In accordance with the case study approach mentioned above, different methods were used to collect data. This process was informed by the research questions and the relevant background literature on IT in the HE context. The methods adopted were as follows:

- Conducting a pilot study before the actual study taken place. More specific details about the pilot study are given in section 4.5.1.
- Interviewing individuals within the HE institutions involved in this research.
- Qualitative survey within the HE institutions involved in this research. More specific details are given in chapter four.
- Use of flip charts, voice recorders and cameras.
- Direct observation of current ICT adoption and technology utilisation by lecturers, professors, decision makers and students.

The combination of interviews, focus groups, questionnaires, and literature enabled the researcher to collate the data and to create a report describing the research from a wider perspective. The sections below illustrate the main data collection methods used.

Interviews

An interview is a social communication between interviewer and interviewee, which aims to establish a rapport between the researcher, who is seeking data, and the participant, who may provide this data (Johnson & Christensen, 2008). Interviews can be recorded, transcribed and later analysed (Dubé & Paré, 2003).

Individual interviews are considered the most widely applied method in qualitative research (Ritchie, Lewis, Nicholls, & Ormston, 2013), since they enable researchers to investigate the personal perspective. The interview is recommended when the researcher is attempting to study a complex phenomenon (Ritchie et al., 2013). Interviews can explore people's perceptions, situations, points of view, and interpretations or explanations of reality (Punch, 2013). They enable the researcher to access people's behaviour, and realise the meaning behind this behaviour (Seidman, 2013).

For these reasons, the researcher decided to use interviews as a primary data collection method.

Interview types

There are three main forms of the interview: structured, semi-structured and unstructured (Lussier, 2011). Semi-structured interviews enable both the researcher and the interviewee to discuss the questions and share the experience in more detail. The open-ended questions typical of semi-structured interviews give participants the flexibility to express more ideas, experiences and suggestions. A structured interview does not allow for this (Brinkmann, 2013). The semi-structured interview with open-ended questions was therefore chosen, to provide the richest possible data.

Selection of participants for interview

To achieve the research aim, data from key stakeholders at Jordanian universities was required. Therefore, participants included top management, such as deans and heads of school, university professors, lecturers, and technical professionals in the field of education technology.

Storing and recording data

The researcher informed each participant that the interview would be fully recorded. Audio recording has many advantages, since it enables the researcher to make notes (for example, about the participant's facial expressions, body language or immediate responses to a question) while the participant is speaking; that is, the researcher can focus on the interview itself, rather than on writing down all the details. The recorded audio can be reviewed at any time for the purpose of analysis. Therefore, all interviews were recorded using a professional audio application installed on the iPad device. After each interview, the researcher uploaded the recorded data to a cloud computing storage application, Google Drive, to securely save a copy.

Qualitative survey

According to Newing (2010, p.66), a survey is "a study that collects data from a sample of the study population". For Punch (2005, p.75), the term survey relates to "any research which collects data from a sample of people". The main reason for using a qualitative survey was to find out the actual usage of information technology in general and cloud computing in particular at JHEIs, as well as to find out the factors influencing the use of IT there.

The questionnaire used in this study started with general questions in IT usage. After this general section, the questions became more specific, concerning Internet usage, IT in general, and cloud computing for education purposes in particular. Open-ended questions were included.

The survey questionnaires were distributed in hard copy by the researcher, who explained the importance of completing the study, and explained each question in Arabic.

Qualitative survey participants' selection

The participants in the qualitative survey included students from different levels of HE: undergraduate, Master's and PhD. They were selected from information system, computer science and engineering schools of four JHEIs, and were expected to have good awareness of and experience in using IT for educational purposes, that is were familiar with the research topic. Since the concept of cloud computing is new, most members of non-technological schools may have little knowledge of it, resulting in misleading data. Related this concept. Finally, for the qualitative approach, this sample selection is acceptable.

Documents and reports - The secondary data

Wolf (2004, p.284) defines primary documents as "standardised artifacts, in so far as they typically occur in particular formats, such as notes, case reports contracts, drafts, remarks, diaries, statistics, annual reports, certificates, judgments, letters or expert opinions". Flick (2009), describes documents as an important resource that researchers use to support the primary data.

Secondary data comprises documents that already exist, collected by different people for different reasons (Johnson & Christensen, 2008). The researcher collected annual reports, statistics and different types of document from the Ministry of Higher Education. They included up-to-date statistics, as well as useful general information and specific details about the size of universities, total number of staff, total number of Jordanian and international students, the usage of ICT and the availability of IT resources to serve students, lecturers and staff.

Direct Observation

Sekaran (2003, p.255) states, "Observational studies can provide rich data and insights into the nature of the phenomena observed. They have offered much understanding of interpersonal and group dynamics". Neuman & Kreuger (2003) added that direct observation provides the ability to understand reality. Moreover, direct observation enables the researcher to understand the process of interactions within systems, and how people deal with these interactions (Delbridge & Kirkpatrick, 1994).

The researcher used direct observation by visiting JHEIs and writing down observational notes on the use of ICT in university laboratories, online registration systems, e-learning systems, server rooms, and the ICT infrastructure. However, many issues must be taken into consideration when practising direct observation, such as the purpose of the study and ethical considerations.

3.8 A plan for the conduct of this research

According to Baran (2016, p. 67), research design can be defined as "a framework or blueprint, which gives structure and direction to show all of the major parts of the research project working together to try to address the research questions. It is the logical structure of any inquiry grounded in the research purpose and research question(s)". The research design is fundamental because it provides a framework that explains the logical connection between the study's theoretical foundation and the data collection and analysis process, aligned with research questions (Yin, 2003).

In order answer the research questions, the researcher developed a conceptual framework from existing studies, combined with the findings from the fieldwork. This framework was supported by the main factors influencing the adoption of cloud computing technology at JHEIs.

Therefore, the research design (Figure 3.2) describes the procedures that form the plan for conducting the study. The first step was choosing a topic. The second was formulation of the research problem, from noting that HE institutions' failure to use cloud computing technology will adversely affects their results. Under-utilisation of IT creates a gap between HE graduates' skills and labour market requirements.

The third step was a literature review to define the context of the research and suggest the main issues to be addressed. The fourth step was designing a theoretical framework, incorporating the DOI, TAM and TOE methods.

The fifth step was the selection of JHEIs as case studies. The sixth step was conducting the pilot study before the actual data collection process to avoid any possible ambiguities, weaknesses or limitations. After conducting the pilot study, the data was collected, as described above, and the eighth step was analysing it. Finally, the findings and results of the project were reported.

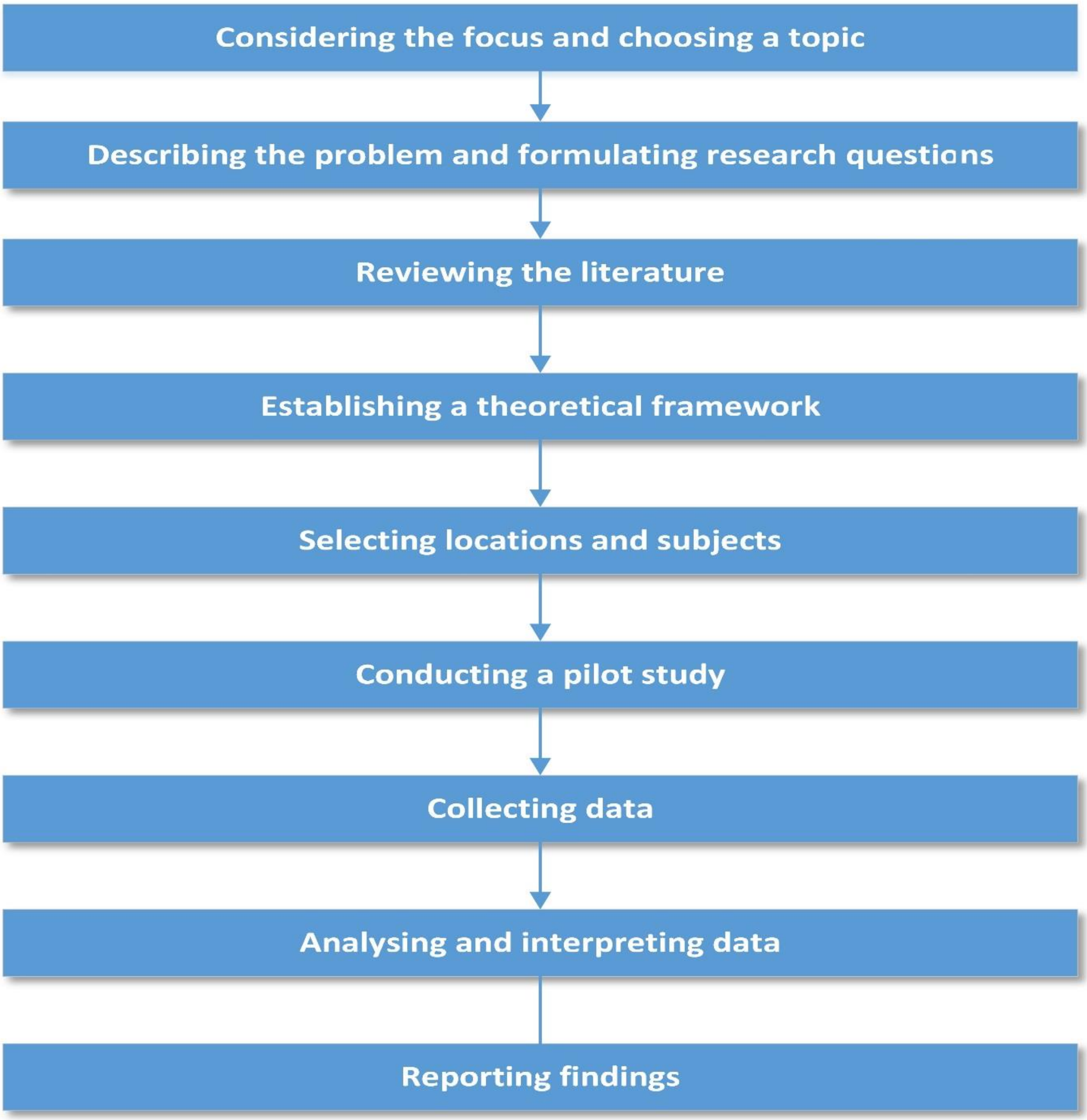

Figure 3-2 A plan to conduct this research – adapted from (Gorman & Clayton, 2004, p.37).

Triangulation

Triangulation is the process of using multiple methods and sources of data, to assure the validity and reliability of the results of the study. Denzin (1989, p. 313) stated that the triangulation process could "overcome the intrinsic bias that comes from single-method, single-observation, and single-theory studies".

Denzin (2011) identified four types of triangulation:

- Data triangulation: collecting the data from several sources.
- Investigator triangulation: many researchers explain the same ideas and the same information.
- Theoretical triangulation: different theories are applied in interpreting the research data.
- Methodological triangulation: more than one specific method is used for data collection.

This research applied three types of triangulation: data, methodological and theoretical. Data triangulation involved using data from the literature, fieldwork, the Jordanian Ministry of Higher Education, and feedback from experts in cloud computing and HE. Method triangulation involved semi-structured interviews, focus groups, surveys and direct observation. Theoretical triangulation consisted of using the DOE, TAM and TOE models in interpreting the data.

3.9 Ethical Considerations

Researchers must ensure that participants are treated in a professional and ethical manner. Ethical conflict may arise from the nature of qualitative research, which requires personal involvement with participants (Miles et al., 2014).

Coventry University's ethical policy obliges any researcher to apply for ethical approval before starting any field studies. Accordingly, the researcher received ethical approval from the university's ethics panel. In order to maximise ethical commitment and minimise any harmful consequences, the researcher also took into consideration the following:

- Meetings with participants for both interviews and the qualitative survey were held at a time convenient for the participants.
- All participants were informed of the purpose of the study and their role in it.

- Before conducting interviews or completing questionnaires, the researcher gained written approval from participants.
- The researcher informed the participants of the approximate time needed in taking part.
- The researcher assured the participants of the confidentiality of their personal data, and how this data would be saved and protected.

For full details of ethical approval (See appendix 1).

3.10 Summary of the methodology chapter

This chapter has provided an overview of the philosophical stance and the methodological approach used in the conduct of this research. It justified the selection of the qualitative approach, regarding an interpretive stance as a suitable way to answer the research question and to achieve the study's aim and objectives. It described the research design, explaining the data required, and justifying the adoption of certain data collection techniques.

The methods selected for data collection were semi-structured interviews, focus groups, document reviews, a qualitative survey, and direct observation. The concept of triangulation was presented, as well as reliability, validity and credibility. Ethical considerations were discussed.

The contents of this chapter are complemented by the description of collecting and analysing the data in the following chapter. Chapter four therefore provides an overview of the nature of JHEIs, the actual data collection procedures undertaken in the fieldwork, and the researcher's role. Chapter four presents further details of the questions that drive the interviews, focus groups and survey, and of the participants' profiles, along with justification for the selection of the participants and research sites during the fieldwork.

4 RESEARCH PROCEDURE

Following the details of the philosophical stance and methodological approach taken in this research in the previous chapter, the current chapter describes the processes of collecting and analysing the data.

The first section situates the case study in the context of JHEIs, and explains why particular sites were chosen for data collection. The second part of the chapter describes in more detail the approach to data collection and analysis. The following section, on data analysis, describes the processes of data transcription and translation, identification of themes, coding, and the creation of a thematic framework. Finally, the quality of the findings is assessed.

4.1 Rationale for selection of research location

This research focuses on Jordan. As a developing country located in the heart of the Middle East, it is an interesting case because it depends on HE institutions to provide the workforce to support the labour market (Khasawneh, 2011). Jordan is considered to have one of the most developed HE systems in the Arab world (Al-Hadrami, 2012), and the government focuses on the education sector in general and HE institutions in particular to improve human resources and the quality of graduates (Al-Khasawneh, 2012). Furthermore, while many developed countries have already dealt with the adoption of new ICT in education, this has only recently, but rapidly, become a pressing issue in Jordan (Abuhmaid, 2011). Jordan has 31 universities, distributed across the major cities. However, despite this large number compared with its size, few JHEIs are using innovative IT within an educational context. Table 4.1 shows the universities in Jordan, and their rankings within Jordan, the Arab World, and internationally.

Table 4-1 Higher education institutions in Jordan (Webometrics, 2017).

Jordan Ranking	Arab World Ranking	World Ranking	University Name
1	8	995	University of Jordan
2	25	1844	Jordan University of Science & Technology
3	29	1966	Yarmouk University
4	30	1994	Philadelphia University at Jordan
5	45	2206	Hashemite University
6	61	2589	Al Balqa Applied University
7	75	2929	Al Al-Bayt University
8	78	3052	Mutah University
9	84	3121	Princess Sumaya University for Technology
10	95	3290	German Jordanian University
11	100	3773	Applied Science University
12	-	3962	Al Hussein bin Talal University
13	-	3990	University of Petra

14	-	4351	Middle East University Jordan
15	-	4520	Al Zaytoonah University
16	-	5060	Zarqa University
17	-	7575	Tafila Technical University
18	-	10070	Amman Arab University
19	-	10437	American University of Madaba
20	-	10512	World Islamic Sciences and Education University
21	-	11058	Jerash Private University
22	-	11172	Arab Academy for Banking and Financial Sciences
23	-	12930	Jadara University
24	-	15710	Irbid National University
25	-	16061	Al Isra University Amman
26	-	17079	Jordan Media Institute
27	-	17130	Queen Noor Civil Aviation Technical College
28	-	18643	Jordan Institute of Diplomacy
29	-	18935	Jordan Academy of Music Higher Institute of Music
30	-	19008	Al Quds College
31	-	19008	Ajloun National University

In contrast to the widespread adoption of cloud computing in education institutions in developed countries, Jordan is clearly falling behind in this respect.

Given Jordan's position as a developing country, and the fact that its education institutions have only recently been confronted with the decision to adopt or reject cloud computing technology, this presents us with a unique opportunity to understand different attitudes towards the issue.

4.2 Rationale of using multiple cases in this research

According to Yin (2009, p.18), a case study can be defined as "an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident". A case study can be a rich source of data, and using multiple case studies ensures that the researcher is not restricted to one specific situation (Cornford & Smithson, 1996). According to Merriam (1998), the use of multiple cases in a research project can improve the study's validity. George and Bennett (2005) argue that adopting multiple case studies can enhance the construction of theories. In the same vein, Bryman (2012, p.67) stated that "by comparing two or more cases, the researcher is in a better position to establish the circumstances in which a theory will or will not hold".

Fletcher and Plakoyiannaki (2011) advised against random selection of case studies, as this approach will not be representative of reality. Although a random sample enables the researcher to enhance the generalisation of the study's results, it is not the most useful approach to conducting complicated studies, which attempt to explain real-world issues (Marshall, 1996). Gorman et al. (2005) stress the selection of cases that are easy to access and relevant to the researcher's inquiry.

The number of case studies selected is another important aspect (Yin, 2013). According to Ritchie et al. (2013), a suitable number of case studies can be determined based on how much information has to be uncovered and how much is comprehended regarding the research phenomena. Eisenhardt (1989) recommended four to ten applicable sites as an appropriate number based on the number of critical causal variables suggested in the study. Miles et al. (2014) pointed out that considering similar cases can add credibility to the findings of the research by presenting varying pictures of the same phenomenon. Employing a multiple case study enables the researcher to compare different contexts, and observe similarities and differences between cases (Voss et al., 2002). To develop a framework that aims to help JHEIs in the adoption of cloud computing, it is necessary to assess evidence obtained from multiple cases. Using a single case in this research would not produce sufficient information. The use of multiple cases will also improve the validation of the study's findings, because the results from each study can be collated and studied alongside one another (Yin, 2013).

4.3 Eleven cases selected for this study

Eleven Jordanian universities were selected to represent the widest range of views possible, and to identify the main factors influencing the adoption of cloud computing technology. They were selected based on their recognition of this research topic as a major issue to confront, as well as on their current levels of ICT utilisation in teaching and learning. Those universities already using ICT, or with some experience of it, were favoured, as were those interested in adopting innovative technologies such as cloud computing to improve the quality of education, as recognised from their vision and mission statements. According to Williams (2008), a mission statement can define the aim and objectives for any institution, and may be a useful tool in understanding what an institution is trying to achieve. Those universities that included the adoption of innovative technology in their mission statements were prioritised, from both public and private sectors in order to improve the applicability of the results.

In addition, following the views outlined by Gorman and Clayton (2004, p.84), the research sites were selected according to the following criteria:

- Access (in terms of being allowed entry) is possible.

- There is a high probability that the appropriate mix of features (processes, people, programmes, interactions, structures, and so on) is present.
- The researcher will be able to build interactive relationships with study participants.
- Data quality and credibility of the study are likely to be ensured.

In addition, the researcher took into consideration some restrictions such as the time framework, budget, cooperation level, and the ability to share annual reports and documents.

Table 4.2 shows the selected universities.

Table 4-2 Jordanian universities taking part in this study and key fieldwork dates

#	Higher education institution name	Total number of students	Total number of staff	Key fieldwork dates
U1	University of Jordan	38536	1436	22 December 2015 to 2 January 2016
U2	Hashemite University	27118	627	03-10 January 2016
U3	Amman Arab University	8270	112	11-18 January 2016
U4	Applied Science Private University	7008	255	20-27 January 2016
U5	Al-Isra University	5349	229	28 January - 4 February 2016
U6	Middle East University	2552	184	6-13 February 2016
U7	Philadelphia University	6906	288	14-20 February 2106
U8	Jerash University	3923	193	21-28 February 2016
U9	University of Zarqa	6610	308	1-2 March 2016
U10	Al-Balqa' Applied University	33125	1458	3-16 March 2016
U11	Jordan Academy for Maritime Studies	1800	80	17-22 March 2016

4.4 Unit of analysis

One of the most important tasks for the researcher is to decide on the unit of analysis, because this is strongly linked with the data collection process. According to Slack and Parent (2006, p.23), the unit of analysis can be defined as "the focus of research; it is the heart of research. [It] can be an individual, a role, a group, an organisation, a community, and so on". Yin (2013) presents several types of unit of analysis, such as the comprehensive single case, the multiple case with several units of analysis, or multiple case studies investigating a specific issue in all institutions. This research used an inductive approach, employed a qualitative methodology, and adopted multiple case studies, considering each university as a basic unit of analysis.

4.5 Data collection and analysis

As explained in the previous section, this study adapted a qualitative methodology using triangulation of data to answer the research questions and address the research problem. Bell (2014) argued that research methods have to be effective to solve the research problem. Tellis (1997) emphasised the adoption of the triangulation methodology to enhance the understanding of the system under examination. Yin (2013) focused on triangulation to meet the ethical requirement of authenticating the validity of the research. Adams et al. (2007) argued that triangulation can be achieved by collecting data from multiple sources.

Fletcher and Plakoyiannaki (2011) pointed out that the strength of a case study is that it enables the researcher to use a variety of methods for data collection, as well as allowing the researcher to make comparisons between cases in order to strengthen the research validity. More details about the methods used to collect data for this study are presented in the following sections.

4.5.1 Conducting the pilot study

According to Saunders et al. (2007, p.606), a pilot study can be defined as "a small-scale study to test a questionnaire, interview checklist or direct observation schedule, to minimise the likelihood of respondents having problems in answering the questions and of data recording problems as well as to allow some assessment of the questions' validity and the reliability of the data that will be collected". Gill and Johnson (2005) argued that conducting a pilot study provides good feedback for the researcher, which may help in developing more accurate questions to be used in the actual data collection process with participants.

Accordingly, a pilot study was conducted to improve the validity and reliability of the actual data collected as well as to avoid any possible weakness in the research; and in addition to provide better planning of the schedule of data collection from potential research sites. During the first two weeks of data collection the researcher visited three potential JHEIs and started informal meetings with the coordinators already contacted by email. The researcher conducted three informal interviews and in addition revised the questions for the interviews, focus groups, and the survey with a professor in management information systems. In addition, the researcher asked five students to answer the questionnaire. The pilot study indicated some errors in the interview and survey questions, and accordingly some questions were modified before the actual data collection took place.

4.5.2 Interview

Rubin and Rubin (2005, p.4) described an interview as a "conversation in which a researcher gently guides a conversational partner in an extended discussion". Qualitative researchers depend heavily on the use of in-depth interviews (Marshall & Rossman, 2010), and Lindlof and Taylor (2010) argued that interviews are an essential form of interaction in society. Ritchie, Lewis, Nicholls and Ormston (2013) argued that researchers have to plan, structure, and control the interview to ensure that the data collected is related to the research topic.

Yin (2013) claimed that exploratory and descriptive research, such as this study, can be more effective if it includes in-depth interviews. As mentioned in the previous chapter, this study makes extensive use of semi-structured interviews. The researcher started with a list of potential interviewees, which included all academic staff; 45 participants were filtered on a contact list based on their research interest and academic experience, with emphasis on elite professors with professional backgrounds in the study topic and decision makers at top management levels. Information was derived from lists of academic staff, their emails, and curricula vitae publicly available on university websites. The researcher then contacted the selected universities and sent them an official request with confirmation of ethical approval, to gain acceptance to contact the potential participants for interview. All these universities welcomed this request and most sent further contact details of people to help the research, to contact more potential interviewees and coordinate visiting dates.

Some potential interviewees were unable to take part because of other commitments, but in total 31 semi-structured interviews were arranged by email for each participant to confirm the meeting date, time and location.

Interviews were conducted from 19 December 2015 to 21 March 2016, with deans of schools, heads of departments, professors in information technology, technical experts in cloud computing, and lecturers. Most took place at participants' offices or in meeting rooms booked in advance by the university staff. Table 4.2 shows the details.

Table 4-3 Jordanian universities and participants taking part in this study with key dates

Code	Higher education institution name	Dates of interviews DD/MM/YY	Number of participants
U1	University of Jordan	21/12/2015 to 31/12/2015	4
U2	Hashemite University	04/01/2016 to 11/01/2016	5
U3	Amman Arab University	12/01/2016 to 19/01/2016	3
U4	Applied Science private university	20/01/2016 to 28/01/2016	2
U5	Al-Isra University	01/02/2016 to 05/02/2016	2
U6	Middle East University	07/02/2016 to 14/02/2016	3
U7	Philadelphia University	15/02/2016 to 18/02/2016	2
U8	Jerash University	22/02/2016 to 24/02/2016	2
U9	The University of Zarqa	29/02/2016 to 06/03/2016	3
U10	Al-Balqa' Applied University	07/03/2016 to 14/03/2016	2
U11	Jordan Academy for Maritime Studies	15/03/2016 to 21/03/2016	3

Table 4.4 lists the codes of interviewees. The table correlates each interviewee with his/her university, and groups them into two categories: professors (P) and decision-makers (DM). It is important to note that decision makers in Jordanian universities could also be professors. (See appendix 11 for organisation of the participants' taking part in this study).

Table 4-4 Interviewees profiles

University code	participants code	Position
U1	P1	Professor in computer engineering/virtual reality.
U2	P2	Professor in computer science/Cloud computing.
U3	P3	Professor in management information Systems/E-government.
U4	P4	Professor in engineering/cloud robotics.
U5	P5	Professor in computer science/3D imaging/cloud computing expert.
U6	P6	Professor in computer science/wireless programming.
U7	P7	Professor computer science/E-commerce.
U8	P8	Professor in systems engineering/ Telecommunications.
U9	P9	Professor in management information systems.
U10	P10	Professor in computer science.
U11	P11	Professor in electric engineering/ Telecommunications.
U3	P12	Professor in management information systems.
U2	P13	Professor in computer science.
U3	P14	Professor in software engineering.
U2	P15	Professor in information systems/ cloud computing.
U2	P16	Professor in computer engineering/ cloud computing.
U1	P17	Professor in management information systems.
U6	P18	Professor in computer engineering.
U7	P19	Professor in software engineering.
U3	P20	Professor in management information systems/ E-commerce.
U10	P21	Professor in computer science.
U4	P21	Professor of computer engineering.
U4	P22	Professor of computer engineering.
U1	DM1	Head of computer engineering school.
U1	DM2	Head of management information systems department.
U5	DM3	Head of the information system school.

U9	DM4	Chairman of the Board of Trustees. MP, Senator & Minister of Higher Education, Jordan.
U11	DM5	University Vice Chancellor.
U8	DM6	Professor in electronic engineering/ wireless telecommunication.
U11	DM7	Professor in information systems/ IT manager in the university computer centre.
U6	DM8	Professor in computer science/ Dean of computer science school.
U2	DM9	IT manager in the university computer centre.

Following the advice of Myers and Newman (2007, p.14) the semi-structured interviews were conducted as follows:

- Introduction to interview: The researcher introduced himself to the participant at an informal meeting, around ten minutes before the formal interview, explaining the purpose of the study and the aim of the interview, and outlining the ethical considerations. He explained the estimated time needed for the interview, prepared the audio recording equipment, and asked the participant to sign the interviewee leaflet. This kind of informal meeting enabled the researcher to break the ice with participants, as well as making each interviewee feel as comfortable as possible.
- Starting the formal interview: After the participant's final confirmation to take part, the researcher started the audio recorder. The formal interview included no more than 20 open-ended questions, giving the interviewee the opportunity to explain his or her answers in detail. Yin (2013) argued that using open-ended questions in semi-structured interviews enables the researcher to gain a better understanding of the participant's views. Semi-structured interviews also allow the researcher to ask for clarification regarding the interviewee's answer (Seidman, 2013).

- The participant had the right to withdraw at any time during the formal interview without providing any reason. The interviews lasted around an hour on average, but some took longer, as the researcher gave participant time to answer the questions without interruption. Almost all the interviews were conducted in English.
- Ending the interview: After asking all the questions, the researcher thanked the participant and informed him/her that the interview transcript would be sent by e-mail for verification. Saunders et al. (2009) recommended verification of the transcript in order to control bias and enhance data reliability.

Repetition of these steps with each interviewee enabled the researcher to gain more experience in creating a comfortable atmosphere (Corbin & Strauss, 2014).

The interview questions focused on the level of ICT utilisation at the participant's institution, the level of cloud computing utilisation there, and factors influencing the adoption of cloud computing at JHEIs in general and in the participant's institution in particular. The interviews therefore, endeavoured to gain a deep understanding of each participant's view regarding the adoption of cloud computing at JHEIs, the benefits and limitations of the technology and the main challenges to its adoption by JHEIs.

The questions were tailored to obtain an understanding of participants' attitudes towards using cloud computing technology, as well as their views on the need to develop a framework to help JHEIs adopt it effectively. The interview questions and the objective of each are shown in Table 4.5.

Table 4-5 Interview questions and objective of each question

Question	**Objective of the question**
Q.1.Please describe the utilisation of ICT in your university. Please explain why you think that is the case.	Will inform framework development in the area of ICT adoption level and gauge the readiness of the institution to utilise IT in general.
Q2. Please describe your own understanding of what cloud computing means.	Will inform framework development regarding levels of awareness of cloud computing and prerequisites to adoption of cloud computing.
Q.3. Please describe the utilisation of cloud computing in your university. Please explain why you think that is the case.	Will inform framework development in the area of cloud computing utilisation levels. Assists researcher in identifying: • Prior conditions: previous practice level, needs/problem felt by institution employees. • Innovation factor: whether early majority, late majority or laggards.
Q4. The literature shows that the latest technologies, such as cloud computing, are under-utilised in the teaching and learning at higher education institutions in Jordan. Do you agree/disagree? Why?	Will help the researcher to identify relevant factors contributing to under-utilisation of cloud computing at JHEIs.
Q.5 Please describe the quality outcomes of higher education in Jordan and the quality-related factors that would influence Jordanian higher education institutions in adopting cloud computing.	Will inform framework development in the area of perceived usefulness of ICT as well as providing input regarding the acceptance of cloud computing. TAM needs to be considered.
Q.6 How could cloud computing be used as a tool to improve the processes of learning and teaching at higher education institutions?	Use TAM (perceived usefulness and perceived ease of use) to inform the research framework.

Q.7 Do you have any existing framework, model or strategy at higher education institutions in Jordan to adopt and use technology?	Will inform the framework about the TOE factors already in use (if any), and will inform the researcher about the awareness of the need for a new framework.
Q.8. How can cloud computing be introduced in the teaching and learning processes in Jordanian universities?	To help the researcher establish methods in which cloud computing could be implemented practically, in conjunction with TAM and DOI.
Q.9.Would the adoption of cloud computing technology improve the quality of higher education in Jordan?	Will inform the framework development in the area of perceived usefulness of cloud computing.
Q.10.What are the main challenges currently faced by Jordanian higher education institutions in adopting cloud computing technology?	Will inform the framework in addressing challenges related to technology, organisation, and the environment (TOE).
Q.11.What are the main benefits of adopting the latest information technologies, such as cloud computing, at higher education institutions in Jordan?	Benefits will inform the framework in understanding relative observability of advantages and benefits.
Q.12. Does the existing usage of ICT help to achieve the goals of higher education in Jordan? How?	Will provide input for framework regarding benefits of innovative technology (i.e. helping the achieve HE goals). Addresses availability, technology support, infrastructure, and government regulation factors.
Q.13. Do you have any negative experience in using current ICT at your institution (e.g. down-time, complexity, centralisation of use)?	Estimate current ICT, which will inform the framework about quality level (excellence factor) and allow an understanding of TAM factors (attitude towards technology and usability).
Q.14. How would you describe the current technology investment in higher education in Jordan compared with services available?	Addresses factors of quality in HE (mainly fitness for purpose) and Return On Investment level (ROI).
Q.15.What do higher education institutions in Jordan gain from investment in information technology? Please explain.	Will provide estimate the current, relative advantage for DOI theory.
Q.16. Do you think adopting the latest innovations in information technology at Jordanian higher education institutions could influence the unemployment level in Jordan?	Will address possible link between adoption of cloud computing and its effects on the unemployment level.
Q.17. Do you think adopting the latest innovations in information technology at Jordanian higher education institutions could influence the level of knowledge sharing?	Will address factors relating to the adoption of cloud computing and its effects on and relations with the level of knowledge sharing.
Q.18. Do you have any concerns regarding the adoption and use of cloud computing at Jordanian universities? Please describe.	Will inform the framework in relation to attitudes towards technology and behavioural intention to use.
Q.19.What are the main barriers currently faced in using ICT at higher education in the context of Jordan?	Will provide input relating to environmental special factors in JHEIs
Q.20. Is there anything else you would like to add?	Will provide other ideas or factors to support the research framework, such as environmental and social context

4.5.3 Qualitative survey

According to Fink (2003, p.61), a qualitative survey can be defined as follows: "collect[ing] information on the meanings that people attach to their experiences and on the ways they express themselves". The qualitative survey is a useful method that offers answers to questions starting with "what is" and "how" (Hays & Singh, 2011). The qualitative survey in this study was an important data collection method, since it provided the opportunity to collect information from students regarding their own experiences (Andersson & Runeson, 2002). Survey questionnaires were distributed in person by the researcher to students at the selected universities between 19 December 2015 and 21 March 2016.

It was noted during the pilot study that both lecturers and students in the scientific schools were more interested and familiar with the use of innovation technology as well as cloud computing. Therefore, the researcher believed that focusing on these schools would be more useful in achieving the aim and objectives of the study, especially with the time and budget constraints during data collection. However, such selection could be one of the limitations of the study, as the findings could not be generalised to all JHEIs' schools without further investigation (see section 8.4).

The respondents were students from information technology, engineering, computer science and management schools. They had different educational levels: undergraduate and Master's students, and PhD candidates. The researcher focused on these schools because their students were more likely to be familiar with the research topic. He coordinated with lecturers to introduce him to students in these classes, explained the aim of the study, and distributed the questionnaires by hand. He then read through and explained the survey questions, and asked the students to complete the form.

Ethical issues were taken into consideration, and the researcher informed each participant of his or her rights, pointing out that participation in the study was optional, and that the student had the right to withdraw at any stage without providing a reason. The overall process took around one and a half hours for each of 16 classes. Each class had around 20 students, and those who agreed to participate signed the survey leaflet.

The researcher attempted to distribute the maximum number of questionnaires possible, although this was limited by the availability of participants and the time framework. In total, 300 were distributed, of which 100 were correctly completed and returned. Survey questions focused on students' awareness levels of cloud computing, as well as their use of the Internet, ICT, and cloud computing. Some questions asked them to share their own experiences of the role of ICT in improving the quality of education, and to discuss the main barriers to and enablers of using ICT and cloud computing as they perceived them. The survey questions and the leaflet describing ethical considerations are in Appendix 3.

4.5.4 Document analysis

According to Myers (2013), document analysis is a useful way of augmenting the data collected, such as settling disagreements between interviewees. Bryman (2015) agrees that document analysis helps to improve the validity of data collected by other methods. It may even provide further data to support the research topic. The documents analysed came from JHEIs, the Jordanian Ministry of Higher Education (JMHE), and the Higher Education Accreditation Commission (HEAC). They included up-to-date annual reports on universities' size, total numbers of students and staff, the number of students in each department, and evaluations for each department. The contents of all these documents were confirmed by (HEAS).

The researcher applied to the office of the Prime Minister to request access to these documents, and after obtaining official approval had the right to access the documents and to obtain copies. The president of HEAS, Professor Basher Al-Zoubi, agreed to provide current documents after reviewing the request form and reviewing the ethical approval letter provided by Coventry University. (See Appendix 1)

The main aim of reviewing the documents was to see whether they confirmed the views of participants, and whether they could make further contributions to the research. Official approval from JMHE and HEAC enabled him to scan and filter the documents that seemed most relevant to the research aim and could serve the research objectives. This process took place over several visits to the employees responsible for documentation and backup in both JMHE and HEAC. The researcher explained the type of documents required, and reviewed those deemed suitable by the employees. Finally, the target documents were selected, and the researcher made copies. A sample of the reviewed documents is attached (see Appendix 6).

4.5.5 Focus groups

As was pointed out in section 3.6.2, this research used focus groups as another data collection method. This method consists of interviewing a group of people and asking them prepared questions in order to understand their views about a specific topic (Bryman, 2015). Litosseliti (2003) notes that the main benefit of focus groups is that they provide primary data, covering a range of different views through dynamic interaction with participants. Such individualised results may not be obtained as easily through other less interactive data collection methods, such as direct observation or surveys. Accordingly, the researcher expected to learn from the students who participated in the focus groups the main reasons for the under-utilisation of ICT in general and cloud computing in particular, as well as the main factors influencing the adoption of cloud computing, and their attitude towards using this technology. These focus groups explored the awareness levels of the students regarding cloud computing technology, and the main challenges and barriers preventing them from using it.

Litosseliti (2003) recommended selecting participants who have the same level of experience and understanding of the topic. In this case, the focus group participants were students from the same school, with about the same level of education. They were selected from computer science, computer engineering and information systems schools, as being more familiar with the research topic, which forms part of their studies.

Adams et al. (2007) suggested that the optimal number of participants in a focus group is eight to twelve. It is necessary to encourage all participants to take part in the discussion, especially in larger groups where some participants may be overshadowed by those who are more vocal. Accordingly, the researcher restricted the number of participants in each focus group to no more than eight.

No standard number of focus groups is recommended, since the number depends on the topic and the data required (Litosseliti, 2003). In this case, the researcher conducted three focus groups, taking into consideration the limited time available and the uncertain acceptance rate of HE institutions in allowing focus groups to be conducted. The first group consisted of six Master's degree students and one lecturer acting as a coordinator and monitor, from the School of Information Systems of the Amman Arab University for Higher Education Studies. The second group consisted of eight undergraduates and one lecturer as coordinator and monitor, from the Computer Science Department of Israa University, and the third of seven undergraduates from the School of Information Systems of Jerash University. See Table 4.6.

Table 4-6 Focus groups taking part in this research

Group Number	Higher education institution name	School/Department	Number of participants	Level	Date of focus group
1	Amman Arab University	Information Systems	Six students and one lecturer	Master's	5 January 2016
2	Israa University	Computer Science School	Eight students and one lecturer	Bachelor	28 January 2016
3	Jerash University	Computer Science	Seven students	Bachelor	23 February 2016

The researcher sent a request to the heads of the targeted schools, informing them of the purpose and importance of the study, and asking for help from each school's management and staff to coordinate the focus group (e.g. place, time, participants, and lecturers with the experience to coordinate the group). The average time for each focus group was around two hours. At the beginning of each session, the researcher read the ethical rights to the participants, then distributed leaflets detailing the study's ethics approval and participants' rights, and asked participants to sign these if they consented. The list of leading questions asked at these focus groups is attached in Appendix 4.

4.5.6 Observation

Observation is a data collection method used extensively in recent years in computer-based information systems research (Walsham, 1995). It involves watching and listening to what people do and say during their daily activities, and in some cases asking them to explain certain acts (Lamb, Hair, & McDaniel, 2011).

The researcher employed this method because it was advantageous to directly observe lecturers during classes, students' and staff members' use of ICT resources, and the infrastructure of Jordanian universities (e.g. server rooms). In order to document observations, the researcher recorded these in a small notebook.

4.5.7 Case study protocol

According to Yin (2013), a case study protocol is a document that provides full details of the research design, including an overview of all individual projects, case study objectives, questions that the researcher wants to ask, a plan for the structure of the research, field procedures, and an outline or template of the final report. Several authors have recommended a case study protocol as a guide to constructing the research plan (Brereton, Kitchenham, Budgen, & Li, 2008; Gable, 1994; R. K. Yin, 2011). The protocol is helpful in a single case study, and strongly recommended in a multiple-case study, but researchers must prepare it before the data collection process (Baskarada, 2014). It enhances the reliability of the study and helps the researcher to focus on the major tasks and objectives, improving their progress in completing fieldwork (Gable, 1994).

In this study, the protocol consisted of the research background, including previous literature on the topic, the research questions, a plan for data collection, an outline of the strategy for data analysis, an explanation of the interpretive approach adopted, a list of ethical considerations, and an explanation of the role of the researcher in conducting the study. It also noted how validation of the study could be achieved through the adoption of several data collection methods, and through asking participants to verify the transcribed interviews.

The researcher also used previous studies related to the research topic as comparisons (Ridley, 2012). Theoretical saturation was also decided on, to stop the process of collecting extra data which would lead to redundancy and fail to improve upon the existing data (Auerbach & Silverstein, 2003).

4.6 Data analysis

Following the description of the data collection methods, this section explains the data analysis approach. According to Marshall and Rossman (1989, p.112), data analysis is "the process of bringing order, structure and meaning to the mass of collected data". Here, the mass of collected data included transcriptions and notes from interviews and focus groups, survey results, notes from direct observation of staff, students and infrastructure, and reports provided by the selected universities and the Department of Education.

Data analysis was based on the three-step process recommended by Miles and Huberman (2014): data condensation, data display and drawing/verifying conclusions. Microsoft Excel was used to present information held as frequencies or statistics (e.g. in the form of tables, pie charts, bar charts and column charts).

As mentioned in the methodology chapter, triangulation of methods and aims was used to ensure validity and reliability. However, some difficulties may arise in the analysis process, such as data overload. For instance, the study included 21 hours of voice recordings from interviews and focus groups, 100 questionnaires from students, many notes and records from direct observation, and government documents.

Auerbach and Silverstein (2003) argued that a crucial step for successful data analysis is the ability to define the analysis procedure during the early stages of data collection. However, Miles and Huberman (1994) pointed out that the two most important issues in qualitative data analysis are focusing on the significant parts of the collected data, which can only be accomplished after all data has been collected; and transforming the collected data into meaningful information.

4.6.1 Qualitative data analysis components

The three-step process outlined above was carried out.

4.6.1.1 Data reduction or condensation

According to Miles, Huberman and Saldana (2014, p.12), data condensation is "the process of selecting, focusing, simplifying, abstracting, and/or transforming the data that appear in the full corpus (body) of written-up field notes, interview transcripts, documents, and other empirical materials". This is a fundamental step in helping to manage the data collected from the field.

The data collected from Jordanian universities and government institutions was transcribed, organised into groups, filtered according to its relevance to the research topic, and finally every piece of data relating to cloud computing adoption at JHEIs was coded.

4.6.1.2 Data display

This is "an organised, compressed assembly of information that allows conclusion drawing and action" (Miles et al., (2014, p.12). In this study data display involved graphics, charts, tables and networks. Tables and conceptual network maps were the most important tools; they appear clearly in chapters five and six. Accordingly, the data was transferred into tabular format after transcription, reduction and coding.

4.6.1.3 Drawing/verifying conclusions

The third phase of the data analysis process involves drawing conclusions: "deciding what things mean by noting regularities, patterns, explanations, possible configurations, causal flows, and propositions" (Miles et al., (2014, p.12). The results of the data analysis process were used to develop theoretical constructs, which were then turned into grouped conclusions in order to develop the study framework.

The processes of verifying conclusions and creating a conceptual framework helped to validate the results. To test the validity of the results in this case, the researcher asked for feedback on the study conclusions and conceptual framework from experts in cloud computing and HE.

Miles et al. (2014) also suggested validating qualitative data by linking it with any quantitative data collected, and Chapter five provides some supporting statistical indicators analysed from the surveys.

Figure 4.2 shows the main steps for the data analysis process used in this research.

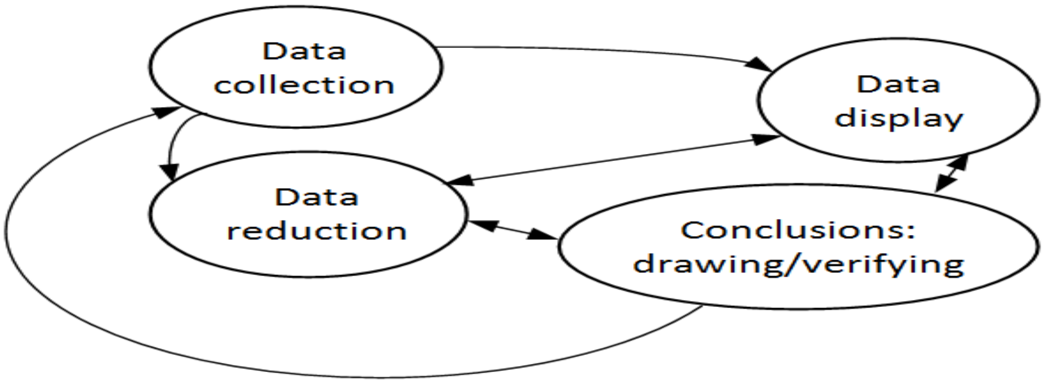

Figure 4-1 Data analysis components adopted from *Miles & Huberman (1994, p.12).*

4.7 Explaining the practical approaches taken for the qualitative data analysis steps

As already explained, the qualitative approach was deemed appropriate; ontologically, the research considers the universities in Jordan to be the unit of analysis, while epistemologically its exploratory nature, through adoption of the qualitative methodology with an interpretive stance, is supported by statistical frequencies indicators. The data collected from interviews and focus groups took the form of words, which are not meaningful in themselves. Four main steps for analysing this information to derive meaning are recommended by different authors, as follows:

1. Data transcribing and translating (Brinkmann, 2013; Bryman, 2012)
2. Identification of themes (Bloor & Wood, 2006; Grbich, 2012; Miles et al., 2014)
3. Data coding (Corbin & Strauss, 2014; Flick, 2009; Marshall & Rossman, 2010; Neuman & Kreuger, 2003; Punch, 2005; Punch, 2013)
4. Generating a conceptual framework (Marshall & Rossman, 2010; Miles et al., 2014).

4.7.1 Data transcribing and translating

The first step of data analysis was to transcribe and translate the digital audio-recordings (Brinkmann, 2013; Bryman, 2012), mostly conducted in English. The professional manner and seniority of participants enabled the researcher to gain rich, considered data from their professional, direct answers.

However, two aspects of the same problem were associated with this huge amount of data: how to categorise the data under the research aims and objectives; and how the data could be connected in a logical way in order to answer the research questions and implement a cloud computing adoption framework.

Only two of the interviews were in Arabic, requiring translation in addition to transcription. The researcher listened to each interview several times during the transcription process, and once again afterwards to check the transcripts against the interview recordings. Some of the interviews were fully transcribed, and other interviews only partly to avoid any repetitive answers, data redundancy and information not related to the research topic.

On average, every hour of audio recorded needed four hours for transcribing. A copy of the transcribed interview was sent by e-mail to each interviewee to ensure credibility, and most confirmed the transcribed content. A few participants did not reply, which the researcher assumed as agreement that the transcription was correct.

4.7.2 Identification of themes

Identification of themes is considered by some as the starting point for qualitative data analysis (Willig, 2013). In this step, all elements of the transcribed data that had the same label are first categorised into major groups (Grbich, 2012), according to their relevance to the research questions. This step seeks to clarify the relationship between the various elements of data and suggests initial connections between the data and the research questions.

4.7.3 Data coding

A number of authors have described coding as reviewing the transcribed data, grouping and dividing it into small units or chunks, and assigning labels to each unit (Bloor & Wood, 2006, p.101; Marshall & Rossman, 2010, p.220; Miles et al., 2014, p.72; Saldaña, 2015, pp.3-4). The identification of themes from the transcribed data may include connected or unconnected groups of words, sentences, paragraphs or whole interviews (Saldaña, 2015, pp.3-4). Coding, a useful tool for data reduction (Clark & Adler, 2011), can be either concept-driven or data-driven (Kvale & Brinkmann, (2009). Concept-driven coding involves codes that have been created in advance, from theories in the literature or developed by the researcher, while data-driven codes arise from the data itself.

Miles et al. (2014, p.74) also describe descriptive coding, defined as,

> *Assign[ing] labels to data to summarise in a word or short phrase—most often a noun— the basic topic of a passage of qualitative data. These eventually provide an inventory of topics for indexing and categorising, which is especially helpful for*

ethnographies and studies with a wide variety of data forms (field notes, interview transcripts, documents, etc.).

Descriptive coding was applied as illustrated in Table 4.7.

Table 4-7 Descriptive coding exercise

Code (Concept)	Code	Source
Technology Availability	Tec-Avi	Innovation theories, Literature review, RQ, proposition, Conceptual Framework
Resources and Budget	Res-Bud	Innovation theories, Literature review, RQ, proposition, Conceptual Framework
Awareness limitations	Awr-Lim	Innovation theories, Literature review, RQ, proposition, Conceptual Framework
Compatibility	Comp	Innovation theories, Literature review, RQ, proposition, Conceptual Framework
Complexity	Comx	Innovation theories, Literature review, RQ, proposition, Conceptual Framework
Benefits observability	Ben-Obz	Innovation theories, Literature review, RQ, proposition, Conceptual Framework
Technology perfection	Tec-per	Innovation theories, Literature review, RQ, proposition, Conceptual Framework
Return on investment	ROI	Innovation theories, Literature review, RQ, proposition, Conceptual Framework
Conformance to requirements	Con-req	Innovation theories, Literature review, RQ, proposition, Conceptual Framework
Perceived usefulness of technology	PUT	Innovation theories, Literature review, RQ, proposition, Conceptual Framework
Perceived ease of use	PEU	Innovation theories, Literature review, RQ, proposition, Conceptual Framework
Sharing knowledge	Sh-Know	Innovation theories, Literature review, RQ, proposition, Conceptual Framework
Cultural issues (spoon feeding, technology resistance, and traditional education methods)	Cult-Iss	Fieldwork
University size	UN-S	Innovation theories, Literature review, Fieldwork
Government support	Gov-Supp	Literature review, RQ, Conceptual framework
Infrastructure limitations	Inf-lim	Fieldwork and Literature review.
Attitude towards technology	ATT	Innovation theories, Literature review, RQ, proposition, Conceptual Framework

Technology role in job employment opportunity	Tec-empl	Literature review, RQ, proposition, Conceptual Framework
Cost of technology adoption	Cotp-tec	Innovation theories, Literature review, RQ, proposition, Conceptual Framework
Environmental factors	Env-fac	Fieldwork, Conceptual Framework
Quality of higher education	Q-HE	Fieldwork
Lack of frameworks	Lack-FW	Fieldwork
Regulations and policies	Reg-Poli	Fieldwork

4.7.3.1 Using Computer Assisted Qualitative Data Analysis (CAQDAS)

In recent years, qualitative research has seen a notable development in computer-assisted qualitative data analysis: NVivo, for example, enables the researcher to code the collected data, as well as to link and create relationships between codes (Gilbert, Jackson, & di Gregorio, 2014). It helps to reshape, reorganise and compare coding nodes. The descriptive codes in Table 4.7 were used as input for coding the transcribed interviews. Each code is represented as a node, and is connected to a suitable argument taken from the interview. Since this research is interpretive in nature, it was important to review the themes and codes several times, and to uncover the relations between the themes through comparing the different codes. See Figure 4.2.

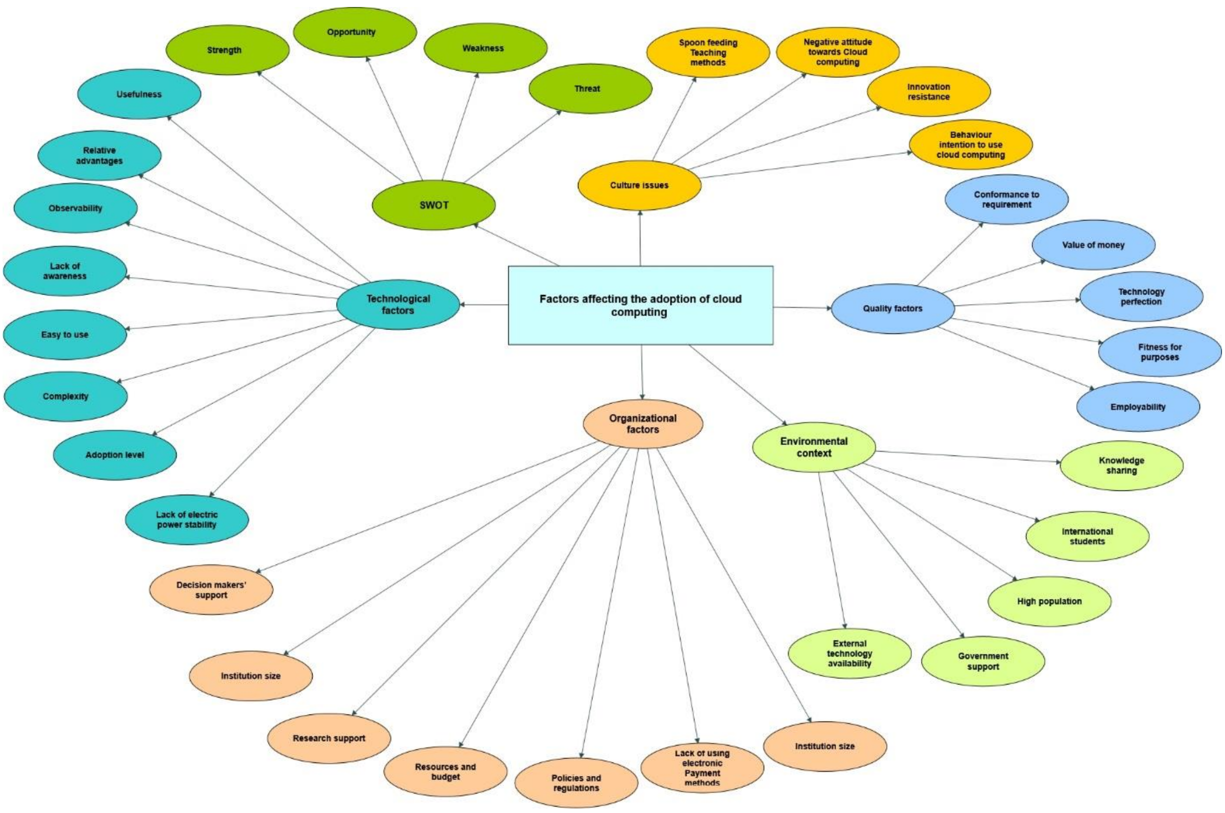

Figure 4-2 An example of identifying relevant data from transcribed interviews and assigning codes to these data using NVivo software

4.7.3.2 Second cycle of coding

The first-level coding, also known as pattern coding, enabled the researcher to summarise a considerable amount of the data. Difficulties arose, however, due to the large amount of analysed data, and the repetition of ideas. It was, therefore, important to undertake a second level of coding. According to Miles et al. (2014), second-cycle coding is the process of grouping the summarised segments of data, derived from the first level, into a smaller number of categories. Pattern coding reduces the number of repeated ideas (Auerbach & Silverstein, 2003).

Accordingly, the researcher reduced the data from the first cycle using a smaller number of categories, which could be mentally stored and readily retrieved. Table 4.8 presents these categories, synthesising the sets of concepts that were originally defined in Table 4.7.

Table 4-8 second-level coding

I.	<u>Technological approach</u>: The role of all technological factors affecting the adoption of cloud computing. Used to group data that assists in understanding the extent to which technology-related factors could be enablers or barriers in the cloud computing adoption process.
II.	<u>Organisational approach</u>: The role of organisation-related factors affecting the adoption of cloud computing. Used to group data that assists in understanding the extent to which the organisational level could be an enabler or barrier in the cloud computing adoption process.
III.	<u>Environmental context</u>: The role of the education sector in the context of Jordan. Used to group data that assists in understanding the extent to which the environment of Jordan (the education industry in general, the government, the support given by the Ministry of HE, and the cultural context of Jordan) affect the adoption and implementation of cloud computing.
IV.	<u>Quality</u>: The role of quality and quality-related factors in higher education outcomes Used to group data that assists in understanding the role of technology in improving the quality of students, and to understand the extent to which the adoption of the latest technology, such as cloud computing, may improve educational quality, which may affect the employability level.

Tables 4-9 and 4-10 present examples of identifying relevant text within a section of the interview and embedding codes in it (first and second level coding presented in **bold**)

Table 4-9 example of identifying relevant data from interviews and assigning first-level coding to these data.

We have a lot of software that was developed in house, and it is not compatible with all lecturers' PCs ***[*****Compatibility: Comp*****].*** *Therefore, this compatibility problem with our software is one of the biggest negative experiences we have* **[Attitude towards technology*****: ATT].*** *In addition, we have downtime problems, and staff are always complaining about complexity* ***[*****Complexity: Comx]***.* *For example, we have the ACAD system, which is an automated system to upload the marks of students, instead of using paperwork. This system has a problem with compatibility* ***[*****Compatibility: Comp*****]***. Users can open it only in specific computers inside the university campus* ***[*****Technology Availability: Tec: Avi*****].***

Table 4-10 example of identifying relevant data from interviews and assigning second-level coding to these data.

We have a lot of software that was developed in house, and it is not compatible with all lecturers' PCs **[<u>Technological approach: T</u>]***. Therefore, this compatibility problem with our software is one of the biggest negative experiences we have. In addition, we have downtime problems, and staff are always complaining about complexity* **[<u>Technological approach: T</u>]***. For example, we have the ACAD system, which is an automated system to upload the marks of students, instead of using paperwork. This system has a problem with compatibility* **[<u>Technological approach: T</u>]***. Users can open it only in specific computers inside the university campus* **[<u>Organisational approach: O</u>]**

Every transcribed document was allocated first-level coding as described in Table 4-8. Second-level coding reduced the huge amount of collected data and organised the transcribed data into technological, organisational, environmental and quality approaches, as seen in Table 4-9.

4.8 Quality of findings and conclusions

Before analysing the collected data, it is important to address the issue of its quality, which has an impact on the validity and reliability of the findings of the research. Several approaches have been suggested. Denzin and Lincoln (1994), for example, suggested focusing on the research findings from the perspective of fitting the accepted level to the body of knowledge in the research topic. Golafshani (2003) focused on testing the trustworthiness of the research by considering the reliability and validity of data. Miles et al. (2014, p. 311) suggested that the researcher should be a "critical realist", and evaluate the study's quality according to the following standards:

- Objectivity/confirmability

  Objectivity and confirmability allow the researcher to avoid "unacknowledged research biases" (Miles et al., 2014). To address this issue in qualitative research, Miles et al. (2014) suggested examining the study's research methods and procedures, the way/s in which the data is collected, transformed, displayed, and how the researcher draws conclusions from the study. In addition, they recommended developing a thorough knowledge of the overall background of the study, with a review of the literature most relevant to the research topic.

  The following points are dedicated to making the findings of this study objective and able to be replicated: in this chapter, the procedures used to collect and analyse the data, with representation of the whole picture and background to the aim, objectives and questions which led to this research; chapter five presents the data analysis findings and the factors influencing the adoption of cloud computing in JHEIs, which shape the study framework; chapters six and seven explain the suggested framework and how it was developed and validates; and, chapter eight concluded the research and linked the findings to the literature review.

- Reliability/dependability/auditability

  This issue concerns whether quality and integrity have been addressed throughout the research. During the early stages, both the research problem and questions were clearly defined. The researcher attempted to study the under-utilisation of cloud computing technology at JHEIs, its effects on the quality of education, and how such technology could be adopted in JHEIs. The use of multiple case studies, as well as the procedures of data analysis, were created and implemented in conjunction with the research questions. Data was collected with the aim of addressing the main factors influencing the adoption of cloud computing technology in JHEIs in order to establish a framework to help JHEIs adopt such technology. A number of scholars in information systems and cloud computing in Jordan reviewed the proposed cloud computing adoption framework. This process ensured reliable and dependable findings that could be replicated.

- Internal validity/credibility/authenticity

  It is vital that the findings of the study make sense, and that they are credible to the participants in the research, as well as to the reader. The researcher sent each participant a copy of his or her transcribed interview in order to ensure the validity of the data. This is in keeping with the ideas of Stake (1995), that good qualitative research must uphold ethical obligations by avoiding misrepresentation and misunderstanding.

As mentioned in chapter three, triangulation was applied to improve the credibility of the study's findings. Chapter five links the conceptual framework from the literature review and the theories adopted (i.e. TOE, DOI and TAM) with the categorisation of factors, while chapter six shows how this conceptual framework is linked with the suggested framework for the adoption of cloud computing in JHEIs in this study.

- External validity/transferability/fitness

  This issue focuses on judging whether the conclusions of the study have further validity, beyond the scope of the institutions and people involved in the research, and the extent to which the conclusions can be generalised. The evaluators of the study's framework were from three institutions: two private universities, one public university, and an institution mainly interested in providing education services and applications to HE institutions. Therefore, it can be argued that the study framework and conclusions can be applied to other HE institutions in Jordan that were not involved in this study.

  Yin (2003), however, points out that researchers should be cautious of generalisation, which attempts to extend the study's results to other institutions from other countries. Accordingly, although the proposed framework could be applied to other developing countries, especially in the Arab Word, it would be wrong to apply the conclusions to developed countries which do not face the same problems.

- Utilisation and application

  This inquiry addresses the potential benefits to be gained by the HE institutions that participated in the case study. At the end of the data collection process, one of the public universities (U2) organised a workshop with the researcher, with 150 students and several lecturers. Its aim was to introduce cloud computing technology to the university, as well as to help participants to use simple cloud applications, such as Google Docs and storage services. The workshop enabled the researcher to create a clear image of the proposed framework for this study, and how to employ the collected data to serve the framework.

4.9 Chapter summary

This chapter explained in detail how the researcher conducted the pilot study and how the actual data was collected during the fieldwork. It began by justifying the selected research location and the JHEIs selected to take part as multiple case studies. It also described and justified the selection of individual participants.

Triangulation of the of the data collection methods was presented, and all the sources of data were identified. The chapter then considered the data analysis process, describing how the collected data was reduced, coded, and analysed. Finally, the quality of the findings and conclusions was addressed by considering several issues, such as reliability of findings, validity of collected data, transferability, generalisability, and the utilisation of the findings and conclusions by the institutions and individuals involved in the study. The data collected will be displayed and analysed in the next chapter.

5 FINDINGS FROM FIELDWORK: FACTORS INFLUENCING THE ADOPTION OF CLOUD COMPUTING IN JHEIs

The focus of this chapter is the analysis of the data gathered from the interviews, focus groups, qualitative surveys, and documents as presented in the previous chapter. From this analysis, several conclusions can be reached in relation to the many varied factors influencing the adoption of cloud computing technology in JHEIs, its enablers, and its barriers. Thus, the research question addressed in this chapter is: "What are the main factors influencing the adoption of cloud computing in JHEIs?".

A total of thirty-three factors were found during the fieldwork, reported in this chapter. The findings that result from this analysis will also be a part of the final framework, to be proposed in chapters six and seven.

5.1 The Technology-Organisation-Environment-Quality (TOEQ) framework

As it was explained in the literature review chapter, this study adapted (Technology-Organisation-environment) the TOE framework (Tornatzky et al., 1990) as a theoretical foundation to categorise the factors that may influence the adoption of cloud computing at JHEIs. In addition, to adapting the TOE framework, the study used additional factors, which came from the fieldwork experience during the data collection process and from the findings from data analysis. The study also suggested quality as a fourth component in the original TOE framework, which consists of: the quality of higher education, employment level and its relationship with use of cloud computing technology, the sharing of knowledge, and finally, value for money.

These factors have been added to the quality component because they result from the quality of education in JHEIs. It can be argued from the interviewees' comments that one of the reasons for the high unemployment level in Jordan is the quality of HE. Similarly, failure to share knowledge between Jordanian universities, students, and lecturers has a direct influence on the quality of HE in Jordan. The value of money spent in JHEIs is related to the return on investment, which is an important factor in the quality definition adopted in the introduction and literature review chapters of this study. Finally, the definition of quality in section 2.3 is connected with these factors. Further discussion about the quality factors will be presented in section 5.6.

Accordingly, this chapter proposes a four-dimensional model (technology, organisation, environment, and quality) to address the main factors influencing the adoption of cloud computing in JHEIs (see Figure 5.1).

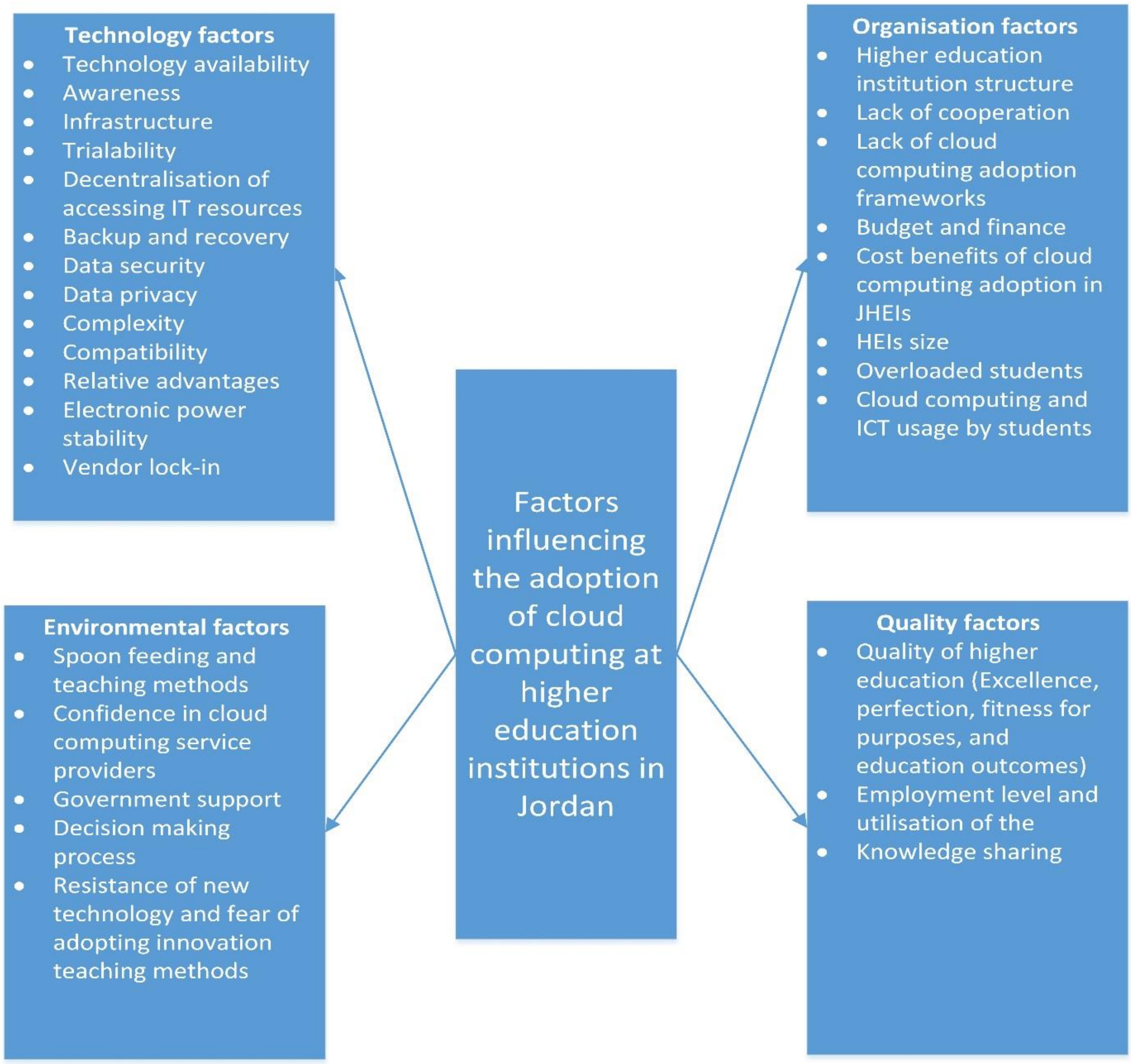

Figure 5-1 TOEQ categorisation factors. Adapted from TOE framework (Tornatzky et al., 1990).

5.2 Definitions of the TOEQ framework factors

Before exploring the factors that influence the adoption of cloud computing at JHEIs in detail, it is important to briefly describe each factor. Accordingly, tables 5.1, 5.2, 5.3, and 5.4 below illustrate some of the main characteristics of each category. These descriptions of individual factors derive from the theoretical foundation in the literature review chapter, as well as the findings from the fieldwork.

Table 5-1 Technological factors

Factor	Description
Technology availability and adoption level	Used to group data relating to the internal technology available within the academic institution and the external technology available in the market.
Awareness	Used to group data relating to the awareness level of those involved about the concept of cloud computing.
Infrastructure	Used to group data relating to the infrastructure of Jordanian universities, as well as the suitability of this infrastructure for cloud computing technology.
Trialability	The degree to which cloud computing technology could be trialled at Jordanian universities before full implementation.
Decentralisation of accessing IT resources	The ability to access information technology from any geographical location
Backup and recovery of learning materials	The ability to run automated scheduled backups, and put in place a recovery process. This requires the availability of large storage capacity.
Data security	The protection level of the customer data from unauthorised access.
Data privacy	The permissions and policies that determined who is authorised to access customers' data.
Complexity and ease of use	Used to group data that relates to ease of use of the internal ICT system, as well as cloud computing technology. Also, encompasses the extent to which the use of cloud computing services at Jordanian universities will be free of extra effort.
Compatibility with in-house technology	The degree to which cloud computing technology could be implemented with the institution's existing technology.
Cloud computing relative advantage	Used to group data that relates to the advantages and main benefits that would be gained from adopting cloud computing at JHEIs.
Electric power stability and risk of unavailability	The sustainability of electrical infrastructure that supports cloud computing online services.
Vendor lock-in	The potential threat of inability to change cloud computing service provider because of a customised platform and service.

Table 5-2 Organisational factors

Factor	Description
Higher education institution structure	Used to group data that explains the relationship between an institution's structure and the adoption of cloud computing technology.
Lack of cooperation between Jordanian universities	The potential for multiple Jordanian universities to share the same cloud computing services.
Lack of cloud computing adoption frameworks	Used to group data that addresses the availability of cloud computing adoption frameworks.
University resources and budget	Used to group data that examines the effect of a university's financial resources and budget on its decision to adopt cloud computing.

Cost benefits of cloud computing	Used to group data that presents the financial benefits of cloud computing.
Higher education institution size	Used to group data that relates to determining the effects of university size on cloud computing adoption.
Overloaded students	Data relating to the effects of overloaded international students in JHEIs and the adoption of virtual classes based on cloud computing technology as a solution.
Cloud computing and ICT usage by students	Used to group data that shows the actual usage of cloud computing and ICT by Jordanian university students.

Table 5-3 Environmental factors

Factor	Description
Spoon-feeding and teaching methods	Data relating to the effect of teaching and learning culture at JHEIs on using cloud computing technology.
Confidence in cloud computing service provider	Data exploring confidence levels among internal and external service providers of cloud computing, and its effects over the adoption of cloud technology.
Government support	Data relating to the role of the Jordanian government in supporting universities in adopting the latest information technology.
Decision making process	Data relating to the process of decision making at JHEIs, which presented the long and complicated process for adoption of innovation technology in Jordanian universities by top management.
Innovation resistance	Data relating to the resistance of any new technology and the effect of such resistance on the adoption of cloud computing at JHEIs.

Table 5-4 Quality factors

Factor	Description
Quality of higher education in Jordan (excellence, perfection, value, fitness for purposes, and education quality).	Data relating to the readiness of graduate students for the labour market needs, especially in the technology industry market as well as the quality of higher education factors determined in chapter two, section 2.3.
Employability and its effects on adopting innovation technology	Data relating to the role of providing up-to-date information technology for students in accordance with labour market needs.
Knowledge sharing	Data relating to the role of cloud computing in sharing academic knowledge between lecturers and students.
Technology perfection	Data relating to current technology use in JHEIs at optimum level (e.g. taking into consideration down time, usefulness, speed, and output quality), compared with use of cloud computing services.
Value for money	Data relating to the return on investment of adopting cloud computing technology in JHEIs.

5.3 Technological factors

The first group consists of technological factors that may influence the adoption of cloud computing at JHEIs. As was mentioned in the literature review Tornatzky et al (1990) argued that innovation technology adoption is influenced by the utilisation level of technology within the institutions and what innovation technology is available in the market. This study considers, the technological factors' emphasis on the cloud computing concept as an available technology to be adopted in JHEIs and its characteristics (e.g. trialability, complexity, security, privacy, and vendor lock-in) as well as other factors related to the technology awareness and technology utilisation level in JHEIs.

5.3.1 Technology availability and utilisation level

The following section considers the technology availability in JHEIs and the views by interviewees about the utilisation level of cloud computing technology in teaching and learning process at JHEIs. In order to follow the key terms provided by participants, the researcher has added a **bold** type on the important points as keywords to be discussed and highlighted.

It is interesting that almost all interviewees considered cloud computing within JHEIs to be in its very early stages. One of the professors (P1) stated that:

In fact, I think that cloud computing here in our university is at ***infant level****. However, we look forward to integrating cloud technology to be a part of our system. The biggest challenge is from where to start and what we need to take into consideration, do we have suitable infrastructure that supports cloud computing and how to know if we have it or not.*

In addition, another professor (P2) added about utilisation:

As far as cloud computing is differentiated from ICT, I think we are still at the beginning. We still follow the old fashion or probably the old model. Given my practice at this university, and knowing many colleagues from different universities, cloud computing did not actually take the right position or get the proper moment to be pushed forward, but mainly we use cloud in a very narrow way, perhaps as ***mail servers or storage only****.*

The feedback from (P1 and P2) shows that the JHEIs are in the infant level of using cloud computing as they only using this technology in a basic level such as storage service for saving files. In addition, the presence of using ICT in teaching and learning in JHEIs seems to be very limited.

Utilisation of ICT in public and private universities in Jordan

However, the utilisation level of ICT in general is varied from one university to another in Jordan. This underutilisation is particularly clear in the case of universities in urban areas. One of the decision-makers (DM3) supporting this idea said:

Universities in urban areas or the south of Jordan have very poor facilities and poor human resources because they are far away from the capital, which makes the adoption of information technology a solution to connect them with the capital. There is a ***gap*** *between universities in Jordan, such as universities in the capital of Jordan and private universities in other cities. In addition, there is a big gap between* ***private*** *universities and* ***public*** *universities in Jordan. Therefore, using* ***cloud-computing*** *technologies can play a good role to reduce this gap between Jordanian universities. In addition, the technology can reduce the gap between Jordanian universities and other universities outside Jordan.*

The feedback from (DM3) explains the reasons behind the variety between JHEIs in using ICT. However, using cloud computing technology may decrease the technological gap between Jordanian universities as well as HEIs outside Jordan. This is because cloud computing promises to provide almost unlimited virtual resources at a low cost (Sultan, 2013a).

Utilisation level of ICT and its role in achieving the goals of JHEIs

The results from the qualitative survey show that 52% of participants believed that the existing ICT at JHEIs is insufficient to achieve current education goals, and that there is a notable lack of ICT utilisation in Jordanian universities. This is shown in figure 5.2.

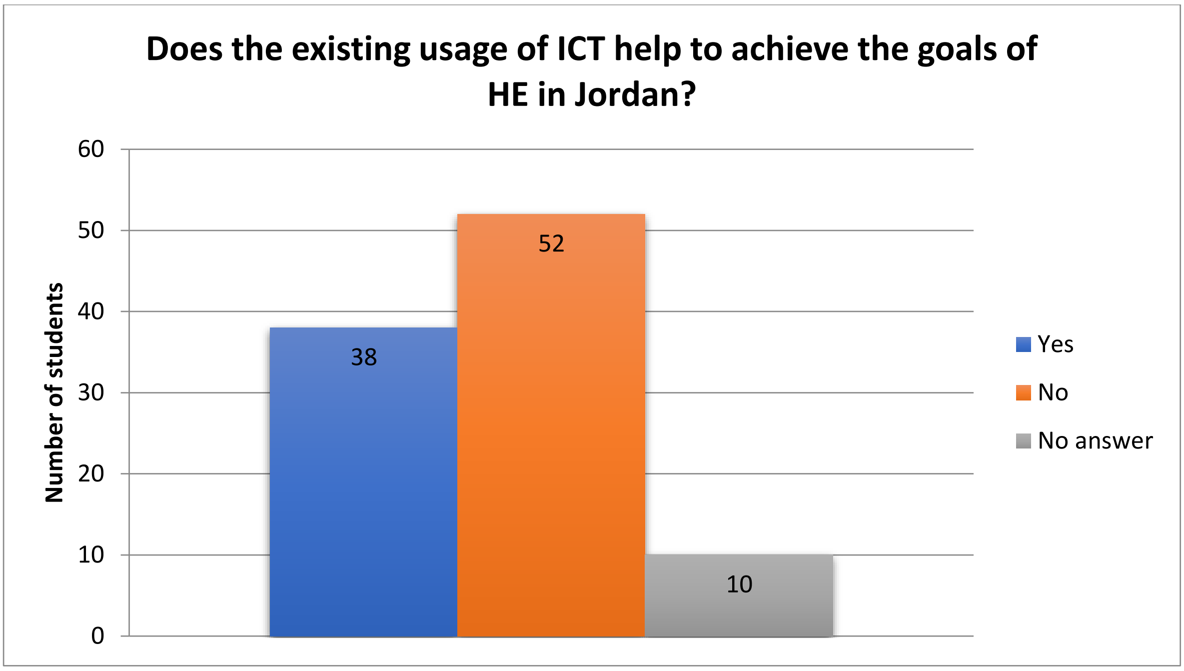

Figure 5-2 The existing usage of ICT at JHEIs and its role in achieving the goals of higher education in Jordan

While many felt that ICT was underused, one of the senior lecturers (P17) in the management information systems department argued that innovation technology such as cloud computing is in fact widely available, and service providers are always ready to support universities with this technology; however, a lack of awareness about cloud technology is considered to be the main challenge facing its widespread adoption:

> *Cloud computing tools themselves are widely available. The question is how to motivate staff to use these tools. It is a managerial issue to increase the awareness and to make everybody use the innovative technology.*

Moreover, a professor from the computer science department (P10) showed that the technologies currently in use in most Jordanian universities are outdated, and that lecturers encounter technical problems when using this technology in the classroom.

> *I have much negative experience in using Information and Communication Technology. We have* ***outdated technology*** *in the classroom, which takes a lot of time to operate and to connect to the Internet. For example, on some laptops, we still have Microsoft Windows XP, which is not supported by Microsoft itself since a long time ago. The adoption of Office 365 would help us to use cloud-computing applications directly, such as Google Drive.*

Another professor (P28) added that:

> *Sometimes we* ***cannot connect to the Internet*** *due to technical problems that prevent us from accessing different kinds of lectures. Therefore, we try to use our personal resources in order to deliver the class objectives to students.*

To summaries, it is clear from the findings that both students and staff in Jordanian universities are dissatisfied with the current utilisation level of ICT. It is evident that there is a notable underutilisation of ICT in general and cloud computing in particular at JHEIs. Although the Jordanian government has made significant efforts to improve ICT use within the context of education, further and more consistent efforts in this field are required.

The fieldwork shows that the right technology is not readily available and that the technology available is underutilised. This has implications for the ability of JHEIs to produce the quality professionals that the Jordanian economy and labour market require.

5.3.2 Awareness

Knowledge about cloud computing's benefits, limitations, and pay-per-use business model could play a vital role in increasing the opportunity to adopt this technology in JHEIs (Low et al., 2011). Such knowledge includes the basic characteristics of cloud computing service models, including software as a service, platform as a service, and infrastructure as a service, as well as deployment models, which include public, private, hybrid and community groups (Chou, 2015). Rogers (2003) argued that awareness of the innovation is the first step in its adoption. If the HE institutions become aware of innovative technology, then a positive attitude towards adopting this technology increases.

An awareness of cloud computing and its potential benefits is one of the most important factors in this study. According to Rogers (2003), the first step of innovation adoption is to know about the existence of the innovation, and have the opportunity to understand how it functions. In a study which set out to conceptualise a model for the adoption of cloud computing in education, Sabi, Uzoka, Langmia, & Njeh (2016) found that awareness is positively correlated with the intent to adopt cloud computing.

In most cases, the interviewees in the present study stressed that an awareness of the benefits of cloud computing is an important factor affecting the decision to adopt cloud computing. The acknowledgement of a lack of awareness about cloud benefits appears to be clear at all levels (e.g. management, administration, academic staff, and students).

I do believe that it is still the lack of awareness probably with the people who govern this university which prevents us from going forward (P5).

Before going to the actual adoption phase, I think we should focus on the awareness phase that tells the university staff and students: what is the meaning of cloud computing and what is the benefit of cloud technology? (P3).

Lack of awareness is the main challenge that currently faces the universities in Jordan in adopting cloud computing. The decision makers and staff have no awareness about the implication of using this technology. I think other challenges could be the security and privacy of using cloud computing. However, security and privacy could be solved if the awareness level increased (P13).

In addition, the research findings indicated that providing training programmes in cloud computing could play a vital role in promoting more widespread awareness of the technology among universities' staff and students.

We do not have any training courses in Cloud computing. Our staff and students sometimes use cloud computing services, but they did not know that this is cloud technology and what cloud computing is, and even what this technology can do for us (P28).

Echoing critiques of this kind, a professor in computer science and cloud computing technology stated that the lack of awareness of the significant benefits of cloud computing in higher management is the main barrier to adopting this technology.

There are many people who still do not know what cloud computing is, especially the decision-makers. However, in our last meeting with the university president, we discussed using and adopting cloud computing. Unfortunately, I have mentioned that almost all lecturers talked about their concerns, and the threats of using cloud computing, and they did not focus on the positive side of this technology (P21).

To summarise, the findings of this study showed that there was a notable lack of awareness of cloud computing at all levels in JHEIs. Training programmes and workshops on cloud computing could help to combat this. However, such a widespread lack of awareness could negatively affect the adoption of cloud computing, leading to a negative impact on quality of outcomes of JHEIs. Improving the overall awareness about the role of innovation technology such as cloud computing and its benefits in improving the quality of HE is an important factor playing a vital role in accelerating the wheel of the adoption of cloud computing in teaching and learning activities as well as in enhancing the quality of HE outcomes.

5.3.3 Infrastructure

The readiness of ICT infrastructure is an important factor in this study; this refers to the readiness of hardware, software, and networks currently in use JHEIs. As was pointed out in section 4.5.5 the researcher has observed the readiness of ICT resources through using direct observation as a data collection method. In addition, the researcher asked IT managers and professors in JHEIs about the infrastructure's readiness during the interviews. This is because suitable ICT infrastructure is crucial for cloud computing adoption in higher education institutions (Sabi et al., 2016).

However, another primary concern of participants interviewed in this study was the current poor infrastructure in Jordanian universities, which could act as a barrier to the adoption of cloud computing.

A professor from one of the engineering school in JHEIs (P1) argued that the engineering school suffers from the lack of infrastructure and advanced simulation software and hardware. The limitation of not having access to these resources prevents graduate students from creating novel projects. This has resulted in staff being forced to ignore the weakness of students' projects.

> *The lack of **simulation resources** is the main problem that we are facing in our school. Simulator programs are very **expensive** and we do not have the ability to offer a license to all engineering students. In addition, there is a lack of advanced hardware here in our school. Therefore, the students try to overcome this by reducing the size of their project or their sample size. As a result, their project outputs are very weak. Actually, we enforce [a policy of] ignoring the students' weak output. We cannot blame them because they do not have enough resources to do the novel projects that we are looking for. Cloud computing may solve this problem by offering customised simulation as a service online for a specific period. I hope that this will solve our school's problem here*

This feedback from (P1) shows that the lack of advanced ICT resources is having a negative effect on the quality of Jordanian students' graduate projects. The inability to provide suitable hardware and software resources to students is mainly because of the high cost of such resources. The presence of cloud computing could allow for this resource to take place through renting virtual hardware and software for a specific period: it would therefore contribute positively to the overall teaching and learning processes.

In the same vein, two other professors from the computer science department (P30 and P26) said:

> *Existing **infrastructure** probably needs more **enhancement**, but I think we may have the chance to start using cloud computing. However, the **poor Internet bandwidth** could be an issue in using such technology (P30).*

> *We have a number of laptops; we also have access to the Internet, which can be accessed by both students and staff. However, despite this investment in technology, the **infrastructure** is still **poor**, and the laptops in our school cannot serve all students, especially in peak periods such as exams and the few days before assignment submission deadlines. In my evaluation, I think the current infrastructure can only serve 30% of our students (P26).*

Moreover, one of the IT managers (DM8) stated:

> *Because of the **lack** of university **resources**, we have poor e-learning systems, which are only used for uploading and downloading the materials. The current **infrastructure** cannot offer an interactive environment between students and lecturers. Furthermore, our servers cannot serve all students at once; they have to wait in a queue. I believe that **cloud computing** can handle the limitations of resources in our university and provide almost unlimited **resources** with high **quality** service. In addition, **pay per use** would help a lot to reduce the cost, especially when we calculate the difference of students' load between the peak periods and non-peak periods.*

In brief, the key challenge affecting the ability to adopt cloud computing in Jordanian universities is the readiness of the ICT infrastructure. An additional challenge, which requires studying, is how to adopt cloud computing within the limits of the current resources. However, without the right infrastructure it could be not possible to maximise on the benefits of cloud computing and therefore the JHEIs are unable to produce the expected quality of graduates' projects by Jordanian students.

5.3.4 Trialability

Trialability refers to the degree to which, pre-adoption, an innovation technology can be tested and experienced on a limited basis (Lin & Chen, 2012). Trial versions of innovation technology will increase the familiarity of this technology with users before the full adoption takes place (Rogers, 2010).

The research demonstrates that stakeholders at JHEIs always prefer to try any technology before implementing it fully. It is the results of these trials that mainly affect the decision to adopt the technology or not. According to Mohamad Hsbollah, Kamil, & Idris (2009), trialability is one of the most important factors influencing the implementation of new technology in the context of education. When any institution decides to start using new technology, it usually requests a trial version before the full implementation (Y. Y. Alshamaila, 2013).

The finding of this research showed that trialability might have a direct connection with the observability of benefits, as well as perceptions of the ease of use of cloud technology. The ability to sample a product or trial version of any cloud service for a certain period enables the users to create a vision about such a product, thereby assisting in making the initial decision regarding the implementation. One of the decision-makers (DM 6) stated:

> *It is very difficult to judge the benefits and limitations of any technology before trying it. For sure, **trying cloud computing** services before the full adoption would give us the chance to find out the **advantages and disadvantages** of this technology in general and specific services from specific cloud providers in particular. Unfortunately, we had a very bad experience in adopting some enterprise projects in our university. Therefore, we will not accept any full adoption of a technology before careful thinking and full feedback from all stakeholders in order to be realistic and to avoid any disappointment from staff, lecturers, and students.*

One professor in a computer science school, who is also a database expert (P29), stated:

> *The integration and transformation process from current internal systems to external storage and systems based on cloud computing is not an easy process. It is not logical to transfer or even integrate records of **38000 students** from our in-house database to cloud computing services, storage, and databases without **trying a small sample** first. Therefore, as a first step, it is important to transfer a small sample of students' records to a cloud computing database service first, using the active passive*

> *technique for testing this technology's performance and quality. Then we may decide to adopt cloud technology or to reject it.*

The feedback from (DM6 and P29) argued that stakeholders in JHEIs prefer to adopt a trial version of cloud computing to avoid any disappointment in this technology and to more fully understand its advantages and disadvantages. Furthermore, trial version of any application of cloud computing offer the opportunity to test the migration and transformation process of in-house systems at JHEIs to cloud computing virtual services.

Although almost all interviewees supported the importance of trying cloud services before full implementation; two professors (P23 and 15) had a different opinion about trialability. They stressed that the adoption of cloud computing is not an optional decision, but an inevitability in the near future, and that trying it before the actual use would be a barrier to adoption because of the tendency to resist innovation in the Jordanian context.

> *Adopting cloud computing in Jordanian universities is not optional; it is necessary. There is no need to try this technology, because it has been validated and tested in different academic institutions around the world within different contexts. Trialability is usually important for early adopters, and here in Jordan we are very late adopters not just in cloud computing but also in any technology. Therefore, there is no need to waste more time to validate a technology that has already validated (P23).*

> *I believe that trying cloud technology services would be a barrier to adopting this technology in Jordanian universities. It is important to study the behaviour and attitudes of resistance towards innovation technology in Jordan in general and the educational context in particular. For instance, our staff showed a resistance towards using an online grading system. In addition, they showed another resistance towards using smart boards. Therefore, I expect that our staff and students will resist the cloud computing services for a while, but then it will be a part of our education process (P 15).*

In summary, there were differences of opinion regarding trialability. The majority of interviewees (e.g. decision-makers, professors, and cloud computing experts) agreed that trying the cloud services before the full implementation would increase awareness of cloud computing's benefits and usability. Therefore, trialability could be a factor of cloud computing that may positively influence its adoption. Trialability may lead to a better conception about the role of cloud computing in improving the quality of HE outcomes. This is because the initial impacts of cloud computing on the quality of outcomes for HE could be partly recognised by the adoption of a trial version.

5.3.5 Decentralisation of accessing of information technology resources

Centralisation of information technology refers to the inability of accessing university ICT resources from different geographical locations outside the university campus; this means that the only way to access such resource is through the university intranet (Jamsa, 2012).

Most of the interviewees argued that university systems and applications in JHEIs are centralised in a university data-centres and cannot be accessed from outside the university network. For example, the grading system in U1 can only be accessed from the university campus.

> *We are suffering from using the university services, which can only be used **inside** the university **campus** via the intranet. For example, the **grading system** only works inside the university network. Therefore, if you are a lecturer you need to be inside the university to upload students' marks. In addition, the students cannot get their results from outside the university through the Internet (P 2).*

The technical engineers in U1 argued that the reason for such centralisation is security. However, interviewee participants who work as lecturers argued that the centralisation forces them to stay at the university campus after the exam periods to upload students' results. This prevents them from taking part in any other activities outside the university campus, such as attending conferences or travelling outside the country. As one of the interviewees stated:

> *Uploading students' grades on the university **grading system** is one of our responsibilities. However, we cannot upload the students' results outside the university. Personally, I have missed many conferences outside Jordan because of our university polices and rules, which prevent us from travelling outside during and after students' final exams (P17).*

This feedback shows that the inability to interact with the university system from outside university premises is having a negative effect on other areas of the academic activity of participant P17. The presence of cloud computing could allow this interaction to take place and therefore positively contribute to the overall quality of the teaching and learning processes.

There were also difficulties when international students wanted to access the grading system:

> *The* ***grading system*** *and* ***payment system*** *in our university forces us to stay in Jordan around two weeks after the final exams. As international students, using these systems via the internet from any place would significantly help both Jordanian and international students (Student focus group).*

New solutions are required for the availability of information to students. Cloud computing is a potential solution to this challenge, albeit its perceived limitations. However, the privacy of universities' data, which would be stored outside the university servers and storage devices, could be encrypted to prevent any unauthorised access. In addition, selecting a suitable deployment and service model is considered an important step in the process of cloud computing adoption. This view is supported form the feedback by several professors in JHEIs. For example, one of the professors in computer science (P5) stated:

Cloud computing offers different ***deployment models****, which are public cloud, private cloud, and hybrid cloud. I believe that private cloud is the best choice for the sensitive data in Jordanian universities. Service provides offer a private cloud service, which can be operated and owned by one institution. Although it is more expensive than other cloud models, it is still cost effective compared with physical servers and traditional technology.*

Another professor from the engineering school added that:

The data of universities in Jordan should be ***secure*** *in the transaction process from university devices to cloud applications or storage, and the best technique to secure our data is* ***encryption methods*** *that could be provided by a third-party service provide.*

From the preceding data, we can surmise that geographical centralisation for Jordanian universities, which forces university staff to use some applications inside the university campus, is a real problem. The centralisation of ICT resources, therefore, may have a negative implication on the fitness of purposes of using ICT technology, which is a sub-factor of the quality of HE in this study. The adoption of cloud computing at Jordanian universities could be beneficial in terms of its location-independent features, which could solve the centralisation problem (Jamsa, 2012).

5.3.6 Cloud computing back up and disaster recovery

In recent years, many countries in the Middle East, such as Syria, Iraq, Libya, and Yemen have suffered from different wars (Kanaan, 2009). The majority of universities in these countries have suffered from destruction, and university data, students' records, operating systems, and databases have been lost. According to the feedback provided by international students in one of the focus groups, these universities had not used remote backup outside the country or online cloud computing services, so all data was stored in one physical place. The feedback from the field showed that this was problematic, as international students from these universities had no evidence of their records, which could have improved their level. This feedback is supported by one of the senior lecturers (P12) in a public university who stated that:

> *Almost all the undergraduate international students who come from the neighbouring countries because of* ***war*** *started as first-year students, because there was* ***no record*** *that showed their level. I believe that if the universities in these countries had used* ***cloud computing*** *for* ***data storage and recovery****, then we could have found a way to access these universities' data by asking the service providers or even asking these universities' management for permission to know the students' levels.*

One of the most important features of cloud computing is data backup and recovery (Jamsa, 2012). The SAN-to-SAN data backup between different geographical sites provides the ability to recover any services, operating systems, databases, and applications in case of any disasters, which could happen because of fire, earthquakes, storms, wars, or any other reasons (Nayak & Rao, 2014). Furthermore, the online backup feature in cloud computing is considered as cost-effective compared with physical storage devices, and it can provide a full recovery in a very fast period (Armbrust et al., 2009).

In 2013, the University of Jordan was partly destroyed by a strong storm. University of Jordan president, Professor Al-Tarawneh, noted that around 500 trees were destroyed, buildings suffered damage, electricity was cut off, and several laptops were destroyed (Ammon newspaper, 17 Dec 2013). Many interviewees understood that the adoption of cloud computing would prevent the JHEIs from losing their data in case of disaster.

One of the professors (P11) in computer science stated:

> *I believe that the most important benefits of cloud computing are the* ***backup and recovery*** *features. Cloud computing can help universities to overcome* ***disaster***

> ***situations***, *such as computer breakdowns or flooding. Therefore, no matter where you are and which device you have, your data is safe and you can access it from anywhere, any time, and through any device. In 2013, we had a bad experience when a storm hit the university. In fact, we were very worried about the students' records, and we expected to lose all data.*

> In the same context, another professor (P4) from the same department added:

> *Assume that another* ***strong storm*** *comes in the future or even this winter, and destroys the university data centre. Then what can we do and how can we recover the databases, applications, students' records, grading system, financial system, and administration records? In fact, adopting cloud commuting is an urgent issue, and we should start the implementation very soon.* ***Cloud computing*** *provides the ability to* ***recover*** *everything, such as operating systems and applications, not only the row of data.*

In summary, the majority of participants in the study agreed that data protection is a priority and cloud computing could be one of the solutions of data protection and recovery. The benefits of cloud computing in offering disaster recovery can positively influence the adoption of cloud computing in JHEIs (P13). Cloud computing provides multi-site backup replication, which means keeping several copies of data at the same time at different geographical locations.

In addition, cloud technology offers the potential for a scheduled backup process, as well as cost-effective solutions for backup and recovery. Taking into account the recent history of natural disasters suffered by Jordanian universities, it is clear that disaster recovery is one of the most important factors to influence the adoption of cloud computing in JHEIs.

5.3.7 Security and privacy concerns

Security refers to the protection of customer data from unauthorised access, whereas privacy is about the permissions and policies that determine who is authorised to access customers' data (Y. Alshamaila, Papagiannidis, & Li, 2013). The interviews, focus groups, and qualitative survey findings show that security and privacy concerns are considered to be the most important issue affecting the adoption of cloud computing at JHEIs. Such concerns may be classified as a top priority for the decision-makers in the Jordanian education sector. It is interesting to note that the decision-makers who are not fully aware of cloud computing technology expressed significant concerns about security and privacy. Other interviewees, who are professionals in cloud computing, expressed fewer concerns about security and privacy, especially when dealing with a well-known company (e.g. Google, Microsoft, and Amazon). Almost all participants agreed that security and privacy are critical concerns, since the data is stored outside the university's physical devices. As one of the professors (P3) in management information systems explained:

> ***Privacy** is the main concern in using cloud computing. A considerable amount of publications agreed that privacy and security are the fundamental issues in cloud computing, and we cannot ignore this fact. Although there are several solutions, such as data **Encryption**, I believe that the service providers can access the customer data. Many governments around the world have policies and regulations that enable them to access the companies' and service providers' customers' data if needed for security purposes.*

In addition, the findings of this research indicate that participants who are decision-makers ranked security and privacy as a very high priority, preferring to pass over or reject any technology that cannot ensure a high level of data privacy:

> *In the case of making any cloud computing agreement with service providers, the first question would be how to **improve** the **security and privacy** of our data. The service providers must provide a clear answer to this question. However, it is very important to study these procedures carefully before accepting any services. In fact, if there is any risk to security and privacy, then it is much better to keep using the current technology instead of transferring to cloud computing. I believe that security and privacy are more important than cost benefits, especially in several departments, such as the examination unit and financial department (DM3).*

The concept of cloud computing is to rent storage, services, and applications that are hosted in physical devices outside the institutions (Sultan, 2010). However, technical engineers and IT managers at Jordanian universities argued that the privacy of critical data could be protected by several methods, such as using encryption and complex passwords to ensure that there is no unauthorised access at any level of the data transfer process.

> *In my opinion the issue of **privacy** of data when using cloud computing could be **solved**, and it is not a reason to reject the adoption of cloud computing in our university. The top management is always asking about the privacy of the data as the main question when talking about cloud computing. My answer is that there are*

professional companies working as a third party to ensure the privacy of data when adopting cloud computing. In addition, the cloud computing service providers themselves consider privacy and security to be a top priority. It is our responsibility to ensure the maximum level of data privacy and security when using any technology (P22).

Other IT managers were worried that the privacy concerns would be the main barrier to adopting cloud computing:

*Although cloud computing service providers invest a huge amount of money to ensure customers' **privacy**, the data of several international companies has been revealed in public before. I am sure that the fear of privacy is the main **barrier** preventing all Jordanian institutions from adopting cloud computing (DM7).*

The feedback from (DM7) expressed that privacy and security of data is one of the main barriers to adopting cloud computing at JHEIs.

The aim of this subsection was to highlight the concerns in JHEIs about privacy and security factors in order to raise awareness of their importance for successful implementation of cloud computing solutions.

5.3.8 Complexity and familiarity with current technology

Several studies have considered the issue of complexity as a barrier to cloud computing adoption (Chou, 2015; Lian et al., 2014; Lin & Chen, 2012; Sabi et al., 2016). Similarly, the findings from this study showed that JHEI stockholders see this factor as a concern, acting as a barrier to the adoption of any innovative technology in general, and cloud computing in particular. The findings from this research revealed that the perceived complexity of any technology might prevent Jordanian universities from moving from their current services to cloud-based technology, especially when the staff are already familiar with a specific technology environment and platform. However, the complexity of any information technology is hard to measure because it varies from one individual to another, depending on several factors, such as familiarity with technology and the individual's technical skills.

One of the IT managers (DM7) in a Jordanian public university stated:

*It was notable that when we adopted any new application or software, such as a grading system, the lecturers needed daily support, and at the beginning they always argued that it was **complicated** to use. However, after a while they started to become **familiar** with the* *system and changed their mind. I believe that the main concern is changing any system after high levels of familiarity with current systems.*

Another IT manager in a private Jordanian university (P13) noted:

> *The **complexity** of using any technology, such as cloud computing, mainly depends on the user's **skills**. In addition, it depends on its similarity to previous systems. In our last research, we found that human behaviour always prefers a similar system to work with. Therefore, when adopting cloud computing technology, it is very important to find the most **similar environment** to the current technology. High levels of similarity with previous systems mean a low level of complexity for the end user.*

Furthermore, the findings from the field showed that dealing with cloud computing technology consists of two levels: advanced and basic. The advanced level relates to technical engineering, and the responsibilities surrounding advanced tasks, such as security in virtual servers, the backup process, migration with current systems, database support, and other advanced tasks. On the other hand, the ability for the end user to complete daily tasks constitutes the basic level of using and utilising cloud computing technology. This level should be user–friendly, because the end users are limited in their technical level compared with technical support engineers.

In this context, one of the IT managers (DM8) stated:

> *My main concern in cloud computing adoption is the **complexity** of using cloud applications in new environments for the end users. As technical support, our job is to solve any technical problem. Therefore, the advanced tasks, such as the migration process and full back-up for all records, which is supposed to be the technical support's responsibility, is not the main point for me. We have a high-level, skilled engineering staff, and they can deal with any type of technology. Again, the problem of complexity or even **unfamiliarity** with cloud platforms may happen from the end user's side, such as from lecturers, university employees, and students.*

In conclusion, complexity could be one of the crucial factors negatively affecting the adoption of cloud computing in Jordanian universities. However, IT managers argued that cloud computing applications should be easy to use, and if this were the case, adoption would be easier. In addition, IT managers believed that the complexity level will be different from one user to another, according to the computer skills of each, and their familiarity with dealing with applications similar to cloud computing services.

5.3.9 Compatibility

According to the findings from the interviews, the compatibility of cloud computing with current technology is an important factor in enabling cloud technology adoption. Cloud computing applications and services in general can be accessed through any device, which is connected to the Internet. One of the IT managers (DM 9) in a public university in Jordan argued that the university has a considerable number of problems in terms of compatibility, stating:

> *We have a lot of software that was developed in house, and it is **not compatible** with all lecturers' PCs. Therefore, this compatibility problem with our software is one of the biggest negative experiences we have. In addition, we have downtime problems, and staff are always complaining about complexity. For example, we have the ACAD system, which is an automated system to upload the marks of students, instead of using paperwork. This system has a **problem with compatibility**. Users can open it only in specific computers inside the university campus.*

As mentioned before, one of the main strengths of cloud computing technology is the ability to use the services anywhere, at any time, with any device (Sultan, 2013b). Thus, the feedback from interviews show that cloud computing may provide a solution to problems of compatibility with all devices for all universities' software and applications. In addition, cloud technology would enable the IT technical support to focus on creation and development, instead of constantly having to deal with problems caused by incompatible software. The high level of compatibility in cloud computing technology could positively affect its adoption in JHEIs.

5.3.10 Cloud computing's relative advantages

Relative advantages refer to the "the degree to which an innovation is perceived as better than the idea it supersedes. The degree of relative advantage may be measured in economic terms, but social factors, convenience, and satisfaction are also important factors" (Rogers, 2003, p.15). A considerable amount of literature considered the relative advantages of cloud computing as an important factor, which connected with other factors such as cost, time, performance, efficiency, effectiveness, and any other potential advantages of cloud computing for the institutions (Low et al., 2011; Lin & Chen, 2012; Lian et al., 2014; Sabi et al., 2016). In this study, relative advantages refer to the potential benefits of the adoption of cloud computing in JHEIs. Such benefits are derived from the view of participants as well as the fieldwork experience.

An understanding of cloud computing's relative advantages is one of the most important factors affecting the adoption of this technology. A lack of awareness about cloud computing's benefits is one of the causes that postponed the adoption of this technology in JHEIs. During the interviews, it was noted that participants who were aware of the relative advantages of cloud technology were more motivated to adopt this technology than others. One of the professors (P22) in management information systems argued:

> ***Cloud computing has excellent advantages***. *Google Forms, for example, is a useful cloud computing application, which can be used by teachers to upload the assignments on a dynamic portal, and provides the ability for students to share and discuss these assignments with teachers and together at the same time. Such technology* ***can improve the quality learning process****. It can provide useful statistical analysis and charts within around 5 minutes to the lecturers. In addition, these charts help the management to evaluate the students' results, as well as the lecturer's performance.*

The findings also revealed that relative advantage relates to other factors. As one of the IT managers (DM9) stated:

> *Cloud computing has a considerable number of* ***relative advantages*** *compared with the existing in house service provided by our university. Adopting this technology would improve the* ***back-up*** *and* ***restoration process****, avoiding service downtime,* ***offering location, time, and device independency****, decreasing the* ***cost****, and improving the* ***quality****, among other services.*

Based on the feedback from participants the initial relative advantages of cloud computing adoption at JHEIs may include the cost benefits, location independency, and time saving. Such benefits may lead to improvements in the quality of HE in Jordan. However, lack of awareness of cloud computing benefits could prevent the JHEIs stakeholders and decision makers understanding the relative advantages of this technology.

5.3.11 Electricity stability

The data collected suggests that unsustainable electricity and poor broadband infrastructure in many Jordanian universities is considered to be one of the main barriers negatively influencing the adoption of cloud computing. The findings from the field observation in JHEIs argue that the electrical supply can shut down unexpectedly from the power supplier. Such instability of power may interrupt and destroy the processes of uploading and downloading, especially if there is a large amount of data that depend on automatic tasks (e.g. the scheduled backup of students' records). As one of the IT managers (DM10) stated:

> *We are suffering from electricity problems here in our university. On many occasions, the electricity suddenly shut down and came back after a while. This is annoying to our technical team because they have to repeat many tasks that were automatically cancelled by the system. However, this problem can be solved by setup uninterruptible power supplies (UPSs).*

In brief, improving the stability of the electrical supply in JHEIs could maximise the benefits of cloud computing; the feedback from (DM10) showed that the unexpected power cuts could be avoid by (UPSs), which also may provide better services for students and staff that may lead to better quality of services in JHEIs.

5.3.12 Vendor Lock-in

Vendor lock-in is a technique which ensures that the customer or tenant who wants to change the current cloud service provider must start the new service from scratch, which applies pressure on the cloud customer to keep dealing with a specified service provider (Odeh et al., 2015). Some of the cloud service providers even impose a restriction on the type of software, application, or hardware to be employed in order to increase take up of their own services. For example, Google uses Big Table for storage, whereas Facebook uses Cassandra, and Amazon uses Dynamo. Since there is no common interface between these databases, migration or transferring between them is either not possible or is quite costly.

Stakeholders within the JHEIs may perceive vendor lock-in as a barrier to adoption of cloud computing. For example, the findings show that IT managers and professionals in information technology in Jordanian universities are aware of this threat in cloud computing. A professor in management information technology (P24) argued:

> *Vendor lock-in is a big challenge in case the university wants to replace the cloud computing service provider. However, we may overcome this problem by studying the service's level agreement (SLA) very carefully, as well as making the right decision when dealing with a suitable cloud service provider.*

In brief, Vendor lock-in is a challenge in cloud computing adoption in general within any context. Even though such a challenge could arise after the adoption of cloud computing, the feedback from (P24) recommended that JHEIs address these problems in advance through SLA with the cloud computing service providers. This recommendation may provide the maximum benefits of using cloud computing, which also may influence the quality of HE outcomes by the adoption of the most appropriate cloud computing service providers based on the JHEIs requirements.

5.4 Organisational factors

The organisational context was found to be an important context in this study; this refers to the characteristics and resources of the HEI. Seven organisational factors were found from the field expertise, which may influence the adoption of cloud computing in JHEIs. These are: Institution structure, lack of cooperation between Jordanian universities, lack of cloud computing adoption frameworks, university budget and financial issues, cost efficiency of cloud computing adoption for JHEIs, higher education institution size, and cloud computing usage by students.

5.4.1 Institution Structure

The institution structure in this study refers to the managerial structure and the decision making process in the JHEI for the adoption decision of any innovation. The institution's structure may play a significant role in adopting cloud computing technology (Bernard, 2012). One dean of an information technology school (P19) stated:

> *I believe that the cloud concept will not be accepted soon. It needs more time to be accepted by the top management. The **structure** of our university is very complicated, and if we accept the implementation of any **technology**, such as cloud computing, or even reject it, this may not affect the top management's decision. Therefore, the decision to adopt cloud computing requires a long and complicated process.*

Another professor (P25) also criticised this process:

> *The **structure** and the way of thinking at our universities in Jordan must be changed, especially in decisions about the adoption of innovative technology. Education technology is rapidly growing, and we need to be as fast as it is growing. Waiting for a long time because of complicated **routine procedures** to make a **decision** in adopting any new technology will make us lose the round.*

Feedback from (P19 and P25) revealed that the managerial structure of their universities is having a negative effect on the adoption decision of innovation technology. Simplifying such a process may enable the Jordanian universities to keep up with the revolution in information technology. This finding validates that of Alshamaila (2013) who found that the complicated structure of organisations in decision making would negatively influence the adoption of cloud computing.

As explained in section 2.10.3 JHEIs can be divided into public and private universities. There is a notable difference between them in structure, as well as in the process of decision-making. For example, public universities are attached to the Jordanian government, and their decision process needs government permission. Private universities rely on shareholders and university owners, and the final decisions only require their own permission. In addition, public universities are non-profit institutions, while private universities make a profit.
One of the decision-makers (DM5) from a Jordanian public university stated:

> *The adoption of cloud computing in our university will not be a straightforward decision. In fact, we need a* ***considerable number of signatures*** *for this decision. As you know, this is a public university and we need acceptance from the Minister of Higher Education, as well as the Jordanian government for any major decision. Furthermore, the adoption of cloud computing would significantly alter all university systems, backup and restoration, infrastructure, storage spaces, security, and privacy. Therefore, we must be very clear with Jordanian government about the benefits and limitations of Cloud computing. Therefore, the* ***decision-makers*** *here inside the university will be fully responsible for such a decision, even in the long term.*

On the other hand, another professor (P8) from a Jordanian private university revealed:

> *The university president, IT manager, and owners of this university have the final decision about the adoption of cloud computing. If there is a* ***clear proposal****, which can show the benefits of cloud computing, such as decreasing the total cost, as well as improving the services level, which means more profits, then I believe that the adoption of cloud technology would be possible. We have partly adopted simple cloud computing applications and services. However, privacy and security is our concern. Furthermore, we still do not have a* ***clear plan*** *for transferring an internal system to cloud computing.*

In summary, the feedback from the field experience revealed that the HEI structure may influence the adoption of cloud computing. Simplifying the decision-making process for the adoption of innovation technology may positively influence the adoption of cloud computing in JHEIs: this will in turn lead to an improvement in the quality of education by speeding up the rate of adoption of innovation technology in teaching and learning. It is likely that a clear and direct internal structure, coupled with a strong proposal, could improve the chances of the university deciding in favour of adopting cloud computing. In contrast, a complicated internal structure at a university may negatively influence the adoption of cloud computing in JHEIs.

5.4.2 Lack of cooperation between Jordanian universities

According to Burg et al. (2013), cooperation between universities is an important factor, which normally increases the contribution to knowledge and improves economic development of countries. Such contribution could be enhanced through increasing the sharing of knowledge and research activities (Garcia-Perez, 2011). Rakocevic et al. (2016) confirm that cooperation between universities in any country has a positive influence on the quality of education, which also will positively affect the social economy. Unfortunately, the evidence from the fieldwork findings suggests that there was a lack of cooperation between universities in the field of research, as well as in sharing knowledge and resources.

In addition, the findings of this study showed that there was a lack of cooperation across projects in sharing ICT resources. One expert in cloud computing (P2) stressed that cooperation between Jordanian universities in using and adopting cloud computing would provide considerable benefits, such as cost effectiveness and quality of service.

> *The influence of **cloud computing** might be very high if we **share** online open **courses** based on cloud computing services, which can be accessed by all students and lecturers from all Jordanian universities at once. However, all public and private universities in Jordan have developed their own systems **without any cooperation**. There is no umbrella, which can embrace all universities' efforts, projects, and services together. I hope that adopting cloud computing can offer an umbrella to improve such weak cooperation.*

In the same context, another professor (P7) noted:

> *The adoption of **cloud computing** would be excellent if all Jordanian **universities shared** the cost and services. This sharing of cloud services will effectively reduce the cost because all Jordanian universities will pay for the same service at once.*

Furthermore, a professor in computer science school (P5) at one of the private universities in Jordan stated that:

> *Many Jordanian universities can **cooperate** to adopt **cloud computing**, as many courses could be developed, shared, and finally provided as a service to the students. This will absolutely reduce the cost because all universities will work together to provide the same services. In addition, this will improve the quality of such services and courses. Individual efforts by one university in adopting cloud computing technology will not be as good as working together to share the same services. Unfortunately, up to this point we have not reached the level of acceptance in cloud computing principles.*

The perception from JHEI stakeholders is that cooperation is important for quality and that cloud computing could help foster such cooperation and therefore impact on the contribution to knowledge and could improve economic development of Jordan.

In conclusion, cooperation between Jordanian universities would positively affect the adoption of cloud computing services. Furthermore, this cooperation in cloud technology adoption may provide considerable benefits, such as cost effectiveness and quality of services. Moreover, increasing cooperation between JHEIs would decrease the overall cost of the adoption of cloud computing through distributing the expenses of the cloud services; the cost would be similar to that of each university's standalone service. Cooperation between JHEIs can be improved through different approaches including research, library resources, publications, engineering projects, and patents.

5.4.3 Lack of cloud computing adoption frameworks

To the knowledge of participants in this study there has been limited research in the area of developing a framework for the adoption of cloud computing in JHEIs. In addition, all participants in this study agreed that JHEIs have a notable lack of research for the adoption of cloud technology in the teaching and learning process. One of the professors (P30) stated:

> *As for me, personally I do not believe that we have any **framework** regarding the adoption of cloud computing. We may have a **simple methodology** concerning the selection of free cloud computing services, such as Dropbox, Google Drive, and One Drive. Creating a framework to guide the higher education institutions through adopting cloud computing would be helpful.*

Another professor (P26) agreed, saying that:

> ***To the best of my knowledge there is no framework*** *or even any strategy in Jordanian universities for adopting cloud computing. We are still trying to develop a framework for using cloud computing. We have some applications based on cloud computing. Honestly, we do not have a clear plan or strategy for adopting this technology.*

Almost all participants in JHEIs agreed that Jordanian universities need a framework for adopting and using cloud computing technology in an effective way:

> *I totally agree that the Jordanian educational environment* ***needs a framework*** *that must first include all the factors affecting the adoption, and the enablers and barriers of cloud computing, before considering the adoption phases (P11).*

> *The Jordanian context has a special nature different from any other context. Technical difficulties are not the only factor in adopting Cloud computing here. The question is: what is the value of any technology if there is not enough awareness about its benefits and how to effectively use it? However,* ***we still need a roadmap*** *or a procedure to follow for adopting cloud services (P18).*

> *Planning is more important than execution. To succeed in adopting any new technology, we need 80% planning and 20% execution.* ***A valid framework*** *would help to avoid ambiguity or fear in cloud computing adoption (P20).*

The feedback from participants showed that they are not aware of any framework for the implementation of cloud computing, and that this lack of awareness hinders the possibilities of a consistent approach its adoption: this means that JHEIs are less likely to benefit from cloud computing technology for the purpose of quality of education. Developing a new framework for adopting cloud computing may positively affect the use of this technology in Jordanian higher education. The limitations of cloud computing research, as well as the limitations of effective and valid frameworks, have led to the underutilisation of cloud technology within Jordanian universities.

5.4.4 Budget and financial issues

Several studies have considered budget and financial issues as an important factor influencing the adoption of cloud computing (Y. Y. Alshamaila, 2013; Hsu, Ray, & Li-Hsieh, 2014; Lian et al., 2014; Pardeshi, 2014). Most interviewees argued that limited finance is one of the main concerns negatively affecting the adoption of ICT in Jordanian universities. During the interviews, it was clear that decision-makers focused on restrictions on funding. Although cloud computing may minimise spending on ICT, several participants argued that Jordanian universities had limited financial support for utilising ICT. One of the experts in Cloud computing (P16) stated:

> *I think the main challenge faced by the Jordanian education sector in adopting cloud computing could be the* ***budget and finance issues****. The Jordanian universities do invest in technology, but still not enough.*

In addition, one of the decision-makers (DM8) claimed that the university experienced financial difficulties, so investment in information technology had to be postponed:

> ***Financial limitations*** *constitute the main challenge in adopting any new technology, not just cloud computing, in our universities in Jordan. We are always looking for savings in the* ***budget****, and we have a difficult financial situation. Therefore, it is possible in this period to keep the same usage level with no increase in services, because the university cannot invest in new technology with its current budget.*

It is interesting to note that some of the participants provided an explanation for the underutilisation of cloud computing by comparing it with traditional technology. They argued that physical machines, such as server rooms and storage devices, had been provided through external funding to the university, whereas cloud computing services have not been funded in the same way before:

> *There is no reason why the Jordanian universities are still not investing in cloud computing except the lack of awareness about this technology's benefits. Another important reason is that the* ***funds*** *from outside universities go towards physical hardware and software, as well as servers. Such funds provide the universities with desktops, laptops, and other equipment. In fact, our university has never had any external funds for cloud computing services before (P3).*

> *We have laptop computers here for students from international companies, which have been provided by Dell and Solarise for free. Furthermore, we have several laptops from local companies in Jordan (P5).*

Feedback from (P3 and P5) argued that the funding to Jordanian universities from external resources mainly focuses on physical devices, which may serve to prevent JHEI from adopting cloud computing services.

In brief, the data shows that individuals in significantly important roles within JHEIs understand that budget constraints and financial concerns might negatively affect the adoption of cloud computing in JHEIs. This means in their perspective that implementation and adoption of cloud computing without increasing the budget is less likely to succeed, which would also negatively influence the quality of HE in Jordan.

5.4.5 Cost efficiency of cloud computing adoption

The feedback from the field experience has shown that cost benefits of cloud computing constitute a significant factor in this study. Almost all participants understood that the primary benefit of introducing cloud computing is the cost effectiveness of this technology. A considerable amount of literature supports this argument (Jones, 2015; Chou, 2015; Sultan, 2014a; Pardeshi, 2014; Y. Y. Alshamaila, 2013; Sosinsky, 2010; Hsu et al., 2014). During the interviews, almost all participants stressed the cost benefits of cloud computing as a main enabler to the adoption of this technology in Jordanian universities. However, several IT managers stated that it is important to study the return of investment in cloud computing, especially in the long term, before committing to its implementation and adoption. As one IT manager said:

> *It is very important to know that the implementation of cloud computing and physical servers is very different. The implementation cost of cloud computing is almost zero because there is no **need to buy any hardware or software** at the very beginning. Therefore, the rent of cloud computing services continuously increase according to a pay-per-use business model, while the cost of physical servers gradually decreases after the implementation period. Therefore, we need to study the **return of investment** in cloud computing adoption for the short and long term before the decision to adopt the technology.*

Cloud computing technology promise to save the overall IT expenses within any HEI, especially in the upfront costs (Armbrust et al., 2009; Stein et al., 2013). This argument is in line with the feedback from the experts in cloud computing in JHEIs (e.g. P19, DM3 and P3) who argued that the use of cloud computing may enable the JHEIs to start the process of operation directly, with very low upfront investment. Cloud computing adoption would decrease IT expenses in Jordanian universities, especially when the university creates new buildings, which require IT infrastructure. This also has the effect of reducing spending on infrastructure assets, such as storage devices, networks, and servers, which are no longer necessary. This view is supported by one of the professors (P19) in the computer science department who stated:

> *The main feature of cloud computing technology, which makes it worth using, is that there is no need to spend on* ***upfront costs*** *that usually entail heavy investment. For example, over the past five years, our university has initiated [the construction of] three* ***new buildings****, and each building costs the university* ***around £90,000*** *for IT infrastructure. Such infrastructure will need maintenance and continuous upgrading in the future to meet the students' requirements. Therefore, the* ***adoption of cloud computing*** *would save us all these losses in budget. Of course, we will pay for the cloud service, because nothing is free, but it will not be on the same level of full in-house hardware and software.*

Another benefit of cloud computing adoption is that the cloud service provider will be responsible for the cost of maintenance, updating, and upgrading the hardware and software that is used by customers (Lin & Chen, 2012). As one of the IT managers (DM3) stated:

> *I believe that the adoption of cloud computing will* ***reduce*** *the IT staff. This will absolutely reduce* ***operation costs****. Furthermore, the developers in our university can depend on cloud platforms to customise any service needed, instead of implementing the whole software from scratch.*

The feedback from (DM3) revealed that the adoption of cloud computing at JHEIs would reduce the IT maintenance staff, which would save in the overall IT expenses.

Moreover, the pay-per-use business model (see section 2.5) of cloud computing, enables universities to save a considerable amount over the summer when only a minimum number of students and lecturers are using the university facilities. In relation to this, one IT manager (DM7) stated:

> *The* ***pay-as-you-go*** *business model in cloud computing provides the ability to pay according to hourly usage or bandwidth traffic. This model can also enable our university to* ***predict*** *the* ***budget*** *needed and the upfront costs. In addition, we have [known] peak periods when the usage of information technology and facilities increases. On the other hand, we have off-peak periods, such as summer term. Such fluctuation of technology usage during the academic year makes cloud technology one of the best options for our university.*

However, other experts on cloud computing (P3) argued that it is important to select the most suitable service type, as well as service provider, helping education institutions to attain the best benefits with minimum prices:

> *There are many cloud computing service providers available in the market, as well as many cloud services and applications. Therefore, it is very important to conduct a careful study of the university's requirements before deciding to adopt cloud computing. Preparing a plan for cloud computing adoption is the first step for successful adoption of this technology. This plan must include [selecting] the [most] suitable cloud service provider, as well as the [most] suitable services needed. Random selection of cloud services and providers would increase IT expenses instead of decreasing them.*

To conclude, based on experts of cloud computing in JHEIs perception, the findings of this study suggests that the cost benefits of cloud computing should be considered as an enabler of this technology in JHEIs, which may help JHEIs minimise excessive expenditure on ICT. In addition, the business model of cloud computing, which depends on pay-per-use, would prevent universities in Jordan from paying additional costs in the off-peak periods. This would lead to a positive effect on the quality of education by maximising the services of ICT to both staff and students.

5.4.6 Higher education institution size

Several studies have revealed that the size of an institution has a considerable effect on the adoption of cloud computing (Sabi et al., 2016; Lian et al., 2014; Y. Y. Alshamaila, 2013). According to Gutierrez, Boukrami, & Lumsden (2015), smaller institutions are more flexible in changing direction.

The data collected from the Jordanian Higher Education Accreditation and Quality Assurance Commission (HEAC) showed that Jordanian public universities' size (e.g. size of facilities, number of students and staff) is much greater than that of private universities (see Appendix 6). Accordingly, small private universities have more flexibility in terms of the adoption of cloud computing. However, despite the huge size of Jordanian public universities, the findings also show that these universities suffer from overpopulation. Table 5.1 provides a summary of the statistics for different Jordanian universities in 2016-2017 collected by the researcher as a secondary data, which includes the sum of Jordanian student numbers, the sum of international student numbers, the percentage of Jordanian students and international students, the maximum allowed capacity, the number of students above the maximum allowance capacity, and the total sum of academic staff members.

Therefore, the adoption of cloud computing technology could provide more virtual classrooms, services, and resources, which could solve the limited capacity of such universities. Furthermore, the scalability and pay-per-use business model of cloud computing can provide flexibility in increasing or decreasing the amount of resources, according to students' requirements.

Table 5-5 Statistical information related to public Jordanian universities

Jordanian public university Name	Sum of Jordanian students	Sum of international students	Total of all students	Percentage of Jordanian students	Percentage of international students	University maximum allowed capacity	Differences between the maximum allowed capacity and total of all students	Total number of academic staff
University of Jordan	40269	4787	45056	89.38%	10.62%	34240	-10816	1436
Jordan University of Science and Technology	20344	5261	25605	79.45%	20.55%	20479	-5126	933
Al Balqa Applied University	32983	1132	34115	96.68%	3.32%	31204	-2911	1458
Al Al-Bayt University	15924	1770	17694	90.00%	10.00%	8762	-8932	379
Hashemite University	26736	1134	27870	95.93%	4.07%	15482	-12388	627
Mutah University	18234	1358	19592	93.07%	6.93%	16023	-3569	574
Yarmouk University	29246	7302	36548	80.02%	19.98%	21215	-15333	942
Al-Tafila University	5063	47	5110	99.08%	0.92%	6057	947	236
Al Hussein bin Talal University	6132	107	6239	98.28%	1.72%	7814	1575	313
German Jordanian University	3451	555	4006	86.15%	13.85%	1638	-2368	278
Sum	198382	23453	221835	89.43%	10.57%	162914	-58921	7176

Table 5-6 Statistical information related to private Jordanian universities

Jordanian private university Name	Sum of Jordanian students	Sum of international students	Total of all students	Percentage of Jordanian students	Percentage of international students	University maximum allowed capacity	differences between the maximum allowed capacity and total of all students	Total number of academic staff
Jadara University	2391	369	2787	85.79%	14.21%	4800	2013	154
Jerash Private University	3225	972	4197	76.84%	23.16%	5087	890	194
Ajloun National University	995	29	1024	97.17%	2.83%	2533	1509	76
Irbid National University	2125	921	3046	69.76%	30.24%	3517	471	98

Al Zaytoonah University	6312	1443	7755	81.39%	18.61%	10000	2245	328
Al Isra University Amman	3798	1729	5527	68.72%	31.28%	7000	1473	229
Al-Ahliyya Amman University	4940	829	5769	85.63%	14.37	7858	2089	257
Amman Arab University for HE	1040	313	1353	76.87%	23.13%	2467	1114	112
Middle East University Jordan	2266	859	3125	72.51%	27.49%	4000	875	184
Philadelphia University at Jordan	4037	2941	6978	57.85%	42.15%	8000	1022	302
Applied Science University	4550	2643	7193	63.26%	36.74%	9302	2109	255
Zarqa University	5496	1245	6741	81.53%	18.47%	9579	2838	307
Petra University	5227	1767	6994	74.74%	25.26%	8024	1030	294
Collage of Educational and Sciences/ UNRWA	1375	0	1375	100%	0%	1688	313	37
Princess Sumaya University for Technology	2761	252	3013	91.64%	8.36	3147	134	121
American University of Madaba	1305	389	1694	77.04%	22.96%	2184	490	103
Open Arab University/ Jordan branch	2804	225	3029	92.57%	7.43%	3364	335	50
World Islamic Sciences and Education University	4534	1091	5625	80.60%	19.40%	7528	1903	226
Sum	59181	18017	77225	76.63%	23.37%	100078	22853	3327

As can be seen from the tables above, public Jordanian universities are suffering from an excess of students, which is likely to influence the ICT services provided to students' and staff. This may negatively influence the quality of education outcomes because of the limited IT resource. For instance, the university of Jordan maximum allowed capacity is 34240, which means that the university ICT resources is designed to service only that number of students. However, the university has 10816 students more than its maximum allowed capacity. In addition, there are a total of 58921 overloaded students in Jordanian public universities. This may have a negative influence on the quality of education and academic outcomes. This argument is supported by one of the senior lecturers in management information systems (P24) who stated:

> *In computer science department, we have very important courses such as introduction to C++ and Java programming languages. The normal size of the computer lab for these courses should be around 15 students. Believe or not in this semester I have 66 students in one computer lap. It is impossible to teach all of them the programming skills because every four students have only one desktop. Thus, the **quality** of our students in programming languages **is very law**. During the practical exams, I mentioned that students cannot write any program without a considerable number of mistakes.*

One of the decision-makers in a Jordanian public university argued that the reason for the overpopulation of students in the last 5 years, which exceeded the maximum capacity allowance, is the influx of international students who come from neighbouring countries because of war:

> *We have more than 10.000 'excess' students in our university, which would make a **notable scramble for the use of the limited resources** between students. This **limitation** in resources is a challenge we face in our university. Information technology resources are one of these limited resources available here to our students. We hope that cloud computing may help in solving this problem and provide unlimited resource, as cloud experts have said (DM5).*

Furthermore, table 5.5 shows that there are 58921 'excess' students studying in Jordanian public universities. Such overcrowding in student numbers makes the servers and networks shut down several times during the academic year due to high traffic in peak periods, which is likely to be having a negative effect on aspects of the quality of education outcomes in

JHEIs. The findings from interviews show that IT managers believe that cloud computing is the best solution to the problem of service downtime and the current limitations in IT resources in Jordanian universities:

> *It is a fact that we have **too many students sharing the same IT resources**. If we buy more and more servers and more laptops, this will cost the university more. The main concern is that if student numbers drop, as the rising up of their numbers is an exceptional case, then these resources would be useless. Therefore, **cloud computing option is one of the best options** we have, as we can add or remove the servers, storage, and services virtually.*

To summarise, the differences in size among Jordanian universities mean that their computing requirements vary. Public universities have more resources, students, staff, and facilities compared with private universities in Jordan. However, they also have too many students, which may provide a point in favour of adopting cloud computing technology. That is, it would provide scalable IT resources.

In contrast, most of the private universities in Jordan are small institutions compared to public universities, allowing them more flexibility in adopting innovative technology, such as cloud computing. Thus, in the case of Jordanian universities, overcrowding in student numbers means more service demands on ICT. Sharing the current ICT resource without providing any solutions such as cloud computing to overcome such problem would therefore lead to poorer education outcomes

5.4.7 Cloud computing usage by students

Several studies have revealed that the usage level of cloud computing has a considerable effect on the adoption of cloud computing within their institutions (Arpaci, 2016; Sabi et al., 2016; Stieninger et al., 2014). The findings of the survey in this study show that the current overall usage of cloud computing by students was moderately low. Figure 5.4 presents an overview of cloud computing usage within specific periods. Out of 100 students, 43 students have never used cloud computing before, 18 students started using cloud computing mobile applications less than one month previously, 12 students began using cloud computing 6 months ago, 8 students began using cloud computing one year previously, and 19 students began using cloud computing applications more than one year ago. As was mentioned in the previous chapter, the qualitative survey sample was collected from the computer science schools, computer-engineering schools, and information system schools. Therefore, the researcher expected that the number of students who had never used cloud computing before might be even higher in other schools (e.g. humanities schools, law schools, religion and history schools, and schools of politics).

However, it is interesting to mention that there was a notable increase in cloud computing usage among the students over the last year. The reason for this increase could be the more widespread availability of smart phones, on which students could use simple cloud computing applications for storage, such as iCloud, Dropbox, Google Drive, and Microsoft One, as well as other education applications, which helped them to find more resources for assignments.

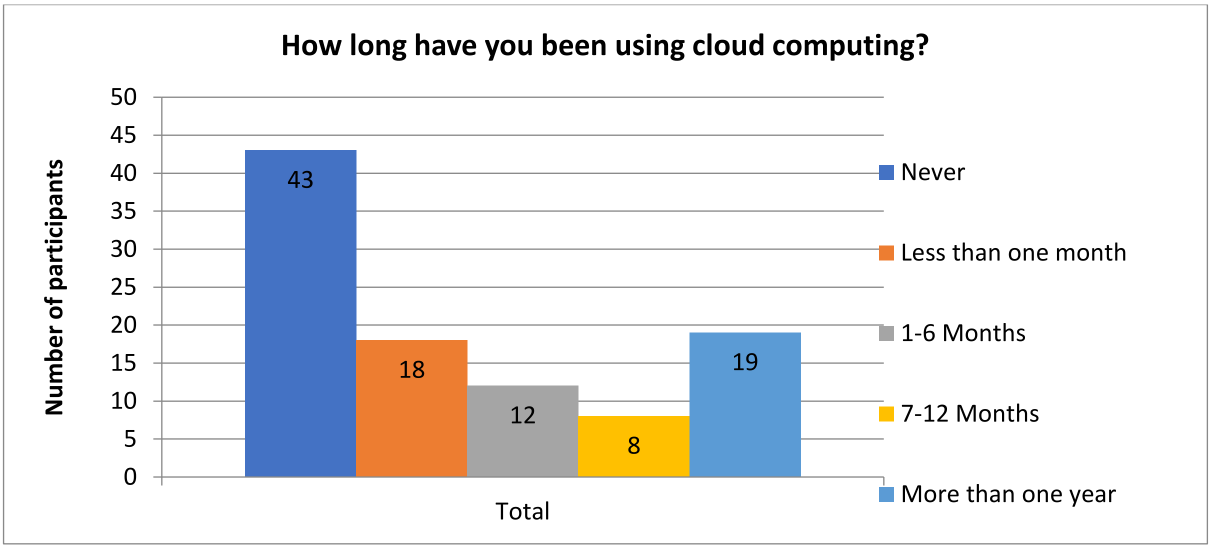

Figure 5-3 Cloud computing usage by students in Jordanian universities

On the other hand, the findings show that Internet usage among students was extremely high. This means that they already have the ability to use cloud computing services, which mainly depend on internet connectivity. In spite of relatively low-level cloud computing usage by students, figure 5.5 shows that almost 92 % of students were using the Internet daily. According to the qualitative survey, there were no participants who had never used the Internet before.

The daily use of the Internet by students could be a positive driver in integrating cloud computing technology into the education sector in Jordan. In addition, there is clear evidence from the interviews and survey that students already have access to laptops and smartphones, through which they can connect to virtual servers and other services. Therefore, the availability of such devices and widespread access to the Internet could play a significant role in enabling the adoption of cloud computing at JHEIs.

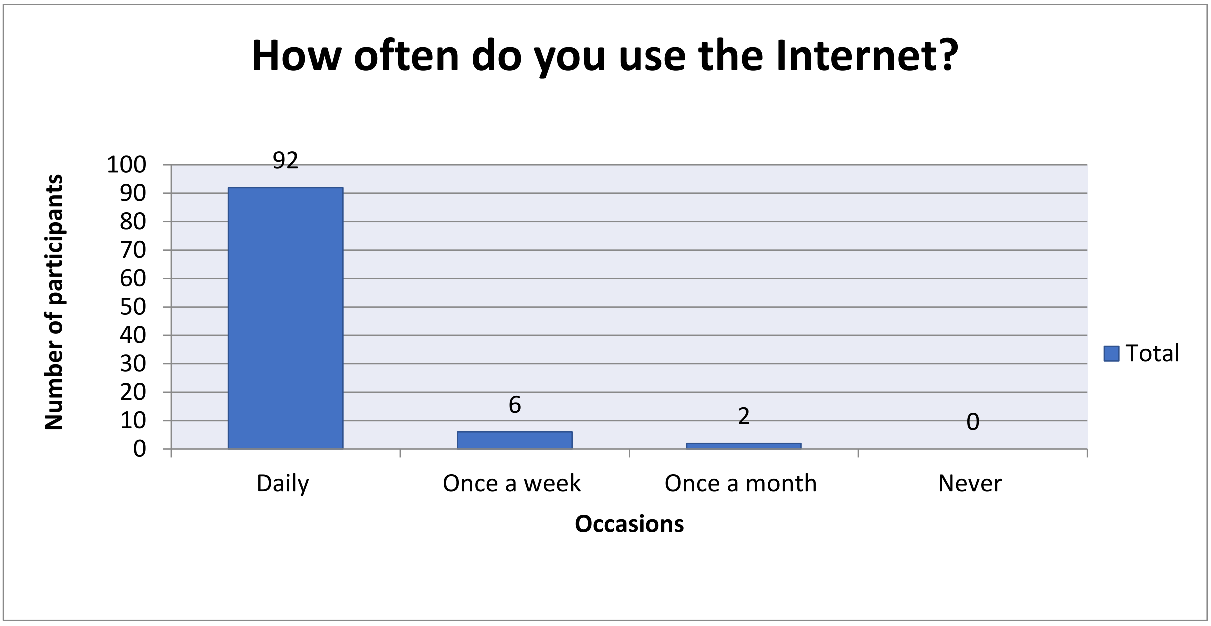

Figure 5-4 Internet usage by students in Jordanian universities

In addition, figure 5.6 illustrates the main devices used by students for accessing the Internet. Based on the survey results in this research, it is important to note that the same participant may have used different devices at the same time for accessing Internet resources. The findings show that out of 100 students, 70 used laptops for accessing internet resources, 27 used desktops, 62 used smartphones, and 13 used tablets. As mentioned previously, the underutilisation of ICT and the lack of computer laboratories for students at JHEIs could be the reason for low-level use of desktops for accessing the Internet, compared with personal laptops and smartphones.

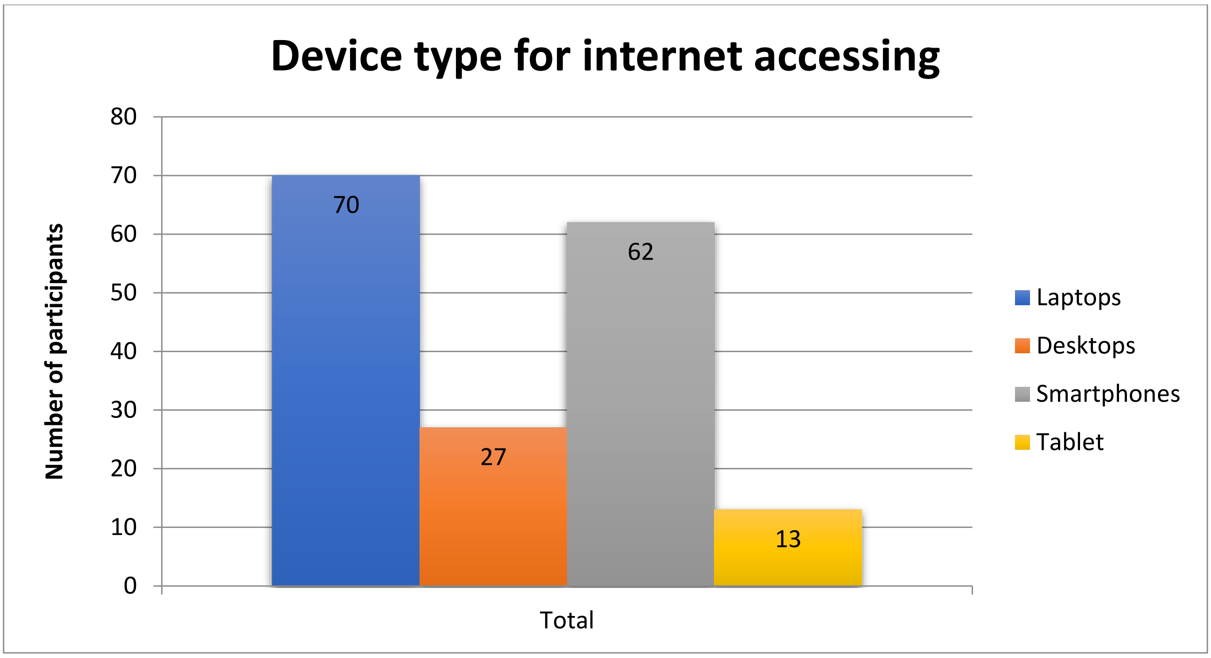

Figure 5-5 Device type for accessing the Internet by Jordanian students

The Jordanian government has worked hard to increase the use of ICT in Jordanian universities (Al-Khasawneh, 2012). Such efforts have enabled students to access ICT resources, such as e-learning, which is used extensively in JHEIs (Al-Hadrami, 2012). In addition, email was consistently employed as the primary communication method between students and lecturers (Tubaishat, Bhatti, & El-Qawasmeh, 2006). However, e-learning and other educational applications were only used for uploading and downloading materials. Unfortunately, more advanced use of ICT, such as virtual classrooms, a virtual cloud computing machine, and simulation engineering applications based on cloud technology are still very limited, and at a very basic level.

The findings showed that 92% of students in JHEIs use the Internet daily and 19 students began using cloud computing applications more than one year ago. These early adopters of cloud computing and the extensive usage of cloud computing between students could play an important role in the efforts to implement cloud computing and thus support the benefits of the technology for JHEIs which could positively impact the quality of education.

Although the findings show that both lecturers and students have smartphones and laptops to access Internet resources, it is not clear whether students and staff are ready to use cloud computing at an advanced level, such as in graduate projects. However, such utilisation of cloud computing applications and services must fall under universities' supervision, in order to provide a secure and trustworthy platform for critical data, such as exams, grading applications, curriculum-authorised references, financial data, and other critical data that may be accessed through a cloud service.

5.5 Environmental factors

Environmental factors refer to the current operating environment of the institutions (Lian et al., 2014). They represents both constraints and opportunities for the adoption of innovation technology (Oliveira & Martins, 2011). Environmental factors, therefore, would significantly influence the adoption of cloud computing at HEIs (Stein et al., 2013; Sultan, 2010). Five environmental factors were found from the field expertise, which may influence the adoption of cloud computing in JHEIs. These are: Spoon-feeding and teaching methods, confidence in cloud service providers, government support, decision-making processes, and resistance to new technology.

5.5.1 Spoon-feeding and teaching methods

According to Hao (2012), spoon feeding is a dependent teaching process that hinders students from being creative and finding answers from different information resources. A well-known approach to teaching and learning at JHEIs is that lecturers are the only source of information for students (Hammad, 2014). Students expect that lecturers are supposed to teach them everything, and feed them all the required information (Daouk, Bahous, & Bacha, 2016). This approach prevents students from using ICT to search for and find more resources (Shen, 2010). One interviewee (DM8), who worked as a former minister of Jordanian higher education argued that the spoon-feeding method prevents students from being independent researchers and taking responsibility for their studies:

> *Actually, we need to rethink carefully about the* ***teaching and learning methods*** *in our universities and to adapt more effective methods. Recently we discussed different issues, such as* ***spoon-feeding****, with several universities' presidents. Unfortunately, the current teaching methods prevent the students from being creators or even from thinking. They are like robots, and are always looking for direct feeding from lecturers.*

One of the professors (P14) supported this idea, saying that:

> *I have noted that in assignments students only used the resources, which had been provided by the lecturers.* ***They are not trying to find more resources by searching physical or electronic books*** *and publications from the university library. Motivate*

students to use ICT in searching for additional resources of knowledge would be the best solution for the spoon-feeding problem.

However, one student participating in a focus group explained:

> *There are **not enough resources in our library**, and it is very old. For example, I tried to find a reference about virtual programming, and the latest one I found was published in 2002. In addition, the facilities that supporting **information technology services** in the library **are not enough**, and are not available most of the time. One librarian told me that the library servers have no storage devices to save more electronic resources. Furthermore, we cannot access the library from outside the university (student- focus group).*

The feedback from the former minister of Jordanian higher education emphasised the importance of combining more exploratory and collaborative approaches to teaching and learning in JHEIs. (P14) supported this argument by providing an example of the negative influence of spoon feeding on Jordanian students and recommended an increase in the usage of ICT as a solution to increase the exploratory skills of students. However, the feedback from the students from focus groups showed that JHEIs are suffering from the lack of the ICT resources. Adopting cloud computing technology may help Jordanian universities to rent virtual servers and storage resources, which may supplement libraries by allowing access to almost unlimited resources and services. Encouraging students to use information technology to gather research from different resources will help to avoid spoon-feeding (Sultan, 2010). This is likely to result in improving the quality of HE outcomes in Jordan through an increase in the collaboration, communication, and knowledge sharing between Jordanian students.

5.5.2 Confidence in cloud service providers

The confidence in the cloud computing service provider is an important factor in the adoption of cloud computing, which is connected with the security and privacy concerns of cloud computing customers (Y. Y. Alshamaila, 2013). The security and privacy of the customers' data are considered the cloud computing service provider's responsibility (Jones, 2015). The study revealed that decision-makers at JHEIs have more confidence in dealing with international ICT service providers than local providers in Jordan. Almost all interviewees at the level of decision-making believed that local companies in Jordan might not provide a sustainable service, and that they might go out of business at any time. One decision-maker (DM3) stated:

> *If we start dealing with local companies for cloud computing services and for any reason one of these companies leaves the market, this would be a disaster for our university. In this case, transferring services and data to another cloud service provider would not be a straightforward technical process.*

On the other hand, confidence might be one of the main challenges in adopting cloud computing, especially in the case of storing critical data on cloud storage applications. As one IT manager (DM9) in a public Jordanian university said:

> *As an IT manager, it is very difficult to imagine that someone else stores your data. Of course, full confidence in this provider is the only accepted scenario for that.*

One researcher in cloud computing (P1), who has published extensively on this topic, found that there is a difference between the context of England, as a developed country, and Jordan, with regard to this:

> *I can tell you one interesting factor in my current research about the adoption of cloud computing at small and medium companies in Jordan.* ***When I did my PhD research in England****, one of the main factors was the theory restriction, which meant that when I interviewed people in England they said "OK, it is important for us that* ***the data centre should be in the UK and under UK registration****, not in any other place, such as the USA".* ***In Jordan, it was totally the opposite****. What they said here was that the data centre should be outside Jordan, as well as the cloud computing service provider. They argue that Jordanian companies open now and normally close after 3 months. Therefore, trust of local companies in Jordan was a big concern for them.*

The same participant also made a pertinent point about the lack of policies for data protection, which also negatively affects trust when dealing with local cloud computing service providers in Jordan:

> ***Another interesting finding in my research*** *is that there is no* ***registration and role*** *for data protection* ***in Jordan****. The current registration is* ***not good enough*** *to deal with cloud computing issues and consequences****. Developed countries such as the UK started cloud computing in 2007, whereas Jordan just started now in 2016****.*

In brief, confidence in cloud service providers is an important factor that influences the adoption of cloud computing. The findings revealed that decision-makers are not totally confident in dealing with local cloud computing service providers, who instead showed a greater willingness to deal with international service providers. In addition, there are weaknesses in Jordanian policies regarding the protection of data. These factors may negatively affect the adoption of cloud computing technology in Jordanian universities.

5.5.3 Government support

This section reflects on the stakeholders' perception of the relationship between government support and the successful adoption of cloud computing in HEIs, with the subsequent implications for quality of education. Although in some cases (e.g. public Jordanian universities) it is more important than in others (e.g. private Jordanian universities), it is always important for governments to support the quality of HE as it has direct implications for socio economic development.

The support of the Jordanian government is vital for the adoption of innovative technology, according to this study's findings. However, many interviewees agreed that the government is still in the planning phase, and has no clear vision regarding the implementation process.

> *The **government** is working nowadays to **adopt cloud computing** in all universities in Jordan, **especially in the public sector**, including all systems, devices, infrastructures, and platforms. However, they are still on the planning level, and I believe that the government has no clear framework or roadmap to start using cloud computing technology.*

Other participants, however, argued that the Jordanian government did not effectively support the adoption of cloud computing, and that the lack of innovative technology adoption in JHEIs is the government's responsibility. As one of the professors (P3) stated:

> *I think it is an administrator issue; the **government did not have vision** about cloud computing services and their main benefits. I believe that the lack of cloud computing adoption is not because of technical difficulties, but that it is mainly government policy difficulties. However, there are notable efforts regarding the e-government project. Last month the government decided to provide an electronic ID card, which can provide different services to citizens. I hope this is a good indicator f**or adopting cloud computing**. However, to the best of my knowledge, the majority of these services are mainly hosted in the internal government servers, not in the cloud.*

Furthermore, a professor in management information systems (P9) argued that the Jordanian government has no clear process for the acceptance or rejection of any innovative technology or creative project:

> *Several years ago, I submitted a project to the* ***government*** *to create a solid system for electronic voting in the Jordanian parliament. Unfortunately, top management in the Jordanian* ***government did not evaluate or even study my project****, and the project was rejected without any clarification [as to why this was the case]. In fact, there is* ***no support*** *for any new project or innovative ideas.*

In brief, the support of the Jordanian government is perceived as a crucial factor that may accelerate the adoption of cloud computing in the educational sector, especially at Jordanian public universities and so help to improve the quality of education. Despite the efforts of the Jordanian government to improve the teaching and learning processes, many participants perceive that this support is not sufficient and strongly recommend further efforts to increase the focus on innovative technology, such as cloud computing.

5.5.4 Decision-making process

This section highlights participants' perception of the relationship between the decision making process and the success of cloud computing adoption in JHEIs. A common view amongst interviewees was that many Jordanian universities have a decision-making problem as decisions can only be made by top management who fail to devolve any authority to university staff. Because of this, top management would accelerate the adoption of cloud computing in the Jordanian educational context only if they were convinced about the technology, and aware of its benefits.

However, the adoption of cloud computing would be very difficult if managers in the top hierarchies reject cloud computing adoption (Lian et al., 2014). One computer science professor (P8) at a Jordanian public university stated:

> *I believe that we have a bureaucracy problem in our university, which prevents us from making any progress in* ***improving the educational level*** *through* ***adopting innovative*** *technology. The* ***top management*** *here enforce us to wait for a long period, with a long process of accepting or rejecting any decision.*

Another professor (P21) in management information systems at a Jordanian private university stated:

> *The priority for adopting any new information system, such as cloud computing, is to change the bureaucracy and the way of thinking. Unfortunately, the majority of* ***presidents in Jordanian universities*** *are of the old generations, and most of them do not believe in the role of information technology in* ***improving education quality****.*

Another professor (P24) argued:

> *The **top management** must give more permission to young people to decide whether to use a technology, instead of centralising the final decisions within their offices, especially in the field of adopting or even rejecting cloud computing applications.*

In sharp contrast, demonstrating the sometimes arbitrary nature of the decision making in Jordanian universities, one professor at an engineering school (P29) did not have to petition for permission from higher powers:

> *We have **full permission** to adopt or reject cloud computing or any other technology in our school. However, cloud computing still has security and privacy issues, and we need to think carefully about the process of adoption and its circumstances. If we recommend cloud technology, the **top management** will absolutely accept our recommendations.*

Thus, the decision making process in Jordanian universities can potentially hinder the adoption of cloud computing. However, many of the solutions to this problem, suggested by interviewees, can be summarised as follows:

- The top management in Jordanian universities, which is highly bureaucratic, must delegate more permission to individual university departments, decentralising the decision-making process.
- The role of computer centres in Jordanian universities to validate and study the benefits and limitations of any new technology should be improved, instead of enduring the lengthy, and potentially unsuccessful, bureaucratic process of top down management.
- Professional recommendations about how to use innovative technology, such as cloud computing, should be taken into account. This would enable new users to gain the primary benefits, while avoiding any limitations or disadvantages.
- A roadmap or framework should be developed, which may include clear phases for adopting or rejecting any new technology, instead of following a complicated centralised process.

Although the decision making process in some of JHEIs could be an issue, the perception of stakeholders is that it can be overcome by delegating more authority to university departments and universities computer centres. This issue could be also overcome by establish a new mechanism for the adoption of innovation technology. This study attempts to develop a new framework for the adoption of cloud computing at JHEIs and to explain both strategic and implementation perspectives for the adoption of cloud computing in JHEIs.

5.5.5 Resistance of new technology and fear of adapting innovation-teaching methods

The adoption of innovative technologies, such as cloud computing, at JHEIs is a transformation from old and traditional learning methods to new ones, which necessitates a new teaching and learning environment for lecturers and students. The implementation of cloud computing might therefore produce a resistance to this transformation process. Such resistance to cloud computing adoption in developing countries has already been identified in several studies (Dada, 2006; R. Sharma, 2003; Xu, 2012; Yeboah-Boateng & Essandoh, 2014b).

The findings showed that resistance to the adoption of cloud computing is motivated by several different causes. Some participants from a computer technical support unit in a Jordanian university said that they feared losing their jobs in the case of adopting cloud computing, because technical support would come from the cloud service provider's side.

> *The acceptance of adopting cloud computing means a major change in our rules as a technical support team. Our tasks would mainly focus on* ***consultations*** *and organisation, rather than daily diagnostics for servers and local applications. The top management must be aware about this fact. Otherwise,* ***they may assume that we are useless*** *and an additional cost, and that the cloud providers can handle all technical tasks remotely (Technical support - Focus group).*

In the same vein, an IT manager (DM9) declared:

> *I think that adopting cloud computing technology is a good step in automated services, and depends on online service more than in-house applications. However, our concern is* ***replacing us with this technology****. In this case, we will not support the adoption of cloud computing at all.*

In addition, when the implementation of cloud computing training courses and workshops was discussed, most lecturers considered these courses to be exam-based, and that they should attend and pass as a one-off occurrence, without trying to develop practical skills in the long term. This attitude may increase the resistance to cloud computing, because it would result in a lack of skills in the use of cloud services, especially with complicated services such as cloud database platforms and programming applications. As one decision-maker (DM5) stated:

> *Our lecturers have attended a considerable number of courses in cloud computing, which were provided by several companies in Jordan. Unfortunately, most of them informed me that they* ***forgot the skills*** *of using cloud applications, such as* ***cloud database platforms****. I believe that the* ***culture of our employees must be changed****, because it is not an* ***exam to pass****. It is an extensive investment to improve the employees' skills in both the short and long term.*

In addition, one professor (P11) argued:

> *Cloud computing is not fully adopted in our work environment, and it is* ***waste of time to perform the task twice****, for example saving the daily records on internal storage devices and saving them again on cloud computing applications.*

Furthermore, one IT manager (DM6) stated:

> *In the current situation, the adoption of cloud computing would not be success. It is clear that there is a* ***strong resistance*** *by technical engineers to the adoption of this technology, especially those in the first-line technical support. This* ***resistance*** *is because they believe that cloud computing technology will replace them and take away their tasks (Focus group).*

Another IT manager (DM8) stated:

> *In the case of the cloud computing migration process,* ***the role of the technical support team is very important****. Furthermore, after the migration process they have an important role because we cannot transfer all applications to cloud computing. It is a long process and without the technical support team's cooperation, the adoption of cloud technology might fail.*

Moreover, it was noticed during interviews that lecturers from older generations have a strong resistance to using ICT, and that they prefer traditional methods in teaching, such as forcing students to write down lecture notes by hand.

In this context, a retired professor argued that the utilisation of ICT is not an important issue, and Jordanian universities have the ability to graduate students without depending on any technology.

> *Thousands of students graduated 20 years ago from Jordanian universities* ***without using electronic libraries and cloud technology****. It is important to increase the number of physical resources, such as books and thesis in libraries. It is not acceptable to decrease these physical resources and replace them with virtual shelves and cloud services* (P30).

In contrast, the data showed that young lecturers are highly motivated to use ICT in general and cloud computing in particular. As one young lecturer (P13) stated:

> *The adoption of innovative technology will absolutely accelerate the process of teaching and learning. In addition,* ***it will make teaching*** *as well as research* ***more interesting and easier****. For example, using* ***cloud computing*** *technology could enable both students and staff to access educational materials from anywhere at any time. Moreover, it can provide excellent applications for teamwork online.*

In conclusion, cloud computing is still generally considered to be a new, unfamiliar technology in Jordan, and so it has not been fully adopted in Jordanian higher education. The data available has shown that resistance to the new technology arises not only from scepticism about its benefits, but also from technical staff's fear of losing their job, and from the older generations, who prefer to use traditional methods in the teaching and learning process. This resistance to new technology is likely to negatively affect the adoption of cloud computing in JHEIs.

5.6 Quality factors

Within the early stages of this research, factors relating to the quality of education have been observed on many occasions (See sections 1.2.1 and 2.3). The quality of higher education and its important role in improving the overall development of any country has been discussed in the literature review chapter (see section 2.2). In addition, quality factors are considered an important part in the conceptual framework of this study (See section 6.3.3.3). Such factors and their relation with the adoption of cloud computing were investigated in the fieldwork. The quality factors that were investigated in this research were: the quality of higher education in Jordan, employment levels, use of the latest technology and knowledge sharing. It is important to note that these factors included the factors that are in the quality of higher education definition in section 2.3.

5.6.1 Quality of higher education

As explained in the previous section, the quality of HE in Jordan is a key concept in this research. However, there are problems with evaluating the quality of JHEIs because of differences between Jordanian universities' rankings, and differences between students' levels. The majority of participants in the study agreed that there is a gap between Jordanian university curricula and the labour market's requirements. In addition, almost all participants voiced the belief that adopting the latest information technology would help decrease this gap, allowing students to become up-to-date with market trends.

A head of a management information systems (P3) school in a Jordanian private university stated:

> *It is* ***difficult to evaluate the quality*** *of higher education in Jordan. We are still not satisfied about the* ***quality*** *of research, the* ***quality of students*** *themselves, and the* ***quality*** *of staff. The story at every single university here in Jordan is to close the* ***gap between the theoretical part and the practical part****, which is needed in the market. I am positively sure that in the case of Jordan there is a big gap between the theoretical concepts that have been given to the students and market requirements.*

In the same context, a professor in computer engineering school (P1) in a public university argued that the quality of graduate projects is not aligned with labour market trends:

> *One of the big reasons for this* ***gap*** *is that the universities are* ***off-track about providing the right kind of knowledge*** *that fits the labour market. On this point, we had a discussion with the president of our university. He is enthusiastic about finding out how to close the* ***gap with the labour market****, and even stressed that before any department creates its curriculum and confirms graduate students' projects, it should ask the leaders and professionals in the labour market about the outcomes they want to see in our graduate students.*

Almost all interviewees agreed that ICT in general and cloud computing in particular could positively affect the quality of students. As one professor (P4) in an engineering school stated:

> *Information and Communication Technology as a tool always enhances the quality of higher education: there is no doubt about that. Cloud computing is the new generation of ICT. Therefore, it will improve quality in education and even in any other context.*

Another professor (P9) in information technology added:

> ***The mission of information technology is to enhance the performance*** *of people. Investing in information technology is a win-win situation, which will enhance performance and* ***quality*** *at the individual level, as well as at the institutional level. I believe that* ***cloud computing adoption*** *in higher education will absolutely* ***improve the quality of Jordanian education****. In addition, it may* ***decrease the gap*** *between Jordanian universities and other international high-ranking universities around the world, especially in research and publication outcomes.*

In addition, one professor (P11) asserted that:

> ***Cloud computing can enhance the teaching environment****. It can save* ***time****, as in the example that we discussed in our informal interview about collecting 30 students' answers within half an hour, being able to comment on the results during less than five minutes, and finally increasing the* ***quality of teaching****.*

Furthermore, Figure 5.7 shows the results obtained from the qualitative survey about students' perceptions of the ability to improve the quality of JHEIs through the adoption of cloud computing technology. There were 100 responses from 109. The research showed that 74 participants believed that the adoption of innovative technology such as cloud computing would improve the quality of education in the teaching and learning process, as well as in student outcomes. 17 participants believed that the adoption of cloud computing would not improve the quality of education in Jordan, and 9 participants did not know.

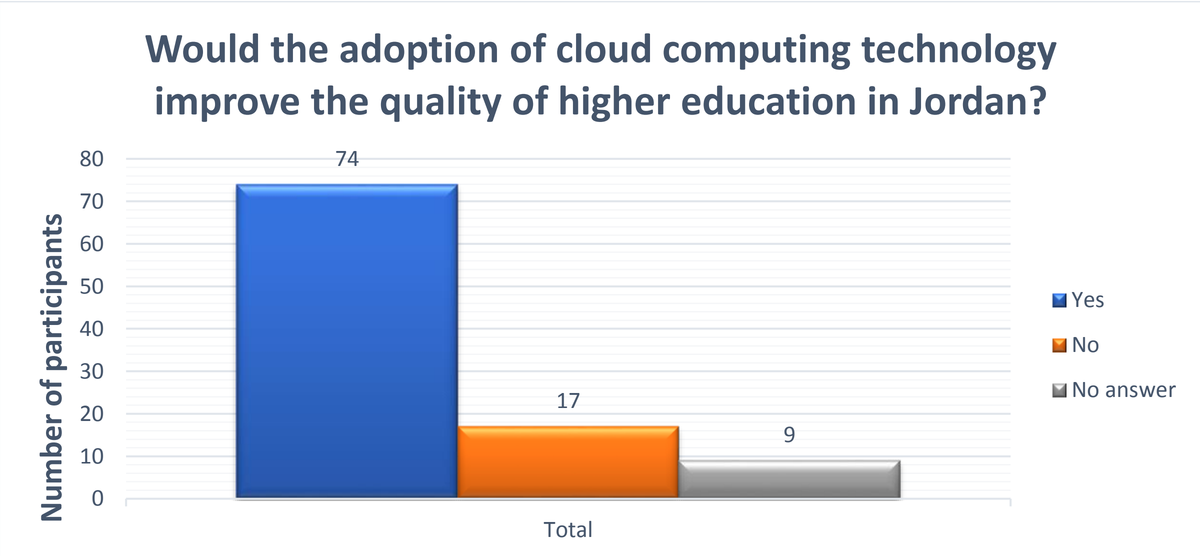

Figure 5-6 Student perspectives on whether the adoption of cloud computing technology might improve the quality of Jordanian higher education

The findings show that students have a positive attitude towards using information technology. In addition, they achieved better outcomes when using cloud computing applications such as Google Forms:

> *We observed that students prefer to contact each other through social media, which is based on cloud applications. In addition, we discovered that* ***students' performance became much better when we integrated simple cloud computing applications*** *into their studies, such as Google Forums, and they asked me personally to adopt other cloud applications as an authorised method to deliver their shared projects (P17).*

However, one of the professors (P22) in an engineering school stated:

> *Although University of Jordan students achieved the best outcomes from their secondary schools, the students in the computer science department here still have a* ***lack of awareness*** *about virtual and simulation services, which are offered by* ***cloud computing technology****. I believe that this is one of the main reasons influence the* ***quality*** *of education in Jordanian universities.*

To conclude, the findings revealed that the perception of decision makers and other stakeholders within JHEIs is in line with the adoption of cloud computing as one solution to improve the quality of HE, which may positively influence the socio economic development in Jordan. Furthermore, the feedback from participants showed that there is need for a framework for the adoption of cloud computing in JHEIs to explain both strategic and implementation phases. This could also help in decreasing the gap between labour market needs and educational institutions in Jordan.

5.6.2 Employment level and utilising the innovation technology

As mentioned in the literature review (section 2.10.5), Jordan has a high unemployment rate, which is estimated at 12.2-14.0 % between 2013-2017 (Schinke et al., 2017; Bondokji, 2016). The findings of this study showed that there is a perceived connection between the unemployment level of graduate students and the Jordanian universities' inability to engage with the latest ICT. This is in line with the theoretical developments in the field (Al-Omari et al., 2012). This section seeks to understand the perceptions of JHEIs' stakeholders of the relationship between HE students and their readiness to meet the needs of the jobs market in Jordan.

Most of the participants in the study argued that there is a notable gap between Jordanian universities' outcomes and labour market requirements. One of the reasons for such a gap is the underutilisation of innovative technology, which prevents graduate students from being qualified to work within a professional environment. As one of the professors (P29) who work as a CEO in cloud computing services company stated:

> *We are surprised about the **level of graduate students** who come for meetings here in our companies. For example, they are not familiar with 3D programming or the latest oracle versions, such as 11g or 12g. In addition, **their graduate projects are not creative**, and they use a **small sample size in their simulations**. Unfortunately, when we ask them about virtual reality based on **cloud computing** technology, which is a speciality of our company, most of them have no idea about it.*

However, it was noticed that most of the interviewees from all academic levels were aware about this gap. As another professor (P16) argued:

> *One of the big reasons for the **gap between the universities and market requirement** is that the **universities being of track** about providing the right kind of knowledge that fits to the **labour market**. In this point, we had a discussion with the president of our university and he is enthusiastic about finding out how to close **the gap in labour market**. Furthermore, the president stressed that before updating the curriculum we should first ask the leaders and professional in the labour market about the things they want to see in our graduate students.*

One interesting point made by a decision-maker (DM3) in a Jordanian private university was that the key point of success in Jordanian universities is to understand how to use ICT in an effective way:

> *Well, technology by itself cannot do anything. **It is the story of how to use** that **technology**. It is not the idea that if you build it will come. Suppose that we invested in technology but we did not really know how to **utilise this technology in a proper way**. If the university **smartly employ the technology** towards achieving our learning goals and objectives, then most likely we will succeed. On the other hand, if the university just invest on technology and waiting for results without doing any extra efforts nothing would happened, **even worse the gap will be increased** year after year.*

In addition, another decision-maker (DM5) stated:

Using IT can always increase job opportunities. Definitely, it is good to increase our students' level in ICT. One example that comes to my mind is the ***Scandinavian countries****. They have a very advanced level in using ICT, which positively reflects the Gross Domestic Product (GDB).* ***Another example is India****, which is using advanced programming languages in higher education in different computer courses. This creates very good job opportunities for graduated students.*

Figure 5.8 presents a summary of the understanding of Jordanian students about the relationship between the unemployment level in Jordan and the adoption of the latest ICT, such as cloud computing: responses were gained from a qualitative survey. There were 100 participants who agreed to participate in this survey out of 150 requests. 68 participants believed that the adoption of cloud computing in Jordanian universities could contribute to solving the problem of unemployment in Jordan, and 32 participants believed that the adoption of cloud computing in Jordanian universities would not affect the unemployment level in Jordan.

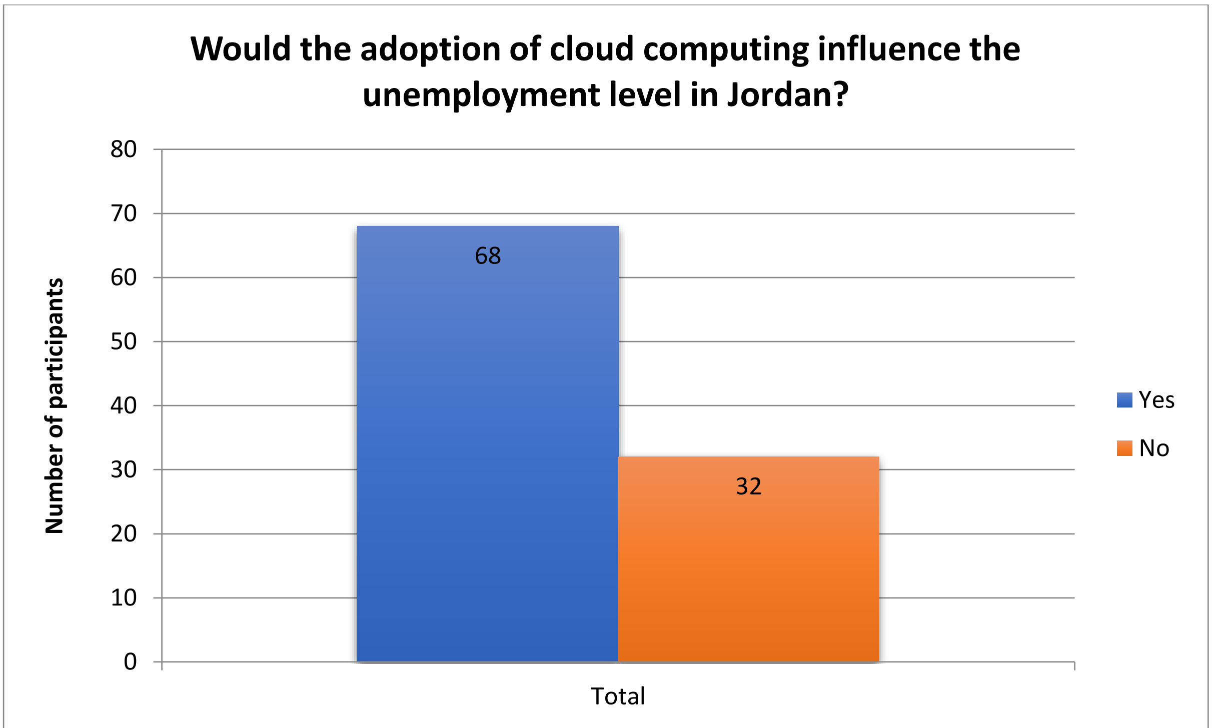

Figure 5-7 The influence of cloud computing adoption on the unemployment level in Jordan

In general, the findings of this study showed that both students and staff believed that there was a relationship between unemployment levels in Jordan and the underutilisation of innovative technology in JHEIs. Almost all interviewees agreed that the adoption of ICT in general and cloud computing in particular would decrease the gap between Jordanian universities and labour market requirements. This in turn could lead to a decrease in unemployment in Jordan, especially within companies based on technology services.

5.6.3 Knowledge sharing

Several studies have revealed that sharing knowledge is considered to be a key factor in improving the value of an institution (Garcia-Perez & Ayres, 2015; Sassman, 2014; Sohail & Daud, 2009). The findings of the current study are consistent with those of (Garcia-Perez, 2011; Sassman, 2014; Sultan, 2013b), who stress the positive role of innovative technology in improving knowledge-sharing within an organisational context.

This section aims to summarise the views of JHEIs stakeholders about the potential relationship between knowledge sharing and the adoption of latest technology such as Cloud Computing in their HEIs. Almost all participants argued that the adoption of cloud computing in Jordanian universities would increase knowledge sharing. As one of the professors (P9) in information systems asserted:

> *As long as the* ***cloud computing platform*** *was adopted, it would eliminate any reason preventing* ***knowledge-sharing****. Therefore, having cloud computing will absolutely increase knowledge-sharing.*

In addition, the findings showed that students in JHEIs have already created several approaches to increase the sharing of knowledge, such as creating pages in social networks to share resources for different courses. However, a common view amongst many interviewees was that using social networks in knowledge sharing is not a professional approach, and the content shared between students is not officially authorised by the university. Therefore, one of the interviewees (P28) suggested using only non-social cloud computing applications, which are mainly dedicated to sharing academic materials, as well as sharing knowledge between students and lecturers.

> *Students at our university are* ***using social networks for sharing knowledge****. It is clear that they would like to* ***share the academic knowledge*** *between each other, which is a great thing. However, social networks are not professional, [that is, not] for academic purposes. There are many professional* ***academic tools for sharing knowledge****, which mainly depend on* ***cloud computing technology****. Our university was facing many problems over the last few years because of fake accounts that provided misleading resources for exams and assignments. Unfortunately, some of the owners of these fake*

accounts claimed that they were university lecturers or members of university staff (P31).

The other finding to emerge from this study was that the sharing of knowledge between Jordanian universities is very limited. As one professor in a computer science department (P2) stated:

> *I believe that the **sharing of knowledge** between Jordanian universities is almost zero. **There is no sharing of research**, software and services, **publications**, **and workshops**. Hopefully, **the adoption of cloud computing** would open new sharing channels if we have the same shared services that may help us to communicate together.*

In summary, stakeholders of the JHEIs believe that sharing knowledge is an important factor that could positively encourage Jordanian universities to adopt cloud computing technology. Almost all participants agreed that the adoption of innovative technology, such as cloud computing, to connect Jordanian universities with one shared service or application might increase the sharing of knowledge between students and lecturers. This would go some way to solving the current problem of limited communication within universities and between universities, especially if all JHEIs worked together, and the Minister of Higher Education in Jordan authorised such applications. Enhancing knowledge sharing in JHEIs through adopting innovation technology such as cloud computing could be one of the potential solutions that may improve the overall quality of HE in Jordan. Therefore, developing a conceptual framework to help JHEIs in the adoption of cloud computing may also increase the growth of knowledge sharing..

5.7 Representing factors influencing the adoption of cloud computing in JHEIs using NVivo

As was explained in section 4.7.3.1, the researcher used NVivo software for analysing, coding, connecting, and categorising the qualitative data. This software also enables the researcher to create diagrammatic forms that indicate correlation among factors. The final categorisation of these factors into a secondary cycle of codes (technology, organisation, environment and quality) as well as the primary cycle which included thirty-three factors is presented in Figure 5.9. These factors form the backbone to the framework that will be presented in the next chapter.

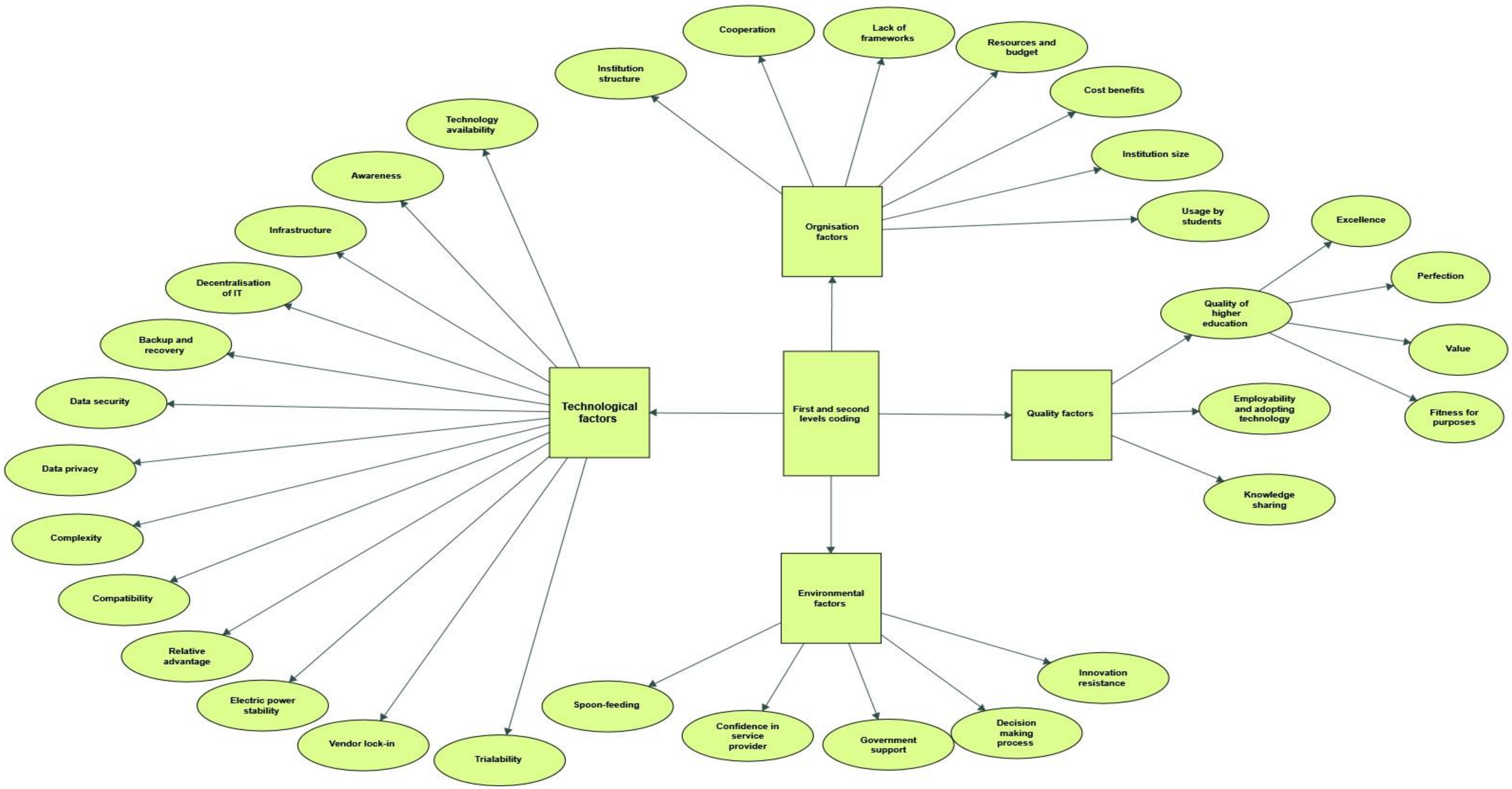

Figure 5-8 Final (first and second level) coding for the factors influencing the adoption of cloud computing at JHEIs

5.8 Chapter summary

This chapter presents an analysis of the data collected from interviews, focus groups, direct observation, and provides frequencies from data collected by qualitative survey. The main aim of this chapter was to present the factors influencing the adoption of cloud computing technology at JHEIs. This chapter draws links between these factors, and categorises them into factors relating to technology, organisation, the environment, and quality. Furthermore, new factors were discovered in the fieldwork and analysis process, which might influence the adoption of cloud technology in JHEIs. These factors will be employed as part of the suggested framework for cloud computing adoption in chapter six.

The next chapter presents the conceptual framework, developed for the purpose of adopting cloud computing technology in JHEIs. The suggested framework has been developed in the light of this chapter's findings.

6 DEVELOPMENT OF THE FRAMEWORK

The aim of this chapter is to answer the research questions: “How can higher education institutions in Jordan effectively adopt cloud computing technology in the learning and teaching process?”, “What are the main phases for the effective adoption of cloud computing technology in JHEIs? and “What are the motivators for and barriers to cloud computing adoption by JHEIs?”. In order to answer these questions, this chapter presents the process of implementation of a conceptual framework to help JHEIs in the adoption of cloud computing technology.

The proposed framework emerged from the theoretical foundation described in chapter two as a starting point to extend and merge the theories applied in this study. In addition to this theoretical foundation, the empirical findings were used to develop the proposed framework; the framework referred to as the TOEQCC. Finally, the actual adoption of cloud computing was suggested by the TOEQCC framework by extending the actual use of TAM components and connecting them with DOI theory, presented through a sequence diagram to suggest a process for the implementation of cloud computing by JHEIs.

6.1 Emergence and merging of conceptual framework

A conceptual framework explains, “either graphically or in narrative form, the main things to be studied: the key factors, variables, or constructs and the presumed interrelationships among them. Frameworks can be simple or elaborate, commonsensical or theory driven, descriptive or causal” (Miles et al., 2014, p.20).

Alvesson and Karreman (2011, p.1) stated that “It is not so difficult to produce a description of what people do and say through interviews, observations and other methods, but to continue beyond that and suggest insights, concepts, explanations and other 'deeper' aspects offering a more abstract theoretical understanding that goes beyond the relevance of a particular case or sample studied is not so easy”. Accordingly, this chapter drawing together both the findings of this study and findings from the literature review in section 2.11, concentrates on the development of a conceptual framework for enhancing the overall understanding of cloud computing technology, explain the motivators for and barriers to cloud computing adoption, and suggesting a roadmap for cloud computing adoption at JHEIs. Developed on a theoretical foundation with practical elements, it addresses the following issues:

- What are the motivators and barriers to cloud computing adoption by JHEIs?
- What are the pre-requisites for the adoption of cloud computing by JHEIs?
- What analytical steps are needed for the adoption of cloud computing by JHEIs?
- How can systems which are currently being used in JHEIs to support teaching and learning be migrated with cloud computing technology?

6.1.1 TOE framework limitations

The original TOE framework includes critical factors related to utilising cloud computing technology within HE (Sabi et al., 2016), as shown by studies adopting innovative technology in different contexts (Y. Y. Alshamaila, 2013; Jia, Guo, & Barnes, 2017; Y. Wang, Li, Li, & Zhang, 2016). Despite the benefits of the TOE framework, there are a number of challenges in using TOE for the study of the adoption of CC in the context of JHEIs Jordan, such as:

- The TOE framework categorises the variables without suggesting a conceptual framework to address the adoption of a specific innovative technology such as cloud computing (Dedrick & West, 2003).
- The use of a variety of variables is limited, these include knowledge-sharing variables, quality variables, skills, IT investment and budget, infrastructure readiness, and security and privacy concerns (Y. Wang, Wang, & Yang, 2010).
- It does not suggest practical steps for adopting the innovative technology such as cloud computing (Low et al., 2011).

The new TOEQCC framework has addressed missing factors in TOE framework and integrates TAM and DOI theories for cloud computing technology in the context of JHEIs. In addition, to adapting the TOE framework, the study added the factors which came from the fieldwork during the data collection process and the findings from data analysis. It also suggested quality as a fourth component in the original TOE framework for analysing excellence, perfection, fitness for purposes, and higher education outcomes. Such component enhancing TOEQCC provides a theoretical and structured approach to presenting the factors that influence technology, organisation, environment, and quality in the given context.

6.2 Extending the TAM framework with TOEQ framework and DOI theory

As already explained, in incorporating TAM, DOI and TOE into the TOEQCC framework, the author introduced the quality of higher education as a fourth component of the TOEQ framework, a characteristic emphasized from an early stage in this study. The quality component consists of several factors, which are addressed in the literature review and developed from the fieldwork. These factors are presented in the TOEQCC framework in the implementation process of cloud computing.

Figure 6.1 presents the proposed TOEQCC framework. The essential elements of TAM (perceived usefulness, perceived ease of use, attitude and BI) are applied to the potential adoption of cloud computing in JHEIs. The TOEQ framework factors are dispersed on the left-hand side as well as in the body of the extended framework. On the right-hand side is the implementation process adapted from DOI theory as described above.

6.3 TOEQCC framework illustration

This section is an overview of the TOEQCC framework in narrative form, which serves to complement its graphical representation in Figure 6.4, in line with Mile and Hubermann's description of the concept of a framework. The new framework extended the Technology Acceptance Model (TAM) framework (Davis, 1989) and merged it with the Diffusion of Innovation (DOI) (Rogers, 2003; Rogers, 2010) and Technological-Organizational-Environmental (TOE) theories (Tornatzky et al., 1990). The factors influencing the adoption of cloud computing by JHIEs identified in chapter five were adopted as an important part of this framework. Such factors identified from the context of HEIs in Jordan through interviews, focus groups, survey, direct observation and document analysis. The T-O-E-Q factors framework from chapter five with TAM was used to identify the motivators (M) and barriers (B) relating to the adoption of cloud computing: these are given letters (A to P) in the TOEQCC framework.

The first part of the TOEQCC framework, which represents the motivators and barriers relating to TAM, is intended to answer the third research sub-question: "What are the motivators for and barriers to cloud computing adoption in JHEIs?". The second part of the TOEQCC framework represents the process of cloud computing adoption by JHEIs, using a process flow diagram to explain the stages of adoption. This diagram adapted DOI theory, modified with the quality factors and additional stages. This part of the TOEQCC framework is intended to answer the research question "How can JHEIs adopt cloud computing technology to improve the quality of the learning and teaching process?"

The new framework therefore includes both theoretical and practical approaches to the adoption of cloud computing technology in HE institutions in developing countries in general, and the Jordanian educational context in particular.

The TOEQCC framework can be used by JHEIs as a blueprint for better understanding of the process of adoption of cloud computing. It provides the main steps in implementation and the most important factors affecting the adoption of cloud computing. It could also be applied in similar contexts in Middle East countries, which share common denominators such as culture, language, economy, attitude toward using cloud technology, behavioural intention to use new technology, and level of ICT use.

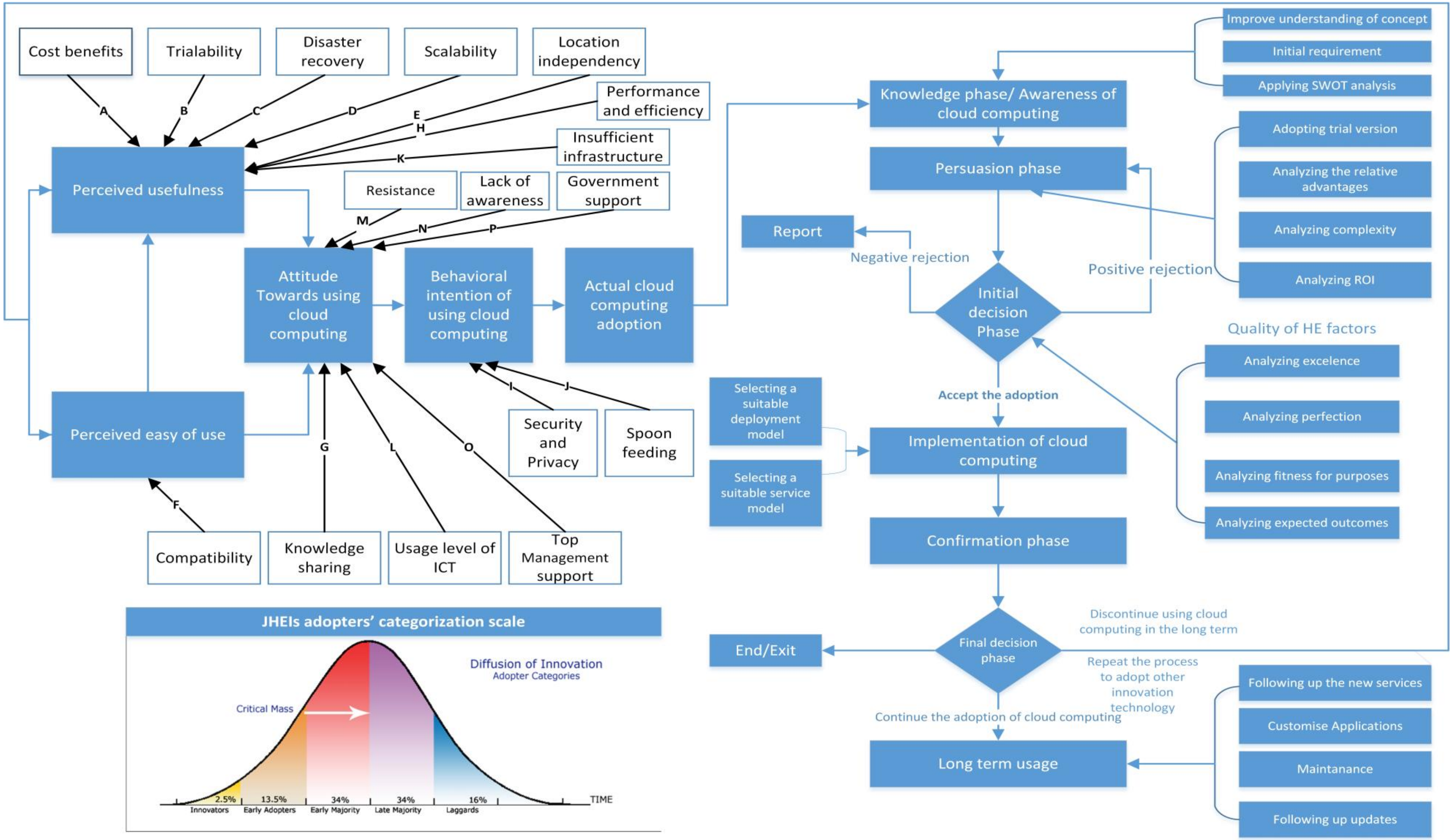

Figure 6-1 The initial TOEQCC framework for the adoption of cloud computing technology in JHEIs

6.3.1 Motivators for cloud computing adoption

The next section presents a total of eight motivators for cloud computing adoption at JHEIs through presenting such factors and their relationships with the TAM framework as a part of the TOEQCC framework.

Link A: Cost benefits of cloud computing have a direct influence on usefulness

A reduction of total IT expenses tends to have a high impact on the usefulness factor (Sabi et al., 2016), and the services offered by cloud technology have the potential to increase usefulness in many regards, such as freeing HE institutions from the cost of purchasing, implementing, and maintaining hardware and software locally (Hsu et al., 2014). Chou (2015) similarly emphasises that the high cost of upgrading ICT may prevent HE institutions from adopting advanced IT and suggests that cloud computing is a useful solution. The findings of this research confirm the assumption of Lian et al. (2014), who argued that the high cost of implementing IT, as well as technology upgrades, makes institutions consider cloud computing as a useful solution enabling them to avoid additional costs in implementing hardware and software.

Another useful feature of the adoption of cloud computing is that it reduces electricity consumption. Continuous running of hardware devices such as servers, storage devices, and network routers and switches is responsible for a large part of the total energy costs (Palanivel & Kuppuswami, 2016). Cooling server rooms is a further challenge faced by technical engineers in Jordanian universities, where summer temperature can rise to 55 degrees Celsius. The cost of purchasing and running advanced cooling units is very high (Bianchini & Rajamony, 2004), and adopting cloud computing virtual servers would remove much of this expense.

As a result, the cost benefit of adoption of cloud computing by JHEIs has a positive link with the usefulness factor, as it could reduce overall expenses, by avoiding running costs, hardware and software upgrades and shutting down cooling units in server rooms. It might also enable Jordanian universities to reduce the number of technical staff, as maintenance of cloud computing's physical resources is the responsibility of a service provider. Thus, cost benefit is one of the most important motivators for adopting cloud computing.

Link B: Trialability of cloud computing has an influence over perceived usefulness

Adopting a trial version of cloud computing services and applications enables Jordanian universities to experiment with this technology, even if it is only on a limited basis (Linthicum, 2009). A trial version can provide a better vision of the technology, with the opportunity to discover advantages and disadvantages of cloud services, (see section 5.3.4), which might positively persuade JHEIs to adopt cloud computing. This finding is consistent with those of Sabi et al. (2016), that trialability is a positive influence on educational initiatives to adopt cloud computing. According to Rogers (2003), trialability usually increases the opportunity for adoption. Nevertheless, trialability does not mean that a university will definitely adopt cloud computing, as it can be rejected after the trial (Rogers, 2003).

Trialability is a key advantage that positively influences the usefulness factor; it allows for feedback encouraging more informed decisions on whether to accept or reject cloud computing. Accordingly, in the TOEQCC framework there is a direct link between trialability and usefulness.

Link C: Disaster recovery of cloud computing has an effect on perceived usefulness

As pointed out in chapter five, Jordanian universities continue to seek solutions to rationalise the process of backup and recovery. Cloud computing offers a range of remote automated backup and recovery services (Rao, 2015); a significant solution to the universities' problem that influences perceived usefulness. As the dean of one computer science school (DM5) said:

> *Backup and restoring university data is one of the most important issues that we have to face almost every day. We have a local SAN storage for backup purposes. However, the SAN storage unit is inside the server room. This will not help us to restore the data in the case of any disaster.*

An IT manager (DM6) largely agreed:

> *I believe that backup and disaster recovery in cloud computing is the second useful feature after the cost reduction. In 2012, the university cooling system suddenly stopped working. It was in the middle of summer term and after 30 minutes one of the main storage units caught fire. The internal cables were destroyed and we lost the data stored in that unit.*

As can be seen from these comments, data backup and disaster recovery are a priority in Jordanian universities and are vital in the case of unexpected loss of data. Cloud computing storage can deliver several backups, from different geographical locations (Murugesan & Bojanova, 2016). This service is therefore a useful solution to Jordanian universities' data disaster recovery challenge.

Thus, disaster recovery and perceived usefulness are linked. This finding agrees with Jost (2015), who argues that the disaster recovery service enables cloud users to recover their data in the event of natural disaster (e.g. earthquake, flood, fire.) or unexpected error by humans or machine. Since user data and applications are saved at different geographical locations, with several backup copies, data backup and recovery is a useful feature which can be considered as a motivator in the adoption of cloud technology by JHEIs.

Link D: Scalability of cloud computing has an influence on perceived usefulness

Cloud computing technology offers end users the flexibility of adding or removing nodes, servers and resources dynamically (Linthicum, 2009), and enabling HE institutions to customise the virtual resources based on upscaling or downscaling requirements (Velte et al., 2009). Scalability, therefore, is one of the useful characteristics of cloud computing technology, and is considered as a motivator for adoption. This finding is in line with Lehrig (2015), who claimed that scalability saves time and the cost of using additional resources; it also allows institutions to maximise the number of users, based on increasing the actual requirements.

Interviewees argued that the process of upgrading and utilising new resources in Jordanian universities is a complicated process requiring much time and effort by the technical staff. An IT manager in one of Jordan's private universities (DM3) explained that:

> *To add a new server is a long process starting with an offer a tender to local companies, then sorting the offers, comparing the prices with technical specifications, and finally conducting the selection process. This usually takes at least six weeks. In addition, it is not possible to remove servers not in use. This long process can be eliminated by using cloud computing, which enables the university technical team to add or remove any server with one click.*

This explanation confirms that scalability can save the university time, effort and cost, as well as the ability to downgrade additional physical resources such as servers, which otherwise would not be possible. In addition, the pay-per-use business model of cloud computing would enable universities to pay only for what they need to use to meet their requirements. This finding supports Saya et al.'s (2010) study, which found that the scalability of cloud computing enables institutions to dynamically add and remove resources, including the number of users, processors and the amount of storage. Along with the pay-per-use business model, this is a strong motivational factor.

Based on the above, it can be argued that scalability has a direct influence over the attitude to cloud computing in the TOEQCC framework. The flexibility of handling increasing or fluctuating workloads through the dynamic adoption of virtual resources is considered as a motivator that influences the perceived usefulness of cloud computing technology.

Link E: Location independent of cloud computing influences perceived usefulness

One of the main advantages of cloud computing applications and services is that it can be accessed from anywhere and at any time (Chee & Franklin Jr, 2010). As indicated in section 5.3.5, applications and services which can only be accessed through the university intranet prevent lecturers and students from using them outside the university. Such centralisation of use is considered as one of the most important challenges faced by Jordanian universities, and the ubiquitous access offered by the cloud is a strong motivator and an influence on the perceived usefulness of the cloud. This finding confirms the view of Miller (2008), that the usefulness of cloud computing is that it enables users to work from anywhere by connecting any device to the Web; it also enables groups of users to access the same application or document at the same time despite their different locations.

In this context, one of the professors (P13) of computer science stated:

> *Geographical location is not a barrier to using cloud computing services. Cloud users can access fully the functions of any service through any device connected to the Internet. For example, cloud computing users can use a basic laptop or tablet to access almost unlimited storage devices or supercomputers that can perform millions of processes a second, from any place in the world. I believe that this is the usefulness of this technology.*

Accessing applications and services outside Jordanian campuses is considered as a motivator and a useful feature for students, lecturers and university management. This feature can help both Jordanian and international students to access university resources and to access services when they travel away from the university campus.

Link F: Compatibility of cloud computing has an influence on perceived ease of use

Compatibility has been mentioned several times in this study as an important factor in the adoption of cloud computing technology in JHEIs (see section 5.3.9). Compatibility is the extent to which cloud computing technology is consistent with the in-house technology, existing resources, and software and hardware already adopted by JHEI (Rogers, 2003; Rogers, 2010; Sabi et al., 2016).

Evidence from senior academic and technical staff, and the researcher's direct observation of university server rooms and computer laboratories, suggests that the greater the compatibility between cloud computing and in-house systems, the easier it will be to adopt cloud computing in JHEIs. Consistency between cloud computing and in-house applications and services will also influence the ease of use and adoption of the new technology.

This finding is supported by a number of authors who emphasise the role of compatibility in influencing the use of cloud computing technology (Lin & Chen, 2012; Nedbal, Stieninger, Erskine, & Wagner, 2014; Sabi et al., 2016). For example, Sabi et al (2016), in their study on the adoption of cloud computing in universities in developing countries, found that compatibility with existing devices, platforms and software has a positive relation to the intention and actual adoption cloud computing. Similarly, Nedbal et al. (2014) found a positive correlation between compatibility and both the actual adoption and intention to use cloud computing. Iyer (2016) emphasised the importance of testing the compatibility of cloud computing with the institution's devices, browsers and platforms as an essential step in the process of cloud computing adoption.

The findings from this study also argue that compatibility is the main challenge to be faced during the implementation phase, especially in the migration step. As one IT manager (DM8) said:

> *The cloud computing implementation process consists of many stages. I believe that the big challenge is how to migrate cloud computing advanced database services with our old databases. We have thousands of records stored in our databases for more than 20 years. Cloud computing platforms have to be at least partly compatible with these records and databases. Otherwise, it will be very difficult to adopt cloud technology.*

The compatibility of cloud computing with in-house resources and devices thus has a significant effect on the ease of use and adoption of this technology. The feature can be categorised in two groups: compatibility with JHEIs' devices and resources, and compatibility in the process of migrating cloud computing to in-house hardware and software (e.g. servers, databases, e-learning applications). In brief, a high level of compatibility means easier use and adoption of cloud computing technology in JHEIs.

Link G: Knowledge sharing and attitude towards using cloud computing are linked.

Knowledge sharing has a significant role in the success of any institution (Garcia-Perez, 2011). According to Sultan (2013b), cloud computing enables users to share their experience, skills and personal knowledge. In the context of HE, the need to share scientific knowledge motivates lecturers and students to use ICT. The findings of this study argue that cloud computing features could improve the sharing of knowledge between lecturers and students, and almost all interviewees agreed that cloud computing would enhance it. The need to increase knowledge sharing in Jordanian universities is an important factor that influences the attitude towards using cloud computing technology.

As was pointed out in section 5.6.3, the sharing of knowledge among Jordanian universities is limited, as indeed it is between departments. Most of the interviewees emphasised the need to share knowledge in order to improve the quality of HE outcomes in Jordan, and the value of new technology in achieving this.

In this context, one professor from an engineering school (P23) stated:

> *Both students and lecturers have to learn how to share the knowledge. It is very important to increase the sharing of knowledge between university departments. Teamwork and sharing knowledge will provide more outcomes such as research publications if we compare it with individuals' work. Using cloud computing can help to share all academic materials and create shared publications from several Jordanian universities.*

This feedback shows that knowledge sharing is an important issue in improving the overall quality of outcomes in JHEIs, and cloud computing would allow it to take place.

Another professor from a computer school (P27) noted that:

> *Despite the geographical location of each Jordanian university, cloud computing technology has the capacity to enable us to create virtual workspaces where each group of scholars could create a project and share knowledge at the same time. First, we need to create an academic platform by using infrastructure as a service in cloud computing. However, this needs permission from university management to handle the cost of using this platform, the security issues, and the privacy of materials.*

The feedback from many interviewees as well as focus group participants suggests that sharing knowledge has a positive influence on attitudes towards using cloud computing in

JHEIs. The findings of this study are in line with those of Diffin, Chirombo, and Nangle (2010), who explained the role of cloud computing in improving knowledge sharing at the University of Maryland University College (UMUC). UMUC selected Microsoft's SharePoint as cloud-based software for the purpose of sharing information internally within departments. The findings of this study also agree with Sassman (2014), who stresses the vital role of innovative technology in enhancing the sharing of knowledge between people, and its role in improving the quality of outcomes of any institution.

In brief, the need to increase knowledge sharing in JHEIs positively influences attitudes towards using cloud computing technology, and may influence the quality of students' and lecturers' work.

Link H: Improving performance and efficiency has an influence over the perceived usefulness of cloud computing technology

Performance refers to the extent to which the technology supports people in achieving institutional goals (Van Tiem, Moseley, & Dessinger, 2000). Cloud technology promises to provide a high level of computer power through offering almost unlimited processing resources using virtual machines as well as unlimited storage space for cloud users (Sultan, 2013a). The findings of this study (section 5.3.1) show that 52% of participants do not believe that the current technology is helping JHEIs to achieve their teaching and learning goals. Only 38% believe the opposite, with 10% undecided. Such goals include the mission and vision of Jordanian universities, for example supporting the local market with advanced graduate projects, supporting students with up-to-date technology, and enhancing students' performance.

In addition, the findings from interviews revealed that several science schools in Jordanian universities, including information systems, engineering and computer science, are suffering from the poor performance of the current technology. For instance, as reported in section 5.3.3, P1 mentioned that most graduate students' projects are not aligned with the global trend because of the unavailability of advanced technology in the engineering school (U1). This lack of current technology explained the poor performance of simulating servers and testing nodes. In the same context, P5 (U5) stated that:

> *The weak performance of the current technology prevents our students from creating novel projects. For example, the maximum for testing 3D projects in our department is 500 CPUs with limited graphic performance. However, some projects need at least*

6000 CPUs to validate the results of the project. Unfortunately, the university has insufficient budget for this huge amount of resource. We need more resources and it is fine to use virtual resources such as those provided by cloud computing. I believe that cloud technology is the best solution for this challenge as it can rent virtual machines at a low cost.

This finding is in line with Lian et al.’s (2014) study, which found that improving performance and saving costs were considered as important factors in adopting cloud computing technology. Effectiveness and performance are essential factors in HE institutions (Sabi et al., 2016). The finding of this study is also consistent with that of Jones (2015), who argued that cloud technology provides high-performance services, offering access to computer resources 24 hours a day, 7 days a week, and 365 days a year from any place in the world; despite the efficiency of the machine used to access the virtual resources, almost the same performance will be achieved. Efficiency, therefore, has an important role in the usefulness of cloud computing technology.

Sultan (2013a) claimed that cloud computing technology can bring democracy to IT users, by empowering weak institutions with almost unlimited resources, equal to those of wealthy institutions which can afford to invest heavily in ICT resources (e.g. server rooms, storage devices, and networks). Such democratisation of IT resources could help HE institutions, in developing countries in general and in Jordan in particular, to offer the latest technology to both students and staff, emulating wealthy universities in developed countries. Accordingly, it can be argued that the high performance of cloud computing as well as the variety of IT resources available through this technology are useful features, motivating JHEIs to adopt it.

6.3.2 Barriers to cloud computing adoption

Despite the many motivators for the adoption of cloud computing in JHEIs presented in section 6.3.1, the findings from case studies show a number of barriers that could hinder this adoption. Although most Jordanian universities have not yet adopted cloud computing, the results of this study have identified a number of potential drawbacks. Almost all participants were concerned about security and privacy issues in cloud computing, one of the most important barriers hindering JHEIs’ adoption of the technology.

The level of the lack of awareness of both the benefits and threats of cloud computing, and how to deal with the threats, is another concern which also impinges on the security and privacy issue. Another concern of many participants about ICT in general and cloud computing in particular was the use of “spoon feeding” as the main learning and teaching method, encouraging students to focus on lecturers as the only source of information.

Other barriers identified from the case studies are lack of government support, the utilisation level of ICT in general and cloud computing in particular, resistance to using innovative technology, and the weak technical infrastructure at JHEIs.

Further details of the barriers to cloud computing in JHEIs are discussed in the following sections.

Link I: Security and privacy may have a negative on behavioural intention of use of cloud computing technology.

In the views of potential stakeholders in cloud computing technology in JHEIs who participated in this research (see section 5.3.7), security and privacy are the most important negative influences on the adoption of cloud computing by JHEIs. Almost all the participants in interviews, focus groups and the survey expressed a negative attitude towards using innovative technology as regards privacy and the security of data. In particular, most of the interviewees exhibited negative behavioural intention towards using cloud computing when the researcher raised the issue of the security of critical data.

As was outlined in chapter five, the findings from the survey showed that 69% of the participants had negative experiences regarding the use of innovative technology. Most of the decision makers and professors interviewed (e.g. DM3, DM7 and P3) ranked security and privacy as the top concern in the use of cloud computing technology. This top-priority concern is correlated with the behavioural intention of users towards this technology. Users’ data in cloud computing would no longer be under university control, but under the control of the service provider, and stored physically outside the university at remote sites (Linthicum, 2009).

Several studies have considered security and privacy as important concerns in the field of cloud computing technology (Chou, 2015; Lian et al., 2014; Lin & Chen, 2012; Sabi et al., 2016; Stein et al., 2013; Sultan, 2014a). Their agreement with the findings of this study help to validate them. For instance, our findings on security and privacy are in line with Chou’s (2015), who analysed the components of risks and values in moving to cloud computing and stressed that security and privacy of data are the most important risk factors, capable of causing major damage to institutions attempting to move to cloud computing. The same author argued that the main concern in moving to cloud computing is that the data will be controlled by the service provider and stored on remote sites, which increases the concern over institutions’ critical data.

Similarly, Lin and Chen (2012) suggested that the reason for most institutions not adopting cloud computing was uncertainty about privacy and security, resulting from the limited control of cloud customers over the physical resources. Likewise, Sabi et al. (2016) found that data security has direct negative correlation with the adoption and actual use of cloud computing in education institutions.

In a survey of 60 participants to determine the critical factors influencing the decision to adopt cloud computing, Lian et al. (2014) found that security was one of the five most critical factors. The other four factors were cost, management support, the need to gain advanced technology, and complexity.

Thus, it can be argued that security and privacy influence behavioural intention to use cloud computing in JHEIs. Passive behaviour in using new technology in general and cloud computing in particular resulting from security and privacy concerns might also negatively influence the quality of JHEIs’ outcomes, despite the technology enhancing overall quality in HE institutions (Senanayake, Hettiarachchi, & Hewagamage, 2015).

Link J: Spoon feeding as a teaching method has with a negative influence on behavioural intention to use cloud computing at JHEIs

As was pointed out in section 5.5.1, most Jordanian universities rely on spoon feeding in learning and teaching, a traditional and old-fashioned method which considers lecturers as the only source of information (Samah, Jusoff, & Silong, 2009). Cloud computing could provide multiple sources of information to support educational applications, such as e-libraries, e-learning systems, and online courses, helping students to be more independent (Yan, Au, Chan, & Tsang, 2013).

The findings from the survey indicate that 85% of participants believed that using cloud computing would improve the quality of HE in Jordan. One decision maker (DM8) and a professor in information systems (P14) emphasised the role of new technology in weaning students away from spoon feeding (see section 5.5.1). Nevertheless, the findings from section 5.5.1 also suggested that fear of spoon feeding as a teaching method in the cloud negatively influences the adoption of cloud computing. In the TOEQCC framework, the spoon-feeding method and behavioural intention to use cloud computing technology are linked, because of a perceived increase in reliance on the lecturer instead of searching for other sources of information using the technology.

To summarise, the use of innovative technology as a source of information to avoid spoon feeding would improve the quality of learning and teaching and therefore of students' outcomes. However, given that this method has been used traditionally in Jordanian universities for many years, motiving students to use ICT and cloud computing as another source of information would be a challenge. Yin (2015) concluded that universities have to improve the quality of education by avoiding the use of spoon feeding, depending instead on cloud education platforms and open online courses, as required in the projects conducted by the electronic engineering colleges.

Link K: Insufficient infrastructure has negative influence on the usefulness of cloud computing technology

Cloud computing services are dependent on the technology infrastructure, such as a reliable and stable Internet connection (Sosinsky, 2010). In the views of potential stakeholders of cloud computing technology in JHEIs who participated in this research (see section 5.3.3) both high-speed Internet connections and the availability of associated resources (e.g. advanced Internet switches, routers and terminals) would improve the usefulness of services provided by cloud computing technology. Similarly, Armbrust et al. (2009) stressed that the speed of the Internet and the stability of connections influence cloud computing services. Some Internet service providers charge ten times more than others for extra services and high-quality Internet connections that affect the usefulness of cloud services. Accordingly, infrastructure readiness, especially networks and Internet speed in JHEIs, has a direct positive link with the usefulness factor.

Therefore, a serious investment in hardware and software resources as well as communication infrastructure should be taken into consideration in the short term by JHEIs and the Jordanian government in case they attempt to adopt any innovation technology and not only cloud computing in the teaching and learning process.

Link L: Usage level of ICT has a relation with perceived ease of use and attitude towards using cloud computing

The frequency of IT use could influence the ease of use, and the results from our qualitative survey showed that 92% of students use the Internet daily. Accordingly, JHEIs students appear to have good experience and skills in using Internet services in general, which could influence their ease of using cloud computing, hosted on the Internet network. Section 5.4.7, however, showed that 43% of participants had never used cloud computing itself; 18% had used it for less than one month, 12% for six months, 8% for a year, and 19% for more than one year.

Although these findings indicate that a large number of participants had never used cloud technology before, an acceptable number did have some experience. Some of the interviewees (e.g. P16 and P19) stated that their use of the cloud was only for simple applications such as Google Docs, Microsoft OneDrive, Apple storage applications, and basic academic services. Such usage may also influence their attitude towards using cloud computing. This finding appears to be in line with Al-Hadrami (2012), who investigated the factors affecting the use of web courses in Hashemite University in Jordan; he found a positive relation between students' experience in using web courses and their attitude towards using innovative technology.

To summarise, it can be argued from our findings that in TOEQCC the experience of using innovative technology would positively influence the attitude towards using cloud computing applications and services and their perceived ease of use. Jordanian students and lecturers will be positively motivated to use cloud computing if they already have experience of using ICT in learning and teaching.

Link M: Resistance and fear to new technology is connected with attitude towards using cloud computing

In the context of ICT, resistance can be defined as a behavioural rejection of the adoption of new systems (Markus, 1983). Resistance and its influence on adoption has been studied by many researchers. For example, in a comprehensive review of the resistance to new technology, Ali et al. (2016) claimed that resistance from individuals or groups could be the main reason preventing the adoption of innovative technology in institutions. Similarly, in a study which investigated the factors influencing the adoption of mobile learning, Mac et al. (2014) stressed that anxiety about changing current educational methods is an important factor in resistance among teachers.

Resistance to using new technology is another important barrier to the adoption of cloud computing in JHEIs identified in this study. Both staff and students prefer traditional methods (e.g. physical resources and face-to-face interaction in the classroom) to innovative technology (Al-Adwan & Smedley, 2012). However, section 5.5.5 suggests that resistance to new technology is not at the same level among all lecturers and students, as those with good experience and skills in ICT showed less objection. Dabaj (2011) similarly argued that resistance to using new technology is an important barrier among students, especially those with less experience of IT.

The findings of this research indicate that as resistance to new technology increases, the negative attitude towards using cloud computing also increases. The findings from interviews, focus groups, and direct observation revealed that lecturers had different levels of resistance, resulting from privacy and security concerns, especially concerning critical data such as students' exams, financial data, and exam results. This was in addition to a lack of skills in using ICT in teaching and learning. However, many interviewees claimed that this was more evident in the older generation of lecturers (see section 5.5.5).

Findings from the qualitative survey showed that 70% of students have a positive attitude towards using IT. However, using cloud computing for educational purposes would have to be used first by lecturers, and students would follow them. As one of the decision makers (DM5) said:

> *Using cloud computing applications and services in a professional way must start with adoption of this technology by the university management. The top management then can inform staff how to use this technology as a trusted method for teaching and learning (e.g. uploading critical data, sending projects for processing purposes, and conducting exams based on virtual servers on cloud computing). Otherwise, the usage of cloud computing by students would be limited to very simple applications such as Google Docs or Microsoft OneDrive storage services.*

A professor in management of information systems (P3) added:

> *This limited usage will not change anything and will not improve the education process. What we are looking for is advanced usage of supercomputers as well as other professional tools of cloud computing inside and outside the classroom.*

In brief, in the TOEQCC framework the resistance to using new technology factor has an influence on the attitude to using cloud computing in JHEIs. Although this factor is based on students' and lecturers' behaviour, affected by their individual computer skills, this factor could be one of the most important barriers to the adoption of cloud computing in JHEIs.

Link N: Lack of the awareness of cloud computing is related to attitude towards using this technology.

The attitude of top management, lecturers and students towards using cloud computing could be increased by increasing their awareness level, through conferences, seminars and training courses. The findings form this research suggest that when awareness of cloud computing increases, the attitude towards using this technology also increases. As the findings from the qualitative survey revealed a lack of awareness of cloud computing: 36% of students provided no definition of the concept, 42% provided incomplete answers, and only 22% a basic definition. Students' and lecturers' attitude towards using cloud computing varies according to their level of awareness level about this technology. The results from interviews and focus groups revealed that the lack of awareness was one of the main reasons that might negatively affect attitude towards adopting this technology. As one of the professors in computer science (P21) stated:

> *In the last meeting with the university vice chancellor, I noted that almost all the lecturers have a negative attitude towards using cloud computing because of their fear about security and privacy. I believe that the main reason for their fear is their lack of awareness about the security precautions. Companies such as Google and Amazon offers a secure service to their customers. All the services are encrypted at different levels and the data stored on cloud servers could be more secure than the data stored in their local machine.*

This agrees with Sabi et al. (2016), that awareness of cloud computing in universities in developing countries has a direct correlation with a positive attitude towards its adoption. Similarly, Low et al. (2011) found that increasing awareness of cloud computing's benefits will positively influence its efficient adoption and effective use.

Kanaan (2009) emphasised the role of increasing awareness of ICT knowledge through supporting students in Jordanian universities with personal laptops, and its effect on their intention to use IT. However, because of poverty, most of students attempted to sell their laptops instead of using them, which negatively influenced the overall awareness of using ICT in Jordanian universities. The findings from Kanaan's (2009) study could explain the low level of awareness of ICT in general and cloud computing in particular. As pointed out earlier, only 22% of students were able to provide a definition of cloud computing, while 78% failed or provided a wrong definition.

<u>Link O: Top management support has a link with attitudes towards using cloud computing technology</u>

The findings showed that top management support towards using cloud computing has a great influence on lecturers', students' and staff attitudes, because top management has the power to motivate them, especially if the technology is likely to provide the benefits already described. Some interviewees argued that investigating the potential of adopting cloud computing became a serious concern among the technical support team and at other management levels, once top management started asking about the benefits of this technology. This may also positively affect the attitude of senior management itself towards using cloud technology. In this context, one of the professors in information technology (P27) stated:

> *Although cloud computing technology has been available for the last 10 years, the adoption of this technology in an educational context in Jordan became very clear when the top management shed light on it. Unfortunately, we were always waiting for top management to motivate us to use any innovation technology. Recently, the adoption of cloud computing became a very serious matter when the university vice chancellor emphasised the benefits of using ICT in teaching and learning, including the use of e-learning and cloud computing.*

Accordingly, the support of top management is correlated with attitudes towards using cloud computing in JHEIs. This is corroborated by Low et al. (2011), who found that top management's support positively influences adoption. Likewise, Oliveira et al. (2014) found that recognition of the benefits of cloud computing by top management influenced staff to start considering it, and encouraged the institution to find out how to adopt it. The authors concluded that the support of top management positively influenced the adoption of the technology.

To summarise, in the TOEQCC framework top management support is correlated with attitude towards using cloud computing as in TAM, and also influences the implementation of cloud computing in DOI theory.

Link P: Government support has an influence on attitudes towards using cloud computing at JHEIs

The support of government is another important factor influencing attitude towards using cloud computing technology in HE institutions (Chang & Wills, 2013). Jordanian government support could be achieved by providing funds, training courses, technical advice, and workshops that motivate the universities. In 2013, the government launched a cloud computing platform, developed by Microsoft and the government to enhance e-government services and create a centralised infrastructure for government institutions (Sulaiman & Magaireah, 2014). However, despite extensive support for using cloud computing to enhance Jordanian e-government, limited focus has been put on its adoption in JHEIs (Massadeh & Meslah, 2013).

This lack of government support could negatively influence attitudes towards using this technology, as one of the professors (P5) at a Jordanian public university said:

> *It is a government responsibility; Jordanian government support plays an important role in motivating lecturers and management in Jordanian universities to use cloud computing.*

In summary, most of the interviewees emphasised the role of the Jordanian government in encouraging adoption of innovative technology by JHEIs. Encouragement would motivate the universities to study the adoption of cloud computing. Nevertheless, the extensive use of cloud computing in the government sector can itself be considered as a positive indicator to use cloud technology in the education sector, as the government has already gained experience in e-government, which could support the education sector and remove barriers and fear.

6.3.3 Cloud computing adoption process

In order to help JHEIs to adopt cloud computing technology, this research has designed a sequences diagram, which included five main steps that JHEIs can run. Such steps can be outlined as follows: awareness, persuasion, decision, implementation, and confirmation.

As explained earlier, Rogers (2003) points out that the main problem in adopting any innovative technology is how to obtain, use, implement and maintain operation innovation. This section attempts to explain the process of adopting and using cloud computing and how to draw a roadmap for its adoption through five steps as part of the TOEQCC framework.

Russell (2008, p.76) stated, “Scholars must be willing to explore how the theory of diffusion can be applied to develop situation-specific models that can be scoped to maximise the utility of the innovation in a given scenario”. Accordingly, the proposed process of cloud computing adoption in HE institutions in the TOEQCC framework was developed based on Rogers’ DOI (2003) model within the scenario of JHEI, using cloud computing as the specific technology.

A process flow diagram, seen on the right side of the TOEQCC framework, was employed to explain the main stages of cloud computing adoption in HE. The following sections illustrate the phases of adoption, adapted from the original DOI theory (Rogers, 2003).

6.3.3.1 Awareness of cloud computing technology (Prior conditions)

The previous chapter revealed that the lack of awareness about cloud computing is one of the most significant factors negatively affecting its adoption in the context of JHEIs. Therefore, the first phase in the process of adoption of cloud computing in JHEIs is to raise awareness of this technology: this is considered a pre-requisite for success of the cloud computing adoption. As a result of this research the awareness level could be raised through three steps as follows:

Enhance understanding of the concept of cloud computing

Understanding the concept of cloud computing and its benefits and limitations is strongly recommended, making the university stakeholders aware of them (Sabi et al., 2016) through seminars, workshops and seeking advice and professional consulting from experts. More specific details of cloud computing’s benefits and limitations can be found in appendix 8.

Addressing the initial requirements of JHEIs

Once the university stakeholders are aware of the concept, as well as its benefits and limitations, it is important to develop a plan to determine the initial requirements needed for the adoption of cloud computing, including the needs of students, lecturers, administrative staff and management.

Applying SWOT analysis

After determining users’ requirements this step aims to deliver a detailed understanding of cloud computing’s Strengths, Weaknesses, Opportunities and Threats. The SWOT model provides a detailed understanding of the computing characteristics, and was applied to increase understanding of cloud computing, as a second level of awareness. More specific details of the cloud computing SWOT analysis model can be found in appendix 8.

6.3.3.2 Persuasion phase of cloud computing adoption

At the persuasion stage, the decision-making unit attempts to be more psychologically involved in the process of adopting cloud computing. This stage is a cornerstone for the next phase (decision phase), and will provide more realistic feedback about the technology than the first stage (awareness phase), which provides only theoretical assumptions regarding cloud computing's limitations and benefits. In the persuasion phase, Jordanian universities seek feedback and detailed reports about cloud computing from lecturers, students, staff, technical support teams and financial departments. This feedback can be collected by following five steps:

Adopting trial version of cloud computing services (Trialability step)

The findings from the data analysis chapter showed that the trialability factor positively influences the adoption of cloud computing. The opportunity for university stakeholders to test and experiment with cloud computing services has a significant effect on discovering the benefits and limitations of the technology. This step also enables decision makers to distinguish between various cloud computing service models and deployment models, supporting the decision stage.

The trial version of cloud computing could be adopted to handle non-critical, low-level university workloads such as students' trial projects, trial databases for teaching and learning, non-sensitive students' records, and storing and processing data that the university already has additional copies of. The universities can then adopt the active-passive technique, which refers to using some of the services provided by in-house technology in the passive mode, and executing the same services through cloud computing in the active mode. In the event of any downtime or failure caused by cloud services, the in-house servers will automatically switch off the cloud computing and return to the in-house servers.

Analysing *the relative advantages*

After adoption of the cloud computing trial version, the university decision-making unit should compile reports, based on the feedback collected from stakeholders. Technical support units can generate additional reports from their experience in using the trial services. The aim of these reports is to study the relative advantages of cloud computing based on actual use.

Analysis compatibility

Migration to cloud computing technology with in-house resources is a critical task, so analysing compatibility between existing hardware and software and cloud technology is essential. Transferring university data and applications is a complicated task, especially if the data contain a huge amount of detail and records (e.g. student records, academic resources databases, financial records, and management records). It relies on the technical support team's compatibility report. Such reports largely depend on the previous steps' testing of the trial version, to address the cases where in-house computing is not compatible at all, partly compatible, or fully compatible with cloud computing resources.

Analysis complexity

Analysing the complexity of cloud computing is the third step in the persuasion stage, addressing the ease of use and user-friendliness of the cloud computing technology and applications. Ease of use, the minimum amount of effort to provide the maximum level of performance, varies from one user to another based on their technical skills and familiarity with the applications. The decision-making units can estimate the complexity level of the trial version from the users' feedback.

Analysis of cloud computing ROI (Return of investment)

Even though the previous steps are all fundamental, analyzing the ROI from cloud computing adoption can be considered as the single most important step. It includes comparison of the cost/ benefit of keeping the in-house technology with that of using cloud computing. The financial department should analyse both short-term and long-term cost/benefit. Despite the fact that the cloud computing's front-end cost is almost zero, as already explained, it could be that it is a costly option in the long term. The pay-per-use model may be more expensive, for example when there is intensive usage of the bandwidth as well as a considerable number of transactions over a long period. In this case, the pay-per-use business model could be more expensive than the university's ownership of the services and software, especially in the long term. Calculating ROI for the adoption of cloud computing for at least five years can help the decision-making unit in accepting or rejecting this technology.

6.3.3.3 Decision phase (Quality factors)

The third phase in the adoption process is to decide whether to accept or reject cloud computing technology. For this phase, decision-making units should have detailed reports from the first and second phases. The two approaches to acceptance and two approaches to rejection of cloud adoption were outlined in section 6.1.3.

In temporary rejection, the HE institution provides a report explaining the reasons for rejection. In this case, the cloud computing service provider and the institution itself study the report and suggest solutions, offering another chance for the adoption of cloud computing. If the HE institution later accepts the technology, the steps are repeated from the persuasion stage. Alternatively, continued rejection refers to the decision to permanently close the door on cloud computing adoption and never re-enter the adoption process loop.

The decision to accept the adoption of cloud computing could be either one of continuance or discontinuance; these acceptance types will be discussed in the confirmation phase.

The quality factors adopted earlier, defined by Harvey and Knight (1996) in the literature review and analysed in the data analysis chapter, are applied in the decision phase as follows:

- Analysing excellence of cloud computing: in this step the decision-making unit analysis determines whether the cloud computing technology could deliver high standards of services to university users. Such standards include the response rate of the cloud services, the satisfaction of students and lecturers, service performance, and whether the technology has achieved the minimum standards of the university requirements. The excellence of cloud computing can be tested by comparing the performance of the current technology used in the university and the cloud computing trial service.
- Analysing the perfection of cloud computing services: perfection in this step refers to zero defects through emphasis on a quality culture. Zero defects mean the extent to which the technology has no faults, errors, downtime or non-response rate during the trial period.
- Analysing fitness for purpose: the decision-making unit judges the quality of the cloud computing in terms of the extent to which its services meet the university's purposes. This step may affect the perfection analysis, as if it does not meet the expected purposes, it is not completely perfect, even though the service delivers an excellent level of performance.
- Analysing the expected outcomes: the HE institutions evaluate the expected role of cloud computing in reducing the gap between performance of university graduates and the requirements of the labour market. As was

pointed out in the data analysis chapter, almost all participants agreed that a gap between Jordanian universities' outcomes and the labour market does exist, partly because of under-utilisation of IT.

Finally, the decision-making unit must accept or reject the adoption of cloud computing based on the findings of their analysis. In the case of acceptance, the implementation phase follows. In the case of rejection, the unit may generate a report to explain the reasons for the decision; this could be helpful if the question of cloud computing is raised in the future.

6.3.3.4 Implementation Phase

The challenge of the implementation phase lies in the operational steps required. In order to overcome this challenge, an approach to implementing cloud computing follows:

Selecting a suitable cloud computing deployment model

Selection of the appropriate deployment model depends on the university's existing infrastructure and requirements. The university must decide whether to select a public, private, hybrid or community deployment model, based on the outcome of the previous three phases as well as the factors addressed in the previous chapter.

If the university has no appropriate infrastructure, a public cloud is the most suitable option. A private cloud can be adopted if the university already owns an IT infrastructure of critical data and applications, in which case the data and applications are transferred into virtual resources hosted by the private cloud. This model leaves the university with full control over the data, and the ability to select the security level. However, the private cloud model is more expensive than the public model and requires more effort from the professional technical team in conducting the migration and in the transfer process.

A hybrid cloud avoids the high cost of the private model and avoids the privacy limitations of the public model. A decision must be made as to what is critical data, used by the private model, and what is less critical, accessed by the public model.

Finally, a community model is strongly recommended if the universities in Jordan decide to share the same standards and services offered by the cloud computing providers, a possibility as they already share the same concerns and educational structure. Sharing cloud services can be offered at a comparatively low cost to each institution, but with a high quality of service. The cloud services might be provided by a cloud educational community, which shares the same concerns and policies.

Selecting a suitable cloud computing service model

As explained in the literature review, cloud computing offers many types of service models. The aim of this step is to select one or more cloud service models according to the university's requirements, and based on the output from the decision-making unit of previous phases.

The process of selecting the cloud service model is a fundamental task, since selecting an unsuitable model would negatively affect the relative advantages of cloud computing. The key to selecting a suitable model is to understand the characteristics of each one: what solutions does the model provide, and do such solutions fit with the university requirements?

Table 6-1 summarises cloud computing service models and suggests reasons for selecting each model.

Cloud computing service model	Reasons of selection
Storage-as-a-service Refers to disk space on demand using remote storage services, hosted via the Internet (Bond, 2015; Wilson & Ateniese, 2014).	• Limited availability of storage devices in the JHEI. • The need to access the university data and applications remotely from any location. • The need for advanced automated backup services. • Low cost of using cloud storage services compared with in-house resources.
Database-as-a-service Refers to the ability to create the database which function physically as the customer has it on the local machines (Linthicum, 2009).	• The need for loading, storing, and creating university tables through a remote database hosted online. • The high cost of database software licences. • The difficulties of database maintenance, administration, management, and backup and recovery.
Application-as-a-service/ Software-as-a-service Refers to any application delivered through a web platform to the end user using an Internet browser (Rittinghouse & Ransome, 2016).	• Simplifies the process of providing any application through a web platform to students and lecturers. • The need to use university applications without any installations. • The ability to access the university applications from any device (e.g. laptops, smartphones, tablets and desktops). • The need for low-cost applications that can serve a huge number of students.
Platform-as-a-service Refers to cloud delivery service that supplies the cloud customer with all the resources needed to build and develop web applications (Velte et al., 2009).	• The need for building and developing applications by university development team using a ready platform provided by cloud computing service providers. • The need to design customised applications. • The need to test university applications.

Integration-as-a-service Refers to connecting different files and applications through a web interface (Gai & Li, 2012).	• The need to transform any information from one system to another. • The need to connect applications despite differences in software interfaces. • The need to access all integrated software at one virtual location.
Infrastructure-as-a-service Cloud computing form with the ability to provide virtual servers, virtual storage, and any virtual hardware instead of physical in-house resources with full control permissions to customer (Landis & Blacharski, 2010).	• The need for full control over the cloud computing resources such as servers and storage resources. • The need to enforce university requirements • The need to adopt the university level of security, policies, and rules. • The ability to take full responsibility for hardware maintenance, support and upgrades.
Information-as-a-service Refers to a service that offers the ability to access useful information hosted on cloud computing via APIs (Bento, 2012).	• The need to validate student critical information such as addresses, credit cards, and debit cards. • The need for statistical information from social websites.
Process-as-a-service This is a delivery model where cloud service providers offer the ability to make backend tasks for processing in order to decrease the cost and accelerate data processing (Linthicum, 2009).	• The need for supercomputing power for advanced data processing services. • The need to reduce the time required for advanced research. • The need to process data form different resources and locations at the same time from one virtual machine.

Studying and selecting the potential options of cloud computing service providers

The aim of this step is to create a list of potential cloud computing service providers in order to select the most appropriate option. The comparison may include feedback from previous customers, the cost of services available, security and privacy measures, and the threat of vendor lock-in. The HE institutions have to think about the following for the selection process:

- The service level agreement provided by the cloud computing service provider, the availability of services throughout the year, the expected percentage of the downtime of services and any compensation given in the case of service failure.
- Where are the service provider's main branches and service locations?
- Can the service provider access the university's critical data?
- Is cloud computing technology the core business of the service provider?
- What is the technical support level offered by the service provider, such as for response time and communication tools.

The selected cloud computing service provider must meet university requirements; failure to achieve this will drain the university's time and money, especially in the case of vendor lock-in: in this case the university would need to start the technical migration or data transfer from scratch. Any decision to change the service provider would mean repeating many of the stages involved in cloud computing adoption.

6.3.3.5 Final decision, confirmation phase, and following up of cloud computing adoption

In the final decision phase, the decision makers attempt to reinforce the decision to adopt cloud computing for the long-term period. After the initial acceptance for the adoption of cloud computing, the JHEI normally continues to use cloud technology. The long-term usage of cloud computing may consist of asking the service provider to offer customised applications and services and following up with new services, maintenance, and updates provided by the service provider, to maximise the benefits of cloud computing during the long-term period.

However, it is possible to stop using cloud computing after adopting it, following a discontinuance decision. If the decision-making unit decided to discontinue using cloud computing technology and replace it with any other innovation technology the TOEQCC framework suggests repeating the process of the adoption of potential innovation technology from the perceived usefulness and perceived ease-of-use factors. This option can be found on the right-hand side of the final decision phase. However, another option is still available from the left-hand side of this phase, which is considered as the end/exit of the implementation process.

Discontinuing use of the cloud computing can result from either a replacement decision or a disenchantment decision (Rogers, 2003). Following the viewpoint suggested by Legris et al. (2003), researchers can use the external variables to extend the original TAM through suggesting factors influencing the system design, institution characteristics, and task characteristics (e.g. nature of the development or implementation and organisational structure). Accordingly, the TOEQCC framework employed the technological, organisational, environmental and quality factors as external factors as well as feeding the PU and PEOU from the final decision phase of the process of implementation. This replacement tended to add more value to the original TAM variables through suggesting specific factors discovered in this study and extending the original TAM by connecting the external variables with the DOI theory decision phase.

Finally, replacement refers to the decision to reject cloud computing by JHEI because another technology appears to provide better benefits in the future. Disenchantment means rejecting cloud computing because it proved to be inappropriate for the JHEI and did not meet the expected relative advantages for the long term. In this case, it would be useful to generate a report to illustrate the reasons for rejection and how cloud computing failed to meet the university's requirements.

6.4 Chapter summary

This chapter emerged from research discussed previously, and focuses in detail, on the development of a new conceptual framework. The new TOEQCC framework covered both strategic and implementation approaches for the adoption of cloud computing in JHEIs. The framework was based on the merged theories applied in the early stage of this research further developed by the empirical findings from the fieldwork with details about the relationships between these factors. The following chapter will concentrate on the validation and evaluation of the TOEQCC framework.

7 Framework validation and evaluation

The factors influencing the adoption of cloud computing in Higher Education Institutions in Jordan were addressed in chapters five and six. The development of a new conceptual framework (TOEQCC) for the adoption of the cloud computing technology was also described in chapter six.

The aim of this chapter is to evaluate and validate the TOEQCC framework, by explaining the evaluation strategy, evaluation methods, selection of the participants for evaluation and validation, analysis of the participants' feedback, and presentation of the final framework.

7.1 Strategy adopted for the evaluation

It is important to evaluate the new framework to determine whether it has achieved what it was developed for, and determine the reliability of the research results (Zaphiris, Ang, Henderson, & Tosheff, 2008). Validation is an essential part in the process of framework development, making it more effective and valuable (Kennedy, Xiang, Madey, & Cosimano, 2005). Evaluation of TOEQCC was achieved through a combined process of internal and external validation. External validation compared the findings of this research with previous studies, whilst internal validation by experts in JHEIs and cloud computing contributed to the assessment of the perceived value of the framework for its stakeholders, and the feasibility of its adoption and implementation.

The objectives of the process of evaluation and validation of TOEQCC were to determine its weaknesses and limitations, to evaluate the practical issues experienced during the process of implementing cloud computing, and to improve the framework as much as possible based on the evaluators' feedback. All of these were to be completed during the latter stages of this research and within the time and cost constraints of this PhD research. Accordingly, the TOEQCC framework was tested by five evaluators selected from three HEIs in Jordan.

7.2 Selection of the evaluators

In order to achieve the objectives of the process of validation and evaluation, it was important to select individuals who had the right combination of knowledge about higher education and cloud computing technology (Singh & Kasavana, 2005) and also about the socio-economic environment of Jordan as that was the context for which this solution was being designed. The selection process was difficult because it required identification of individuals with those three skills sets. According to Mont et al. (2000), an expert in a specific domain has a deep understanding and experience of the domain, and is intensively involved in both its theoretical and practical aspects. Garcia-Perez (2011) recommends selecting evaluators who had already been involved in the research as stakeholders and would therefore be familiar with its context. Three options were then available for selection: interviews, focus groups and surveys. Although the participants' profiles were reviewed during the process of data collection, the researcher checked them again in order to select the most suitable evaluators for TOEQCC, focusing on their academic and practical backgrounds based on their academic outcomes, publications, and contribution to knowledge within the domain of cloud computing and information technology in HE. Accordingly, interviews were selected as most suitable option due to the participants' deep understanding and experience of the topic; most of the interviewees were professors in information technology and decision makers in JHEIs.

The number of the evaluators was another important decision to be made. Kreber (2002) argued that there is no standard number, while Law and Hvannberg (2002) suggested that three to five would be the appropriate number of evaluators. The researcher contacted 11 potential evaluators with an aim to obtain a minimum of 5 positive responses. Such 11 potential evaluators were selected from total of 31 interviewees involved in this study as they were the most suitable based on their professional background on the topic of this research. As a result, five accepted the invitation. All those individuals who agreed to participate as evaluators had at least 15 years' experience in HE. Table 7.1 presents evaluators' codes, their domains of expertise, the JHEI in which they work, their years of experience, and the type of university (public or private). The evaluators were from the same institutions that had been involved in the research. The codes used in this table correspond to those assigned to institutions in previous chapters, summarised in chapter four, Table 4.4.

Table 7-1 Evaluators details

Evaluator	Professional background	Years of experience	University name code/ Type
P1	Professor of computer engineering/virtual reality	23 years	U1/ Public University
P15	Professor of Information Systems/ cloud computing	21 years	U2/ Public University
P16	Professor of computer science/cloud computing	19 years	U2/ Public University
P3	Professor of Management Information Systems	15 years	U3/ Private University
P20	Professor of Management Information Systems	17 years	U3/ Private University

7.3 Mechanism taken for validation and evaluation

The mechanism used for validation and evaluation had three main phases. Figure 7.1 illustrates the process undertaken to carry out the validation and evaluation of the TOEQCC framework. Each phase will be explained in the following sections.

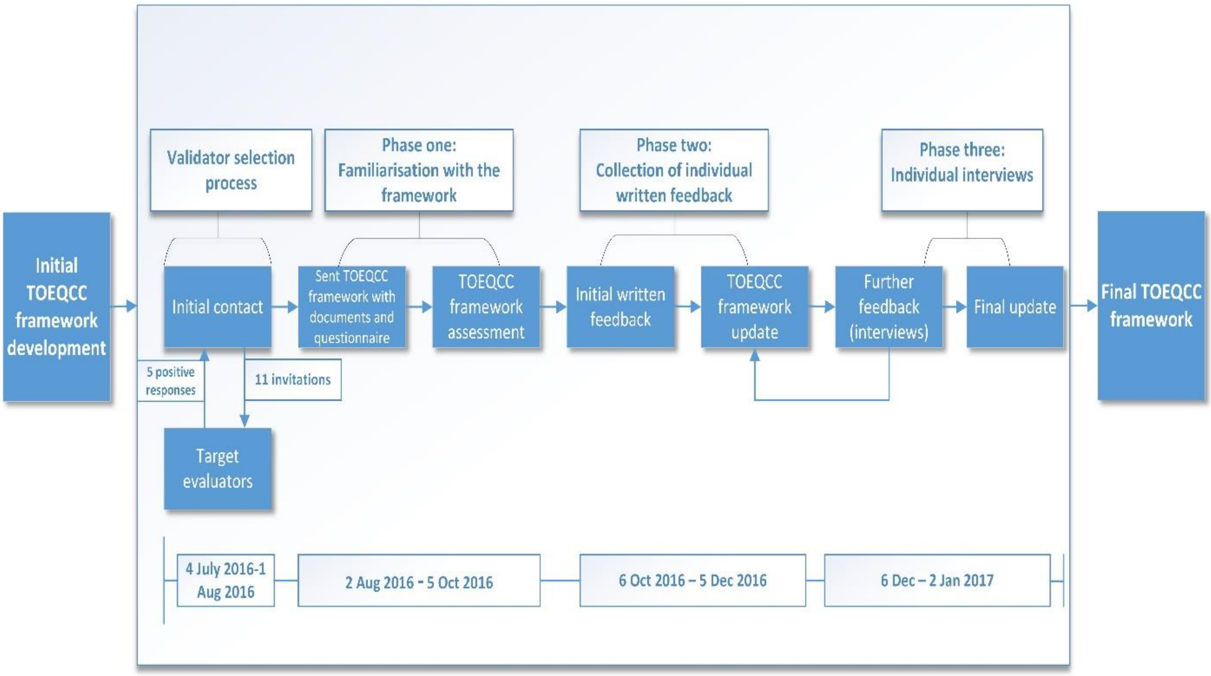

Figure 7-1 The TOEQCC Framework Validation and evaluation process

7.3.1 Phase one: Familiarisation with the framework

A questionnaire for the TOEQCC framework evaluation was designed (see Appendix 5), focusing on five conditions: comprehensiveness, testability, adoptability, clarity and correctness, adapted from the theory of validation of Kerlinger and Lee (1999). The researcher sent an e-mail to all evaluators, which included a copy of the questionnaire and the TOEQCC framework with documents that illustrate all factors and linkages. The evaluators were kindly requested to study the TOEQCC framework and to contact the researcher for any further explanation if needed. The aim of sending the framework with such documents was to enhance the familiarisation of the framework and to open the door with evaluators for any inquiries or clarifications needed for the evaluation and validation process. In addition, participants were asked to randomly adopt three cloud computing services or applications using the adoption sequence diagram in the TOEQCC framework to further validate the practicability of the framework. The evaluators were asked to return the evaluation feedback form and to answer the evaluation questions within two months. A reminder was sent by email a week before the expected return date

7.3.2 Phase two: Collection of individual written feedback

After receiving the feedback and evaluation forms, the researcher organised and analysed all the answers and comments for updating the framework. The evaluators' feedback and recommendations were divided into two groups: (1) those to be taken into consideration for updating/improving the framework; and (2) those which were outside the study boundaries or were unachievable because of time and budget constraints such as asking for further months for the evaluation and validation until the next semester as well as a recommendation to make a list of all cloud computing service providers as well as all their services and applications.

7.3.3 Phase three: Individual interviews

Having collected and analysed the feedback, the researcher invited each evaluator to an online individual interview using Skype. Each interview took around one hour. The purpose was to discuss the evaluators' feedback and comments with a view to capture any details that had not been covered by the questionnaire, as well as to inform them as stakeholders of the TOEQCC framework, of any changes made as a result of their feedback. Finally, the researcher sent them another e-mail with comments from the interviews and the minutes of the meeting; they were asked for their final feedback on TOEQCC, and whether they had any further recommendations.

7.4 Analysis of responses

The evaluation of the framework was conducted in the real HEIs in Jordan, and by experts in the field of this research. Interestingly, the updated final framework gained better feedback from the evaluators after their comments and recommendations had been taken into consideration. It was noted that the feedback differed between evaluators, possibly because of their different backgrounds. For example, evaluators from universities with low ICT budgets considered cost as an important factor in the TOEQCC framework, and recommended focusing on savings.

However, evaluators from universities with a more significant budget for the adoption of innovative technology focused on issues such as security and privacy. In addition, the evaluators with a technical background focused on the implementation aspects of cloud computing from the technical side, such as scalability, compatibility, migration process, and infrastructure readiness. The evaluators with a management background, however, focused on other aspects such as cost, budget, top management support, behavioural acceptance of using cloud commuting, government support, and the spoon-feeding issue. Analysis of the evaluators' feedback after reduction process is presented in Tables 7-2 to 7-5. The tables also include details of actions taken by the researcher in response to participants' feedback.

Table 7-2 Evaluators' feedback to the first question and the researcher's response

	Q1. Please describe your overall impression of the TOEQCC framework and its usability				
Validator	P1	P15	P16	P3	P20
Answer	My first impression was that the TOEQCC framework is complicated. The factors' roles and relationships are not clear.	It is obvious that this framework addressed both practical and theoretical aspects. However, there is no clear border that separates or explains the theoretical part and the practical part.	Lack explanation of the sequence diagram for the adoption of cloud computing. The decision making including several options are linked with several attributes in the right and left hand of the adoption process.	The process of adopting cloud computing applications or services does not include a specific or recommended cloud application for the academic purposes. It would be much better to provide a list of cloud computing service providers with recommended applications (e.g. Google-Google Docs). This would be more specific, instead of testing random applications.	There are some factors that vary from one institution to another, such as cost, electricity unsustainability, and management support. I would suggest reducing the number of factors in the body of the TOEQCC framework.
Solution/ Response	Illustrate the role of each factor by change the colour of motivators to green and barrier to red. Added M to motivators and B to barriers. However, chapters five and six provide a detailed explanation of each factor and its role in the TOEQCC framework.	The framework has been divided into two parts: strategic and implementation.	Explanations of how to use the cloud computing sequence diagram are provided in chapter six. However, it is not possible to add all these details in the body of the TOEQCC framework.	The framework is not designed to serve a specific application in cloud computing or to recommend one application rather than others. There are thousands of cloud computing applications which need to be tested through following the main steps in the adoption part of the TOEQCC framework. However, in the initial decision stage the HE may decide to accept or reject a cloud computing service or application based on the initial outcomes from trial versions.	No changes were made to the framework. This is because these factors were discovered during the data collection process in the fieldwork at JHEIs. However, some universities may focus on specific factors more than others, based on their financial or managerial situation.

Table 7-3 Evaluators' feedback to the second question and the researcher's response

	Q2 Are there any parts of the framework that appear disjointed or lack cohesion?				
Validator	P1	P15	P16	P3	P20
Answer	It is not clear how the TOEQCC framework has connected the actual use of cloud computing with the sequence diagram.	The starting point of the adoption process is not clear. In addition, there are no milestones for the adoption process in case we need to repeat the same phase.	The last phase of cloud computing adoption in the sequence diagram process (long-term usage) is not achievable because of the short period provided for the evaluation process. It would be better to remove this phase and focus on short term only or to increase the validation period.	There is no approach to measure the complexity level of cloud computing applications between students or staff members.	Security and privacy are linked with behavioural intention and attitude towards using technology. However, the relationship between these two factors appears disjointed in the TOEQCC framework.
Solution/ Response	Create a direct link between the actual use of cloud computing and the start of the sequence diagram instead of knowledge phase, which is the first phase of the adoption process.	The factors influencing the adoption of cloud computing are the starting points. However, practical starting point was added to the framework. Each phase can be separated and repeated until the move to the next phase. Therefore, there is no need for milestones within the TOEQCC framework; they would also increase the complexity.	The TOEQCC framework is designed to cover both short and long terms. However, the long term is considered as future work because of time constraints.	As was pointed out in chapter five, there is no standard for the complexity factor and it cannot be measured because it depends on individual computer skills. Therefore, complexity needs direct feedback from users. Accordingly, no changes were made to the TOEQCC framework.	This comment is noted but no action taken. Although security and privacy are related, in cloud computing there is a further privacy factor, the possibility of the cloud service provider accessing customer data. Therefore, the services could be very secure but with a low privacy level. Privacy should be discussed in the service-level agreement with the service provider.

Table 7-4 Evaluators' feedback to the third question and the researcher's response

	Q3. Which elements would you add, change, or alter and why?				
Validator	P1	P15	P16	P3	P20
Answers and suggestions	In the cloud computing adoption sequences diagram the knowledge phase is briefly mentioned without any guidelines to inform the user of the following issues: (1) How can cloud computing awareness be increased? (2) What methods do JHEIs have to use to enhance the awareness level? It would be useful to add such details to the framework.	More explanation and guidance should be added to the selection of cloud computing deployment models and service models. What is the most suitable model to be selected and why? What are the main features of each model? And what are the main limitations of each model?	There are two decision phases in the framework: initial and final. It would be better to remove one of these phases to avoid redundancy.	Technology Acceptance Model, which is adapted as a part of your theoretical foundation in the TOEQCC framework, has direct relations between perceived usefulness with attitude towards using technology and behavioural intention to use it. I would suggest adding such relations unless it is not suitable in the case of cloud computing technology, or you have a clear justification.	For the Minister of Higher Education in Jordan it is useful that you added innovators scale suggested by Rogers in the Diffusion of Innovation Theory. This will help them to identify the innovators' level because adopters of innovation technology in Jordanian universities are not at the same level. However, you must cite Rogers (2003) in your framework in this part.
Solution/ Response/ Accepted and included in the update framework/ Noted and recognised /Noted only/ Not accepted.	Three additional sub-phases were added to the knowledge phase as follows: (1) Workshops and intensive training courses for both students and staff (2) Addressing the initial requirements by top management and technical team (3) Applying SWOT analysis to enhance the Strengths, Weaknesses, Opportunities and Threats of cloud computing.	Section 6.3.3.4 provided details of the characteristics of both cloud computing services and deployment models. These details cannot be added directly to the TOEQCC framework. However, according to the HE requirements the decision-making unit can decide which model they need to adopt based on the institution's requirements.	No change made. The initial decision phase attempted to address the quality factors (analysing excellence, perfection, fitness for purposes and outcomes) whereas the financial decision was to determine whether to use cloud computing for the long-term period or to discontinue using it and search for other technology or solutions.	This comment is noted but no action taken. Roles of linkages between perceived usefulness, attitude towards using cloud computing, and behavioural intention to use cloud computing have been explained in chapter two.	Accepted and included in the TOEQCC framework. It has been declared that (adopters' classification of innovation over the time) chart was adopted from Rogers (2003), to help JHEIs to categorise cloud computing adopters over time.

Table 7-5 Evaluators' feedback to the forth question and the researcher's response

	Q4. What are the primary factors that need to be considered more than others in the TOEQCC framework and why?				
Validator	P1	P15	P16	P3	P20
Answer	Student and staff skills in using ICT is the key factor in using cloud computing.	Budget and cost of the adoption of ICT are the key barriers influencing the adoption of cloud computing.	Top management support is the key factor in adopting cloud computing. Other factors are not important if the top management rejects it.	Disaster recovery should be the key factor in the cloud computing adoption sequence diagram. The TOEQCC framework does not mention how to adopt a specific cloud computing application for data recovery.	I believe that all factors in the framework are important to my institutions. However, I would suggest using one colour for motivator factors and another colour for barriers. This would make the framework easier to follow.
Solution	The TOEQCC framework pays attention to the under-utilisation level of ICT in JHEIs, which influences both students' and lecturers' ability to use innovative technology such as cloud computing.	Noted but no change made. Cloud computing technology promises to reduce the total cost of ICT. Therefore, as was pointed out in the TOEQCC framework, the cost benefit is a motivating factor. However, budgets vary between JHEIs.	No change made. Other factors such as cost, relative advantages, students' requirements, and centralisation would force top management to search for ICT solutions such as cloud computing. That is, other factors influence the top management's decision.	No change made. The adoption sequence diagram is not designed to support a specific cloud computing application or service. Rather, it provides a comprehensive roadmap for the adoption of any cloud computing service or application.	Accepted, and change made to the TOEQCC framework by adding additional colours and notes to make the framework easier to follow.

7.5 Outcomes of the evaluation: A revised framework for implementation of cloud computing in JHEIs.

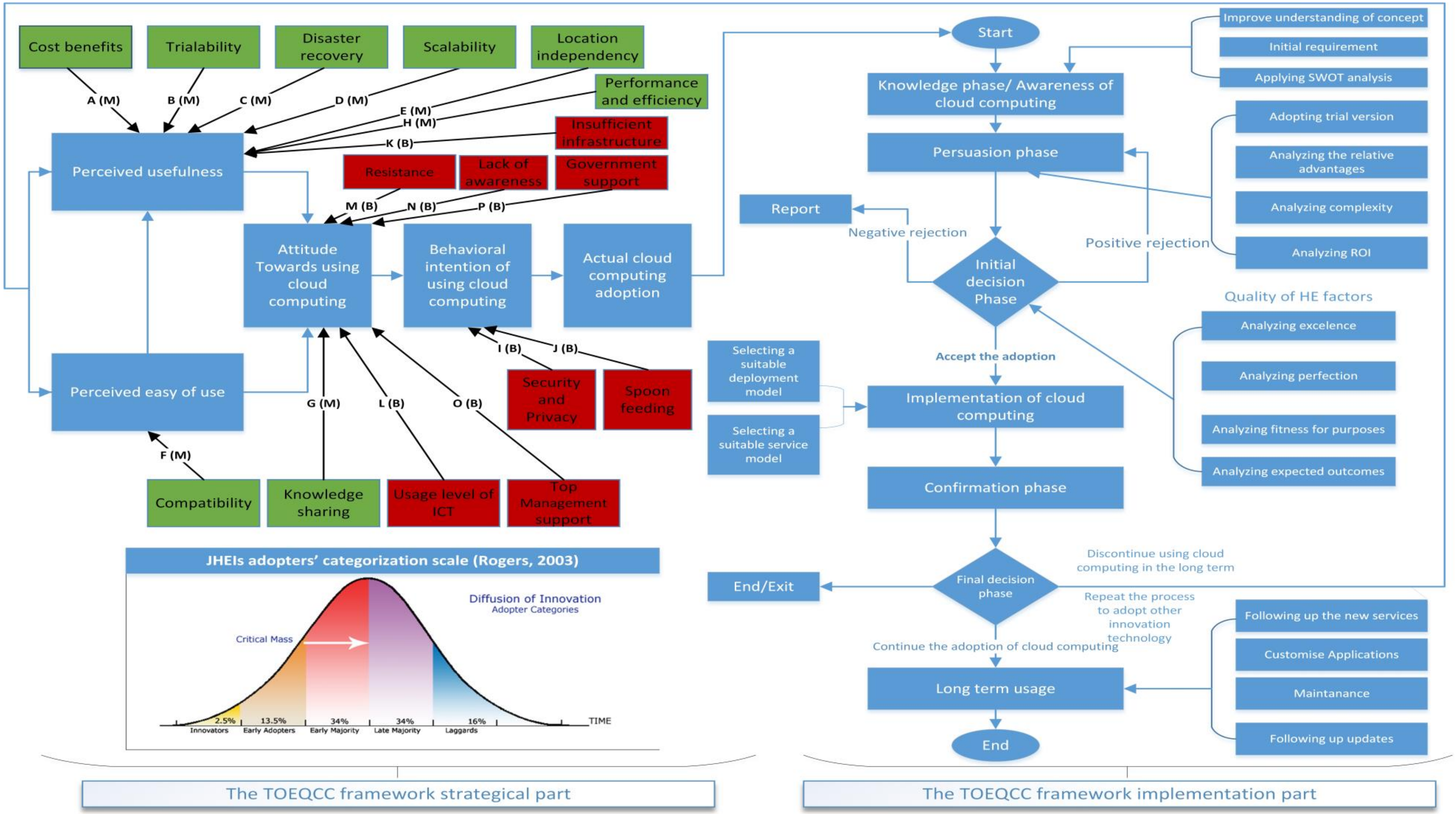

Figure 7-2 A revised TOEQCC framework for implementation of cloud computing in JHEIs

Based on the validation and evaluation feedback from the experts, the TOEQCC framework was updated and minor changes were made. The final framework included all recognised feedback and comments, except for those considered to be outside the study boundaries or unachievable because of time and budget constraints. However, such comments are taken into consideration in chapter eight as limitations of the framework or suggestions for future work.

As a conclusion of the process of development and evaluation a new, revised framework for cloud computing implementation was obtained which met the perceived needs of its main stakeholders. Figure 7.1 shows the final TOEQCC framework including updates from the evaluators' recommendations. However, the validation at the strategic level suggests that support from decision makers in the JHE sector is likely to result in a better level of adoption of cloud computing technology across the JHEIs. Therefore, the validation process of the strategic part of the TOEQCC framework does not necessarily lead to implementation of cloud computing technology in JHEIs.

7.6 Conclusion

This chapter described the framework validation and evaluation. It discussed the feedback from the evaluators and how the feedback was analysed. Five professors from three JHEIs agreed to evaluate the TOEQCC framework. Evaluation and validation of the TOEQCC framework was achieved in three phases. The first involved designing the validation and evaluation questions based on the theory of validation of Kerlinger and Lee (1999). The questions were then sent the evaluators by email, along with the TOEQCC framework. In the second phase, the researcher updated the TOEQCC framework based on the evaluators written feedback and comments. Finally, the evaluators were invited to individual online interviews to discuss their feedback and comments and to make any further comments and suggestions. Based on the feedback, the final draft of the TOEQCC framework was created. However, no major updates or changes to the main structure of the framework were required.

Chapter eight will conclude this study, making recommendations, and presenting the research limitations. It will show how the research has answered the research questions, and achieved the aim and objectives of this study. Finally, chapter eight suggests future work and analysis of areas that will benefit from further study.

8 RESEARCH CONCLUSION AND FUTURE WORK

In response to the research problem, defined in the early stages of this study, a new framework to help in the adoption of cloud computing at JHEIs has been developed, evaluated, and validated. This chapter therefore discusses how the aim of this study has been achieved. It sets out the recommendations suggested for JHEIs for adopting innovation technology. These recommendations form one solution to the problem of improving the quality of HE outcomes in Jordan. The chapter also discusses the primary contributions of this research: expanding academic knowledge, and providing practical solutions that could, with adjustments for context, be applied elsewhere. Finally, the chapter identifies the limitations of the research, and suggests recommendations for future research.

8.1 Research summary

This study set out to enhance the understanding of cloud computing technology in JHEIs, and to determine how they could most easily adopt this technology. To accomplish this, the researcher investigated the main factors influencing the adoption of cloud computing at JHEIs, and developed a new framework based on the theoretical foundations explored in the literature review. This research was conducted through a collaboration with 11 public and private universities in Jordan. It included 31 interviews with elite stakeholders in JHEIs (e.g. the Minister of Higher Education, university vice-chancellors, professors, IT managers, and senior lecturers). The fieldwork in this study included three focus groups, 100 student surveys, direct observation, and analysis of documents from the Accreditation and Quality Control Commission for Higher Education Institutions in Jordan (AQCCJHE).

The starting point of this research addressed the underutilisation of innovation technology in JHEIs as one of the reasons holding back Jordanian HE. This led to identifying the need for a framework for the adoption of cloud computing technology that may help to enhance the use of cloud technology at JHEIs as a part of the solution. Accordingly, as it was mentioned in the introductory chapter, the aim of this research was:

> *To develop a framework considering the key factors affecting the adoption of cloud computing that will help Jordanian higher education institutions to implement cloud computing effectively.*

Cloud computing is a comparatively new technology in the field of ICT. The literature review suggested that there are a limited number of studies that suggest a conceptual framework as a roadmap for the adoption of cloud computing at HEIs in developing countries in general, and JHEIs in particular. However, the findings from the fieldwork revealed that there are factors unique to Jordan's situation which influence the adoption of cloud computing in JHEIs. Thus, 'blanket' approaches used in the western world are not necessarily applicable in the Jordanian context. Furthermore, factors influencing the adoption of cloud computing in JHEIs could be different from those of other countries. For example, the behaviour intention of using innovation technology, the readiness of JHEIs' infrastructure, the overall awareness of the concept of cloud computing, security and privacy concerns by decision makers in JHEIs, universities policies and regulations in Jordan, Jordanian government support, and knowledge sharing between Jordanian universities might be specific to the Jordanian context. A number of research questions were proposed to achieve the research aim. A discussion about these questions and the ways in which the research has answered them is provided in the following section.

8.2 Answering the research questions

The primary research question outlined in the introduction chapter is:

How can higher education institutions in Jordan effectively adopt cloud computing technology in the learning and teaching process?

This question was answered by breaking it down into a series of narrower, more focused secondary research questions, to be examined below. Answering these led to the development of the new framework in chapters six and seven, thereby fulfilling the research aim.

The secondary research questions outlined in the introductory chapter are:

RQ.1 How can Jordanian universities benefit from the adoption of cloud computing technology?

To answer this question, a review of the most relevant literature on the basic concepts of cloud computing, its benefits, and its implications for HEIs in general, and JHEIs in particular, was conducted. The literature review chapter provided an introduction to Jordan and its HEIs. In addition, it provided an overview of the importance of adopting cloud computing in JHEIs. The literature review demonstrated how universities in western countries (e.g. UK and the USA) benefited from several approaches to adopting cloud computing. Several examples were given in chapter two of universities in developed countries that have already adopted cloud computing, and the advantages they gained from this adoption. This evidence from previous studies shows how universities in developed countries have enhanced the quality of the HE teaching and learning processes and outcomes through the adoption of this innovative technology.

However, the review of the existing literature found that most of the studies focused on HEIs in developed countries. Only a limited number of studies were available that focussed on the adoption of cloud computing in universities in developing countries, especially in Jordan.

The final part of the literature review chapter discussed the most influential theories and frameworks relating to the adoption of innovative technology at the individual, organisational, and environmental levels. Thus, the literature review answered the first research question and achieved the first objective of this research “To understand ICT adoption theories and frameworks and how they can be implemented by the individual, the organisation and its context”. *(Objective 1)*

RQ2. What are the main factors influencing the adoption of cloud computing in JHEIs?

To address this question, fieldwork was conducted in 11 JHEIs. Accordingly, in chapter five, the resulting list of 33 factors was considered. In chapter five, an adaptation of the original TOE framework (see figure 5.1) was used to classify these under four headings: factors relating to technology, organisation, environment, and quality. Quality has been added as a fourth attribute added to the original TOE model. These factors and the four-point model were used as important components in developing the conceptual framework in chapter six.

Chapter five elaborated upon whether each factor had a positive or negative influence on the adoption of cloud computing at JHEIs. According to the findings from the fieldwork, a total of 16 factors may have exercised a negative influence. These are: technology availability and adoption level, lack of awareness, insufficient infrastructure, JHEIs structure, data security, data privacy, electric power stability and risk of unavailability, vendor lock-in, lack of cooperation between JHEIs, lack of cloud computing adoption frameworks, university resources and budgets, current cloud computing usage by students, ‘spoon-feeding’ and teaching methods, confidence in cloud computing service providers, lack of government support, the process of decision-making, and innovation resistance.

On the other hand, 17 factors may have had a positive influence. These are: trialability, decentralisation of information technology, backup and recovery of learning materials, complexity, compatibility with in-house technology, cloud computing’s relative advantage, cost benefits, HEI size, overcrowded student populations, quality of graduate students, employability and its effects on adopting innovation technology, knowledge-sharing, fitness for purposes, cloud computing perfection, cloud computing excellence, and value for money.

Based on the above, chapter five answered the second research question and achieved the second objective of this research “To study the factors that influence the adoption of cloud computing in JHEIs (influencing factors)”. *(Objective 2)*

RQ.3 What are the motivators for and barriers to cloud computing adoption by JHEIs?

After determining the main factors influencing the adoption of cloud computing in JHEIs in chapter five and explaining whether each factor had a positive or negative effect, the third research question was answered in chapter six. It forms a part of the TOEQCC framework, which presented the motivators for and barriers to the adoption of cloud computing in JHEIs in the form of relationships between the factors and the body of the TOEQCC framework.

Based on the findings from chapter six, the motivators for the adoption of cloud computing at JHEIs are:

1. The relationship between the **cost benefits** of the adoption of cloud computing with perceived usefulness.
2. The **trialability** feature of cloud computing and its influence on perceived usefulness
3. The **disaster recovery** solution offered by cloud computing and its influence on perceived usefulness
4. The **scalability** of cloud computing and its influence on perceived usefulness
5. The **location-independent** feature of cloud computing and its link to perceived usefulness
6. The **high compatibility** of cloud computing with in-house resources and its influence on perceived ease of use.
7. The relationship between **knowledge-sharing** and attitudes towards using cloud computing technology.
8. The **high performance** and efficiency of cloud computing and its influence on perceived usefulness.

The barriers to the adoption of cloud computing at JHEIs are:

1. The effects of **resistance** to using innovative technology at JHEIs on the **attitude** towards the adoption of cloud computing.
2. The relationship between the lack of **awareness** of the concept of cloud computing in JHEIs with the **attitude** towards using cloud computing.
3. Insufficient **infrastructure** at JHEIs and its influence on the perceived **usefulness** of the adoption of cloud computing.
4. **Government support** and its influence on the **attitude** towards the adoption of cloud computing.
5. The influence of **security and privacy** concerns on the **behavioural** intention to use cloud computing.
6. '**Spoon-feeding'** as a teaching and learning method in JHEIs and its influence on the **behavioural** intention to use cloud computing.
7. The relationship between the **adoption** level **of ICT** and the **attitude** towards the adoption of cloud computing.
8. Lack of top **management support** in JHEIs and its influence on the **attitude** towards the adoption of cloud computing.

RQ4. What are the main phases for the effective adoption of cloud computing technology in JHEIs?

After reviewing the lessons learned from the field experience and the relevant literature regarding the adoption of innovative technology, the second part of the TOEQCC framework was developed. This part proposes a sequence diagram for the effective adoption of cloud computing at JHEIs. It has an adaptation of DOI theory as its theoretical foundation. The key phases suggested for an effective adoption of cloud computing at JHEIs can be outlined as follows:

1. Awareness of cloud computing technology phase, which consists of:
    - Enhancing understanding of the concept of cloud computing.
    - Addressing the initial requirements of JHEIs.
    - Applying SWOT analysis for cloud computing (See appendix 8).

2. Persuasion phase of cloud computing adoption, which consists of:

- o Adopting trial versions of cloud computing services.
- o Analysing the relative advantages.
- o Analysing compatibility.
- o Analysis of cloud computing ROI (return of investment).

3. Decision phase, which consists of:

- o Analysing the excellence of cloud computing.
- o Analysing the perfection of cloud computing.
- o Analysing fitness for purpose of cloud computing.
- o Analysing the expected outcomes of the adoption of cloud computing.

4. Implementation phase, which consists of:

- o Selecting a suitable cloud computing deployment model based on the university's requirements.
- o Selecting a suitable cloud computing service model based on the university's requirements.
- o Selecting the most suitable cloud computing service providers.

5. The confirmation phase and follow-up of cloud computing adoption. This consists of:

- o Analysing long-term usage.
- o Customising application/s for advanced usage.
- o Following up on the new services, maintenance, and analysing updates provided by the cloud computing service provider to maximise the benefits of cloud computing in the long term.

Chapter six, answered the third research questions. A part of the answer of the third research question was answered in chapter five. This is because the factors from chapter five were used in chapter six as a part of the TOEQCC framework. Finally, chapter seven presented the conceptual framework validation and evaluation. Accordingly, chapter six and chapter seven achieved the third objective "To produce and validate a framework that helps JHEIs to adopt cloud computing in an effective way".

The researcher believes that by answering the secondary research questions the primary research questions were answered. Having explained how this thesis answered the primary and secondary research questions, it is important to outline the links between the research questions and research objectives, and the sources that contributed to answering the research questions. Therefore, Table 8.1 shows links between the research objectives and the research questions, while Table 8.2 shows the main source of the contributions that led to the answering of the research questions.

Table 8.1 How research questions were linked with objectives in this thesis

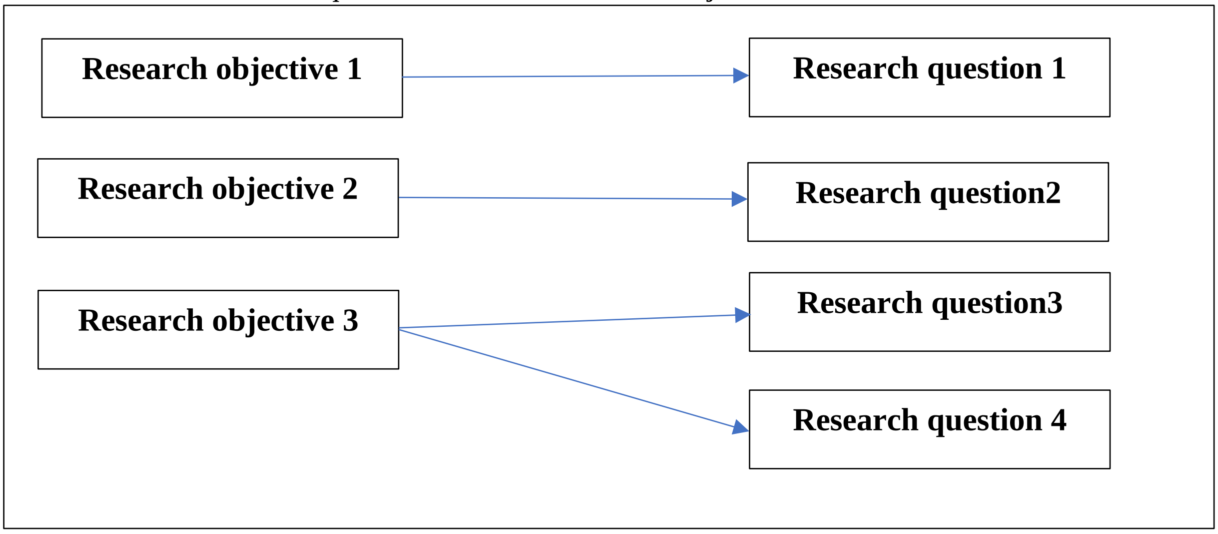

Table 8-1 Source of contributions to answering of research questions

Secondary research question	Source of contribution to the answer
Research question 1	Chapter two
Research question 2	Chapter two and chapter five
Research question 3	Chapter five and chapter six
Research question 4	Chapter six and chapter seven

8.3 Research contributions

The main contributions of this research result from addressing the major factors influencing the adoption of cloud computing (as presented in Figure 5.1 and Tables 5.1-5.4) and creating and validating a new framework aimed at helping JHEIs to adopt cloud computing technology (see Figures 6.1 and 7.5). The conceptual framework itself has suggested a new approach for the adoption of cloud computing in the field of HE.

The main contributions to the body of knowledge can be summarised as follows:

1. To the author’s knowledge, this is one of very few studies addressing the adoption of cloud computing at HEIs in Jordan. As explained earlier, the education system, which

encompasses JHEIs, is considered to be one of the most important sectors for the economy, since this is where the circle of economic development starts. The education system also provides the labour market with manpower, through graduate students. However, JHEIs have unique characteristics, different from those of HEIs in other countries. It was important to address these through fieldwork investigation, and to then transfer the findings to an academic work. In this way, a realistic solution for the research problem was developed, since other solutions suggested by the literature for HEIs in other countries could not necessarily be applied in the context of HEIs in Jordan.

2. The research has enhanced awareness levels of the JHEIs stakeholders of the concept of cloud computing and its benefits and limitations. In addition, it has increased understanding of the potential of innovative technology in general, and cloud technology in particular, to help in improving the quality of HE outcomes in Jordan.

3. The majority of previous studies aimed to investigate the factors of cloud computing adoption by using models that only tested these factors through a hypothesis developed in advance. Thus, unlike this study, they do not address the relationships between the factors. Nor do they go on to develop a framework for assisting HEIs in the adoption of cloud computing, especially in universities in developing countries, such as Jordan.

4. The conceptual framework addressed the technology, organisation, environment, and quality factors, and the relationships between them, providing comprehensive perspectives for the process of adopting cloud computing technology.

5. The conceptual framework caters for both strategic and implementation aspects. The first part of the TOEQCC framework is directed at the strategic level. It presents the motivators for and barriers to the adoption of cloud computing at the organisational, individual, and environmental levels in the context of HE in Jordan. The second part provides the implementation approach to the adoption of cloud computing at JHEIs by suggesting a sequence for effective adoption in diagram form.

6. The research required the stakeholders in JHEIs themselves to take part in developing and validating the conceptual framework. Their direct involvement consisted of feedback and suggestions from interviews, focus groups, and the student survey. In

addition, the conceptual framework benefited from the interviewees' experiences. This is because the interviewees in this study were considered elite stakeholders at JHEIs and included universities vice-chancellors, the minister of higher education, professors in information technology, and IT managers in JHEIs. According to the feedback from almost all interviewees, this is the first longitudinal study that has attempted to develop a realistic framework for assisting the adoption of cloud computing by involving 11 JHEIs. The framework was evaluated and validated by five professors from three JHEIs. As a result of this direct involvement of stakeholders, the researcher was able to gain a well-rounded view of the factors influencing the adoption of cloud computing in JHEIs, and to develop the final conceptual framework based on these factors.

7. As part of the data collection process, the researcher held three workshops in two JHEIs, with the collaboration of these institutions' top management, to increase awareness of cloud computing. The aim of these workshops was to test the awareness factor and its influence on cloud computing usage in JHEIs. As a result of these workshops, around 150 students began to use cloud computing education applications, 14 lecturers started using advanced applications, such as virtual servers, for simulation projects, and a new introductory course to cloud computing technology was established (see appendix 9). This thesis has therefore contributed, in its practice, to raising the awareness level of cloud computing at JHEIs.

8. The development of the conceptual framework and the findings from this research may help students, lecturers, university decision-makers, and IT managers in the adoption of cloud computing. The framework provides prerequisites for the cloud computing adoption process and the implementation process, and recommendations to follow after implementation.

9. Four papers have been published as a part of this thesis. These have been cited by several authors in the field of cloud computing (see appendix 8).

8.4 Research limitations

The research has several limitations that must also be taken into consideration. Such limitations were determined as follows:

1. Geographically, this research was limited to the kingdom of Jordan. Therefore, the findings and conceptual framework would not be suitable for other countries unless

they undertook additional investigation and empirical fieldwork. However, the conceptual framework could be acceptable in other Arab countries, especially those that share the same culture, education, economic, organisational, and environmental factors as Jordan.

2. The focus of this thesis was only the educational context. Therefore, the findings of this research would not be suitable for other contexts unless additional investigation and empirical fieldwork were conducted. Further research in other contexts is required.

3. The data collection and analysis are the interpretations of one person only. Therefore, there is no guarantee that the researcher has collected the data from the right participants in the right place. However, triangulation methods were used to overcome this issue as much as possible.

4. Limitations of the validation process: Although the conceptual framework was evaluated and validated by five professors from three JHEIs, further validation and evaluation by other evaluators from JHEIs is still required. In addition, the time allowed for the evaluation process was only two months, and three of the evaluators asked the researcher for an additional three to six months. However, the time constrains of the PhD project prevented the researcher from granting this request. Further evaluation across more JHEIs would be ideal in the near future.

5. Cloud computing technology is a relatively new technology. Therefore, the participants, especially students, may not have been fully aware of it as a concept. This unfamiliarity could have negatively influenced their contributions.

6. Although all interviews were conducted in English, the focus groups were conducted in Arabic and translated into English. The translation process for the three focus groups may inevitably result in the misrepresentation or imperfect presentation of ideas presented by participants. However, to reduce bias and increase validity and reliability, the researcher sent each translation, in both Arabic and English, to two Jordanian students at Coventry University and Queens University of Belfast to read and correct if required.

7. One of the main limitations in this study is that the participants have been selected from the scientific schools only, as the researcher believed that they were more familiar with the research topic and could provide better contributions to the factors influencing the adoption of cloud computing in JHEIs as well as to the development of the TOEQCC framework. However, selection of these schools prevents generalisation of the findings to all the schools in JHEIs.

8.5 Future work

The researcher has identified many opportunities for further research, which are highlighted as follows:

1. Confirmation of findings: This research resulted from collaboration with 11 JHEIs. However, as section 4.2 notes, there are a total of 31 universities in Jordan. Further research to confirm the current findings and to investigate more factors influencing the adoption of cloud computing could be conducted.
2. Extending the research to primary and secondary schools: The research focused on the adoption of cloud computing at HEIs in Jordan. However, further research could build on this research to focus on other levels of education, such as primary and secondary schools.
3. Extending the research scope: Further empirical investigations on cloud computing adoption within other contexts, such as manufacturing institutions, small to medium enterprise institutions, and government departments, could be conducted. The TOEQCC framework could be used to examine such institutions in order to evaluate the generalisability of it and to determine its key limitations and weakness.
4. Generalise the conceptual framework to encompass other countries: Further research might be considered in HEIs in developing countries, especially in the Middle East, to challenge the TOEQCC framework and to suggest more factors and recommendations, which this study was unable to uncover.
5. The researcher has only focused on the customer side, without involving cloud computing service providers. For example, the researcher did not interview stakeholders from cloud computing companies. It would be interesting to involve cloud computing service providers to improve and evaluate the TOEQCC framework.
6. Cloud computing remains a relatively new technology in JHEIs. Based on the fieldwork in this study, the adoption level of this technology is still in its infancy. However, this may not be the case for much longer. Further research could consider the long-term usage of cloud computing in JHEIs using a quantitative study with a large and random sample size.
7. The researcher has only focused on the scientific schools in JHEIs, such as engineering, management information systems and computer science. For example, participants from law schools were not interviewed. Further research could consider additional schools to those consulted in this study.

8.6 Summary and conclusion

This concluding chapter has explained how the research aim was achieved. It outlined the key contributions of the research, and discussed how the research questions were answered. In addition, it balanced this picture of contributions by presenting its limitations, and some potential ways to combat these in the future. The research provided some insight into the adoption of cloud computing for JHEIs through 33 factors influencing the adoption of this technology. It addressed the motivators for and barriers to the adoption process, and finally suggested a conceptual framework for the adoption of cloud computing technology. Interestingly, the TOEQCC framework has been accepted as an official blueprint in two JHEIs.

For the researcher, this project has provided an opportunity to transfer 10 years of both practical and academic experience in the field of innovative technology for academics into a PhD thesis. It has also enhanced the researcher's academic skills by allowing him to participate in research activities at Coventry University, and to contribute to the body of academic knowledge by participating in advance conferences such as the 2017 conference in the University of Cambridge, Clare College (see appendix 10) and publishing in several academic journals during the PhD journey.

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APPENDICES

Appendix 1: Ethics Form

Some materials have been removed from this thesis due to Third Party Copyright and confidentiality considerations. Pages where material has been removed are clearly marked in the electronic version. The unabridged version of the thesis can be viewed at the Lanchester Library, Coventry University.

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Certificate of Ethical Approval

Applicant:

Mahmoud Odeh

Project Title:

Adoption of Cloud Computing technology in higher education institutions: A case study of Jordan.

This is to certify that the above named applicant has completed the Coventry University Ethical Approval process and their project has been confirmed and approved as Medium Risk

Date of approval:

08 December 2015

Project Reference Number:

P38440

Appendix 2: Interview questionnaire and ethical considerations

Adoption of Cloud Computing technology in higher education institutions: A case study of Jordan.

About this study

This interview is part of a study about the adoption of information technology in general and cloud computing in particular at higher education in Jordan. The researcher trying to find out the effects of cloud computing adoption over the quality of higher education outcomes in Jordan. These effects may provide useful indicators such as the relation between adopting latest technology in education context and unemployment level, as well as the reason why higher education in Jordan is not aligned with global trends. Therefore, the researcher trying to find out more information about cloud computing usage, and main enablers and barriers for adopting the latest technology. The reason why the researcher trying to find out such information, is to develop a new framework that could help the universities in Jordan to use cloud computing technology in a proper way.

This sheet is for you to keep and tells you more about the study and what it involves.

- The researcher is going to interview around thirty participants individually.
- The researcher is going to hold four focus groups.
- The researchers who will conduct this study are based at the University of Coventry.
- All the interviews will be face to face discussions, of approximately one hour.
- With your permission, we shall digitally record your interview, and then it will be written out so that we have a record of what was said in the interview.
- The written interview will be held on a password protected computer file.
- When we write up the interviews we shall change organisations and people's names to protect the identities of everyone who has taken part.
- If you agree to take part in this interview, but feel at any stage that you would like to stop, you are free to do so at any time, and your data will be destroyed.
- If after the interview has taken place you decide you do not want your comments used in the study, you are free to do so and your data will be destroyed.
- If you have any questions about this study, feel free to contact us:

School of Business and Law
Centre for Business in Society
Priory Street
Coventry CV1 5FB

Q.1.Please describe the utilisation of ICT in your university. Please explain why you think that is the case.
Q2. Please describe your own understanding of what cloud computing means.
Q.3. Please describe the utilisation of cloud computing in your university. Please explain why you think that is the case.
Q4. The literature shows that the latest technologies, such as cloud computing, are under-utilised in the teaching and learning at higher education institutions in Jordan. Do you agree/disagree? Why?
Q.5 Please describe the quality outcomes of higher education in Jordan and the quality-related factors that would influence Jordanian higher education institutions in adopting cloud computing.
Q.6 How could cloud computing be used as a tool to improve the processes of learning and teaching at higher education institutions?
Q.7 Do you have any existing framework, model or strategy at higher education institutions in Jordan to adopt and use technology?
Q.8. How can cloud computing be introduced in the teaching and learning processes in Jordanian universities?
Q.9.Would the adoption of cloud computing technology improve the quality of higher education in Jordan?
Q.10.What are the main challenges currently faced by Jordanian higher education institutions in adopting cloud computing technology?
Q.11.What are the main benefits of adopting the latest information technologies, such as cloud computing, at higher education institutions in Jordan?
Q.12. Does the existing usage of ICT help to achieve the goals of higher education in Jordan? How?
Q.13. Do you have any negative experience in using current ICT at your institution (e.g. down-time, complexity, centralisation of use)?
Q.14. How would you describe the current technology investment in higher education in Jordan compared with services available?
Q.15.What do higher education institutions in Jordan gain from investment in information technology? Please explain.
Q.16. Do you think adopting the latest innovations in information technology at Jordanian higher education institutions could influence the unemployment level in Jordan?
Q.17. Do you think adopting the latest innovations in information technology at Jordanian higher education institutions could influence the level of knowledge sharing?
Q.18. Do you have any concerns regarding the adoption and use of cloud computing at Jordanian universities? Please describe.
Q.19.What are the main barriers currently faced in using ICT at higher education in the context of Jordan?
Q.20. Is there anything else you would like to add?

Appendix 3: Survey questionnaire and ethical considerations

Informed Consent Form Template

Adoption of Cloud Computing technology in higher education institutions: A case study of Jordan.

This project is trying to find out the effects of cloud computing adoption over quality of higher education outcomes in Jordan. Such effects may provide a useful indicators such as the relation between adopting latest technology in education context and unemployment level, as well as the reason why higher education in Jordan is not align with global trends.

The researcher trying to find out the effects of cloud computing adoption over the quality of higher education outcomes in Jordan. These effects may provide useful indicators such as the relation between adopting latest technology in education context and unemployment level, as well as the reason why higher education in Jordan is not aligned with global trends. Therefore, the researcher trying to find out more information about cloud computing usage, and main enablers and barriers to adopting the latest technology. The reason why the researcher trying to find out such information is to develop a new framework that could help the universities in Jordan to use cloud computing technology in a proper way.

	Please initial
1. I confirm that I have read and understood the participant information sheet (insert version number) for the above study and have had the opportunity to ask questions	
2. I understand that my participation is voluntary and that I am free to withdraw at any time without giving a reason	
3. I understand that all the information I provide will be treated in confidence	
4. I understand that I also have the right to change my mind about participating in the study for a short period after the study has concluded (insert deadline here)	

5. I agree to be filmed/recorded (delete as appropriate) and for anonymised quotes to be used as part of the research project

6. I agree to take part in the research project

Name of participant: ....

Signature of participant: ....

Date: ....

Witnessed by (if appropriate): ....

Name of witness: ....

Signature of witness: ....

Name of Researcher: ....

Signature of researcher: ....

Date:

Survey Questionnaire:

1. Institution name: ---
2. Email (Optional)--
3. Contact number (Optional)--
4. Gender: Male:☐ Female:☐
5. Age: 18-25:☐ 26-35:☐ 35-45☐ 46-60☐More than 60☐
6. Education level: Undergraduate ☐ Postgraduate ☐ PhD☐

   Other--
7. How often do you use the Internet:

   Daily ☐ Once a week ☐ Once a month ☐ Never

   Other (Please specify)---
8. What devices do you use for accessing the Internet :

   Laptop ☐ Desktop☐ Smartphone☐ tablet☐

   Other (Please specify)--
9. How long have you been using cloud computing technology:

   Never use cloud computing before ☐ less than one month☐ 1-6 month

   7-12 months ☐ More than one year☐
10. For what purposes do you use information technology in education?

    Not using at all ☐ Storage purposes ☐ Education applications☐

    Research services ☐ Sharing tasks with others☐

    Other (Please specify)☐ ---
11. Would the adoption of cloud computing technology improve the quality of higher education in Jordan?

    Yes ☐ No☐

    Please justify your answer --
12. Would the adoption of cloud computing influence the unemployment level in Jordan?

    Yes ☐ No☐

    Please justify your answer---

13. Does the existing usage of ICT help to achieve the goals of higher education in Jordan?

    Yes☐ No☐

Please justify your answer---

14. What are the main barriers currently faced in using ICT at higher education in the context of Jordan?

----

15. What are the main challenges currently faced by Jordanian higher education institutions in adopting Cloud computing technology?

----

16. Do you have any negative experience in using current ICT at your institution (e.g. Down time, complexity, centralization of use)?

----

17. How would you describe the current technology investment in higher education in Jordan compared with the services available?

----

18. What would be the main benefits of adopting the latest information technologies, such as cloud computing, at higher education institutions in Jordan?

Appendix 4: Focus group questionnaire and ethical considerations

Adoption of Cloud Computing technology in higher education institutions: A case study of Jordan.

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Please tick Box

1. I confirm that I have understood the above study (as explained by the researcher and the written information provided) and have had the opportunity to ask questions. ☐
2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving reason. ☐
3. I agree to take part in the above study. ☐
4. I agree to focus group discussion being audio recorded. ☐
5. I agree to the use of anonymised quotes in publications. ☐

______________________ ____________ __________________

Name of Participant Date Signature

Factor	Question
Technology	To what level is ICT used within the higher education sector in your university? Please explain why you think that is the case.
Technology	To what level is Cloud computing used within the higher education sector in your university?
Technology	The literature shows that latest technologies such as cloud computing are underutilized in the teaching and learning at higher education institutions in Jordan. Why is it?
Technology	Would the adoption of cloud computing technology improve the quality of higher education in Jordan?
Technology	How could cloud computing be used as a tool to improve the processes of learning and teaching at higher education?
Organization	How can cloud computing be introduced in the learning and teaching processes in Jordanian universities?
Organization	Would the adoption of cloud computing technology improve the quality of higher education in Jordan?
Organization	What are the main benefits to adopt latest technology such as cloud computing at higher education institutions in Jordan?
Organization	Does the existing usage of ICT help to achieve the goals of higher education in Jordan? How

Organization	How could you describe the current technology investment at higher education in Jordan comparing with services available?
Organization	What does higher education institutions in Jordan gain from invest in technology? Please explain
Environmental	What are the main barriers currently faced in using ICT at higher education in the context of Jordan?

Appendix 5: Validation and evaluation questionnaire and ethical considerations

Coventry University

Adoption of Cloud Computing technology in higher education institutions: A case study of Jordan.

Aim of this questionnaire

The aim of this questionnaire is to evaluate and validate the conceptual framework. The TOEQCC framework can be used by JHEIs a blueprint for better understanding of the process of adoption of cloud computing. It provides the main steps in implementation and the most important factors affecting the adoption of cloud computing. It could also be applied in similar contexts in Middle East countries, which share common denominators such as culture, language, economy, attitude toward using cloud technology, behavioural intention to use new technology, and level of ICT use.

About this study

This interview is part of a study about the adoption of information technology in general and cloud computing in particular at higher education in Jordan. The researcher trying to find out the effects of cloud computing adoption over the quality of higher education outcomes in Jordan. These effects may provide useful indicators such as the relation between adopting latest technology in education context and unemployment level, as well as the reason why higher education in Jordan is not aligned with global trends. Therefore, the researcher trying to find out more information about cloud computing usage, and main enablers and barriers for adopting the latest technology. The reason why the researcher trying to find out such information, is to develop a new framework that could help the universities in Jordan to use cloud computing technology in a proper way.

The aim of this questionnaire is to evaluate and validate the TOEQCC framework

This sheet is for you to keep and tells you more about the study and what it involves.

- The researcher is going to interview the evaluators individually after the initial feedback.
- The researchers who will conduct this study are based at the University of Coventry.
- All the interviews will be face to face discussions using Skype, of approximately one hour.
- With your permission, we shall digitally record your interview, and then it will be written out so that we have a record of what was said in the interview.
- The written interview will be held on a password protected computer file.

Adoption of Cloud Computing Technology in Higher Education Institutions: A Case Study of Jordan (Framework Validation and Evaluation)

Q1. Please describe your overall impression of the TOEQCC framework and its usability?

Q2 Are there any parts of the framework that appear disjointed or lack cohesion?

Q3. Which elements would you add, change, or alter and why?

Q4. What are the primary factors that need to be considered more than others in the TOEQCC framework and why?

Q5. Is there anything else you would like to add?

Appendix 6: Sample of secondary data (collected by researcher from the Jordanian minister of higher education)

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Appendix 7: Sample of analysing questionnaire data using Microsoft Excel

	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB
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2		Male	Femle	18 - 25	26-35	35-45	46-60	more 60	Under G	Postgraduate	Daily	Once a week	Once a month	Never	Other	Laptop	Desktop	Smartphone	tablet	Other	Never use	Less than one month	1-6 months	7-12 months	More than one year	Not using at all	Storage education material: Educa
3		54	46	65	27	4	4	0	68	31	92	6	2	0	0	70	27	62	13	0	43	18	12	8	19	43	35
4	University of Jordan		1	1					1		1					1		1					1				1
5	University of Jordan	1			1				1		1					1									1		1
6	University of Jordan	1		1						1	1					1		1	1						1		1
7	Philadelphia University	1			1				1		1					1		1					1				1
8	Israa University	1			1					1	1					1			1						1		1
9	The Hashimate University	1			1					1	1					1		1							1		1
10	Israa University	1			1					1	1					1	1	1	1			1					1
11	University of Jordan	1			1				1		1					1	1					1					1
12	Philadilphia University	1			1					1	1					1		1				1					
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18	Amman Arab University	1			1					1		1						1			1					1	
19	The University of Jerash		1	1					1		1					1		1						1			
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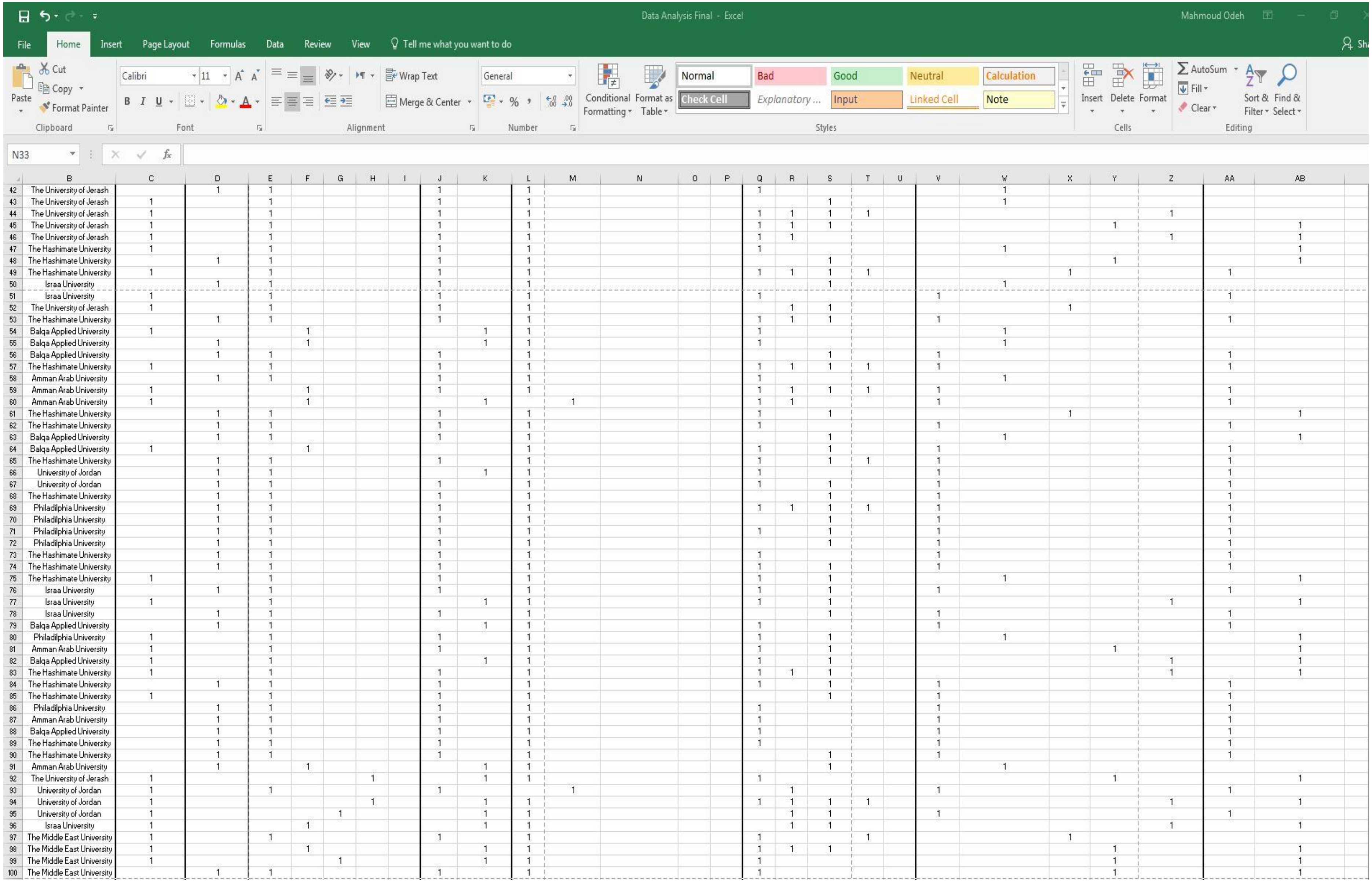

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99	The Middle East University	1				1				1	1					1								1			1
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Appendix 8: Publications

[PDF] Major Differences of Cloud Computing Adoption in Universities: Europe vs. Middle East

[PDF] psu.edu

M Odeh, K Warwick, O Cadenas - ... of Emerging Trends in Computing and ..., 2014 - Citeseer

ABSTRACT The extensive use of cloud computing in educational institutes around the world brings unique challenges for universities. Some of these challenges are due to clear differences between Europe and Middle East universities. These differences stem from the natural variation between people. Cloud computing has created a new concept to deal with software services and hardware infrastructure. Some benefits are immediately gained, for ...

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International Journal of Computer Applications (0975 – 8887)
Volume 127 – No.4, October 2015

The Impacts of Cloud Computing Adoption at Higher Education Institutions: A SWOT Analysis

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International Journal of Information and Education Technology, Vol. 7, No. 12, December 2017

Cloud Computing Adoption at Higher Education Institutions in Developing Countries: A Qualitative Investigation of Main Enablers and Barriers

M. Odeh, A. Garcia-Perez, and K. Warwick

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Factors influencing the adoption of cloud computing in higher education institutions: A case study of Jordan

ABSTRACT: The extensive use of cloud computing is changing the way dealing with information and communication technology. Very little research, however, has been conducted regarding the use of information technology based on cloud computing in developing countries. Recently, a considerable body of literature has emerged around the theme of cloud computing. By adopting Diffusion of Innovation (DOI) and Technology Acceptance Model (TAM) theories and the Technology, Organization and Environment (TOE) framework, this paper attempts to investigate the main factors affecting the adoption of cloud computing in the context of higher education institutes in Jordan. This study was carried out in Jordan, and used an interpretive paradigm with qualitative survey interview approach. The data was collected from 11 universities. The findings of this study suggest that while adopting cloud computing promises significant benefits, such as reducing costs, scalability, and increasing knowledge-sharing, most higher education institutions in Jordan have a limited awareness of these benefits. The study also found that the primary factors affecting cloud computing adoption are technology availability, awareness of cloud computing, attitudes toward technology, security, perfection of technology, culture issues, and environmental effects.

1 INTRODUCTION

As recently as 2010, many authors considered cloud computing to be a new phenomenon or a new paradigm of computing technology that provides on-demand access to IT resources shared with other users (Pallis, 2010; Wang *et al.*, 2010; Zhang, 2010). Since then, there has been a rise in the use of cloud computing, with extensive attention from academics (Lin & Chen, 2012; Schneider & Sunyaev, 2014).

Cloud computing provides advances in technology, such as network speed, distributed and grid computing, and high storage availability (Sultan, 2013). In addition, through its use, common problems like limited computational power and limited physical data storage can be reduced (Stein, Ware, Laboy, & Schaffer, 2013). This synthesis integrates hardware, software, networks, and storage options to deliver shared computing solutions in which applications and other services would be provided over the internet (Mahmood, 2014).

For higher education institutions striving to maintain a competitive advantage, the adoption of information technology should be prioritised. Therefore, universities in developing countries such as Jordan could improve the quality of higher education by increasing information technology usage.

Adopting cloud computing may improve the implementation of educational strategies, as well as decreasing the complexity of the teaching and learning process. According to Weber (2011), many Middle Eastern countries are underdeveloped, and prefer traditional learning methods. Yet the adoption of cloud computing in the educational sphere in developed countries has resulted in its successful integration within certain universities' infrastructure (McCREA, 2009; Sultan, 2010). Such adoption of cloud technology shows that universities elsewhere, particularly in developing countries, could improve the quality of education and the distribution of knowledge.

Jordan is a developing country located in the heart of the Middle East. Since the first public university was established in 1962, there has been a significant effort from the Jordanian government towards establishing more universities in Jordan (Al Jabery & Zumberg, 2008). Such efforts have resulted in a current total of some 10 public universities and 21 private universities.

Although there is intensive support from the Jordanian government towards the development and growth of universities, there is a notable lack of use and implementation of cloud computing. Therefore, the aim of this study was to investigate the main factors that influence the decision to adopt cloud computing at higher education institutions in Jordan. To this end, we collected and analyzed data from 11 public and private universities in Jordan. The collected data consists of 30 semi-structured interviews.

2 CLOUD COMPUTING

There seems to be no standard definition for cloud computing (Sultan, 2010). A number of authors have considered cloud computing as a new phenomenon or paradigm of computing technology, which could provide on-demand access to IT resources shared with other users (Avram, 2014; Chou, 2015; Hsu, Ray, & Li-Hsieh, 2014; Jansen & Grance, 2011). However, other authors have considered cloud computing as a business model that already existed as long ago as the 1930s. For example, Sultan (2014) argues that in that decade some companies such as IBM specialized in offering a punch-card electronic machine to other organisations as a rent service. Companies in that period sent their punch cards, which held data, to IBM for prosecting and finally received the information. Such a process may be considered as pay-per-use service.

Cloud computing has four deployment models: public, private, community, and hybrid. According to Chou (2015), public cloud is considered to be the most popular model in cloud computing. Service providers such as Google, Amazon, and IBM offer inexpensive or even free public services for general usage (Stein et al., 2013). However, despite the public service's low cost and broad availability, it is widely believed that the public cloud model has less security protection compared with other models (Sultan, 2013).

In addition, shared resources lead to limitations in physical capacity, unless the customer agrees to pay more for premium promotion (McDonald, 2010). In the public cloud model, the service provider will not enable clients to control the physical resources at any level. At the level of the organisation, such limitations in control, with extensive resources shared from the same physical servers, might allow other clients to access an organisation's critical data unintentionally.

Unlike the public cloud, the private cloud model enables the client to have control over the physical and shared resources. In the private cloud model the client leases the infrastructure. This infrastructure is operated solely for a specific client by cloud service provider (Linthicum, 2009). However, the cost of adopting the private cloud model is obviously more expensive than the public cloud.

Integration between the public and private cloud models usually offers the benefits from each of the two different models, while avoiding limitations. Such integration is called the hybrid cloud (Sultan, 2013). Finally, the community cloud model enables organisations which have the same concerns, such as security, mission, and policy, to share the same cloud infrastructure (Linthicum, 2009).

The hybrid cloud solution appears to be the best option for educational institutions, as it offers a private, multitenant infrastructure, which is operated solely by an organization, as well as the ability to provide benefits of both the public and community models (Stein et al., 2013).

Cloud computing could also be categorized according to service models. The term 'services' in cloud technology refers to the concept of being able to reuse the service's components through the vendor's network. This is widely described as "x-a-service".

Difficulties arise, however, whenever a higher education institution attempts to adopt a specific cloud technology service. The selection and commitment to one option rather than others is not a simple decision to make. Most cloud computing services are designed to fit non-customized needs. They are most often standard services for a large number of customers.

According to Linthicum (2009, p.11), cloud computing service models could be categorized in the following ways: application as a service; platform as a service; storage as a service; database as a service; infrastructure as a service; and integration as a service.

Application as a Service

Also described as 'software as a service', this refers to any application delivered through the web platform to an end user using an internet browser, such as Google Docs, Google Gmail, and Microsoft Office online applications (Velte, Velte, & Elsenpeter, 2009). Application as a service has many benefits. First, cloud customers can use it directly without any instillation needed on the local machines, since the application can be executed through the web browser (Sitaram & Manjunath, 2011).

Second, the independence made possible by being able to use this cloud service model with any device, such as laptops, a home PC, work PC, tablet, and smart phones, demonstrates the improvement of the application's availability and the intensity of its use (Sitaram & Manjunath, 2011).

Third, the main advantage of cloud applications as a service is the cost (Linthicum, 2009) . The cost factor here is not just for the cloud customer, but also for the cloud provider. On the cloud customer's side, the pay-per-use business model ensures the minimum cost required. Whereas, from the vendor's point of view, it is economically viable to create a cloud service application rather than provide full software packages (Sitaram & Manjunath, 2011). Finally, there is no need to update to newer versions. The application will simply be changed, and the old cloud versions will not be used.

However, there are many limitations in application as a service. First, privacy and security are still the main concern when using a cloud application service. Second, the customer has no control over when the service providers decide to change or replace the service.

Third, although application as a service is considered an economically viable solution for both cloud customer and service provider, accessing applications can result in continuous running costs, instead of paying for the software application once and using it frequently.

Therefore, the adoption of such a cloud solution should be studied carefully by institutions over a long period. Finally, if the institution has a very specific requirement, it is most likely that it will not find the application available online through this service.

Platform as a service

Platform as a service (PaaS) is a cloud delivery service that supplies the cloud customer with all the resources needed to build and develop web applications (Velte et al., 2009). In this service, there is no need to install or download any software for the application development process.

PaaS provides the ability to design, build, and test customer applications (Linthicum, 2009). It enables cloud clients to control the software application. However, it is important that application developers know how to use the programming language, which is provided by the cloud vendor (Chou, 2015). The main advantage of adopting PaaS is the low cost, with the ability to access the enterprise environment, in turn allowing developers to create enterprise applications.

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The disadvantage is the service provider lock in problem. PaaS service providers have no standards regarding programing languages and interfaces. Therefore, it is very difficult for cloud customers to move from one service provider to another (Linthicum, 2009).

Storage as a service

This type of cloud technology provides storage such as a Storage Area Network (SAN storage), a Network Attached Storage (NAS storage), and Direct Attached Storage (DAS storage), which are available in a physical location and accessible remotely through an application hosted logically at a different site (Schulz, 2011). Such service may allow higher education institutions to avoid backup efforts, as well as the cost and time needed for the backup process.

In this type of cloud service, data is replicated in different geographic locations, which also avoids any loss of data if an unexpected disaster happened at one site (Dikaiakos, Katsaros, Mehra, Pallis, & Vakali, 2009) .

Data privacy is still the big issue in cloud computing. The cloud service provider's data center stores the information that the university traditionally has stored on their local servers or storage machines (Dikaiakos et al., 2009). One of the most popular solutions to improve privacy is the data encryption method. This solution is traditionally considered to be the first choice to safeguard an organization's sensitive information (Wang, Jung, Lee, Okuhara, & Yang, 2014).

Since cloud service customers do not have full control of the cloud data centre, the data encryption method enables them to protect their information effectively. Before uploading the data to the cloud storage device, local backup software generates a secret key for the customer to encrypt these data. The local backup software decrypts the data to its original form when the customer retrieves it again (Wang et al., 2014).

However, despite these benefits, data encryption methods in cloud computing are complex and troublesome (Mather, Kumaraswamy, & Latif, 2009). To improve the encryption method, cloud computing customers use a third-party security provider called a cloud broker, rather than a cloud service provider (Ruan & Carthy, 2013).

The cloud broker works as an intermediary between cloud computing service providers and cloud customers. Using a cloud broker ensures that cloud services work properly, as well as ensuring that cloud providers have no access to customers' sensitive information (Mehrotra, Srivastava, Banicescu, & Abdelwahed, 2014).

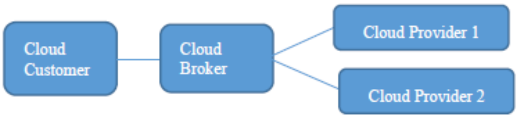


Figure 1. Role of cloud broker, between consumer and service provider (Liu et al., 2011)

Database-as-a-Service

Database-as-a-Service (DaaS) enables the consumer to load the data, store the data, and create tables through a remote database hosted on cloud computing servers. It provides the ability to make the database function logically as the cloud customers have it locally in their servers (Linthicum, 2009).

Cloud consumers using such services have the ability to create a new database in very easy steps, without even buying any hardware or software, and on the same day it can be purchased, which also saves time (Linthicum, 2009). It enables users to manage and access all database functions remotely through the internet at any place and any time using APIs (Raj, 2014).

This service offers virtual servers, virtual storage, and any virtual hardware, instead of physical in-house resources. Cloud customers can access any virtual hardware resources remotely (Landis & Blacharski, 2010).

Infrastructure-as-a-Service (IaaS)

According to Aumueller (2010), the concept of IaaS started under the umbrella of Hardware-as-a-Service before being transferred later to IaaS. IaaS could be used at universities to satisfy students' and researchers' specific needs, such as simulation in engineering projects, which require high specification hardware (Pardeshi, 2014).

The first advantage of IaaS is that it enables cloud customers to access expensive data centre, which may contain super computers (Linthicum, 2009). Cloud customers access these resources as they own them. The second advantage is that the cloud service vendor takes full responsibility regarding hardware maintenance, support, and upgrade. This avoids concerns about maintenance. It also provides the ability to decrease the number of technical staff, which obviously decreases the cost.

Since this service is hosted remotely on network, it provides the ability to access the resources in any place at any time outside the institution. Finally, IaaS offers flexibility and scalability of resources. Such features enable the cloud customer to upgrade resources according to actual need, simply by adding additional CPU cycles or storage. These features also allow the flexibility to downgrade the resources at any time (Velte et al., 2009). This simplicity of using infrastructure resources is almost impossible when using traditional hardware resources.

However, IaaS has many disadvantages, such as that cloud customers have no full control or permission to access physical resources, and the fact that in some cases the cost of physical resources could be less than the cloud bandwidth payment. Therefore, it is important for institutions to know if they really need to move towards IaaS technology or if they do not, according to actual institution requirements.

Integration as a service provides the ability to integrate different service applications, including their interface and design. It offers a solution for connecting different files and applications through a web interface (Linthicum, 2009). Any integration-as-a-service has to provide mainly four functions: transformation, routing, interface, and logging.

In transformation, this service converts any information from one system to another, which means that the receiver system will fully understand the information from the sender system after the conversion process. Routing means the predefined logical connecting of information, which is also known as intelligent routing. Interface in cloud service integration means that the cloud customer can connect with the target application or software, despite the differences in software interfaces.

Finally, logging means the ability to access all integration software. The cloud customer may, however, find that it is very difficult to integrate some customized applications.

3 THEORETICAL FRAMEWORK

To explain the best approaches for the adoption of cloud computing, existing theories and frameworks from different publications will be used in this study. One of the most popular theories in technology adoption is the Technology Acceptance Model (TAM), which was developed by (Davis, 1989). The primary aim of TAM was to determine the main factors related to the adoption of technology at the level of an individual's behavior (Lippert & Govindarajulu, 2015). The Technology-Organisation-Environment framework is another common framework, which was developed in (RW.ERROR - Unable to find reference:176) by Tornatzky, Fleischer, & Chakrabarti. We used this framework to study the factors, which related to the technology and environmental context at higher education institutions in Jordan.

Another famous theory, which has been widely used in several studies, is Diffusion of Innovation (DOI), which was developed by Rogers (1995; 2010). The main aim of DOI is to provide a clear explanation for the process of adopting new technology.

Table 1. Theoretical framework

Theory/ Framework	**Author**
Technology Acceptance Model (TAM)	Davis, 1989
Technology-Organisation-Environment (TOE)	Tornatzky and Fleischer, 1990
Theory on Diffusion of Innovation (DOI)	(Rogers, 2003)

3.1 *Technology Acceptance Model (TAM)*

The Technology Acceptance Model (TAM) is considered to be one of the most popular theories in studying the adoption and diffusion of new technology (Davis et al., 1989). The Technology Acceptance Model was developed by Davis (1989).

This theory was widely used to explain the adoption and diffusion of new technology at the level of the individual, and to provide clarification for computer usage behavior. Numerous studies have attempted to explain the adoption and diffusion of new technology based on the TAM theory (Davis, 1989; Gefen, Straub, and Boudreau, 2000; Legris, Ingham, and Collerette, 2003).

According to Davis (1989), the Technology Acceptance Model theory postulates that there are two main variables that affect users' decisions towards new technology: perceived usefulness (PU), and perceived Ease of use (PEOU). **Perceived usefulness** refers to "the degree to which a person believes that using a particular system would enhance his/her job performance", while **perceived ease of use** refers to "the degree to which a person believes that using a particular system would be free from effort" (Davis, 1989, p.82).

3.2 *Technology-Organizational-Environmental framework*

In 1990, Tornatzky and Fleischer developed the Technology-Organisation-Environment (TOE) framework. The TOE framework depends on three main contexts of adopting and implementing new technology at the level of an organisation, as follows: technological, organizational, and environmental (Lippert & Govindarajulu, 2015). According to Baker (2012), all these contexts strongly affect technological innovation.

3.3 *Theory on Diffusion of Innovation (DOI)*

DOI theory, developed by Everett Roger (1995) has been widely used in technology adoption studies. According to a definition provided Rogers (2003, p.5) diffusion is defined as "*the process in which an innovation is communicated through certain channels over time among the members of a social system*". As can be seen in Rogers's definition, there are four main elements in DOI theory. These elements are: (1) the innovation, (2) communication channels, (3) time, and (4) social system. These four elements provide explanations for the process of adoption by individuals or organizations.

3.3.1 *DOI theory, main elements*

1. Rogers (2003, p.12) defined innovation as "*an idea, practice, or object that is perceived as new by an individual or other unit of adoption*". The innovation does not need to be "objectively" new, and the innovation is varies from one individual or organisation to another. If an idea appears new to individuals or organisations, it is an innovation (Roger, 2003).
2. Communication channels refer to the avenues through which information is created and shared between individuals
3. Time: Rorer's (2003) argues that time is considered to be a strength variable in DOI theory. The time element has three main dimensions: (1) the innovation- decision process, which includes five stages, starting from the individual's first knowledge through to the adoption or rejection of the innovation, (2) the innovativeness, which refers to the earliness/lateness of members' innovation adoption within the same system, and (3) the innovation rate, which is normally measured by the number of members who adopt the innovation in a particular time period.
4. Social system:

These units could be individuals, groups, organisations, and/or subsystems (Rogers, 2003; Rogers, 2010) . Sharing the same problem-solving process to reach the same targets can affect the innovation diffusion. The diffusion process can be affected by social system structure and social characteristics (i.e. social system units are not necessarily identical in their behavior).

According to Rogers (1995; 2003; 2010), there are five main stages that affect the individual's decision to adopt or reject the innovation within the social system, starting from knowledge to implementation. The process of innovation decision through these five stages varies from individual to another. While some people need many years to adopt innovation, others move rapidly from knowledge to implementation. Table 2 provides a brief description of the adopt/reject decision process stages. These five stages have also been explained by Rogers (2003) through the Innovation–Decision Process Model (IDPM) (Figure 3).

Table 2: Adopt/reject decision process stages.

Stage	Description
Knowledge	The first stage, when the individuals or decision unit know about the existence of the innovation, and have the opportunity to understand how it functions.
Persuasion	Consists of five characteristics: (1) Relative advantage, (2) Compatibility, (3) Complexity, (4) Trainability, (5) Observability.
Decision	In this stage, the individual or decision unit decides to adopt or reject the innovation. The individual or group may continue adopting the innovation or discontinue the innovation adoption after a period of time. A decision of rejection may include continuing the rejection as a permanent decision, or deciding to adopt the innovation later.
Implementation	At the implementation stage, the actual use of the innovation in real life will take a place.
Confirmation	This is the final stage, where the individual or decision-making unit evaluates the outcomes of the innovation. Based on these outcomes, the individual or decision-making unit decides finally to keep adopting the innovation or to stop using it for some reason.

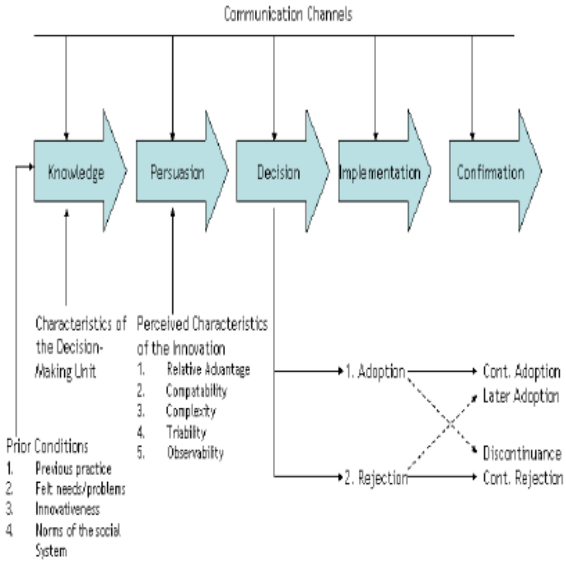


Figure 2. *Innovation–Decisions Process Model (Rogers Everett, 1995).*

According to Rogers (2003) 'innovativeness' is defined as "the degree to which an individual or other unit of adoption is relatively earlier in adopting new ideas than the other members of a system". Roger classified adopters in relation to the time it took them to adopt the innovation, according to a scheme of five levels, as seen in figure 3.

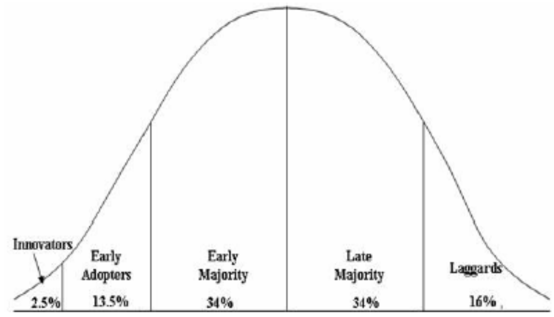


Figure3. Adopters' Classification of Innovation over Time (Rogers Everett, 1995).

1. Innovators: Venturesome Innovators are considered to be risk takers. Usually, they are interested in adopting new technology. Based

on Roger's classification, innovators represent 2.5% of the whole social system. Normally they own high financial resources and are highly-educated. In addition, they have long-term vision and good awareness about the consequences of the innovation adoption.

2. Early adopters: These adopters are considered opinion leaders. They are usually in a leadership position, believe in change, and are always happy to adopt new ideas. Early adopters represent 13.5% of the whole social system. They are also able to provide information regarding new innovation to others.

3. Early majority: The early majority represents 34% of adopters, who sit in the middle between early adopters and the late majority. They accept the innovation adoption after they have observed the reputation of the innovation within the social system. However, they still accept the innovation adoption before the population average.

4. Late majority: This type of adopter refers to the people who do not take any risks at all. Usually they have a limited level of education and limited income. They make the decision to innovate when the innovation level becomes higher than average. Late majority adopters represent 34% of adopters.

5. Laggards: The final group, who represent 16% of the total. They usually have the lowest income, and the lowest level of education. Laggards adopt the innovation only when another new innovation is taking a place. They do not have sufficient confidence to adopt new ideas until all other adopter groups have already accepted them.

4 RESEARCH METHODOLOGY

This study is exploratory in nature. Through interviews and qualitative surveys, it investigated the main factors affecting cloud computing adoption at higher education institutions in Jordan. As Marshall & Rossman (2010) point out, the qualitative researcher depends heavily on the use of in-depth interviews. According to Rubin & Rubin (2005, p.4), an interview is considered to be a "conversation in which a researcher gently guides a conversational partner in an extended discussion".

Researchers usually aim to solve their research problem by adopting suitable research methods, and finding the best answers to the research questions (Adams, Khan, Raeside, & White, 2007). There are two main research approaches in research literature, quantitative and qualitative research.

Quantitative research relates to the positivism principle. Quantitative researchers depend heavily on statistical data analysis to clarify their research results. This kind of research normally has a deductive, theory-testing approach (Bryman, 2012).

Qualitative research, on the other hand, is considered to be a research approach that employs words rather than numbers. It depends on discussion, deep knowledge, and understanding of the research context (Bryman, 2012).

According to (Woods, 2006), qualitative researchers are mainly interested in the following: "how understandings are formed, how meanings are negotiated, how roles are developed, how a curriculum works out, how a policy is formulated and implemented".

In addition, qualitative researchers seek out people's experiences in order to discover and understand the research participant's behavior (Gorman, Clayton, Rice-Lively, & Gorman, 2005). Qualitative research incorporates an inductive analysis approach, which enables researchers to investigate and add new information to the body of the knowledge.

According to several authors, the characteristics of qualitative research can be summarized as follows:

- Qualitative research is descriptive. The qualitative researcher is interested in understanding the meaning of real situations and processes, and employs in-depth analysis to discover what is behind the phenomena, using field notes and observation (Stangor, 2014).
- The researcher's role in qualitative study is to be the main instrument for the data collection and data analysis process, instead of any other "third party" instrument (Merriam, 1998).
- Qualitative research is evolutionary, emergent, and flexible in design (Lee, Mitchell, & Sablynski, 1999). It mainly focuses on interpretive human data and resources because it considers subjective realities, where the researcher endeavours to reconstruct the knowledge (Merriam, 1998).
- The results in qualitative research are comprehensive, holistic, and provide the ability to develop theories as well as frameworks. Therefore, qualitative research is considered an endless creative process. To create a qualitative study, the researcher must take an interpretive approach (Dezin & Lincoln, 2003).
- In qualitative research the sample is usually selective in nature, usually making use of a small group of participants, whereas in quantitative studies the sample usually attempts to be random and large in size (Merriam, 1998).
- When the research includes complex phenomena, the qualitative approach might be the best choice (Yin, 2013).
- According to Creswell (2013) research questions beginning with "how" or "what" suggest that a qualitative approach is required. Therefore, for any study attempting to answer these types of questions, the qualitative approach is considered the most appropriate choice (Merriam, 1998).

As there is a gap in the previous literature in investigating "what" are the main factors influencing the adoption of cloud computing at JHEs and "how" Jordanian universities can benefit from cloud computing, this study applied the qualitative approach as the most suitable research methodology.

In total, 30 semi-structured interviews were conducted from 11 higher education institutions in Jordan. All interviewees have at least 10 years' experience in the field of higher education, and their research interests lie in the field of ICT. The interviewees include university vice chancellors, deans of schools, heads of departments, and educational experts in cloud computing technology.

The interviews were conducted as one-to-one interviews in personal visits. We made a phone call or sent an email to each participant to confirm the meeting date, time and location. All participants received a copy of ethical approval from Coventry University, as well as a copy of interview questions in advance, prior the interview.

Figure 4 describes the main steps of this research, from the period 2014-2016.

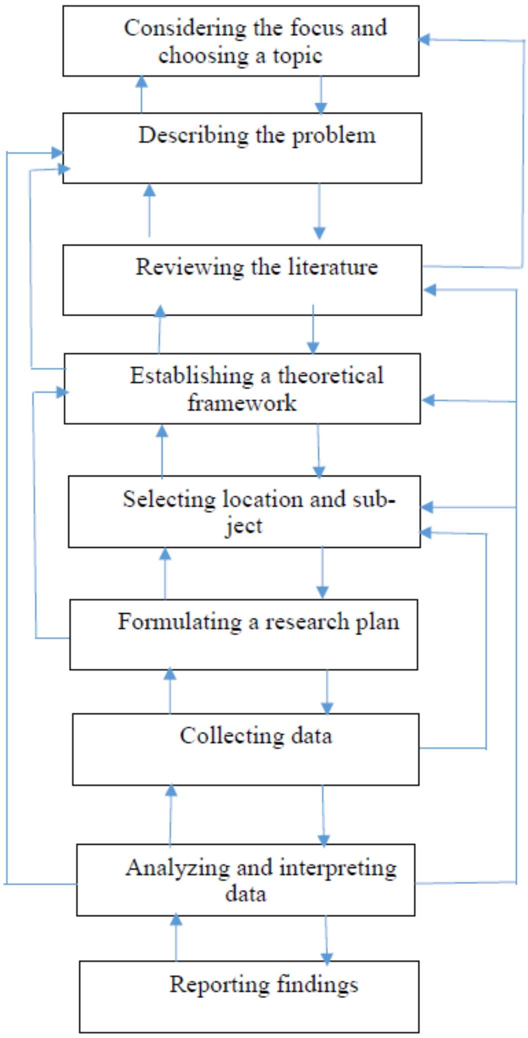


Figure 4: An outline of the main steps of the research– Adopted from (Gorman & Clayton, 2004:37)

As adoption of the latest ICT, such as cloud computing, may influence and affect higher education institutions' stakeholders, it is very important to reach an in-depth understanding of the actual technology usage and the vision for adopting information technology in the Jordanian higher education context, especially from decision makers' point of view.

The research design as shown in figure 4 describes the procedures taken as a plan to conduct this research. The first step was to narrow the focus and choose a topic, in this case the adoption of cloud computing technology in Jordanian higher education institutions. The second step was the research problem. This was formulated in response to Jordan's perceived reluctance to use the latest information technology, which mainly affects the quality of higher education institutions outcomes, and creates a gap between students who graduate from them and the labour market requirements.

The third step was to review the existing literature in order to define the context of the research, and to ascertain the main elements used in this study. The fourth step was to apply theoretical frameworks, through employing DOI theory, TAM, and T-O-E framework. The fifth step was the selection of higher education institutions in Jordan, which could participate in this project as different case studies. The sixth step was the need to formulate a research plan for data collection and analysis, e.g. interviews, qualitative survey. The seventh step was to assess and analyse the data collected from the fieldwork, and finally to report the findings and results from this project.

As shown in Figure 2, this research is not interested in testing hypotheses to accept or reject them. Therefore, a qualitative methodology with an interpretive stance was used in this research because it enabled the researcher to investigate in-depth, and to uncover the main factors influencing the adoption of cloud computing technology in JHEI.

Higher education institutions taking part in this study and selection justifications.

According to Gorman & Clayton (2004), the process of selecting research locations depends on three main activities, as follows: a search for suitable locations, the selection process, and testing of the locations selected.

There are some differences between Jordanian universities, for example in students' academic ability, information technology adoption level, staff size, decision makers' attitudes, budget, and other factors, which are mentioned in the findings section.

Gorman & Clayton (2004) argue that site selection is better if it includes active people who are interested to participating and interacting with the researcher. Therefore, we searched for sites like these, which included active participants who were interested in this study. In addition, to makes this study as comprehensive as possible, we covered the main private and public universities in Jordan.

Table 2 presents an overview of higher education institutions that took part in this study, as well as the fieldwork key dates. All participants were professors with at least 15 years' academic experience, including decision makers; deans of schools; heads of departments; and cloud computing experts.

Table 2: Jordanian universities taking part in this study and fieldwork key dates

Code	University name	Number of total students	Number of total staff	Key dates
U1	University of Jordan	38536	1436	22-12-15 to 02-01-16
U2	Hashemite University	27118	627	3-10 Jan 2016
U3	Amman Arab University	8270	112	11-18 Jan 2016
U4	Applied Science private university	7008	255	20-27 Jan 2016
U5	Al-Isra University	5349	229	28-Jan 2016 to 4 Feb 2016
U6	Middle East University	2552	184	6-13 Feb 2016
U7	Philadelphia University	6906	288	14-20 Feb 2016
U8	Jerash University	3923	193	21-28 Feb 2016
U9	The University of Zarqa	6610	308	1-2 Mar 2016
U10	Al Balqa' Applied University	33125	1458	3-16 Mar 2016
U11	Jordan Academy for Maritime Studies	1800	80	17-25 Mar 2016

5 FINDING FROM THIS STUDY

This section presents the results from data analysis, collected from semi-structured interviews and qualitative surveys. Table 3 describes the profiles of participants interviewed in this research. The table connects each interviewee with the university where he works. In addition, the table groups interviewees into two categories: professors (P) and decision makers (DM). Although decision makers are also professors, the study refers to them in their capacity as DM.

Table 3: Summary of participants taking part in this study.

University code	participants code	Position
U1	P1	Professor of computer engineering /Virtual reality
U2	P2	Professor in Computer science /Cloud computing
U3	P3	Professor in Management Information Systems/ E-government
U4	P4	Professor in engineering/ Cloud robotics
U5	P5	Professor in computer science/ 3D imaging/Cloud computing expert
U6	P6	Professor in Computer science / Wireless programming
U7	P7	Professor computer science/ E-commerce
U8	P8	Professor in system engineering/ Telecommunications
U9	P9	Professor in management information systems
U10	P10	Professor in computer science
U11	P11	Professor in telecommunications
U2	P13	Professor in computer science
U3	P14	Professor in software engineering
U6	P15	Professor in electronic engineering
U1	DM1	Head of computer engineering school
U1	DM2	Head of management information systems department
U5	DM3	Head of information system school
U9	DM4	Chairman of the Board of Trustees. MP, Senator & Minister of Higher Education, Jordan
U11	DM5	University Vice Chancellor

The findings from this study are categorised according to the following factors: technology availability, awareness of cloud computing, sharing knowledge, attitudes towards technology (security, compatibility, perfection of technology, value of money), cultural issues, and environmental context.

Technology availability

Technology availability consists of all internal technology currently in use and all available external technology in the market. According to Baker (2012) "internal" technology is the technology which is already adopted inside the firm, whereas "external" technology is that technology which is available in the marketplace, but has not yet been adopted in the firm. .

It is obvious that almost all interviewees consider cloud computing within JHEI to be in its very early stages. Their main concern is the current infrastructure inside Jordanian universities and whether this infrastructure has the minimum requirements to adopt cloud computing (e.g. network bandwidth, internet connection downtime, and hardware availability).

> In fact, I think that cloud computing here in our university is at infant level. However, we look forward to integrating cloud technology to be a part of our system. The biggest challenge is from where to start and what we need to take into consideration, do we have suitable infrastructure that supports cloud computing and how to know if we have it or not (P1).

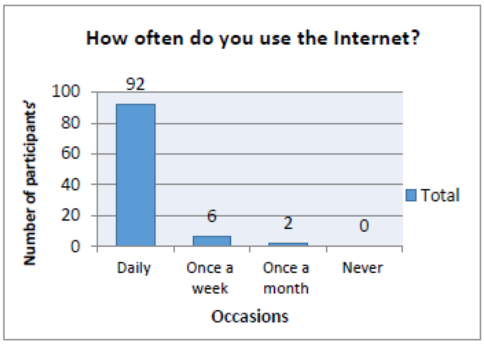
There is a clear evidence form this study that cloud computing is not adopted at Jordanian universities in advanced level.

> As far as cloud computing to be differentiated form ICT I think we still at the beginning. Basically we still follow the old fashion or probably old model way (P3).

> Giving my practice at this university and knowing many colleagues from different universities, cloud computing did not actually take the right position or get the proper moment in to be push forward, but mainly we use cloud in a very narrow way could be as a mail servers only (P7).

A professor from engineering school argued that they suffering from the lack of infrastructure and advanced simulations software and hardware. The limitation of these resources prevent graduate students to create a novel projects and as a staff they enforce to ignore the weakness of students projects because of lack resource availability.

> The main problem that we facing in our school is the lack of simulation resources. Simulator programs such as are very expensive and we do not have the ability to offer license to all engineering students. In addition we there is a lack of advanced hardware here in our school. Therefore the students skip this by reducing the size of project or the sample size. As a result, there projects outputs are very weak. Actually, we enforce to ignore the students weak outputs. We can't blame them because they don't have enough resources to do the novel projects that we looking for. Cloud computing may solve this problem by offering customize simulation as a service online for a specific period. Hopefully this will solve our school problem here (DM1).



Awareness

Awareness of cloud computing as a concept and its potential benefits is one of the most important factors in this study. According to Roger (2003), the first step of innovation adoption is to know about the existence of the innovation, and have the opportunity to understand how it functions. In a study which set out to conceptualize a model for the adoption of cloud computing in education, Sabi, Uzoka, Langmia, & Njeh (2016) found that awareness is positively correlated with the intent to adopt cloud computing.

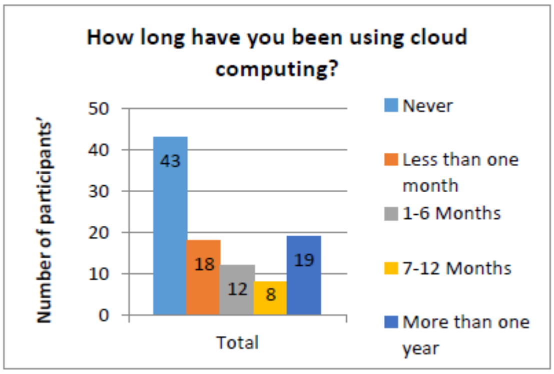
> We observed that students prefer to contact each other through social media, which is based on cloud applications. In addition, we discovered that students' performance became much better when we integrated simple cloud computing applications into their studies. We think that this is because of the independence that the nature of cloud places and devices allows. Recently, it was found that many students prefer Google Forums, and they asked me personally to adopt this application as an authorized method to deliver their shred projects (P17).

The most interesting finding was that in some cases undergraduate students are fully aware about cloud computing, more so than the lecturers.

> Our students are aware about the concept of Cloud Computing. They use for many purposes such as storage and some applications. It is interesting to know that there are undergraduate students who have very active websites for e-commerce; they manage business from home and connect cloud servicers online to serve his customers (P14).

In addition another interested argument made by professor in computer science and cloud computing technology expert stated that the lack of awareness in higher management about the significant benefits of cloud computing is the main barrier to adopt this technology.

> I do believe that still the lack of awareness probably with people who govern this university have a lack of awareness in the concept of cloud computing, which prevent us to go forward (P5).



Sharing knowledge

Sharing Knowles was an important driving factor in this study that may improve the value of teaching and learning in Jordanian universities. According to Garcia-Perez & Ayres (2015) "sharing knowledge is one of the key processes that allow organisations to create value". Cloud computing adoption at higher education institutions may provide better services in teaching and learning process (Sultan, 2010).

> As far as I know in the computer science and information systems cloud computing would play a very vital role in term of knowledge delivery and communicating with students (P10).

> Of course Cloud Computing increases sharing knowledge. This is obviously here in our university, students share their works and the teamwork was improved since they started using cloud computing applications such as Google Drive and Google Forms. (P1).

Most of interviewees believed that the main benefit of cloud computing adoption might be increasing sharing knowledge level. All interviewee claimed that there is serious weakness in sharing knowledge at higher education institutions in Jordan. Such weakness negatively affects both lectures and students level as well as the university value.

> If our students and staff would like to share the knowledge that comes only from printed resources, the sharing of knowledge might be very limited. We try to improve the sharing knowledge in our university through using electronic articles, eBooks, and media resources. Cloud computing, therefore, might provide a significant role in our e-library, which we hope to make fully hosted by cloud computing servers (P11).

> Cloud computing may also increase sharing knowledge between Jordanian universities, because cloud computing could easily connect different locations and universities together easily (P3).

> Unfortunately, there is very limited co-operation between Jordanian universities, which negatively affects the sharing knowledge level. I think the low level of cooperation is because the staff still uses traditional methods in research. New technology always aims to increase the sharing of knowledge between people (P4).

> Cloud computing applications may enable all lecturers in Jordanian universities to contact each other, especially for research purposes (P16).

Although the minister of higher education in Jordan tries to achieve the highest level of cooperation between universities, most of interviewee stresses that the limitation of sharing knowledge is the minister of higher education responsibility.

> The minister of higher education has a significant role and responsibility to increase the sharing of knowledge. If the ministers of higher education push the universities to use cloud competing and other new education technologies, then I'm sure that the sharing of knowledge will be increased (P9).

Attitude towards technology (ATT)

ATT refers to the individual's perception and feelings towards cloud computing technology in the higher education institutions (Khan, 2012; Roger, 2003). According to Harrison and Rainer (1992), a negative attitude towards technology is one of the main causes of unsuccessful technology adoption in the classroom.

Interviewees varied in their attitude towards cloud computing technology. However, most of them share the same attitude regarding, for example, culture, perfection of technology, and perceived usefulness of the adoption of cloud computing.

> My only concern is that of the Jordanian culture towards the new technology. Technical issues can be solved, whereas culture is something complicated. Resistance and fear from any new technology is something that exists deeply in our Jordanian culture. This resistance makes the

decision makers move very slowly. Jordanian government always is slow to accept any technology. They only accept technology, which has already been tested hundreds of times before and validated from different countries (P12).

Using local servers may increase some technical problems, such as long periods of downtime and centralisation constrains. Virtual servers, which are based on cloud computing and cloud applications, promise to reduce such technical problems.

> I cannot confirm that our current technology here in this university is perfect, or even close to perfect. We have down times all over the year. Downtime is a very critical issue for our students. Sometimes they need to download lectures for exams, or send their assignment and unfortunately they found the server down. In some downtime cases they needed to wait for 2-3 days until the technical support came to solve the servers' problem, so basically they are stuck (P13).

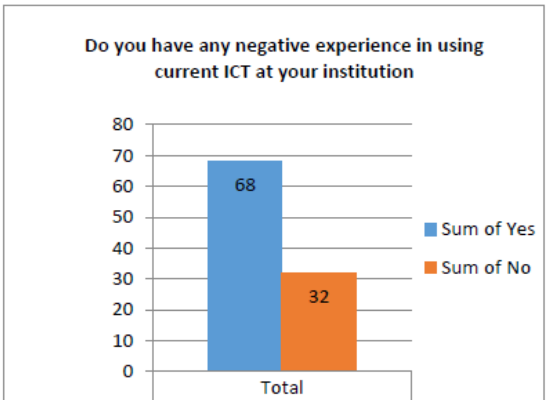
> Cloud computing is very useful technology. Lecturers only need internet connection on any available device, and then they can access documents at any place outside the university. However, we still have some problems with university roles and policies. Therefore, we are not allowed to upload all documents and files on cloud applications (P14).

It was pointed out that implementing E-services in Jordan, such as E-government, decreases the resistance level towards new technology. These E-services, such as government E-payment methods, eliminate the fear of using online services.

> Implementation of E-government helps a lot for dismissing the fear towards technology adoption. Therefore, if the government starts driving people to use online services such as E-payment and E-commerce and makes sure that everything is secure, I think that this will help to improve all service in the context of Jordan and to adopt cloud computing (DM4).

The security of data in a cloud-based service is of particular concern. This is because of the lack of control that the service provider can guarantee, and because of the lack of information about the type of security that the service provider employs. All discoing makers stress that the security and privacy are the main issues prevent them to adopt cloud computing.

> […] The nightmare running to our minds is the security. Despite the cloud computing advantage, we face a strong resistance from our staff that prefers paper work rather than new technology, specially the old generation. They argue that we using this traditional approach since around 25 years. It is absolutely securing why to upload this critical information to mysterious place which we don't have any control on it.



	Total
Sum of Yes	68
Sum of No	32

Environmental context

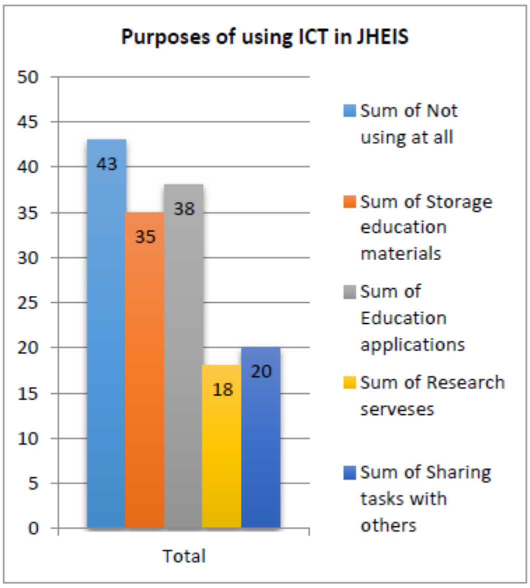
The environmental context includes the industry structure, government, and service providers and suppliers (Tornatzky and Fleischer, 1990). The environmental context encompasses the effects of the external environment outside the organizstion's border. Organisational competitors, industry and sector type, external technology providers, and the availability of new technologies in the market are all factors that have a significant effect on decisions regarding the adoption of new technology within the organisation.

The minister of higher education in Jordan made significant efforts to improve the educational outcomes for higher education students. However, poor infrastructure and hardware and software limitations are the main barriers in the context of Jordan.

> All students at Jordanian universities should pass the minister of higher education exam. This exam needs a huge amount of infrastructure resources. I think if the minister of higher education adopts virtual cloud servers, rather than local infrastructure, they will provide better services. They may avoid the downtime and increase the students' exam capacity. Cloud computing may solve these limitations, for example the scalability feature provides the ability to serve a huge amount of students at the same time (P8).

A common view amongst interviewees was that the Jordanian government has no clear strategy in term of adoption any new services or technology. As one interviewee said:

> The project of the government in Jordan is very slow; I can give you an example about E-government project, it's initiated the project in 1999 and still up to 2016 we have no services completely on line. It is just kind of publishing information. The responsible about this project claims that the strategy was failed and we need to be compline with the Jordanian context. Sometimes they mentioned that there are lack of resources, other times it seem kind of corruption (P3).



6 CONCLUSION

This paper has investigated the main factors affecting the process of cloud computing adoption in higher education institutions in Jordan. Despite the efforts made by decision makers at Jordanian universities to adopt the latest technology, cloud computing adoption is still in a very early stage. The results suggest that many stakeholders in Jordanian universities do not have an in-depth understanding of the concept of cloud computing. In addition, the evidence from this study suggests that many factors affect the decision to adopt cloud computing, such as limited awareness of cloud computing benefits, cultural attitudes, lack of government support, budget limitations, security concern, negative attitude towards new technology and environmental issues.

However, most interviewees believed that the adoption of cloud computing could increase cost–saving, as well as improve the quality of higher education outcomes in Jordan. Despite the benefits of cloud computing technology, there are other issues affecting the adoption of this technology. Such issues, outside the field of technology, include top management decisions, security and privacy policies within universities, and government slow progress. Further studies on cloud computing should focus on the development of a new framework that may help the decision makers at Jordanian universities adopt cloud computing in effective way that best fits their situation and requirements.

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Appendix 9: Picture taken during the data collection and workshops in Jordanian universities

Appendix 10: The University of Cambridge, Clare college, 2017. Certificate

ICEIT 2017

CERTIFICATE

of

PARTICIPATION

Paper Title: *Cloud Computing Adoption at Higher Education Institutions in Developing Countries: A Qualitative Investigation of Main Enablers and Barriers* (*T31*)

This is to certify *Mahmoud Mousa Odeh* from *Coventry University, UK* has attended and delivered an oral presentation on 2017 6th International Conference on Educational and Information Technology (ICEIT 2017) held during March 7-10, 2017 in Clare College, Cambridge, UK.

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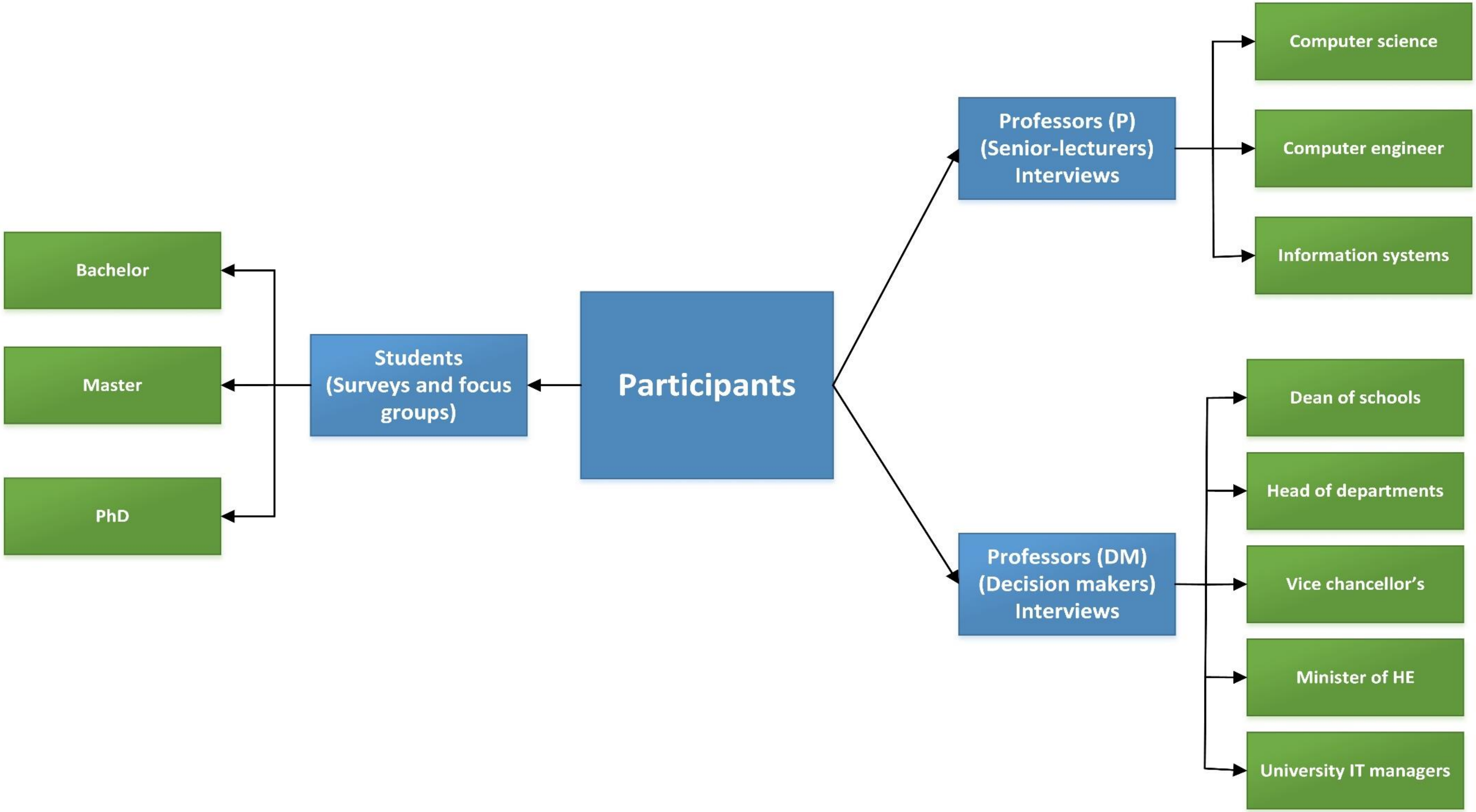
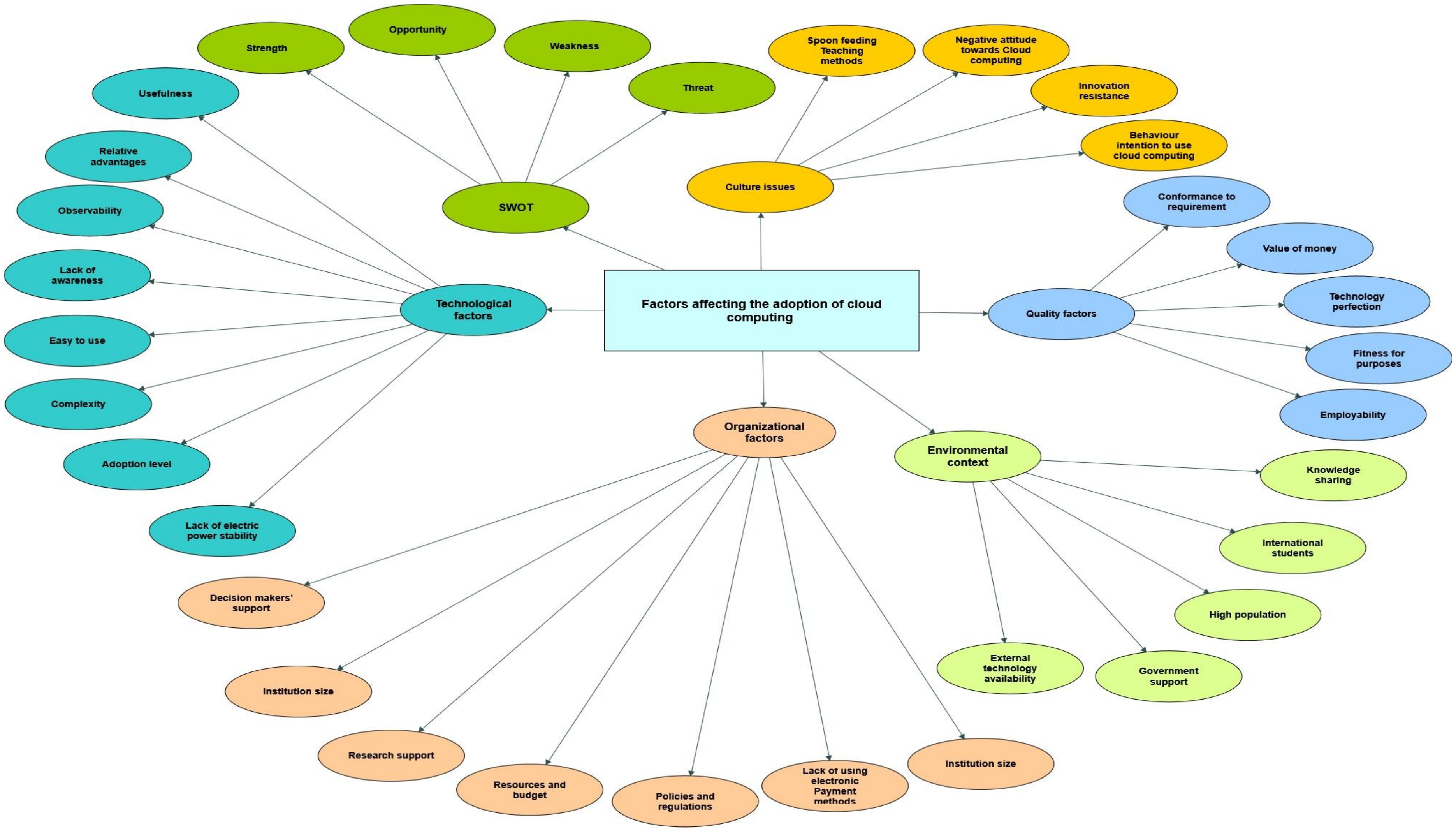
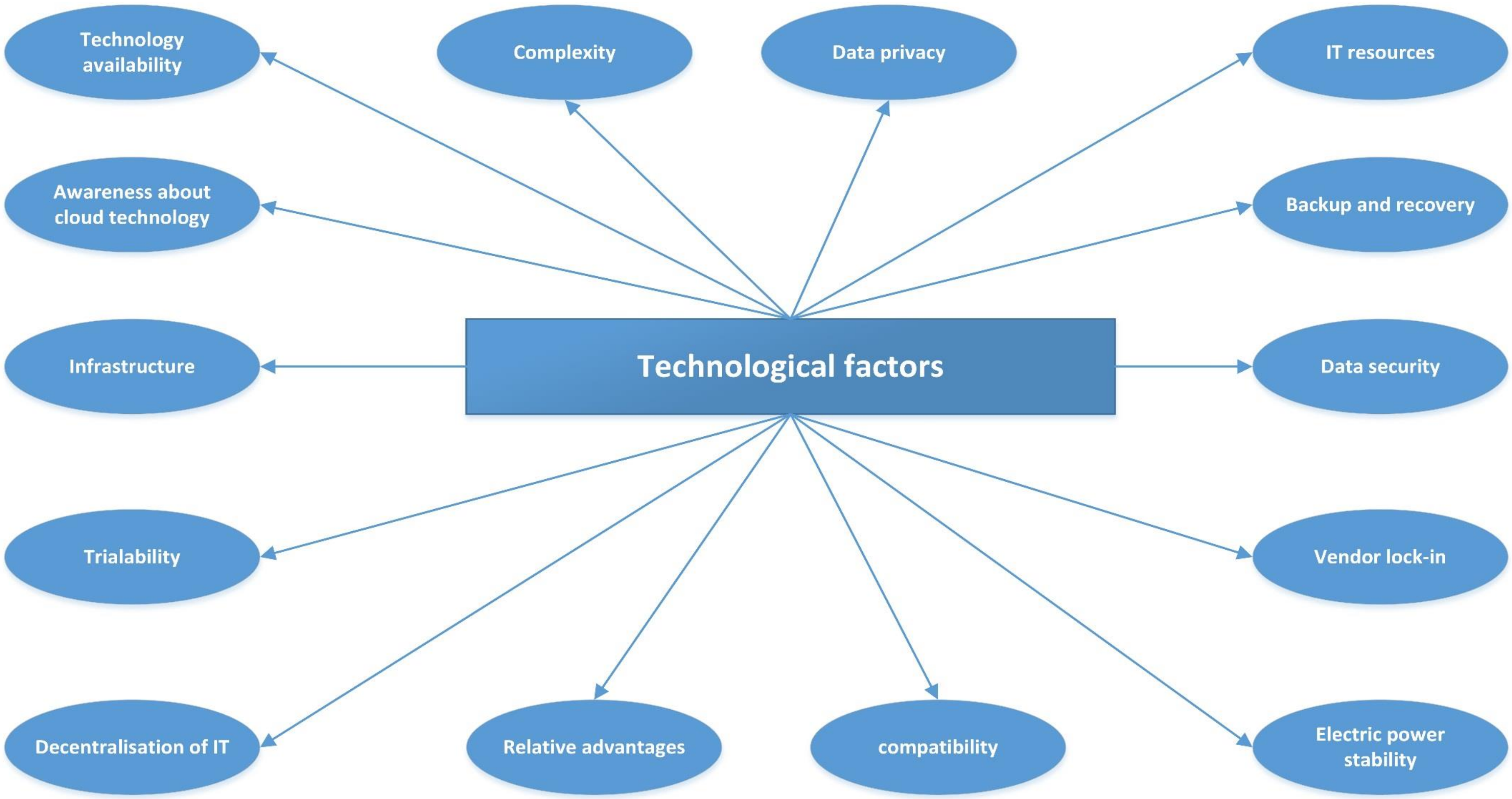
Appendix 11: Classification of Participants taking part in this study



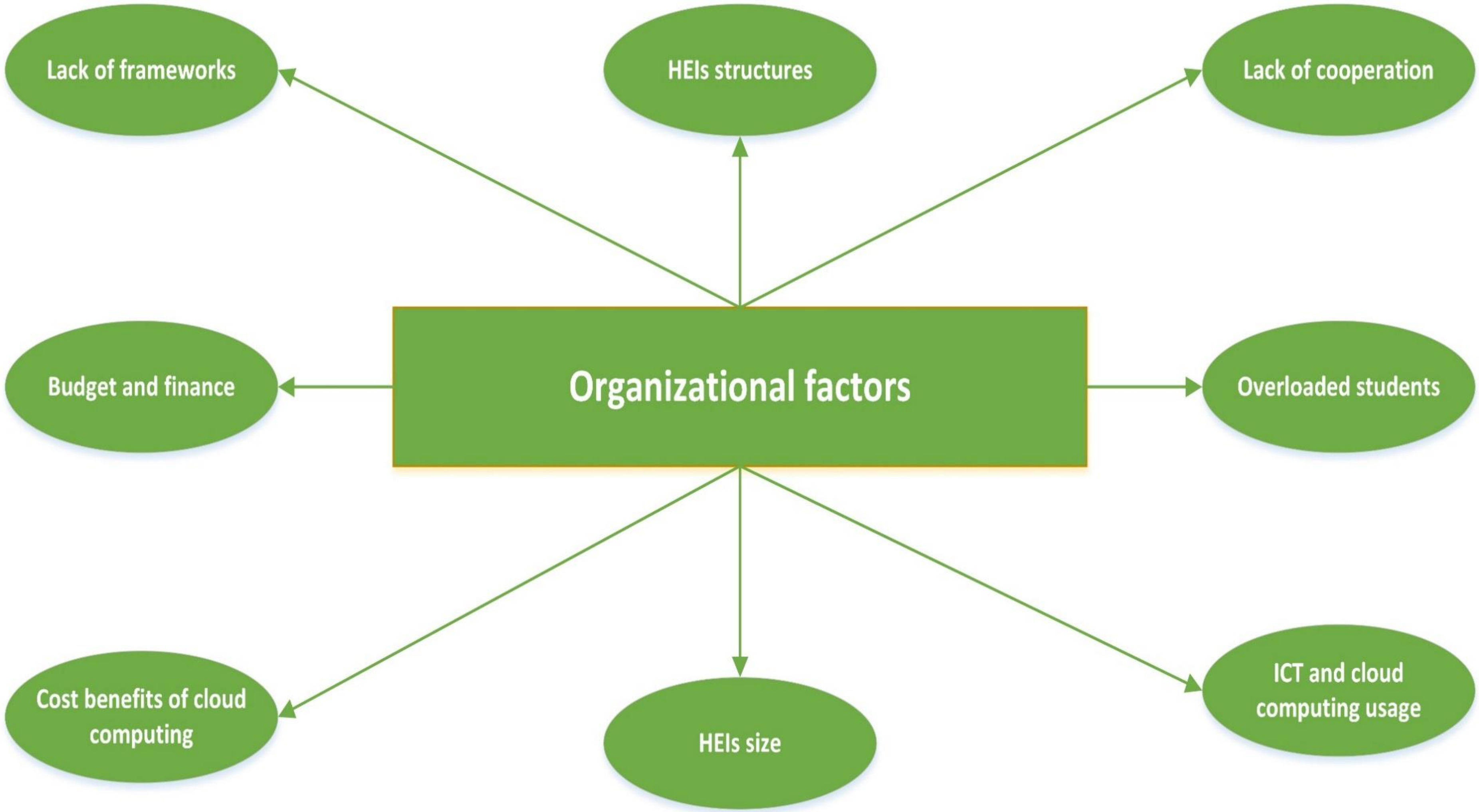
Appendix 12: Sample of initial mind maps (Using NVivo software)



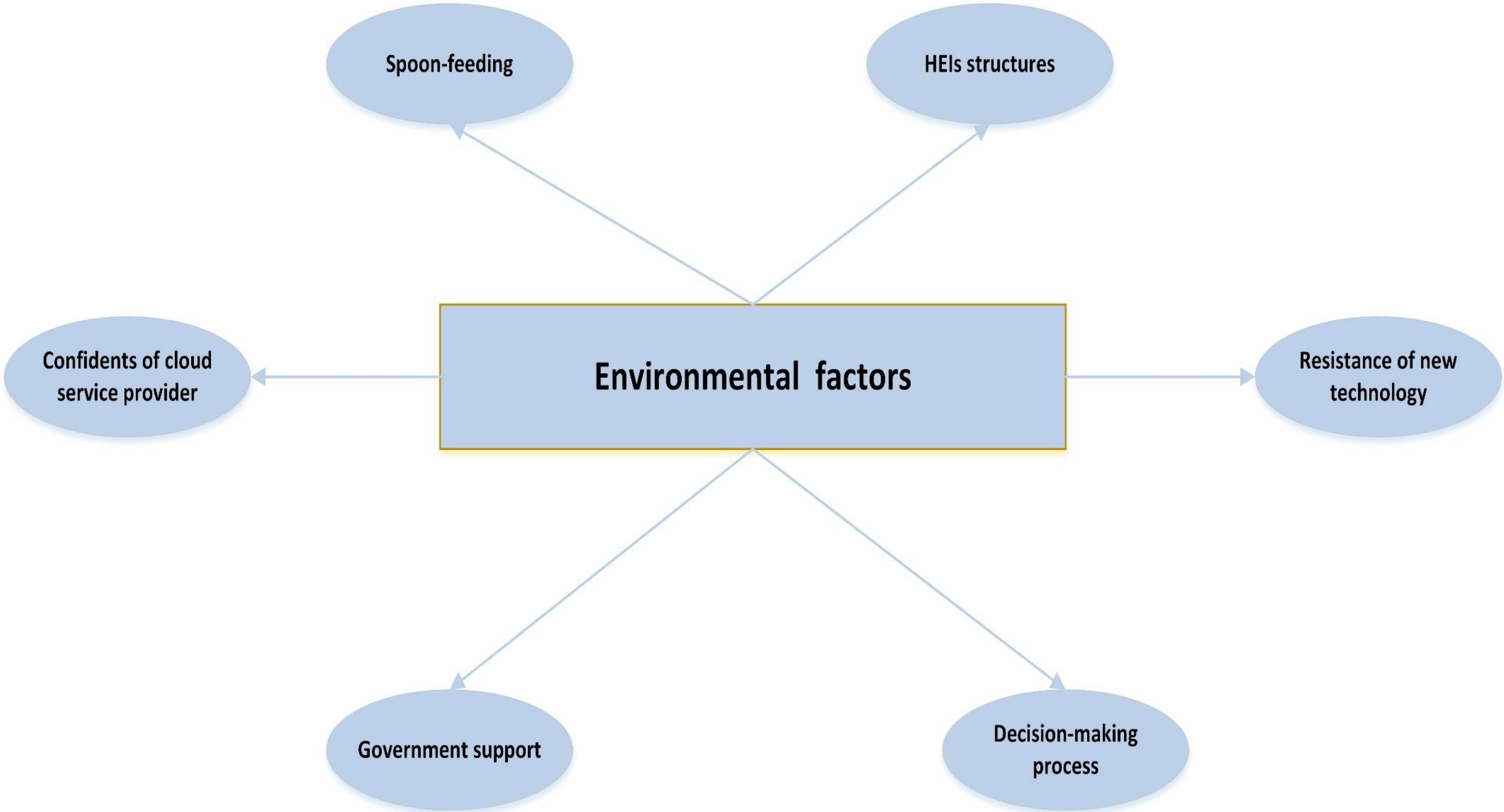
Technological factors mind map



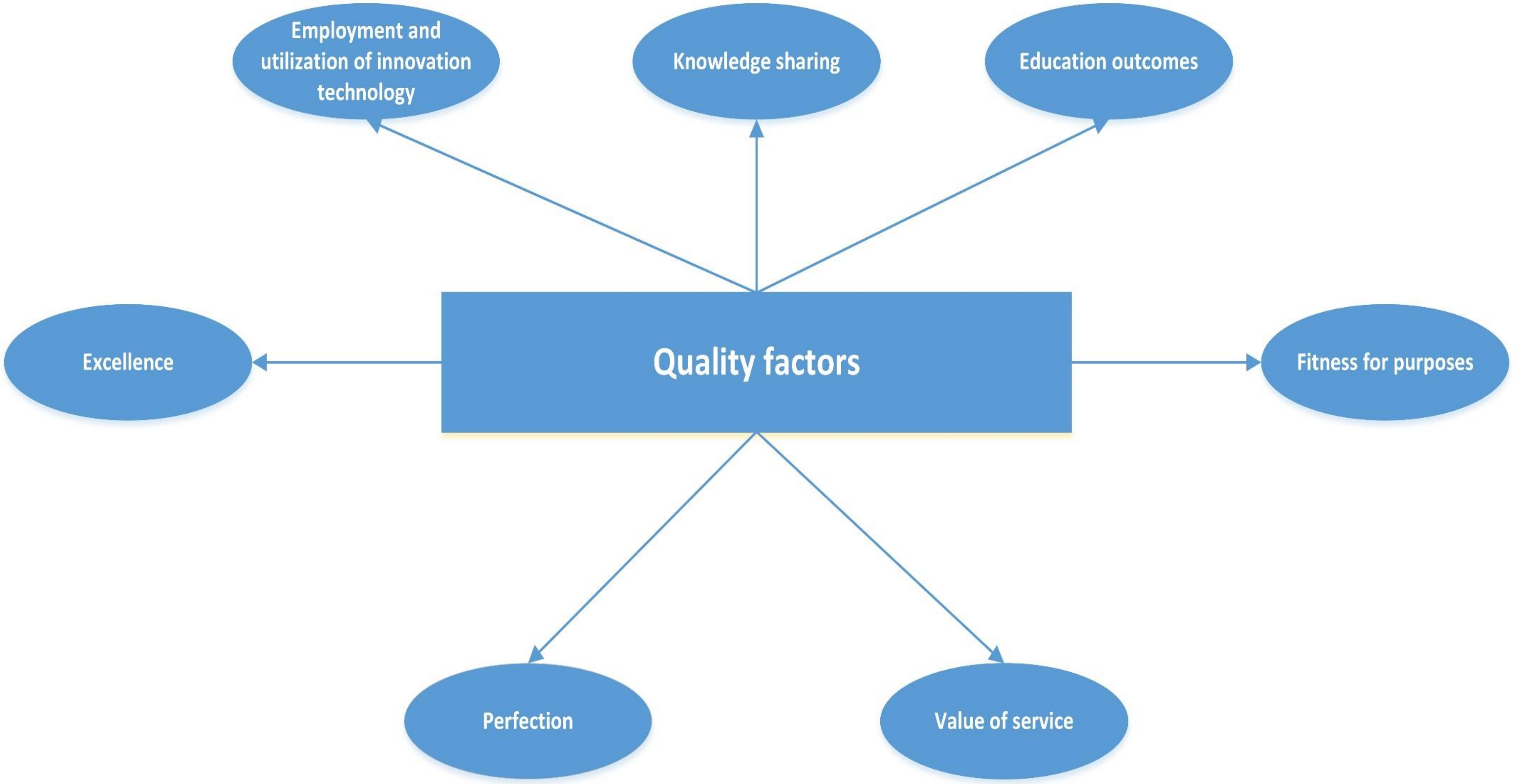
Organisational factors mind map



Environmental factors mind map



Quality factors mind map



Motivators and barriers mind map