THE SUCCESS MODEL OF CLOUD-BASED APPLICATIONS TO IMPROVE INDIVIDUAL IMPACT AMONG UNIVERSITY RESEARCHERS

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DECLARATION

I hereby declare that the work in this thesis is my own except for quotations and summaries which have been duly acknowledged.

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ABSTRAK

Walaupun potensi aplikasi pengkomputeran awan dalam penyampaian perkhidmatan, ia masih belum diguna pakai sepenuhnya dalam komuniti akademik, khususnya sektor penyelidikan. Walau bagaimanapun, kejayaan penggunaan awan bergantung kepada faktor kualiti input dan output dalam sebarang proses. Oleh itu, terdapat keperluan untuk mengkaji faktor yang mempengaruhi produktiviti. Oleh itu, objektif kajian ini adalah untuk mengenal pasti faktor yang menyumbang kepada pencapaian penunjuk peningkatan produktiviti, merumuskan keperluan penyelidik akademik untuk membangunkan portal perisian awan akademik. Kajian ini mengamalkan kaedah campuran untuk mengumpul data melalui tiga fasa: fasa pertama adalah asas untuk menentukan model penyelidikan, melalui temu bual mendalam. Untuk mengenal pasti faktor yang mempengaruhi produktiviti "buangan" dan menentukan keperluan yang berpotensi untuk menyumbang kepada menghapuskan buangan dan keperluan aplikasi awan. Sampel temu bual ini adalah 30 pelajar lepasan ijazah. Kemudian, fasa kedua adalah untuk mengesahkan model yang berkait dengan mengenai konteks model kejayaan aplikasi berasaskan awan untuk meningkatkan produktiviti. Tinjauan soal selidik diberi kepada penyelidik universiti dalam talian. Data dikumpul daripada 800 orang responden menggunakan teknik pensampelan purposive. Keputusan menunjukkan bahawa Kualiti Rangkaian Pusat Data (DCNQ), Sistem Kualiti (SYQ), Kualiti Kandungan (CCQ), Niat Penggunaan (ITU) dan Kepuasan Pengguna (USA) adalah dimensi yang penting bagi kejayaan meningkatkan produktiviti individu. Iaitu, (DCNQ), dan (SYQ) adalah peramal yang terkuat terhadap Impak Individu (IIM). Serta, (ITU) dan (USA sebagai pengantara antara faktor kualiti dan (IIM). Oleh itu, peningkatan berterusan dicapai melalui hasil positif daripada kesan langsung, kesan pengantaraan, kesan korelasi dan keputusan pemboleh ubah bersandar. Akhir sekali, fasa ketiga adalah untuk melaksanakan dapatan kedua-dua fasa di atas dan mengemukakan contoh praktikal yang mencerminkan aplikasi awan keperluan penyelidik akademik. Portal R-CAPP dibangun menggunakan metodologi pembangunan perisian. Kaedah penilaian pakar dan berasaskan pengguna diguna untuk menilai R-CAPP berdasarkan kriteria ISO/IEC 9126-2 & 3. Keputusan penilaian menunjukkan bahawa R-CAPP pada umumnya meningkatkan produktiviti penyelidik dan menghapuskan buangan melalui kualiti luaran yang tinggi dan kualiti yang digunakan.

ABSTRACT

Cloud-based applications (SaaS) is a part of cloud computing services which providing amount of online applications that located in the infrastructure of the cloud through the Internet connection. This creates better opportunities for academics to improve their outcomes, such as knowledge, skills, experiences, performance of their works. Despite the potential of cloud computing applications in the services delivery, it is still not fully adopted in the academic researchers ‘community. The success of cloud applications depend on the quality factor of inputs and outputs. There is also a strong correlation between cloud applications and productivity. This study seeks to identify the factors that contribute to improving productivity using an academic cloud software portal. This research adopted mixed methods for collecting data through three phases. The first phase was fundamental to determining the research model of this study by conducting in-depth interviews to identify the factors affecting research productivity. The sample comprised interviews with 30 postgraduate students. The second phase was to validate the developed cloud-based applications model to improve productivity. A survey questionnaire was administered to online university researchers. Data was collected from 800 respondents using a purposive sampling technique. Results showed that Data Centre Network Quality (DCNQ), System Quality (SYQ), Content Quality (CCQ), Intention to Use (ITU) and User Satisfaction (USA) are the most important dimensions for improving individual productivity. DCNQ and SYQ are the strongest predictor on Individual Impact (IIM). ITU and USA were mediators between quality factors and IIM. Continuous improvement was achieved through the positive results of direct effect, mediating effect, correlation effect and dependent variable results. The third phase was to implement the finding of the above two phases and present a practical example that reflects the academic researcher’ requirements for cloud application. The R-CAPP portal was developed using a software development methodology. An expert and user-based evaluation methods were used to evaluate the R-CAPP based on ISO/IEC 9126-2 & 3 criteria. Evaluation results showed that the R-CAPP increased the researchers’ productivity and eliminate wastes through the high rates of the external quality and quality-in-use.

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LIST OF ABBREVIATIONS

DTPB	Decomposed Theory of Planned Behavior
ICT	Information and Communication Technology
IDT	Innovation Diffusion Theory
IS	Information System
IT	Information Technology
MM	Motivational Model
MPCU	Model of Personal Computer Utilization
SPLS	Smart Partial Least Square
SEM	Structural Equation Modelling
SPSS	Statistical Package for The Social Sciences
TAM	Technology Acceptance Model
TPB	Theory of Planned Behaviour
TPS	Transaction Processing Systems
TRA	Theory of Reasoned Action
LTT	Lean Thinking Theory
UTAUT	Unified Theory of Acceptance and Use of Technology
PLS-SEM	Partial Least Squares Structural Equation Modeling
Q^2	Predictive Relevance
R^2	Coefficient of Determination
SYQ	System Quality
SEQ	Service Quality
CCQ	Content Quality
DCNQ	Data Center Network Quality
ITU	Intention to Use
USA	User Satisfaction
IIM	Individual Impact
D&M	Delone and Mclean’s
D&M ISSM	Delone and Mclean’s Information System Success Model
SQL	Structured Query Language
ISSM	Information System Success Model
TTF	Task-Technology Fit
URL	Uniform Resource Locator

SaaS	Software as A Service
TAM2	Technology Acceptance Model 2
SCT	Social Cognitive Theory
CRM	Customer Relationship Management
VA	Value Added
ISO	International Organization for Standardization
ISO/IEC	International Organization for Standardization and The International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
ANSI	American National Standards Institute
DIN	German Industry Standard
NVA	Non-Value Added
LHE	Lean Higher Education
HEI	Higher Education Institutions
GAE	Google Apps Engine
OS	Operating Systems
VPN	Virtual Private Network
NIST	National Institute of Standards and Technology
PaaS	Platform as A Service
IaaS	Infrastructure as A Service
SaaS	Software as A Service
EC2	Elastic Compute Cloud
EECS	Of Electrical Engineering and Computer Science
ASP	Application Service Providers
AWS	Amazon Web Service
AP	Academic Productivity
RP	Research Productivity
QUIS	Questionnaire for User Interface Satisfaction
SDM	Software Development Methodology
R-CSPP	Researcher-Cloud Software Productivity Platform
S3	Amazon Simple Storage Service
SDK	Software Development Kit
PDF	Portable Document Format
HR	Human Resources

CHAPTER I

INTRODUCTION

1.1 INTRODUCTION

Many successful studies have measured the success of cloud computing services and applications across several fields. The success of a cloud computing solution does not only depend on the ability to provide the characteristics of easy management, availability, integration, accessibility, automation, and infrastructure but the support for productivity improvement (Smith 2013; Microsoft 2014a; Polančič et al. 2015). Cloud computing provides the ability to deal with the challenges of scientific research, the burden of cost, and acceleration of time, by employing modern technological means in the virtualised environment to support the purposes of research and innovation (Braman 2006; Sampath Kumar & Manjunath 2013; Nayar & Kumar 2015; Moghaddasi & Tabrizi 2017). Thus, the work of an academic researcher is no longer confined by ideas or knowledge but rather by access to the vast resources, information, and tools required to execute the experiments and analyse the results (Sasikala & Prema 2011). It is essential for researchers to adopt an advanced application of cloud computing that will increase their outputs to prepare and equip them for current and future scientific research needs with the least time, effort and cost.

This study researches cloud-based applications and their capacity to improve academic researchers' productivity. The academic researchers' productivity refers to an increase in their learning, innovation, skills, experiences, knowledge, collaboration, for improved scientific publishing and accomplishing work more quickly with less time and cost. This is achieved through the optimal utilisation of cloud applications through the features of usability, availability of resources or services, speed, delivery, security, and flexibility. High individual productivity is achieved when resources add value to the user's outputs and achieve their needs (Emiliani 1998, 2004; Jang et al. 2011).

There are only very few completed studied similar this theme. Cloud-based applications and the issue of improved individual productivity is an emerging area of research. This research combines the qualitative and quantitative methods in its study of the factor contributing to the success of cloud-based applications to improve individual productivity. It identifies the main factors that affect the university researchers' productivity, as well as identifies the needs of academic researchers to determine the requirements for academic cloud applications. This is done through the interconnection between the dimensions of DeLone and McLean's Model (1992 & 2003), and the indicators of productivity improvement based on Lean Thinking Theory (LTT) in higher education and research productivity indicators.

1.2 BACKGROUND OF THE STUDY

Many studies have addressed the academic researcher as a critical factor to increase the productivity of knowledge, exploration and their role towards creating the future change (Steinlicht et al. 2010; Thomas 2011; Al-Rahmi & Othman 2013; Kyvik 2013; Nayar & Kumar 2015; Zeglat et al. 2016). However, academic researcher face numerous difficulties and challenges when research perform, which affected on their productivity (Braman 2006; Steinlicht et al. 2010; Kyvi 2013; Silinda & Brubacher 2016). For example, information explosion, the diversity of their sources, increasing competitive pressure, shorter study lifecycles, financial constraints and rapidly changing technological innovation (Silinda & Brubacher 2016). In contrast, the traditional methods are insufficient to address all the needs of the academic community, especially academic researchers (Yuvaraj 2013; Devi et al. 2014). This is due to the nature of the needs of academic researchers that require in-depth study to meet the challenges that affect their outputs. Such as, information explosion, the diversity of their sources, increasing competitive pressure, shorter study life cycles, and rapidly changing technological innovation (Goeldner & Powell 2011; Kyvik

2013). Also, they have a wide range of interconnected tasks and roles in the research process which they must complete them in the shortest time (Braman 2006; Kyvik 2013). It is essential for researchers to adopt the advanced technology to meet their requirements and increase outputs.

At present, the higher education communities have become highly dependent on cloud services and applications as a necessary technology for reducing the scope of time and money for performing research (Milian et al. 2014; Nayar & Kumar 2015). The cloud services are often cheap or free when they are for educational purposes, often with much higher availability and scalability than can be provided by the educational institution or traditional methods such as local storage, limited by PC ability, renewal of software licences and others (Yadav 2014).

Cloud computing is an ideal option for many universities which are under budget constraints (Sultan 2010; Masud et al. 2012; Marinela Mircea & Andreescu. 2011; Chandra & Borah 2012; Mitchell & Cunningham 2014; Ibrahim et al. 2015; Sabi et al. 2016). Cloud computing is spreading rapidly in all industries where it is estimated to grow from $40 billion in 2011 to 240 billion by 2020 (Lepi 2013; Mokhtar et al. 2013; Yadav 2014; González-Martínez et al. 2015). Other studies forecasted that by 2020, cloud-based applications in higher education (SaaS) would focus on tech-centric solutions and methodologies such as teleconferencing, distance learning and hybrid classes (i.e. Online and off-campus learning) (Bansal et al. 2012; Lepi 2013).

Despite the advantages of cloud computing applications, its current adoption and usage in higher education is still in the initial establishment phase, especially with regard to university researcher category (Razak 2009; Taylor & Hunsinger 2011; Weber 2011; Mokhtar et al. 2013; Odeh et al. 2014; Devi et al. 2014; Ibrahim et al. 2015; Al-Ghatrifi 2015; González-Martínez et al. 2015; Seke 2015; Alharthi et al. 2016; Sabi et al. 2016). There is a lack of study addressing cloud-based applications and its association with improved academic researchers' productivity (Herrick, 2009; Flack & Dembla, 2014).

There is a shortage of effective academic applications to enhance researchers' productivity (Ozdamli et al. 2015). Critical features of cloud applications include scalability, reliability, portability, flexibility, availability, data recovery, accessibility, storage and software (Anderson et al. 2008; Sultan 2010; Thomas 2011; Adi A. Maaita et al. 2013; Mitchell & Cunningham 2014). Among the factors preventing academic researchers from adopting cloud computing applications in their research perform are lack of trust, lack of privacy and security, technical and cost considerations, and information flow (Razak 2009; Anjali Jain & Pandey 2013; Milian et al. 2014). Implementing a successful cloud application requires knowledge of the academic researchers' needs for these applications in addition to identifying effective factors that contribute to the success of cloud application to improve academic researchers' productivity.

Altmann et al. (2009) and Byatt et al. (2013) stated that there is a lack of studies that emphasise on the academic community. The previous studies that relate to adopting cloud applications were focused on improve teachers' skills, school students, educational institutions, and the university community or higher education in general (Razak 2009; Altmann et al. 2009; Chen 2009; Marston et al. 2011; Ercan 2012; Joe Winslow1 et al. 2012; Mehdi 2015; Wu & Chang 2016). In addition, there are other studies concentrated on one side of researchers' activities, for example, publishing task, knowledge field or learning, along withy the studies examine the relationship between the researcher and supervisors (Lally 2001; Alireza Isfandyari Moghaddam et al. 2012; Cassandras 2012; Doctor 2012; Kang et al. 2013; Sharma et al. 2016). Thus, these studies had not improved the efficiency of researchers' performance.

Also, only a few studies have been focused on improving individual productivity at the micro level (Tangen 2005; Brew et al. 2016). The implementation of the research productivity often focused on examining the macro level (Tangen 2005; Brew et al. 2016). The macro level is related to examining the global, national or industry levels. While, the micro level focuses on a single organisation, department, unit, process or individual (Jonna Käpylä et al. 2010). Hence, there is room to focus on university researchers' needs through the empirical study of improving their productivity at the micro level. Consequently, there is a need to determine better tools or applications in the cloud environment by understanding the most important needs of the academic researchers that support their research outputs, performance and productivity improvement.

1.3 PROBLEM STATEMENT

As illustrated by the background of the study, the earlier research in higher education has concentrated on undergraduates and identifying what influences successful postgraduate study and improve outputs (Billot et al. 2013). This has resulted in increasing the challenges that academic researchers face during the research process (Nayar & Kumar 2015). For instance, information explosion and the diversity of their sources have led to increasing competitive pressure, shorter study life cycles, and shorter technology innovation cycles (Goeldner & Powell 2011; Kyvik 2013; Nayar & Kumar 2015). Also, they have a wide range of interconnected tasks and roles, which place increased pressure to complete their programmes within a specified period (Braman 2006; Kyvik 2013; Silinda & Brubacher 2016; Ekpoh 2016).

As stressed by Emiliani (1998, 2004), Diane (2000), Balzer (2010), Thomas et al. (2015), and Ekpoh (2016), the most influential waste on the academic researchers' productivity is long queue times between operations, which lead to wasted time and money. Throughout this thesis, the term 'waste' refers to any activity or behaviour in a research process that consumes time, cost, resources and effort. It does not add value to the academic researchers' outputs ''Non-Value Added (NVA)''. For example, long queue times between processing and handling information or documents, searching processes between the vast amounts of resources. Extra or unnecessary steps, processes or sources, duplications or redundancies of information, needless physical movement, unused the skills or improve learning. As well as, inability or failure to perform some things related to research tasks. This is time-consuming resulting in lower quality research, financial losses, dissatisfaction with outputs.

Correspondingly, continuing to rely on traditional methods of research perform, teaching, and supervision. It is wasting time (e.g. holding meetings to get the instructions and guidance, office actions such as waiting to get signatures, printing, and scanning) (Billot et al. 2013; Polgar 2014; Dennis & Dailey-Hebert 2015; Nayar & Kumar 2015). While, Billot et al. (2013), Silinda & Brubacher (2016), and Brew et al. (2016) see the lack of adequate support and proper guidance from research supervisors cause them to feel frustrated and prevent them from performing their research adequately. In addition, lack of researchers' experience in scientific research field (Wisker et al. 2007; Kennedy 2011; Silinda & Brubacher 2016), and not fully utilising s researcher's creativity or developing their skills (Sampath Kumar & Manjunath 2013; Smith et al. 2016) are critical issues that lead to wastes occurrence. Furthermore, there is a deficiency of effective tools dedicated to academic researchers to support their research outputs, performance and productivity improvement (Sampath Kumar & Manjunath 201; Davyi et al. 2014; Fonteijn 2015). Hence, the kind of tools academic researchers need differs from their predecessors (Braman 2006; Razak 2009; González-Martínez et al. 2015).

From the point of view of this study, to achieve individual productivity improvement and the smooth running of academic researchers' performance, cloud computing applications is an ideal solution (Flack & Dembla 2014). Despite the considerable resources invested in cloud computing applications, the major concern of cloud software developers is the lack of IS success models that identifies the most significant factors for raising individual productivity and their failure in achieving expected goals (Iivari 2005; Lee, Kim, et al. 2009b; Noorman Masrek et al. 2010; Hsu et al. 2015).

To resolve this gap, the present study adopted the DeLone and McLean Model of Information Systems Success Model 1992 and 2003 (D&M ISSM). It is the most comprehensive model concentrated on measuring the essential dimensions related to raising productivity (Tangen 2005; Iivari 2005; Lee, Kim et al. 2009b; Noorman Masrek et al. 2010; Hsu et al. 2015; Rezaei et al. 2016). However, there are a number of empirical studies, such as Petter et al. (2008), Ou et al. (2011), Kang et al. (2013) and Chiu et al. (2016) that noted, the D&M ISSM dimensions are not sufficient, since other core elements may also contribute to cloud computing success, especially when we are dealing with the applications of cloud. For this reason, Ou et al. (2011) and Kang et al. (2013) added specific types of networks to D&M model, based on the specific type of cloud services and they emphasised the need to conceptualise additional constructs related to networking quality to measuring its effect on outputs and performance.

The general problem addressed in the present research is a lack of focus on improving university researchers' productivity at the micro level. Hence, lack of practical study identifying the most important wastes affecting university researchers' productivity and their performance based on the codified principles and theories. Besides, determines the actual needs of academic researchers for cloud applications to eliminate wastes and contribute to increasing their research productivity. To date, there is no success model of cloud-based applications that connect between the dimensions of DeLone and McLean Model (1992 & 2003), and the indicators of productivity improvement at the individual level. Accordingly, there is still a lack of adding a new dimension of data centre network quality and examining its effect on improving individual outputs.

This study will identify the principal wastes that affect the university researchers' productivity and outputs. It identifies their needs that will contribute to eliminating waste and determines the academic researchers' requirements for cloud applications. At the end of the study, a new conceptual model will be developed that serves as a reference for developing academic cloud application that contributes to improving the individual productivity.

1.4 RESEARCH QUESTIONS

The primary research questions of this study are:

Q1. What are the current wastes that affect the research productivity of university researchers?

Q2. What are the actual needs of university researchers that will contribute to eliminating those wastes?

Q3. What are the factors that contribute to achieving the indicators of productivity improvement of cloud-based applications, and what are the relationships between these factors?

Q4. What are the requirements that academic researchers need for the development of the Researcher-Cloud Software Productivity Platform portal?

Q5. How to measure the effectiveness of cloud computing applications to improve university researchers' productivity and eliminate wastes?

1.5 OBJECTIVES OF THE STUDY

The primary objective of this study is to improve university researchers' productivity by using cloud computing applications. That is, through developing a new conceptual model to measure the success of cloud-based applications to achieve productivity improvement. Specifically, the objectives of the research are:

1. To define the current wastes that university researcher's face when performing research activities, which affected their research outputs.

2. To determine the actual needs of university researcher from cloud computing applications to eliminate those wastes and contribute to raising their productivity.

3. To construct a conceptual success model of cloud-based applications to improve researchers' productivity.

4. To develop cloud applications for academic researchers which support the academic researchers' needs and improve their productivity.

5. To measure the effectiveness of cloud computing applications to improve university researchers' productivity and eliminate wastes.

1.6 RESEARCH SCOPE

This study develops a conceptual model to measure the success of cloud-based applications to achieve the indicators of productivity improvement for university researchers. Part of the aim of this study is to develop a mobile cloud application to support the model. It does this by gathering the useful functions, services, tools and URL pages that raise academic researchers' productivity. Such as, increased innovation, learning, experiences, knowledge, and improve publishing and performance with less time and cost. This research does not cover the cloud-based applications from "a technical point" of view, such as cloud software as a service (SaaS) infrastructure, platform, software protocol and other technical issues. The research is focused on Software as a Service (SaaS) layer, in particular, online applications available on the cloud that can be provided to the university researchers through any device.

1.7 RESEARCH SIGNIFICANCE

The findings from this research will be beneficial to different groups of people depending on their obligations and necessities. Such as university researchers for their future research activities and outcomes, courses administration in the university (responsible for the course development), and cloud applications developers for developing future academic applications. The first group may look at the theoretical perspective of this study. While the second group may look at the productivity improvement perspective. The final group will gain benefit from the course administration perspective. The rationale for dividing these groups of people, according to the perspective suitable for them is to help them gain the maximum advantages from this study.

1.7.1 Significance from The Theoretical Perspective

This perspective will mostly benefit cloud applications developers and researchers who have an interest in enriching the knowledge needs of academic researchers' sectors. This study involves the examination of the two theories and models previously developed. First, to improve productivity Lean Thinking Theory and second, to measure the success of the cloud-based applications DeLone and McLean's Information System Success Model (D&M ISSM). Not only does this study aim to develop a model and new cloud software but will also allow other developers and researchers to develop and improve the existing new model and applications significant to this area of study. Finally, the findings from this study will help the development of cloud applications and researchers identifying the key factors that contribute to achieve productivity improvement through a new model of D&M ISS. Moreover, it will help future developers and researchers design structures for effective academic application on cloud environment and hence increase academic researchers' performance and productivity. The academics will be able to reduce their cost and time through availability and scalability as the most important attributes of cloud computing technology.

1.7.2 Significance from The Productivity Improvement Perspective

On a daily basis, university researchers are faced with several challenges in performing their research and completing tasks. During this evaluation process, certain intrinsic factors influence researchers' performance and their productivity. Since this study hopes to identify the positive and negative factors that influence productivity improvement, providers and developers will be able to avoid dispersion of resources, tools and meet the requirements of the academic sector. The findings can be referred to as a guideline for better instruments to raise productivity, especially when a university researcher aims to use with online sources to enhance their work. Understanding the benefits will motivate university researchers raising their performance and outputs, through more in-depth knowledge of using cloud computing applications. On the other hand, the findings from this study will be a guideline for university researchers to make use of the available resources, services, and tools on cloud computing to help them in their research activities. Other than that, understanding this study is to enable them to make full use of the cloud applications with maximum efficiency. They will not only teach them to enhance their research life in the virtual environment, but also help them control and manage their works, and accessed remotely from any device at any time with the lowest price.

1.7.3 Significance from The Course Administration Perspective

The results of this study can be used to help the university community, research institutions, and higher education sector, to play a vital role to raise the level of knowledge and understanding of their community by holding workshops, courses, and other awareness programs about using cloud computing applications. This study provides a future vision for the impact of cloud computing applications for raising productivity effectively. Which emphasises the role of the university administration and the responsibility for the course development to encourage their researchers and students to use this technology at the beginning of their research.

1.8 THESIS STRUCTURE

The organisation of this study follows a standard thesis format, where the content is organised into seven chapters, as follows:

Chapter II is the literature review that explores the cloud computing technology environment and the academic research process by defining the stages of scientific research that hinder the researchers' productivity. This chapter also presents the environment of productivity improvement and its indicators based on the Theory of Lean Thinking (LTT). In addition, it reviews the basic models of the proposed model, previous studies of cloud-based applications for productivity improvement and offers a summary.

Chapter III is the research methodology that explains the phases of this research used to study the research problem, which addresses the procedures and instruments used to gather and analyse data. This chapter also describes the method used to select samples and presents in detail the methods used in collecting and analysing data which includes: extensive literature review, interviews, discussion and research sample survey.

Chapter IV illustrates the fundamentals to determining the research model of study by conducting the qualitative study using in-depth interviews. It identifies the proposed research model that explores the studies and theories to construct a new model based on DeLone and McLean's Information System Success Models (D&M IS) (1992&2003) in order to measure the success of cloud-based applications to achieve the indicators of productivity improvement according to the theory of Lean Thinking (LTT).

Chapter V is a data analysis and results. It presents the findings, results and discussion. This includes the validation of the proposed model and testing of the research hypotheses. This chapter is divided into data analysis strategy; the response rate; non-response bias; sample demographics and descriptive statistics; scale assessment; the structural model

Chapter VI is a cloud software development that describes the design and development of the suggested prototype of the academic application portal. In addition, it discusses the academic application functional framework and academic application infrastructure framework. The prototype evaluation using experts and user-based evaluation is also discussed.

Finally, Chapter VII concludes the study with summaries of the research results, research achievements, the contributions of the research and future works.

CHAPTER II

LITERATURE REVIEW

2.1 INTRODUCTION

In recent years, cloud computing applications and research productivity improvement have become a central issue in the academic community. The continuous improvement and the importance of the quality factors play a critical role in the success of cloud applications to increase an individual's productivity.

This chapter is divided into four main parts. The first part discusses the factors that affecting academic researchers' productivity, along with identifying their needs from previous studies. The second part is the overview of the cloud computing environment, which is concluded by the current state of cloud computing applications in the higher education sector. The third part looks at the individual impact from the indicator of productivity improvement issue and its measurement. It identifies the research productivity indicators, identifies value added and non-value added based on Lean Thinking Theory (LTT) principles. Finally, the last part reviews the underpinning theories of Information Systems Success Model (D&M ISSM) and the relevant literature. The core of the chapter discusses the relation between cloud-based application and indicators of productivity improvement, as well as D&M ISSM and productivity improvement.

2.2 UNIVERSITY RESEARCHERS

There is strong interest in aspects of educational change and identity and research on learning how to become a professional, as shown in the journal Policy Futures in Education (Angervall & Gustafsson 2014). There are competing discourses in education to deepen the current debate on the restructuring of higher education (Åkerlind 2008). Many studies have addressed the researcher as a key factor to raise the productivity of knowledge and exploration (Steinlicht et al. 2010; Thomas 2011; Al-Rahmi & Othman 2013; Kyvik 2013; Nayar & Kumar 2015; Zeglat et al. 2016). The academic researcher is who has discovered and developed basic principles, effective policies, and best practices that advance research and education, ultimately to improve the science and well-being of individuals and populations (Roberts & Loftus 2013).

Correspondingly, the academic researcher has a wide range of tasks and roles in the research process (Braman 2006; Steinlicht et al. 2010; Kyvi 2013; Silinda & Brubacher 2016). These tasks and activities are varied depending on the field and the nature of the study. Thus, researchers face difficulties and challenges during their research process, which makes them an influential factor in their productivity. This study focuses on determining the factors affecting the researchers' productivity which are called waste in Lean Theory. It determines their needs to reduce these wastes and thus increases their productivity.

2.2.1 The Wastes Faced by Academic Researchers During Research

Earlier research in higher education has concentrated on undergraduate study. More recently, with the increasing number of postgraduate students, there has been a focus on identifying what influences successful postgraduate study (Billot et al. 2013). Which increased the challenges that academic researchers face during the research process (Nayar & Kumar 2015). For instance, information explosion and the diversity of their sources that lead to increasing competitive pressure, shorter study life cycles, and shorter technology innovation cycles (Goeldner & Powell 2011; Kyvik 2013; Nayar & Kumar 2015). In contrast, adhering to traditional methods and infrastructures fail to increase innovation and are no longer viable (Taylor & Hunsinger 2011; Polgar 2014; Dennis & Dailey-Hebert 2015).

As indicated by Ismail, Abidden and Hassan (2011) and Iqbal and Mahmood (2011), postgraduate students face problems during their research process, such as not being familiar with the fundamentals of the research process, difficulties in topic selection and lack of knowledge about research methodology (dues 2010; Ismail et al. 2011; Ekpoh 2016; Silinda & Brubacher 2016). Sometimes students' problems could be personal, financial pressure and problems associated with using technology and research tools (Fonteijn 2015). Further, the absence of the relationship and cooperation between supervisor and their students' effects on student connections, opportunities for discussion, debate, and skill development (Braman 2006; Kennedy 2011; Billot et al. 2013; Silinda & Brubacher 2016). It is a major obstacle facing students, where the supervisor has a primary role to play in supporting to complete and develop both research and skills (Wisker et al. 2007) by providing instructions and guidance to students by checking every aspect of their work and making inputs and comments where necessary (Ekpoh 2016).

Dominguez-Whitehead (2015), Silinda and Brubacher (2016) and Ekpoh (2016) explained in a quantitative study of the major issue in higher education related to leaving the postgraduate student's their university before completing their programs up to 88% end of 2010/2011. This was due to high expenses (Duze 2010; Ekpoh 2016) and lack of adequate support from supervisors, which resulted in them feeling frustrated about the postgraduate program (Billot et al. 2013; Silinda & Brubacher 2016). Other reasons as pointed out by Braman (2006), Wisker et al. (2007), and Kennedy (2011) include insufficient support systems to mitigate the stress from multitasking, which can increase the level of stress (Braman 2006; Kyvik 2013). Also the issues regarding time management (Bhat & Basson 2013), financial difficulties and debt (Iqbal & Mahmood 2011; Devi et al. 2014; Fonteijn 2015; Ekpoh 2016). Besides, the lack of generic skill development, particularly communication skills and technical skills (Byatt et al. 2013; Smith et al. 2016). These skills are a research requirement and will affect the outcomes, and the higher education providers must 'achieve the educational outcomes expected for students' (Chen 2011b; Byatt et al. 2013). Similarly, Byatt et al. (2013) state that the researcher must identify areas where they might lack skills and expertise that they require to develop and find suitable training to improve these skills in a variety of ways.

Fonteijn (2015) showed that the higher education students seek to continuous learning, but in fact, they faced several challenges to support continuous learning in terms of providing financial support and technology. Often this happens because of the lack of support and material allocations that support the study cost, which is one of the barriers faced by researchers (Iqbal and Mahmood 2011). Purchasing hardware and software and installing and maintaining extensive hardware contribute to some of the higher budgets that researcher to allocate (Devi et al. 2014). Furthermore, the lack of the Internet search skills and services and sources usage from the university teachers and researchers (Fonteijn 2015). This is due to the slow access speed of Internet connection, difficulty in finding relevant information, and weakness in the allocate appropriate hardware, software and support resources. Thus, have a negative impact on the researchers' use of the Internet sources, services and search engines, which certainly helps the academic in retrieving relevant information and increase the research productivity (Sampath Kumar & Manjunath 2013).

Table 2.1 Summary of Academic Researchers Wastes from the Relevant Empirical Studies

Summary of academic researchers' Wastes	Related works
The lack of adequate guidance from supervisors	Braman (2006), Kennedy (2011), Ismail et al. (2011), Iqbal and Mahmood (2011), Billot et al. (2013), Silinda & Brubacher (2016), Ekpoh (2016), Brew et al. (2016).
The lack of adequate support to increase experience	Braman (2006), Wisker et al. (2007), Kennedy (2011), Sampath Kumar & Manjunath (2013), Silinda & Brubacher (2016).
The lack of adequate support to increase skills	Chen (2011a), Byatt et al. (2013), Sampath Kumar & Manjunath (2013), Smith et al. (2016).
Stress related to the number of academic works and research activities	Braman (2006), Iqbal and Mahmood (2011), Kyvik (2013), Silinda & Brubacher (2016).
Stress regarding time management	Bhat & Basson (2013), Isaksson et al. (2013), Iqbal and Mahmood (2011), Silinda & Brubacher (2016).
Reliance on traditional methods in research performing	Billot et al. (2013), Polgar (2014), Dennis & Dailey-Hebert (2015), Nayar & Kumar (2015).
Stress-related providing financial support	Iqbal and Mahmood (2011), Ismail et al. (2011), Devi et al. (2014), Fonteijn (2015), Ekpoh (2016).
The lack of effective academic services and electronic materials	Devi et al. (2014), Sampath Kumar & Manjunath (2013), Fonteijn (2015).

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The lack of search engines skill and use of virtual sources and services	Ismail et al. (2011), Sampath Kumar & Manjunath (2013).
Lack of knowledge of the research fundamentals (e.g., selecting a research topic, identify a research problem, research methodologies, data analysis, research writing, etc.)	Duze (2010), Ismail et al. (2011), Isaksson et al. (2013), Ekpoh (2016), Silinda & Brubacher (2016).
Long times between operations.	Emiliani, M. (1998, 2004), Balzer (2010), Isaksson et al. (2013), Thomas et al. (2015), Ekpoh (2016).

Table 2.1 shows that these wastes inadvertently affect academic researchers' ability and achievement. Academic researchers around the world are under increased pressure to complete the interconnected tasks and roles in research process which they must complete them within a specified period (Braman 2006; Kyvik 2013; Silinda & Brubacher 2016; Ekpoh 2016). Several studies that are investigating the wastes that academic researchers address the long queue times between operations (Batch-and-Queue "B&Q"). That means the research actions are processed in large batches; the term Batch-and-Queue "B&Q" is the conventional way to deliver services or processes (Emiliani 1998, 2004; Brady, D. 2000; Balzer 2010; Thomas et al. 2015; Ekpoh 2016). For example, long queue times between processing and handling information or documents, searching processes between the vast amounts of resources, dispersed sources of data storage, and multiple sources of communication. Also, exchange information required for software updates or retrieve data, and continuity of follow-up works are time-consuming and can lower the quality of research, cause financial losses, low efficiency of services, dissatisfaction with outputs, and poor new information flow (Brady, D. 2000; Emiliani 1998; 2004; Balzer 2010; Thomas et al. 2015). Second, the lack of proper guidance by the research supervisor, lack of experience in the field of scientific research, and not fully utilising researcher's creativity or developing their skills. Third, continuity of relying on traditional methods in research performing, teaching, and supervisions because the research tools are ineffective. Finally, increase physical burdens due to purchasing hardware and software, maintenance, installing, software update and renew licences (Devi et al. 2014).

The present study attempts to eliminate the wastes related to academic researchers, to contribute to effective services and tools that support the effective communication and ease of use to support efficient and productive research.

2.2.2 Academic Researchers' Needs

Researchers' work will no longer be restricted by ideas or expertise, but rather by means of having access to the various resources and information required to implement these experiments along with evaluating the outcome (Sasikala & Prema 2011). Braman (2006), Thomas (2011), Yang et al. (2011) and Billot et al. (2013) reported that the result of exponential growth, a quantitative change in the speed with which information is highly processed, and the quantity of information which can be stored, led to increasing the needs of academic researchers. The extent to which information could be exchanged and the complication with which information can be examined has resulted in a qualitative change in how we generate knowledge. All these factors have a direct impact on the research activities (Braman 2006; Steinlicht et al. 2010; Kyvik 2013).

The traditional needs of researchers concentrated on computing power, storage devices and high-speed networking to the desk or labs (Sampath Kumar & Manjunath 2013). Today, their needs have changed completely (Billot et al. 2013). For instance, much more support is needed in learning, adapting, as well as editing and writing applications specifically for their research issues. They require help regarding the long-lived data collections that make them possible for knowledge reuse (Kyvik 2013). Table 2.2summarises the most critical needs of academic researchers from the previous studies.

Table 2.2 Summary of the Most Important Needs of Academic Researchers From Previous Studies

Academic researchers' needs	**The definition adopted of needs**	**Related works**
Computing needs.	Related to computational capacity of high-performance computing processing, such as (ability to store data, accessibility to data, and speed).	Braman (2006), Razak (2009), Sasikala & Prema (2011).

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System Stability.	Related to assurances of platforms migrates after a system upgrade, a backup power supply, and off-site backups provide protection in cases of natural disaster.	Braman (2006).
System Design Flexibility.	Related to flexibility in configuring several accounts and connect with each other and support any software package by any device.	Comm & Mathaisel (2003), Braman (2006), Razak (2009), Çalişkan & Mulgeci (2015), Srichuachom (2015).
Training Needs.	Related to the approach of software training to provide wide expertise and skills in the employment of certain research software packages.	Braman (2006), Chen (2011a), Sampath Kumar & Manjunath (2013). Byatt et al. (2013), Sampath Kumar & Manjunath (2013), Smith et al. (2016).
Software Development.	The need to adapting software and developing new software for data collection, evaluation, presentation requirements and integrate them with the previous useful programs.	Braman (2006), Tan et al. (2013), Yuvaraj (2013), Huang et al. (2015), Zhang et al. (2016).
Networking needs.	Related to providing reliable networking flexibility services in support of scientific research requirements with familiar speed in order to get data, information collection and analysis in real-time to reduce cost.	Braman (2006), Lee et al. (2009a), Ou et al. (2011), Cisco (2011), Networks (2012), Kang et al. (2013), Qi et al. (2014), and Wang et al. (2015).
Researchers' data needs.	Related to data needs access, data collection, preparation, safekeeping desires, and writing scripts with regard to capturing data from the web, to access to remote instrumentation.	Braman (2006), Kyvik (2013).
Collaboration needs among researchers.	The need for collaboration with others to exchange and sharing the information, experiences and expertise to get better guidance and advice.	Melin (2000), Braman (2006), Ou et al. (2011), Kyvik (2013), Wang et al. (2015), Nayar & Kumar (2015).
Increase learning.	Engaging in active learning such as in group work and positive information exchange.	Razak (2009), Thomas (2011), Chen (2011a), Kyvik (2013).
Distributed and presenting research (Scientific Publishing).	Related to publication and present research outcomes, move to the digital environment.	Bruce et al. (2004), Iqbal and Mahmood (2011), Nayar & Kumar (2015), González-Martínez et al. (2015).
Researchers' need Self-Archiving.	Related to keeping up to date with, publishing, and securing one's research and ideas keeping up with others' research, publicising one's work, and quickly asserting intellectual property rights over materials when there is fear that others may steal the ideas.	Braman (2006), Kurosawa & Takama (2011).
Improving the investigation results.	Regarding instructional exploration requires the actual specialist to reach labs, libraries, and the directories from away from the university.	Yuvaraj, M. (2013), Adi A. Maaita et al. (2013).

In summary, computation is usually seen as a next standard component knowledge creation, as well as technological innovations have got affected every aspect of research methods and researchers' performance. The existing technological tools can support the researchers' productivity, as well as research processes, but they are used only partially. Researchers can find these tools very difficult to locate software developed for specialised research purposes or to access data collected and analysed with earlier technologies because these tools may be unfamiliar to them. In addition, they know relatively little about how to use these technologies or manage data for reuse and multidisciplinary use. The recent IT innovations have influenced the researchers' lives substantively, professionally, as well as from a technical perspective. Researchers must, therefore, revisit existing services and software approaches and consider new capabilities in their research activities.

According to this study and previous literature (Comm & Mathaisel 2003; Benson Adogbeji & Amina Akporhonor 2005; Braman 2006; Åkerlind 2008; Youssef & Dahmani 2008; Razak 2009; Moschini 2010; Balzer 2010; Kurosawa & Takama 2011;Sasikala & Prema 2011; Kyvik 2013; Sampath Kumar & Manjunath 2013; Nayar & Kumar 2015; Çalişkan & Mulgeci 2015; Srichuachom 2015; González-Mart ńez et al. 2015; Wang, Li, et al. 2015; Aghakhani et al. 2016), there is a critical need for academic researchers to improve their performance and productivity. They need to eliminate wastes that in their tasks and improve productivity for long-term competitive success (Comm & Mathaisel 2003). Students are seeking to learn and improve their practical skills. More importantly, they need to raise their performance and evaluate and offer creative solutions for society (Razak 2009; Çalişkan & Mulgeci 2015; Srichuachom 2015). Overall, the academic researchers' need high-quality services and tools focused on adding value to their research activities, as well as, to achieve their objectives of productivity improvement at low cost and in the shortest possible time.

2.3 CLOUD COMPUTING TECHNOLOGY

The advances in information technology offer new opportunities in enhancing training. The new technology allows individuals to customise the environment in which they work or study, through using numerous resources and means to satisfy their interests and needs (Thomas 2011; Chen 2011a). In this section, we will provide the basic cloud computing definition based on the previous studies, its characterisation, reference model and types of services. Also, we will present the empirical studies for the role of cloud computing applications in higher education.

2.3.1 Cloud Computing Environment

Cloud computing is unlike network computing or traditional outsourcing. Cloud services and storage are accessible from anywhere in the world over on the Internet connection; with network computing, access is over. With network computing, applications/documents are hosted on a single company's server and accessed over the company's network. Cloud computing is a lot bigger and encompasses multiple companies, multiple servers, and multiple networks (Miller 2008).

a. Cloud Computing Concept and Definition

John McCarthy, a Professor at Stanford University, defined cloud computing in 1961, "computation may someday be organised as a public utility" similar to how public electricity and telephone services are delivered to the consumer (Zhang et al. 2010). In 1997, the initial academic definition of "cloud computing" was created by Ramnath K. Chellappa, who called it a computing paradigm where the boundaries of computing will be determined by economic rationale rather than technical limits (A Vouk 2008; Zhang et al. 2016). The real key to cloud computing is the concept of "cloud" a huge network of servers or even personal PCs interconnected in a grid (Miller 2008). The term "cloud" is borrowed from telephony, and the term "telecom cloud" was used to describe the Virtual Private Network (VPN) services for data communications, which cloud computing is a somewhat similar concept (Giordanelli & Mastroianni 2010). The term "cloud" is utilised because it can "float" between specific servers instead of being in a static or even a location. The major purpose for using the "cloud" is to obtain a much better, a higher level of information technology with consistent data processing, easily accessed, for lower charges as well as better efficiency in the time and money spent on computing, integrating or automating information (Slahor 2011).

Until now there has been no universal definition of cloud computing (Yang 2012; Devi et al. 2014), but diverse interpretations, possibly because in the information technology domain and academic sector the term is very young (Devi et al. 2014). The most frequently cited definition is that by the National Institute of Standards and Technology (NIST) (Sosinsky 2011; Taylor & Hunsinger 2011; Yang 2012; Sharma & Vatta 2013; Mokhtar et al. 2013; Yadav 2014; Devi et al. 2014; Sabi et al. 2016), that defines cloud computing as: a computing capability that provides an abstraction between the computing resource and its underlying technical architecture (e.g., servers, storage, networks), enabling convenient, on-demand network access to a shared pool of configurable computing resources that can be rapidly provisioned and released with minimal management effort or service provider interactions (Mell & Grance 2011). In this definition, the most crucial features of cloud computing are defined as on-demand self-service, resource pooling, broad network access, measured service and rapid elasticity, respectively.

From the perspective of Yarlikaş (2014), cloud computing is as Internet-based advanced distributed computing through which all of the shared computing resources among cloud service providers and cloud customers are provided to the cloud computing users over virtualised and dynamically scalable computing facilities. While, the studies of Hurwitz et al. (2012) and Devi et al. (2014) provided the meaning for cloud computing as an approach to delivering a set of shared computing sources which include applications, software, hardware, storage spaces, networking, development as well as deployment platforms, and business procedure on-demand network access without installing on end-user's computer. The user can access their files on any computer, anywhere, and anytime through Internet network access on a pay-as-you-go (Devi et al. 2014).

In brief, there are numerous definitions for cloud computing, but the idea revolves around enabling end-users, or customers get the computing services with overcoming the complexes of computing resources (e.g. Software, hardware, storage, and infrastructure) (Taylor & Hunsinger 2011; Mokhtar et al. 2013). Within the context of this study, the cloud computing is defined as the innovative technology to provide the highest scalability services and availability of applications, hardware, software, resource pooling, storage spaces, data sharing, and on-demand self-service, to multiple end-users allow them to access their files, applications on any devices, anywhere, anytime through the Internet network to improve satisfaction factor and add value.

b. Cloud Computing Services Layer and Modelling Types

Most studies separate cloud computing into two distinct sets of models:

1. **Services Models**: This consists of the types of services that end-users can access on a cloud computing platform. It includes Cloud Infrastructure as a Service (IaaS) Cloud Platform as a Service (PaaS), and Cloud Software as a Service (SaaS) (Rimal et al. 2010; Sultan 2010; González et al. 2011; Höfer & Karagiannis 2011; Slahor 2011; Mell & Grance 2011; Hurwitz et al. 2012; Yang 2012; Sharma & Vatta 2013; Mokhtar et al. 2013; Marupaka Rajendra Prasad et al. 2013; Milian et al. 2014; González-Martínez et al. 2015; Sabi et al. 2016).

2. **Deployment Models:** This refers to the location and management of the cloud infrastructure (Sosinsky 2011) for more security, privacy and open access to sources and services. It has four fundamental types of cloud computing, private cloud, community cloud, public cloud, and hybrid cloud (Mell & Grance 2009; 2011; Sosinsky 2011; Taylor & Hunsinger 2011; Cisco 2012; Mokhtar et al. 2013; Adi A. Maaita et al. 2013; Sharma & Vatta 2013; González-Martínez et al. 2015; Chou 2015; Sabi et al. 2016). The hybrid cloud is the cloud infrastructure of a composition of two or more clouds (private, community, or public) that remain unique entities, but are bound together by standardised or proprietary technology that enables data and application portability (e.g., cloud bursting for load balancing between clouds, e.g., Amazon or Google) (Sosinsky 2011; González-Martínez et al. 2015).

This study will concentrate on Cloud Software as a Service (SaaS) in particularly cloud-based applications by adopting the hybrid cloud through private and public cloud compositions. The primary differences between the cloud computing services which are deployed are related to the kind of service provided. However, usually, it is possible to group those with the primary three service models depending on the NIST. A cloud provider can present every one of these services based on different deployment models (Mell & Grance 2009).

c. Cloud Computing Characteristics

According to Peter Mell and Grance (2009, 2011) and Sosinsky (2011), the NIST was assigned five essential characteristics that a cloud computing system must offer as discussed in Table 2.3. Moreover, studies suggested other characteristics of cloud computing technology are also important which we cannot ignore.

Table 2.3 Cloud Computing Characteristics

Characteristics	Specifications	Related Reference
The five Cloud Computing Characteristics by NIST		
On-demand Self-Service	A consumer can access computing capabilities independently without requiring human interaction with each service provider, such as server time and network storage.	Anderson et al. (2008), Vecchiola et al. (2009), Shimba (2010), Mell & Grance (2011), Sosinsky (2011), Mokhtar et al. (2013), Adi A. Maaita et al. (2013), Rao et al. (2014), Yuvaraj (2015).
Network Access	Capabilities to access to multiple resources and services are available over the network through standard mechanisms that promote use by heterogeneous client platforms (e.g., mobile phone, tablets, laptops, etc.).	Mell & Grance (2011), Sosinsky (2011), Adi A. Maaita et al. (2013), Rao et al. (2014), Yuvaraj (2015), Seke (2015).
Resource Pooling	The provider’s computing resources are pooled to serve multiple consumers by reassigned according to consumer demand.	Shimba (2010), Mell & Grance (2011), Patel et al. (2011), Sosinsky (2011), Adi A. Maaita et al. (2013), Rao et al. (2014), Yuvaraj (2015), Seke (2015).
Rapid Elasticity	Capability to automatically scale rapidly outward and inward commensurate with demand.	Shimba (2010), Mell & Grance (2011), Sosinsky (2011), Adi A. Maaita et al. (2013), Rao et al. (2014), Yuvaraj (2015), Seke (2015).
Measured Service	The cloud system automatically controls and optimises resource use by leveraging a metering capability at some level of abstraction appropriate to the type of service (e.g., storage, processing, bandwidth, and active user accounts).	Shimba (2010), Mell & Grance (2011), Sosinsky (2011), Rao et al. (2014), Yuvaraj (2015), Seke (2015).

There are additional cloud computing characteristics mentioned by other studies, such as Scalability, Quality of Service (QoS), and User-Centric Interface

(Marupaka Rajendra Prasad et al. 2013; Adi. Maaita et al. 2013; González-Martínez et al. 2015). Autonomous System, Pricing or Cost-Effective, Flexible scale, Virtualisation, Highly Trustable, Adaptability, Accessibility, and User Friendly (Patel et al. 2011; Marupaka Rajendra Prasad et al. 2013; Adi. Maaita et al. 2013; Mokhtar et al. 2013; Adi. Maaita et al.2013; Yadav 2014; González-Martínez et al. 2015; Martínez et al.2015).

2.3.2 Cloud-Based Applications (Software as a Service "SaaS")

Providing software as a service is not a new computing practice. Some companies, known as Application Service Providers (ASPs) provide businesses with software programs as a service via the medium of the Internet during the 1990s (Choudhary 2007). The cloud computing application-enabled platforms enable open sources and creation, which consists of applications offered by the provider over the network, instead of being run on the user's computer (González-Martínez et al. 2015). These platforms represent a new way of delivering software applications and available for end-users through the Internet as a service often referred to as on-demand software. The consumer does not need to know about the infrastructure that runs this application (Ojala & Tyrväinen 2011; Invent 2015). They have just accessed to work and pay for his consumption (Hurwitz et al. 2012; Mokhtar et al. 2013; Sharma & Vatta 2013). The best example of this service Google App, Microsoft Office 365, Amazon Web Services (AWS), Salesforce, and Dropbox. (González-Martínez et al. 2015).

SaaS is increasingly used in a wide range of research processes. This computing revolution led to the rapid growth of the cloud services market over the past decade. According to Gartner (Huang et al. 2015), revenue in the global cloud services market was US$ 111 billion in 2012, a 21.4% increase from US$ 91.4 billion in 2011, and it is expected to reach US$ 206.6 billion by 2016 (Raton 2013; Huang et al. 2015). Also, the Pew Internet/Elon University survey reports that of 1,021 participants, including Internet research experts and users. Furthermore, other studies predict that by 2020 higher education will use cloud-based applications and focus on tech-centric solutions and methodologies such as teleconferencing, distance learning and hybrid classes (i.e. Online and off-campus learning) (Bansal et al. 2012; Lepi 2013).

The NIST also defines the delivery models of SaaS as the capability provided to the consumer to use the provider's applications running on a cloud infrastructure and accessible from various client devices through a thin client interface such as a web browser (e.g., web-based email) (Burkon 2013; Ercolani 2013). The consumer does not manage or control the underlying cloud infrastructure, network, servers, operating systems, storage, or even individual application capabilities, except for limited user-specific application configuration settings (Hurwitz et al. 2012; Mokhtar et al. 2013; Sharma & Vatta 2013; Burkon 2013; Ercolani 2013). With SaaS, a provider licences an application to customers either as a service-on-demand, through a subscription, in a "pay-as-you-go" model, or (increasingly) at no charge when there is an opportunity to generate revenue from streams other than the user (Patel et al. 2011). Currently, a wide range of online applications, including; messaging (email) applications, customer relationship management (CRM) applications, project management applications, financial and accounting applications. It also includes sales applications, expense management applications, applications, human resources (HR) applications which include recruitment, employee portal, travelling booking system, talent management and employee performance management applications. Also including; supply chain management applications, logistic management applications, warehouse management applications, purchasing, sourcing and e-procurement applications, office management such as web conferencing applications, training applications such as e-learning portal and company web portal (Espadas et al. 2008; Tan et al. 2013).

2.3.3 Cloud-Based Applications in Higher Education Sectors

At the present, the trend towards cloud computing has begun for many higher education systems, due to its ability related to the scalability, availability, accessibility and usage of virtualised resources as a service through the Internet (Masud et al. 2012; Ercan 2012; Ibrahim et al. 2015; David & Anbuselvi 2015). Devi et al. (2014) reported that the main reasons to move to adopt the cloud computing services that related to the economic purposes for the issue of reducing the higher budgets that allocated to colleges (Sultan 2010; Marinela Mircea & Andreescu. 2011; Masud et al. 2012; Ercan 2012; Chandra & Borah 2012; Ibrahim et al. 2015; Sabi et al. 2016). While, Sabi et al. (2016) mentioned that the current higher education research trends of cloud computing had been concentrated on the technology, applications, benefits, and security at the education organisation level within small and medium-sized (Al-Ghatrifi 2015). Within this present economic crisis context, the study of Sultan (2010) stressed that using of cloud computing services has become a prerequisite and not an option in many higher education institutions. Cloud computing has the prospect of efficient ability to satisfy the necessities of academic students, teachers, and academic staff with regard to the high cost of hardware and software, as well as technological implications and open access to knowledge (Masud et al. 2012). Table 2.4 summarises the current trends of higher education sectors towards cloud computing services and applications.

Statistics indicated that 70% of higher education institutions in North America have moved to the cloud computing environment and 50% have adopted a cloud-based collaboration system to improve information sharing across campus (Alharthi et al. 2016). Even in Ireland, Mitchell and Cunningham (2014) found there are many types of cloud computing solutions in use within Ireland's academic institutes. Online survey results indicated the hybrid cloud was a very popular choice of cloud infrastructure with 86% of respondents compared with public cloud services in Irish institutions

Table 2.4 Summary of The Trends of Higher Education Sectors Towards Cloud Computing Solutions

Higher education trends in adopting cloud computing	**Related Works**
• Reduce the higher budgets and cost	Anderson et al. (2008), Razak (2009), Herrick (2009), Sultan (2010), Taylor & Hunsinger (2011), Behrend et al. (2011), Marinela Mircea & Andreescu. (2011), Ercan (2012), Chandra & Borah (2012), Huang et al. (2013), Devi et al. (2014), Tashkandi & Al-Jabri (2015), Seke (2015), Mitchell & Cunningham (2014), Sabi et al. (2016).
• Reduce time	Anderson et al. (2008), Razak (2009), Herrick (2009), Sultan (2010), Taylor & Hunsinger (2011), Behrend et al. (2011), Marinela Mircea & Andreescu. (2011), Ercan

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	(2012), Chandra & Borah (2012), Huang et al. (2013), Devi et al. (2014), Tashkandi & Al-Jabri (2015), Seke (2015), Mitchell & Cunningham (2014), Sabi et al. (2016).
• Flexible teaching and learning environments	Anderson et al. (2008), Herrick (2009), Razak (2009), Weber (2011), Behrend et al. (2011), Taylor & Hunsinger (2011), Ercan (2012), Huang et al. (2013), Devi et al. (2014), Mitchell & Cunningham (2014), Seke (2015), Alharthi et al. (2016), Sabi et al. (2016), Sharma et al. (2016).
• Achieve scalability and enhances the reliability	Vujin (2011), Behrend et al. (2011), Marupaka Rajendra Prasad et al. (2013), Adi A. Maaita et al. (2013), González-Martínez et al. (2015), Seke (2015), Sabi et al. (2016).
• Availability of several of virtual resources and services (e.g., database, stored files, emails, file sharing, and productivity tools)	Anderson et al. (2008), Razak (2009), Behrend et al. (2011), Vujin (2011), Taylor & Hunsinger (2011), Bansal et al. (2012), Huang et al. (2013), Yadav (2014), Mitchell & Cunningham (2014), Seke (2015), Nayar & Kumar (2015), Al-Ghatrifi (2015), Seke (2015), Sabi et al. (2016).
• Support facilitates the communication technique	Anderson et al. (2008), Herrick (2009), Kirschner & Karpinski (2010), Behrend et al. (2011), Huang et al. (2013), Devi et al. (2014), Seke (2015), Al-Ghatrifi (2015), Sharma et al. (2016).
• Easy to access and use	Anderson et al. (2008), Razak (2009), Taylor & Hunsinger (2011), Huang et al. (2013), Mitchell & Cunningham (2014), Sabi et al. (2016).
• Availability of good ICT and IT infrastructure	Vujin (2011), Behrend et al. (2011), Seke (2015), Sabi et al. (2016).
• Business Continuity	Anderson et al. (2008), Herrick (2009), Etro (2009), Marston et al. (2011), Aljabre (2012), Berman et al. (2012), Seke (2015), Schniederjans & Hales (2016).
• Mobility support	Anderson et al. (2008), Razak (2009), Vujin (2011), Taylor & Hunsinger (2011), Huang et al. (2013), Ozdamli et al. (2015).
• Collaboration and Sharing	Vujin (2011), Huang et al. (2013), Herrick (2009), Razak (2009), Seke (2015), Sharma et al. (2016).
• Direct access to a broad range of different educational resources, scientific projects, research applications and tools.	Vujin (2011), Behrend et al. (2011), Seke (2015), Sabi et al. (2016).

In conclusion, studies have shown that the situation for the adoption and usage of cloud computing applications in the higher education sector is still in the initial establishment phase, especially regarding university researchers (Taylor & Hunsinger 2011; Weber 2011; Odeh et al. 2014; Devi et al. 2014; Ibrahim et al. 2015; Al-Ghatrifi 2015; Seke 2015; Alharthi et al. 2016; Sabi et al. 2016). Most academicians are not aware of the advantages of high-performance of cloud communication technique service (Taylor & Hunsinger 2011; Devi et al. 2014). That is confirmed by several studies, such as the study of Alharthi et al. (2016) that showed the Saudi universities' status, which is slowly enhancing cloud-based higher educational for the e-learning environment and distance learning platforms. Likewise, the Middle East has just begun the initial phase to offer teaching through cloud computing (Weber 2011; Odeh et al. 2014; Alharthi et al. 2016). Despite higher trends towards social networking sites by 88% of the higher education sector in the Middle East, the use of cloud computing in academic areas is still limited (Sharma et al. 2016). Add to that, the cloud adoption situation in African universities as mentioned by Seke (2015) and the Sultanate of Oman (Al-Ghatrifi 2015) is still relatively new. It is strongly recommended that these universities need to take advantage of cloud computing services in the academic sector (Kirimi 2014). Furthermore, the cloud computing implementation in developing countries' education institutions was very poor (Ewuzie & Usoro 2012; Masud et al. 2012; Ibrahim et al. 2015).

There is a strong growing interest from postgraduate students and universities to move to the cloud (Ewuzie & Usoro 2012; Masud et al. 2012; Morgado & Schmidt 2012; Meske et al. 2014; Yadav 2014; Thaiposri & Wannapiroon 2015). However, there are still issues in current higher education systems related to hardware and software purchases, maintenance, upgrading and licensing (Iqbal & Mahmood 2011; Devi et al. 2014; Fonteijn 2015). There are also issues concerning the lack of providing the effective mobile application (Ozdamli et al. 2015), service-level agreements, information security ensures (Ercan 2012; Mitchell & Cunningham 2014), scalability, reliability, portability, flexibility, availability, data recovery, accessibility, storage and software (Anderson et al. 2008; Sultan 2010; Thomas 2011; Adi A. Maaita et al. 2013; Mitchell & Cunningham 2014). Several studies in this area believe cloud computing will have a significant impact on the future higher education sectors and it will be an alternative for many universities which are under budget constraints and time limitations (Sultan 2010; Masud et al. 2012; Marinela Mircea & Andreescu. 2011; Chandra & Borah 2012; Mitchell & Cunningham 2014; Ibrahim et al. 2015; Sabi et al. 2016). The higher education community needs to conduct a search of cloud application and development of mobile technology to increase these outputs to reduce their cost and time (Ozdamli et al. 2015; Ibrahim et al. 2015). This study attempts to contribute to addressing the gap in cloud computing and higher education and special emphasis on the university researcher.

2.4 INDIVIDUAL IMPACT IMPROVEMENT

In the context of IS studies, individual impact is defined and measured by different indicators. Wu and Wang (2006) define individual impact as the degree to which system usage improves decision-making quality, improves productivity, enhances job efficiency, improves communication quality, acquires new knowledge & innovative ideas, enhance job effectiveness, accomplish tasks quickly, improve job performance, and improves quality of work life. Norzaidi et al. (2007) define individual impact as the degree to which system usage helps to accomplish a task quickly, improves the quality of work, improve job performance, allows more control over work, eliminates errors, and enhance effectiveness on the job. According to Benedetto, Calantone, and Zhang (2003), individual impact is measured through the following indicators; improve efficiency, enhance effectiveness, and increase productivity and problem identification. Different indicators have been used to measure the individual impact variables in the context of IS as shown in Table 2.5.

This research focuses on improving productivity at the individual level. It evaluates cloud-based application usage through the individual impact construct as an individual productivity variable (Wu & Wang 2006; Hou 2012). Individual productivity is defined as the degree to which cloud application usage affects output effectiveness, improved productivity, and improved performance (Davis 1989; Delone & McLean 1992; Iivari 2005; Lee, Kim, et al. 2009b; Noorman et al. 2010; Yuvaraj 2014; Manchanda & Mukherjee 2014; Ishak et al. 2014; Mohammadi 2015; Hsu et al. 2015).

Table 2.5 Indicators of Individual Impact in The Context of IS Among Previous Studies

Authors/Year	**Individual Impact Indicators**										
	Accomplish tasks quickly	**Accomplish tasks easily**	**Improve productivity**	**Improve decision-making quality**	**Improve decision-making speed**	**Improve job efficiency**	**Improve job effectiveness**	**Improve communication quality**	**Acquire new knowledge**	**Acquire new skills**	**Acquire innovative ideas**
(Norzaidi et al. 2007)	√					√	√				
(Hou 2012)			√	√	√	√	√				
(Norzaidi et al. 2009)	√					√	√				
(Wu & Wang 2006)	√		√	√		√	√	√	√		√
(D’ambra et al. 2013)	√					√					
(McGill & Klobas, 2009)	√	√				√	√				
(D’ambra&Wilson 2011)	√			√		√			√		
(Lee et al. 2005)			√			√					
(Princely 2014)	√			√		√					
(Hasim & Salman 2010)	√					√	√				
(Benedetto et al. 2003)			√			√	√				
(Lwoga 2013)	√					√				√	
(Khayun & Ractham 2011)	√					√					
(Cheng 2011)						√	√				

2.4.1 Individual Productivity Improvement

Productivity is one of the most researched topics, and possibly the most complex topic in the organisational process (Palfreyman 2013; Torrisi 2013). The beginnings of the productivity concept were by Quesnay (1766) in the Journal De Agriculture over two centuries ago (Dundar & Lewis 1998; Tangen 2005). Since that time, it has been adopted in several circumstances at various developmental levels, especially in relation to economic issues to minimise the costs and maximise the outputs (Tangen 2002; Duyar 2006; Jang et al. 2011). Previously, the productivity was relegated to the second rank and neglected or ignored by those who influence production processes (Tangen 2005). At present, there is a positive trend towards productivity in several fields, for example software productivity (Käpylä et al. 2009; Grönroos & Ojasalo 2015), research productivity (Iqbal & Mahmood 2011; Wills et al. 2013; Brew et al. 2016), higher education productivity (Siemens et al. 2013; Sullivan et al. 2013; Brew et al. 2016).

Like other concepts, there is no universal definition of productivity, because it is complex and is studied in different ways and domains that require different definitions (Aki Jääskeläinen & Uusi-Rauva 2011; Alireza Isfandyari Moghaddam et al. 2012; Tangen 2005; Wills et al. 2013). Productivity is a multidimensional concept, the meaning of which can differ, relying on the domain within which it is used (Tangen 2002, 2005). Table 2.6 shows several productivity definitions based on the domain of study from different perspectives.

Table 2.6 Productivity Definitions Based on The Domain of Study

Domain	**Productivity Definition**	**Related Works**
The amount	Productivity is the relationship between the quantity of output (e.g. The quantity of products or services produced) and the quantity of input (e.g. The time needed for production) used to generate that output.	Susan M. Gates & Stone (1997), Tangen (2002, 2005), Käpylä et al. (2009), Jonna Käpylä et al. (2010), Jonna Käpylä et al. (2010), Aki Jääskeläinen & Uusi-Rauva (2011), Polančič et al. (2015).
Creation of value	Productivity is closely connected to the use and availability of resources. It is strongly linked to the creation of value.	Tangen (2002), Srichuachom (2015).

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Quality factor	Productivity is significantly related to ensuring the high-quality factor as the input and output to continuous improvement to value added and conforms to users' requirements.	Emiliani (1998), Bowen & Youngdahl (1998), Tangen (2005), Juarez (2014), Srichuachom (2015), Nguyen et al. (2015), Hu et al. (2016).
Number of actions	Productivity is number of actions performed in a specified context of use relative to saving the time and cost by the user to complete the task.	Bevan (2001), Nguyen et al. (2015), Atoum & Bong (2015), Fernández-Alemán et al. (2016).
Customer productivity equation	Productivity = output or value / Time and cost.	Bevan & Azuma (1997), Johnston & Jones (2004), Myronenko (2012).

2.4.2 The Related Concepts of Productivity Improvement

As mentioned in productivity literature, the term productivity is often associated with three important concepts: performance, efficiency, and effectiveness, they are commonly used within academia and commercial circles (Bevan 1999; Tangen 2002, 2005; Jonna Käpylä et al. 2010; Pretel & Lago 2013; Alnanih et al. 2013; Fernández-Alemán et al. 2016). Each concept is complementary to the process of improving the productivity and cannot be separated (Tangenb 2005).

According to Sampath Kumar and Manjunath (2013), academic performance "is the outcome of the academic research process, the extent to which a student, lecturer or institution has achieved their work goals and increasing their research productivity". In return, Tangen (2005) noted performance is an even wider concept that includes both overall economic and operational aspects. It contains any objective of completion and development excellence, whether it is related to cost, flexibility, speed, dependability or quality. Moreover, performance can be described as an umbrella term for all concepts that reflect the success of a service and its facilities (Wu & Wang 2006; Urbach & Müller 2012; Ishak et al. 2014; Manchanda & Mukherjee 2014).

This has led to performance objectives, especially those relating to quality, as well as reducing the time and cost (for example Lee et al. 2009a; Rewatkar & Lanjewar 2010; Ou et al. 2011; Gurunath & Kumar 2015). Nevertheless, the quality term is often used in a very broad context, relating to both input “processes” and output “tool or services” and including both tangible and intangible factors (Dew 2009). Productivity and quality usually come together, but they are two separate concepts (Tangen 2005).

Effectiveness and efficiency are often confused with each other (Tangen 2005). Gates and Stone (1997), Poole (2005), and Garrett and Poole (2006) considered that efficiency and effectiveness are significant parts of productivity. Efficiency refers to “doing things right”, while effectiveness is doing the right things (Tangen 2002, 2005; Hu et al. 2016). Efficiency is related to usability is the extent to which a product can be used by users to achieve particular goals with effectiveness and satisfaction in a specific context of use (Padayachee et al. 2010; Atoum & Bong 2015; Moumane et al. 2016; Fernández-Alemán et al. 2016). While effectiveness is related to the creation of value for the user and affects the output of the productivity ratio (Fernández-Alemán et al. 2016). It is as the level of accuracy and completeness with which users achieve specified goals (Atoum & Bong 2015; Moumane et al. 2016; Fernández-Alemán et al. 2016).

In summary, this study determines that individual productivity is at the centre of the triple aspects; performance, efficiency, and effectiveness to ensure quality factor as an input and output. Individual productivity is strongly linked to achieving users’ needs and added Value to outputs through optimal use of the service or system. This means that user productivity will increase if the system or service is available and is useable and capable to reduce her/his time and cost. High individual productivity results from a flexible, integrated, useful and secure system that improves performance, skills, raise satisfaction and aims for continuous improvement (Jang et al. 2011; Srichuachom 2015; Nguyen et al. 2015; Maguire 2016).

The study has a straightforward operational definition of individual productivity. It is the relationship between the ratio of user outputs, “e.g. The quantity of completed tasks achieved specific goals, value creation and the ratio of inputs related to the optimum utilisation of system or service with high-quality, speed, delivery, flexibility in a shorter time and lower cost".

2.4.3 Research Productivity Indicators

The attention on the notion of research productivity has been increasing in recent years among researchers in various fields of research (Dundar & Lewis 1998; Jung 2012). Research productivity is one of the important measures of university academic performance, and a main indicator for calculating university rankings (Jung 2012). Hence, the research productivity (RP) is defined as a combination of results that are generated by scientific performance, a product or service (patent), and teaching and how much individuals and society are getting from the education sector, given the resources they put in (Susan M. Gates & Stone 1997; Barjak 2006; Torrisi 2013; Kyvik 2013). It refers to the amount of work that is accomplished in a unit of time using the factors of production "environment, human resources, capital, technology and entrepreneurship in the academic sector" (Jonna Käpylä et al. 2010; Aki Jääskeläinen & Uusi-Rauva 2011; Torrisi 2013).

Research Productivity (RP) is composed of two words "Research" and "Productivity". "Research" means very accurate, observant, and conscious study or investigation of phenomena, especially to search and find out new specifics, information and facts (Iqbal & Mahmood 2011). In return, "productivity" means production or output, produced in shorter periods at lower cost by academics (Bevan 2001; Iqbal & Mahmood 2011; Wills et al. 2013; Nguyen et al. 2015; Atoum & Bong 2015; Fernández-Alemán et al. 2016). Studies that relate to research productivity, such as Åkerlind (2008), Balzer (2010), Shahin and Janatyan (2010) and Juarez (2014) found that the academics' productivity indicators are usually related to research productivity indicators. Numerous studies have explored and defined the main indicators enhancing researcher productivity as shown in Table 2.7.

Table 2.7 Summary of the Indicators of Research Productivity through the Empirical Studies

Indicators of Research Productivity	The Definition Adopted of Indicator	Related works
Less time and cost	• Produce improves the research outputs in less time and less cost.	Bevan (2001), Comm & Mathaisel (2003), Emiliani, M. (2004, 2005), Garrett & Poole (2006), Barjak (2006), Herrick (2009), Steinlicht et al. (2010), Balzer (2010), Iqbal & Mahmood (2011), Jung (2012), Isaksson et al. (2013), Nguyen et al. (2015), Atoum & Bong (2015), Vinodh & Ben Ruben (2015), Fernández-Alemán et al. (2016), Alharbi et al. (2016).
Increase of scientific publications	• Published scientific papers in professional journals. • Published in a book. • Published in research papers in conference proceedings. • Publication of monographs. • Production of artistic or inventive works.	Kyvik (1990), Golden & Carstensen (1992), Barjak (2006), Iqbal & Mahmood (2011), Jung (2012), Isaksson et al. (2013), Wamala and Ssembatya (2015), Altbach (2015), Al-Ghatrifi (2015), Brew et al. (2016).
Performance Improves	• Academic performance is completing the research activities, and achieve research objectives easily, time management and flexible in less time, effort and cost.	Dundar & Lewis (1998), Hu & Gill (2001), Emiliani, M. (2005), Barjak (2006), Herrick (2009), Steinlicht et al. (2010), Balzer (2010), Sampath Kumar & Manjunath (2013), Wamala and Ssembatya (2015), Altbach (2015), Alharbi et al. (2016).
Increase Knowledge and Learning	• Everything related to increasing the new knowledge and useful learning..	Hu & Gill (2001), Comm & Mathaisel (2003), Emiliani, M. (2004, 2005), Barjak (2006), Herrick (2009), Balzer (2010), Doman (2011), Wills et al. (2013), Isaksson et al. (2013), Wamala & Ssembatya (2015), Al-Ghatrifi (2015), Vinodh & Ben Ruben (2015), Aghakhani et al. (2016), Moghaddasi & Tabrizi (2017).
Increase Skills	• Increased skill of communication and self-learning good writing, searching, reading, improve time management skills, data analysis, and sharing..	Emiliani, M. (2005), Barjak (2006), Balzer (2010), Doman (2011), Wills et al. (2013), Vinodh & Ben Ruben (2015), Wamala & Ssembatya (2015).
Increasing of Experiences	• Expertise in communication in research and problem-solving, the link between relationships and good use of resources and services.	Herrick (2009), Doman (2011), Wills et al. (2013), Wamala & Ssembatya (2015).
Improve Communication	• A good level of communication with others in the research field and with the supervisors. To receive good consultation for	Barjak (2006), Herrick (2009), Balzer (2010), Wills et al. (2013), Wamala and Ssembatya (2015), Vinodh & Ben Ruben (2015), Brew et al. (2016).

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	• research requirements and problem-solving.	
Academic Satisfaction	• Satisfaction for the effectiveness of the services' ability to achieve desired outcomes. • Satisfaction for the services efficiency to enhancing works and activities. • Satisfaction for increased outputs. • Satisfaction with the academic capabilities and confidence, and self-efficacy.	Comm & Mathaisel (2003), Emiliani, M. (2004, 2005), Steinlicht et al. (2010), Balzer (2010), Doman (2011), Kennedy (2011), Ito (2016), Aghakhani et al. (2016), Alharbi et al. (2016), Brew et al. (2016).
Increase Inventive Works	• Through acquire and increase new knowledge and generating innovative ideas.	Golden and Carstensen (1992), Barjak (2006), Jung (2012), Vinodh & Ben Ruben (2015).
Increase Amount of Work	• Complete the number of works easily with flexibility in time, effort and cost.	Dundar & Lewis (1998), Barjak (2006), Jonna Käpylä et al. (2010), Aki Jääskeläinen & Uusi-Rauva (2011), Doman (2011), Torrisi (2013), Wills et al. (2013), Isaksson et al. (2013).

In brief, as presented in Table 2.7 there is a positive correlation between technology use and research productivity. According to Barjak (2006), the role of new technology usage to increase research productivity includes cloud computing to save time via email tool to improve the communication, increase the amount of knowledge through available sources, databases and get more journal articles that lead to increasing scientific publication. Also, the technology offers the content-rich individual homepages (with full text) and has positive results on writing skills, reading enrichment, and raising of experiences and cooperation in the search, analysis and linkage between events. In this study, the key indicators of research productivity are summarised through high-quality researcher outputs related to research process by improving new knowledge opportunities, building skills, gain experiences, increase scientific production, increase innovation, and improve performance, and task completeness during short periods and at minimum cost and effort.

2.4.4 Lean Thinking Theory (LT) to Improve Productivity

Lean System is as a representative of the productivity improvement theory in construction management (Ross Raifsnider & Kurt 2004, Julien &Tjahjono 2009).

Thus, Lean Thinking can be defined as “a way of thinking” that emphasises on a holistic system which supports a development culture to effect continuous improvement (Jang et al. 2011; Malanda 2015; Srichuachom 2015; Hu et al. 2016). This aim is to serve a requirement of a customer by using a few resources to reduce cost and cycle time significantly throughout the entire value chain while continuing to improve product performance (Comm & Mathaisel 2003; Poppendieck 2007; Balzer 2010).

Lean Thinking (LT) comes from the manufacturing environment and was popularised by the book entitled “The machine that changed the world (1990)” (Womack et al. 1990; Hu et al. 2016). Then, it is developed and supported by the Toyota Motor Company after the Second World War, in the mid-1930s (Bruun & Mefford 2004; Balzer 2010; Ingelsson & Mårtensson 2014; Malanda 2015). Which led to the applications of Lean have been extended to a wide variety of non-manufacturing setting (non-specialists) to understand and use (Balzer 2010). Hence, the Lean management system has the benefit that everyone in an organisation can apply the practices without the need for specialists (Balzer 2010; David E. Francis 2014). For example, including hospitals and health care, public service (Mi Dahlgaard-Park & Pettersen 2009; Ingelsson & Mårtensson 2014), universities (Balzer 2010; David E. Francis 2014; Malanda 2015; Martin et al. 2015), government organisations (Houy 2005; Sergio Rattner & Institute 2006; Riezebos & Klingenberg 2009; Martin et al. 2015), Software development (Poppendieck 2007; Se 2011), information technology sectors (Steinlicht et al. 2010; Juarez 2014; Vinodh & Ben Ruben 2015) and most recently, higher education (Balzer 2010; Parul Sinha & N. M. Mishra 2013; David E. Francis 2014; Vinodh & Ben Ruben 2015; Aghakhani et al. 2016).

a. Lean Thinking Principle of Values Identification

Value is at the heart of Lean Thinking (LT). It is important to identify the exact requirements of beneficiaries to satisfy them at a reasonable price at the right time (Susilawati et al. 2013; Srichuachom 2015). To achieve the Lean Thinking approach and research objectives, the study adopted the principle of values identification, which is divided into Non-Value Added (NVA), and Value Added (VS).

b. Wastes Identification "Non-Value Added (NVA)"

Waste is any step or activity or behaviour in a process that is not required to complete that process successfully (Emiliani 2004; Sergio Rattner & Institute 2006; Mark Robinson & University 2014). In other words, any activity in a process that consumes resources that adds cost but does not add value "Non-Value Added (NVA)" as seen from the perspective of the beneficiary of the process (Emiliani 2005; Balzer 2010). Identifying waste is a critical first step in the productivity improvement journey (Ma et al. 2015), by applying various tools and methods such as process mapping (Doman 2011), value stream mapping (Steinlicht et al. 2010; Juarez 2014; Ma et al. 2015), and interviews (Comm & Mathaisel 2005; Meyer & Mcneal 2011; Srichuachom 2015; Alharthi et al. (2016)). Thus, waste reduction will increase productivity and quality performance for the projects (Ito 2016).

Waste in Lean theory is called "muda, mura, and muri" in Japanese (Emiliani 2004, 2005; Doman 2011; Juarez 2014). Lareau (2003) developed a more elaborate framework that organises waste into four general categories (Balzer 2010) that described nine specific types of waste in the higher education sector that approved by Lean Education Enterprises (2007) and Parul Sinha and Mishra (2013). Table 2.8 and Table 2.9 illustrates the waste categories as well as its types with the description. Which this study is focused on two categories of waste: people waste and asset waste that related to the research problem.

Table 2.8 The Waste Categories

Waste Categories	**The Definition Adopted of Categories**	**Waste Categories Identified by Related Studies**
People Waste	People waste refers to the type of wastes that occurs when beneficiaries fail to capitalise fully on the applications, services, resources, in addition, their knowledge, skills, and abilities.	Lareau (2003), Balzer (2010), Doman (2011).

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Process Waste	Process waste refers to the cluster of waste that occurs due to shortcomings in the design or implementation of system processes.	Lareau (2003), Balzer (2010), Isaksson et al. (2013), Martin et al. (2015).
Information Waste	Information waste refers to the type of wastes that occurs when available information is deficient for supporting system processes.	Lareau (2003), Balzer (2010), Hu et al. (2016).
Asset Waste	Asset waste refers to a cluster of wastes that occurs when the beneficiary does not use its resources (facilities, materials, tools) most effectively as the providers do not present effective products.	Lareau (2003), Balzer (2010).

Table 2.9 Waste Types in Higher Education

Waste Type in Education Sectors	The Definition of Waste Type	Waste Types That Identified by Related Studies
Overproduction Effort	• Generating more of something or information than is needed right now, duplications, redundancies, unwarranted changes for the sake of change.	Lean Education Enterprises (2007), Doman (2011), Parul Sinha & N. M. Mishra (2013), Juarez (2014).
Talent	• Not fully utilising or developing the skills, training, and passion of staff and students. • Limiting authority and responsibility for basic tasks. • Unused the skills or improve learning opportunities. • Limiting useful capabilities and facilities.	Lean Education Enterprises (2007), Parul Sinha & N.M. Mishra (2013), Juarez (2014), Çalişkan & Mulgeci (2015).
Motion	• When a person moves their body as part of an action or task that does not directly add value. • Unnecessary physical movement, searching, or transportation of items or people which do not add value.	Lean Education Enterprises (2007), Parul Sinha & N.M. Mishra (2013), Juarez (2014), Çalişkan & Mulgeci (2015).
Time	• Idle time created when actions, information, people or equipment are not ready; excess or unwise use of time. • Wasting time on the wrong attempts and repetitions due to lack of correct guidance and experience. • Loss of time in searching for information or resources due dispersion and mobility of sources. • Loss of time due the materials and tools are ineffective. • Wasting time due to multiple steps, e.g. (e.g. Office actions such a signature, printing, and scanning) and waiting for software updates or retrieve data or communication.	Lean Education Enterprises (2007), Doman (2011), Parul Sinha & N.M. Mishra (2013), Isaksson et al. (2013), Juarez (2014), Çalişkan & Mulgeci (2015), Martin et al. (2015).

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Processing Handling	• Extra or unnecessary steps, reviews, approvals, or requirements, confusion.	Lean Education Enterprises (2007), Parul Sinha & N.M. Mishra (2013), Çalişkan & Mulgeci (2015), Martin et al. (2015).
Assets	• More inventory, physical resources, or information overload than needed or their misuse.	Lean Education Enterprises (2007), Parul Sinha & N.M. Mishra (2013), Martin et al. (2015).
Capacity	• The ability or power to do, experience, or understand something for a specific role or position. Which the failure to realise the full potential and experience its benefits; capacity can be measured at both the individual and organisational levels, in more specifically. • Fail to set goals and improve their experience due to not understand tasks and fix related problems. • Fail to understand how they learn to perform or do their works, and activities.	Lean Education Enterprises (2007), Parul Sinha & N.M. Mishra (2013), Juarez (2014).
Knowledge	• Everything related to the development of knowledge and recreating already existing knowledge. • Going through training they have already had. • After searching and finding information, recalling already knew it. • Reteaching previously taught courses.	Lean Education Enterprises (2007), Doman (2011), Parul Sinha & N.M. Mishra (2013), Juarez (2014), Hu et al. (2016).
Defects	• A work that contains errors lacks something necessary, requires rework, or must be redone. These occur due to imperfections or poor efficiency and need to be worked upon or improved.	Lean Education Enterprises (2007), Doman (2011), Parul Sinha & N.M. Mishra (2013), Martin et al. (2015).

As seen through Table 2.8 and Table 2.9 the wastes in the higher education process occur as a result of lost time, which negatively affecting physical terms as mentioned by Emiliani (1998, 2004) and Balzer (2010). The academics need “less” in terms of less any waste that comes out from their task is a negative effect on the other stages and productivity, through fewer costs, time and fewer work mistakes such as, rationing keywords and related sources (Comm & Mathaisel 2003; Srichuachom 2015; Aghakhani et al. 2016). Disrespecting people creates waste (Emiliani 2004), but the “Respect for People” principle is usually ignored by senior management (Balzer 2010; Michal Niezgoda & Yorkstone 2014).

c. Value Added (VA)

Value added is an important practice to achieve the beneficiary's needs (Steinlicht et al. 2010; Se 2011). The product or service provider or developer is committed with the beneficiary through reliability, responsibility and credibility which are some characteristics of value. The beneficiary also influences the provider or developer to work according to the beneficiary's needs (Se 2011; Ma et al. 2015). The beneficiary is the value creator, and the provider or developer is a value facilitator (Juarez 2014). When the functions of each one are defined, it facilitates the communication and agreements between both parties (Comm & Mathaisel 2003; Emiliani 2004; Poppendieck 2007; Juarez 2014).

Çalişkan and Mulgeci (2015) and Srichuachom (2015) identified values in the higher education system that related to improving quality, proficiency of the lessons, which lead to the development of beneficiaries' skills. In short, as mentioned by David (2014), the higher education sector will need to do more with less, develop new teaching and learning strategies, that supported by effective products and services, offer a greater value adding proposition to the student and continue to be more "beneficiary" focused. In this research, the value added (VA) related to the indicators of research productivity as explained previously on subsection 2.4.3 is consistent with productivity improvement indicators in Lean higher education, such as Comm & Mathaisel (2003), Balzer (2010), Vinodh & Ben Ruben (2015), Çalişkan & Mulgeci (2015), Srichuachom (2015), Aghakhani et al. (2016).

d. Lean Thinking Success in Higher Education Sector

The Lean methodology has become more common in higher education institutions to reduce waste, simplify processes, improve quality, and increase productivity (Houston 2008; Balzer 2010; Jang et al. 2011; Parul Sinha & N.M. Mishra 2013; Robinson & University 2014; David E. Francis 2014; Thomas et al. 2015). A number of studies have been published relating to the implementation of Lean in higher education. Table 2.10 summarises the relevant studies to adopt the principles and practice of Lean in higher education to improve their productivity. The seminal work in the application of

Lean to academic processes was done by Prof. Emiliani when he was at Rensselaer Polytechnic University in the early 2000s and is described in two papers: Emiliani (2004) and (2005).

Table 2.10 The Success Studies that Applying Lean Theory to Improve Productivity in Higher Education

Productivity indicators achieved	**Studies applying Lean Theory**
• Higher level of student satisfaction. • Management of students' time. • Improved students' outcomes.	Emiliani (2004)
• Quick improvement. • Lower costs. • Higher quality. • Student satisfaction. • Improve products and services.	Emiliani (2005)
• Improve cultural sensitivity. • Willingness of employees to work across different departments and administrative levels.	Balzer (2010)
• Students can quickly learn. • Improve a university administrative process. • Students can have achieved new knowledge and skills. • Increase the highly valued in industry. • Growth higher education procedures through an innovative and engaging learning experience involving undergraduate students.	Doman (2011)
• Reduced waste is about 90% of the time for both the educational and the research process. • Providing newer knowledge and being able to use it much quicker. • Flexible speed of studies and improve educational process on campus. • Reduce time of publishing by 10%.	Isaksson et al. (2013)
• Sustainable, continuous improvement. • True cultural shift. • Positive outcomes.	Barton & Yazdani (2013)
• Process improvement. • More holistic interventions. • Enhances the problem solvers skills and confidence.	Martin et al. (2015)
• Improve learning. • Eliminating knowledge waste. • Emphasising empowerment. • Continuously improving the current statue.	Hu et al. (2016)
• Get the highest by using fewer resources. • Less equipment, and time. • Achieved customers' needs. • Increasing customer satisfaction. • Eliminated loss through continuous improvement and flowing out the product by customers to achieve perfection. • A positive impact on organisational learning and all its aspects.	Aghakhani et al. (2016)

In summary, from the previous studies, few research insights are available on the application of Lean principles in the higher education sector (Balzer 2010; Isaksson et al. 2013; Parul Sinha & Mishra 2013; Aghakhani et al. 2016). There are limited examples of how Lean has been applied by universities particularly the academic community (Vinodh & Ben Ruben 2015). By the same token, the empirical studies confirmed that the Lean approach in higher education was focused on developing the administrative processes as an integrated system, includes all its beneficiaries such as (students, lecturers, staff, and managers), whether at the national or global or local levels (Comm and Mathaisel 2003; Isaksson et al. 2013; Hu et al. 2016). These development studies did not focus on the individual independently from the administrative system regarding finding the practical solutions that contribute to the achievement of their needs and in return eliminate waste. As pointed out by Aghakhani et al. (2016), it is essential to improve the comprehensiveness of needs in relation to each small parts of the beneficiaries' categories individually to be able to meet beneficiaries' needs. In this regard, this study is focused on the individual level related to productivity improvement based on Lean thinking practice that contributes to addressing this gap.

2.4.5 Productivity Measurement in this Study

This study is focused on the productivity of the customer or service user (related to an academic researcher who is using cloud applications). Bevan and Azuma (1997) and Johnston and Jones (2004) measured the customer productivity as a function of the ratio of customer inputs, such as time effort and cost, to customer such as outputs, experience, outcome and value (Gates & Stone 1997; Alnanih et al. 2013; Flack & Dembla 2014; Fernández-Alemán et al. 2016). Bevan (2001), Nguyen et al. (2015), Atoum & Bong (2015), and Fernández-Alemán et al. (2016) confirmed that to evaluate customer productivity there is a need for evaluating operational productivity in terms of good operational factors related to service quality "high-performance" such as usability, security, speed, delivery, flexibility, reliability, functionality in lower time and cost, which lead to improve productivity (Käpylä et al. 2009). Productivity deals with both utilisation of resources and creation of value, through the availability of higher quality resources (Comm & Mathaisel 2003; Tangen 2005;

Käpylä et al. 2009; Shahin & Janatyan 2010; Juarez 2014; Nguyen et al. 2015; Rezaei et al. 2016). Beneficiaries cannot use the application efficiently, effectively and satisfactorily for performing work tasks if, e.g., it takes a lot of time to learn to use the functions, network connections do not work, or the application is for some other non-productive reasons (Käpylä et al. 2009).

a. The ISO/IEC 9126 Quality Standard to Evaluation the Software Quality and Productivity

The International Organisation for Standardisation (ISO) has defined a set of ISO and ISO/IEC standards related to software quality (ISO/IEC 2000; Botella et al. 2004; Djouab & Bari 2016). ISO/IEC 9126 which categorises quality from a user viewpoint as functionality, reliability, usability, efficiency, maintainability and portability (Bevan 1999; Padayachee et al. 2010). There are several others though, such as IEEE 1061, German Industry Standard DIN 55350, and ANSI Standard (Jamwal et al. 2009). For example, IEEE 1061 has three levels of quality characteristics, sub-characteristics, and attributes (Jamwal et al. 2009). While, Bevan and Azuma (1997), Bevan (2001) and Cucus and Novelia (2013) divided the ISO/IEC 9126 into three parts which address the quality model; external metrics; internal metrics; and quality-in-use metrics. It defines 26 attributes that a quality software product must exhibit. They are as follows:

1. **ISO/IEC 9126-1: Part 1:** Internal metrics provides internal quality metrics for measuring software quality characteristics applicable to a non-executable software product during designing and coding at an early stage of the development process (ISO/IEC 2000).

2. **ISO/IEC 9126-2: Part 2:** External metrics provides external quality metrics for measuring software quality characteristics applicable to an executable software product during testing or operating at a later stage of development and after entering the operation process. Quality model for external and internal quality includes six characteristics: functionality, reliability, usability,

efficiency, maintainability and portability (Azuma 2004; Padayachee et al. 2010; Moumane et al. 2016; Djouab & Bari 2016).

3. **ISO/IEC 9126-3: Part 3:** Quality-in-use metrics provides quality-in-use metrics for measuring software quality characteristics applicable to an executable software product after entering the operation process. It is measured by the extent to which the software meets the needs in the work environment that can be measured via output effectiveness, productivity, and satisfaction of the users (Bevan & Azuma 1997; Bevan 1999, 2001; Alnanih et al. 2013). The factors of the quality-in-use are defined as follows:

- **Measures of Output Effectiveness:** Relate the goals or sub-goals of the user to the accuracy and completeness with which these goals are achieved (Bevan 1999). It is to achieve a number of actions in a specified context relative to the time taken and cost (Alnanih et al. 2013; Atoum & Bong 2015).

- **Measures of Productivity:** Relates to the level of effectiveness achieved in the use of resources. It divides user outputs such as outcome effectiveness and value by user inputs such as time and cost in order to represent the user productivity ratio of percentile scale based on the customer productivity equation by Bevan & Azuma (1997) and Johnston & Jones (2004).

$$\text{Customer productivity} = \frac{\text{Outputs Effectiveness “experience, outcome, value”}}{\text{Time \& Costs}} \tag{2.1}$$

- **Measures of Satisfaction**: Assess the comfort and acceptability of the use as well as the user’s level of enjoyment (Bevan 1999; Alnanih et al. 2013). Usually reflects all quality properties (Azuma 2004).

- **Measures of Safety:** The capability of the software product to achieve acceptable levels of risks (Azuma 2004; Alnanih et al. 2013).

Overall, the actual implementation of the research productivity often focused on examining the macro level and do not focus on examining the micro level (Tangen 2005; Brew et al. 2016; Aghakhani et al. 2016). The macro level is related to examining global, national or industry levels, while the micro level focuses on a single organisation, department, unit, process or individual employee (Jonna Käpylä et al. 2010). One possible reason for this is the lack of understanding of the micro method (Tangen 2002, 2005; Altmann et al. 2009; Torrisi 2013).

To solve this gap, this study adopted the standard ISO/IEC 9126-2,3 software quality evaluation, to measure productivity in the micro level, which focuses on an individual level, as well as to measure the functionality and operational quality. It measures productivity at the macro level through the survey method. The SO/IEC model is adopted to measure the micro level because it is the most comprehensive and commonly used quality standard model and is easy to understand and to apply (Fahmy et al. 2012; Bari & Djouab 2014; Djouab & Bari 2016). The main significance of using this model is it has the metrics to evaluate the productivity related to Quality-in-Use dimension (Bevan 1999; Alnanih et al. 2013; Djouab & Bari 2016). It is achieved through the two mutual influence metrics: 1) the external quality (functionality, reliability, usability, and efficiency) and 2) quality-in-use (effectiveness, productivity, and user satisfaction). The procedure for evaluating quality-in-use have been developed as part of approaches to external quality (Bevan 1999, 2001; Alnanih et al. 2013; Djouab & Bari 2016). Good software design of user interface and appropriate functionality will let the user work effectively and efficiently, save time and efforts thereby increasing user productivity (Atoum & Bong 2015).

2.5 CLOUD COMPUTING QUALITY AND PRODUCTIVITY IMPROVEMENT

Cloud computing solutions encompass many aspects that range from the experience that end-users have with the new opportunities offered by this technology to the implementation of systems that make these opportunities a reality (Vecchiola et al.

2009). One of the key features characterising cloud computing is the ability to deliver both infrastructure and software as services (Ardagna et al. 2014). More specifically, it is a technology aiming to deliver on-demand IT resources on a pay per use basis. Previous trends were limited to a specific class of users or specific kinds of IT resources. Cloud computing aims to be global. It provides high-quality services to the masses ranging from the end-user that hosts its documents on the Internet, to enterprises outsourcing their entire IT infrastructure to external data centres (Vecchiola et al. 2009; Ardagna et al. 2014). The next sub-sections indicate the high-quality of cloud-based applications to achieve productivity indicators increases and add value to the beneficiaries' outputs.

2.5.1 Quality of Cloud-Based Applications to Create Values and the Indicators of Research Productivity

The IEEE has defined quality as being "the degree to which a system, a component or a process meet specific customers' needs, requirements and expectations" (Şiclovan 2013). While the International Standards Organisation (ISO) defines quality as "the number of features and characteristics of a process or service that bears the ability to meet the specific needs or implied" (Bevan 1999; Botella et al. 2004). While value is the desirability or utility of a thing (Cronk & Fitzgerald 1999). Value can be measured through increasing the level of satisfaction among end-users after using the service or product to create high-quality and more efficient applications and service to add value for end-user outcomes (Emiliani 2004; Sultan 2010; Wu et al. 2013).

Table 2.11 indicates the ability of cloud-based applications to raise productivity and add value to the end-user outputs. Cloud computing provides new opportunities through cost economy, resource sharing, competitive advantage, value chain, and economies of scale (Vecchiola et al. 2009). It can generate additional value by enhancing environmental sustainability (Chou 2015). The value of cloud offers through unlimited computer hardware and network devices (Vecchiola et al. 2009; Mohammed et al. 2010). Thus, when the cloud applications support interactive online learning environments, it is having added value (Chou 2015). The final objective of the cloud computing process is to create value for the society (Mohammed et al. 2010; Yarlikaş 2014).

Table 2.11 Indicators of Productivity Improvement through Quality of Cloud-Based Applications Adopted In this Study

Indicators of Productivity Improvement Through Cloud-Based Applications	The definition adopted of high-quality cloud-based applications	Related works
Cloud Application Performance "Quality"		
Accessibility	• Cloud applications enable users to control and access applications, accounts, and data from anywhere. • Cloud applications enable users to access research material remotely via computers and other portable devices. • Users are able to connect with others located all over the world to create efficient communication. • Possibility of follow-up works. • Users able to access various databases, and web servers will have the luxury of available resources from anywhere.	Anderson et al. (2008), Miller (2008), Herrick (2009), Sultan (2010), Mircea & Andreescu (2011), Sasikala & Prema (2011), Vujin (2011), Behrend et al. (2011), Morgan et al. (2011), Burke (2012), Mokhtar et al. (2013), Anjali Jain & Pandey (2013), Yadav (2014), Microsoft (2014a), Microsoft (2014b), González-Martínez et al. (2015), Nayar & Kumar (2015), Tan & Kim (2015), Chou (2015), Alharbi et al. (2016), Yuvaraj (2015), Moghaddasi & Tabrizi (2017).
Flexibility and usability	• Cloud applications provide the abstraction and virtualisation construction since it does not require expertise or unique knowledge to manage cloud services. • Cloud applications are user-friendly through new facilities, easy to understand and operate. • Server patching, management, and backup, along with redundancy. • Cloud applications are easy to modify user data shearing, reach a huge amount of communication and get resources. • Simple purchase process by credit card or P.O. • It is increased technical and access flexibility with the ability to scale on-demand.	Anderson et al. (2008), Sultan (2010), Taylor & Hunsinger (2011), Behrend et al. (2011), Vujin (2011), Sasikala & Prema (2011), Alshwaier et al. (2012), Bora & Ahmed (2013), Adi A. Maaita et al. (2013), Krelja Kurelovic et al. (2013), Mokhtar et al. (2013), Anjali Jain & Pandey (2013), Microsoft (2014b), González-Martínez et al. (2015), Chou (2015), Tan & Kim (2015), Yuvaraj (2015).
Highly effective service quality	• Providing high-quality service and computing power and more efficient data storage, processing and bandwidth. • Provide new opportunities through the implementation of systems that make these opportunities a reality. • Provide the supercomputing power available to the masses, and a number of skilled users.	Miller (2008), Vecchiola et al. (2009), Pocatilu et al. (2010), Sosinsky (2011), Conn & Reichgelt (2013) Huang et al. (2013) Anjali Jain & Pandey (2013), Bora & Ahmed (2013), Microsoft (2014a), Microsoft (2014b), Nayar & Kumar, (2015), González-

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	• Provide a global-scale data centre foundation. Data centres are distributed all around the world, and geo-redundancy for critical data and disaster recovery is available.	Mart ńez et al. (2015), Chou (2015), Yuvaraj (2015), Rodrigues et al. (2016), Alharbi et al. (2016),
Outputs Effectiveness		
Improve skills	• Skill of self-learning without any human interaction. • Skill of editing academic writing and reading. • Skill of knowledge of searching with others. • Skill of data analysis.	Anderson et al. (2008), Sultan (2010), Behrend et al. (2011), Chen (2011a), Huang et al. (2013), Invent (2015), Al-Ghatrifi (2015), Fonteijn (2015), Tan & Kim (2015), Alharbi et al. (2016).
Improve knowledge	• Capture and disseminate information and knowledge created by different learners and instructors. • Additionally, the instructor can make a variety of content available to learners, while the learner can often access content at the time and place that best suits their needs. • Create new areas of education, research and development through knowledge transmission. • Increase the availability of data for analysis and broaden the knowledge with less time and effort.	Sultan (2010), Chen (2011a), Vujin (2011), Masud et al. (2012), Huang et al. (2013), Krelja Kurelovic et al. (2013), Seke (2015), Invent (2015), Fonteijn (2015), Al-Ghatrifi (2015), Nayar & Kumar (2015), Rodrigues et al. (2016), Alharbi et al. (2016), Moghaddasi & Tabrizi (2017).
Improve experience	• Experience that users have with the new opportunities provided by this technology to the implementation of systems that help make these opportunities possible.	Vecchiola et al. (2009), Behrend et al. (2011), Huang et al. (2013), Microsoft (2014b), Invent (2015), Fonteijn (2015), Seke (2015), Tan & Kim (2015), Rodrigues et al. (2016), Alharbi et al. (2016).
Improve learning	• Bring flexibility and new possibilities for improving pedagogy. • Can be used to realise different kinds of innovative applications of education. • Providing a virtual interactive platform for users to communicate, sharing information and cooperative learning with each other in a social group. • Deliver the sensor technology-based application and learning style,	Sultan (2010), Chen (2011a), Behrend et al. (2011), Vujin (2011), Ercan (2012), Huang et al. (2013), Krelja Kurelovic et al. (2013), Invent (2015), Seke (2015), Al-Ghatrifi (2015), Fonteijn (2015), Nayar & Kumar (2015), Moghaddasi & Tabrizi (2017).

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	for example, context awareness, augmented reality, motion learning, data acquisition, etc. The data collected by sensors and information equipment can be provided for teachers to leading the learning state of students and to give suitable comment. • Cloud computing services could be used in learning directly, such as Google Apps for Education and Google Docs, to apply it to cooperative writing and managing large-scale works. • Support the autonomous learning of learners without teachers' intervention. Through the instant learning support feature (e.g., Google Scribe), intelligent learning support (e.g., Google Goggles), multi-sensory service experience (e.g., Qwiki), seamless service (e.g., Google Docs), and service for social interaction (e.g., Facebook). • Support the communication and collaboration in virtual learning environments within and beyond exact time slots that are reserved for face-to-face or virtual tutorial group meetings.	
Accomplish more work quickly (completeness).	• Able to upload class tutorials, assignments, and tests. • Improving research materials, methods, and resources. • Enhancing collaboration through supports the work in groups on projects where project team members are geographically distributed. • Provide various education services of information technology just by browser act. • Possibility of follow-up works remotely via any devices and anywhere. • Allowed researchers to search, find models, make fast discoveries, assist in building and creating a smarter planet, and develop and test applications immediately.	Anderson et al. (2008), Vecchiola et al. (2009), Herrick (2009), Scale (2009), Sultan (2010), Mircea & Andreescu (2011), Sasikala & Prema (2011), Taylor & Hunsinger (2011), Alshwaier et al. (2012), Adi A. Maaita et al. (2013), Bora & Ahmed (2013) Conn & Reichgelt (2013), Mokhtar et al. (2013), Adi A. Maaita et al. (2013), Yadav (2014) Microsoft (2014b), González-Martínez et al. (2015), Yuvaraj (2015), Rodrigues et al. (2016), Alharbi et al. (2016).
Improve scientific publishing.	• Enables the academicians, students and researchers ease of access to the latest applications and online resources. • Connects all the university faculties and departments and enables the	Sultan (2010), Vujin (2011), Microsoft (2014b), Al-Ghatrifi (2015).

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	• access to the data storages, emails, databases, educational resources, research applications and tools anywhere. • Provide various hardware and software resources necessary for a smooth flow of electronic education, scientific and research activities and students' projects. • Ensure direct access to a wide range of diverse research applications, tools and amount of research resources through the feature of citations, which provide the list of closely related information and keywords	
Increase Innovation	• Sharing data and making data public is simplified, advancing research and helping lead to increased innovation and practical application of results.	Herrick (2009), Sultan (2010), Krelja Kurelovic et al. (2013), Microsoft (2014b), Nayar & Kumar (2015), Moghaddasi & Tabrizi (2017).
Productivity Criteria		
Reduce Cost	• Pay-as-you-go service. • Free updates. • Free processing, productivity applications and bandwidth. • Ability to share servers and learning materials with other institutes. • Providing free educational resource storage and databases, emails, educational applications and tools. • Zero maintenance cost is involved since the service provider is responsible for the availability of services. • Can use Software, applications, and useful tools for free without having to purchase, install and keep them up to date on your computers.	Anderson et al. (2008), Miller (2008), Sultan (2010), Mircea & Andreescu (2011), Reichman (2011), Vujin (2011), Taylor & Hunsinger (2011), Morgan et al. (2011), Burke (2012), Chandra & Borah (2012), Cisco (2012), Anjali Jain & Pandey (2013), Conn & Reichgelt (2013), Huang et al. (2013), Mavodza (2013), Kang et al. (2013), Adi A. Maaita et al. (2013), Bora & Ahmed (2013), Milian et al. (2014), González-Martínez et al. (2015), Chou (2015), Tan & Kim (2015), Yuvaraj (2015), Rodrigues et al. (2016), Alharbi et al. (2016).
Reduce Time	• Provide quick and efficient communication. • Instant software updates. • Provide high-quality infrastructure (hardware) this reduces the time of building labs, teachers' skills, storage spaces etc. • Possibility of exchanging and sharing resources anywhere and	Sultan (2010), Mircea & Andreescu (2011), Chen (2011a), Vujin (2011), Behrend et al. (2011), Taylor & Hunsinger (2011), Morgan et al. (2011), Agcaoili (2012), Bora & Ahmed (2013), Kang et al. (2013), Adi A. Maaita et al. (2013), Anjali Jain & Pandey

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	anytime. • Offline usage and faster backup files and automatically updated across all devices. • Possibility of attending classes and conferences, and participation by remote on-demand, minimising time loss. • Continuation of flags about useful software and related applications. • Possibility of follow-up works.	(2013), Kottari et al. (2013), Nayar & Kumar, (2015), González-Martínez et al. (2015), Al-Ghatrifi (2015), Yuvaraj (2015), Tan & Kim (2015), Rodrigues et al. (2016), Alharbi et al. (2016).
User Satisfaction	• Satisfied with the variation and consistency of service offerings • Satisfied with the cost saving • Improve satisfaction by allowing new services to be delivered such as self-service stations. • Enhance user satisfaction by improving IT department performance by reducing the ratio of system failures and by reducing time taken to resolve problems	Herrick (2009), Behrend et al. (2011), Tor Guimaraes & Paranjape (2014), Tan & Kim (2015), Rodrigues et al. (2016), Alharbi et al. (2016).

In conclusion, as shown in Table 2.11, the previous experimental studies and literature found a positive role of cloud computing applications to achieve the indicators of productivity. It is a solution for the wastes associated with the academic researcher's task and activities. In addition to the previously mentioned studies of research productivity, such as Åkerlind (2008); Balzer (2010); Shahin and Janatyan (2010); Uarez (2014); and Brew et al. (2016) the indicators of productivity improvement among academics are related to improving their outcomes and meeting their needs. Increasing new knowledge opportunities (Chen 2011; Masud et al. 2012; Seke 2015), building skills (Braman 2006; Razak 2009), gaining experience (Rodrigues et al. 2016; Alharbi et al. 2016), and increasing scientific production (Brew et al. 2016). In addition, it increases innovation and improves performance and task completeness during a short period at minimum cost and effort (Braman 2006; Taylor & Hunsinger 2011; Al-Ghatrifi 2015). That is consistent with Braman (2006), Razak (2009), Taylor and Hunsinger (2011) and Yarlikaş (2014) that confirmed that academic researchers must be able to improve a range of intellectual and practical skills as well as positive attitudes. The effective tools must ensure that academic researchers take responsibility to increase their needs (Ghatrifi 2015). For example, improve self-directed learning, remotely access and manage research, evaluating research outcomes, availability, data retrieval, storage, and save their time and budget and prepare them for lifelong productivity. This helps meet the research challenges efficiently and increase the quality of services and flexibility to promote analytical thinking, problem-solving, and effective communication (Braman 2006; Taylor & Hunsinger 2011).

Cloud applications help meet the research challenges efficiently and increase the quality of services and flexibility to promote analytical thinking, problem-solving, and effective communication (Mika Hannula & Lönnqvist 2011). The reviews also highlighted that private cloud computing applications would provide values for all academic researchers' perspectives with some high expectations for the financial and time reduction perspective. This study is one of the few studies that discuss cloud-based applications implementation to improve the productivity of academic researchers and to add value.

2.5.2 The Evidence for the Adoption of Cloud Applications to Improve Productivity from the Practical Studies

Recently, with increasing performance expectations and complexity, it is more important than ever to be productive (Lackey et al. 2014a). As Lackey et al. (2014b) reported that the performance expectations are at an all-time high for academic research and important to continue to increase in the future, making it a suitable time to focus on personal productivity. Bhargava and Lackey (2013) and Lackey et al. (2014a) considered the productivity is a skill like any other that can be learned and improved through continuous practice. Productivity is not only about getting tasks completed on time but is also about simplifying one's life and removing undesirable confusion so that important tasks may be completed in a timely manner (Bhargava & Lackey 2013). Ever growing dependence on computers and the Internet has significantly influenced the way we work, but not optimising their use can lead to distraction and wasted time. Myriad software applications have been developed to increase personal efficiency (Polančič et al. 2015). As shown in Table 2.12, the results obtained from some studies illustrate the extent of achievement of indicators of productivity using cloud computing solutions. This section will present the successful empirical studies in different fields that using the cloud computing services and applications to raise their productivity.

Table 2.12 Empirical Studies Adopted Cloud Applications to Improve Their Productivity from Different Field

Field of Studies	Cloud Applications Used	Productivity Improvement Indicators
Radiology Education (Lackey et al. 2014a)	• Email (e.g., yahoo email, Gmail, and Microsoft). • Scanner and organise scanned software (e.g., Fujitsu ScanSnap iX500, Brother ImageCenter ADS-2500, and NeatConnect). • Reference management applications (e.g., EndNote, Bookends, Mendeley, Zotero and other). • Note-taking applications. • Text expander's applications.	• Eliminates chaos and stress. • Saving space. • Saving time. • Ubiquitous access. • Instant transfer. • Easily manage references. • Less effort. • Extended resources. • Easy retrieval. • Easily searchable. • Availability anytime and anywhere.

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Radiology Education. (Lackey et al. 2014b).	• Cloud storage and sharing application (e.g., Dropbox, Google Drive, OneDrive, SugarSync, and box). • Remote meeting applications (e.g., GoToMeeting, Watchitoo, join.me, and WizIQ). • Screencasting (e.g., Adobe Captivate, Adobe Captivate, and ScreenFlow). • Speech recognition software. • Password managers (e.g., LastPass, and 1Password). • Online data backup services (e.g., Backblaze an online data backup service).	• Delays reducing. • Duplication work reducing. • Safety of data storage. • Less effort. • Saving cost. • Saving time. • Improving communication. • Offer useful functionality, platform and compatibility. • Ease of use. • Faster tools.
Higher education sector Teaching and learning (Sharma et al. 2016)	• Facebook.	• Improve learning process. • Increase resources. • Accomplish activities. • Flexible learning.
Enterprises and companies (Flack and Dembla 2014)	• Existing SaaS products.	• Resources available when needed. • Saving time through faster response time. • Saving cost. • Access and computational scalability. • Flexibility to allow employees to work from anywhere. • Able to access on-demand from anywhere in the world. • Increase satisfaction.
Undergraduate IT students (Polančič et al. 2015).	• Existing SaaS products.	• Saving time through faster response time • Increase users experience • Increase e-collaboration • Achieved several activities
Central European students in the IT-sector (Bernsteiner & Pecina 2015)	• Google Docs (Office 2.0 tools).	• Able to access on-demand from anywhere in the world. • Resources available when needed. • Saving time through faster response time. • Improve learning process. • Increase resources. • Accomplish activities. • Capability on any devices.
Organisations (Chou 2015)	• Existing SaaS products.	• Enhancing continuous improvement. • Increase resources. • Cost saving. • Ease of use. • Flexibility.

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Libraries (Yuvaraj 2013, 2015)	• Productivity Suites (e.g., Google Doc and Microsoft Office 365). • Mailing Services (e.g., Gmail, and Outlook or Hotmail). • Storage Services (e.g., Google Drive, OneDrive, Dropbox, and iCloud). • Cataloguing Suites (e.g., LibraryThing, Biblios, and Bookwhere). • Calendar Services (e.g., Google calendar Yahoo calendar and Zoho).	• Duplication work reducing. • Safety of data storage. • Less effort. • Saving cost. • Saving time. • Enhancing communication and collaboration. • Availability anytime and anywhere. • High functionality. • Accomplish activities.
Healthcare system (Rodrigues et al. 2016; Alharbi et al. 2016; Moghaddasi and Tabrizi 2017).	• Cloud-based health services (e.g., Balanced Scorecard (BSC). • E-health Cloud (e.g., personal health records (PHR) Healthcare information system, Telemedicine, Clinical Decision Support System (CDSS), and Biological Software).	• Saving cost. • Saving time. • Improve satisfaction. • Raise some privacy and security. • Improve Research and Development. • Enhancing department performance. • Improve management process. • Improve IT resource availability. • Reducing system failures. • Backup and recovery data.
Business (Etro 2009; Marston et al. 2011; Aljabre 2012; Berman et al. 2012; Schniederjans & Hales 2016).	• Google App, Microsoft Office, and Amazon cloud services (Etro 2009; Aljabre 2012). • Cloud computing services and applications (Marston et al. 2011; Schniederjans & Hales 2016).	• Increased company production. • Saving cost. • Saving time. • Continue business works. • Remotely access. • Increase business productivity. • Lesser collaboration. • Improve companies' performance.

In summary, according to Käpylä et al. (2009) and Sharma et al. (2016), the realisation of productivity from the use of cloud applications depends on other factors. Such as, user budget, technology usage level, the utilisation of intellectual capital and the development of business environment and not only on a cloud service. Thus, productivity considerations increase the understanding offered by usability theories of how cloud services are creating value. However, it also works the other way around. It is important to identify the underlying factors supporting the realisation of productivity impacts. Marston et al. (2011), Berman et al. (2012), Microsoft (2014) and Schniederjans and Hales (2016) report that businesses of all sizes and personnel see value in cloud pricing that lets the user pay-as-you-go for the volume of services user use. While Etro (2009) and Marston et al. (2011) report that more than 80% of SMBs in the United States see productivity as the primary benefit from cloud applications. European governments and industry plan to invest 45 billion euros in the development of cloud computing by the year 2020 (Krelja Kurelovic et al. 2013; Moghaddasi & Tabrizi 2017). These applications are broad and increasing daily because of many features to the users and are driven by the increasing use of mobile devices (laptops, tablets and smartphones) and mobile Internet access is more available (Wu & Chang 2016).

As summarised in Table 2.12, the results obtained from the different fields of studies illustrate the extent of achievement of indicators of productivity through using cloud computing solutions. Cloud-based applications have many advantages related to productivity improvement and raise the satisfaction factor (Ahuja et al. 2012; Dominguez 2013; Phaphoom et al. 2013; Flack & Dembla 2014; Tor Guimaraes & Paranjape 2014; Mimoun et al. 2014; Microsoft 2014a).

2.6 INFORMATION SYSTEM (IS) SUCCESS THEORY

IS success being an IS theory that seeks to provide a comprehensive understanding of IS success by identifying, describing, explaining the relationships among the most critical dimensions of success, as well as IS was commonly evaluated (Iivari 2005; Nguyen et al. 2015). Preliminary development of the IS theory was conducted by William H. Delone and Ephraim R. McLean during the first meeting of the International Conference on Information System (ICIS) in 1992 (Delone & McLean 1992). That for attempted to bring some cognizance and structure to the “dependent variable” of IS success (Delone & McLean 1992; Urbach & Müller 2012; Nguyen et al. 2015), they suggested a taxonomy and an instructional model as frameworks for conceptualising and operationalising IS success. Presently, the IS success model has been mentioned in thousands of scientific papers and is considered as the most significant theory in contemporary IS research (Nguyen et al. 2015).

The key variable that has been researched by many authors is the success of information systems (French 2009). The extensiveness of literature in this area had little unification until DeLone and McLean (1992) created a classification for information system (IS) success that resulted in the creation of the DeLone & McLean model (D&M) for IS success. Since the development of the D&M model (1992), many authors have applied this model to several contexts and specified the various dimensions of the model in attempts to make it more comprehensive and applicable. The variety in the approaches of researchers can be categorised into three approaches: Intention to use the approach from the Technology Acceptance Model (TAM), User Satisfaction Theory (UST) approach and DeLone and McLean Model (D&M) approach. The following sub-sections will discuss these approaches.

2.6.1 Intention to Use Approach in Other Theories

The TAM model is developed by Davis (Davis 1989; Venkatesh & Davis 2000), and it is an adaptation of the Theory of Reasoned Action (TRA), and the Theory of Planned Behaviour (TPB), which are two of the most popular models used to explain IS behaviour (Satu-Maria & Markova 1995). Hence, it does a good job in emphasising the factors of Perceived Usefulness and Perceived Ease of Use that affect users' behavioural intentions as the measure of IS success and this effect impacts on IS Use (Rai et al. 2002). Many researchers applied the ITU to different types of technologies and in different contexts (Kang et al. 2014; Manchanda & Mukherjee 2014; Salem & Salem 2015; Rezaei et al. 2016). System usage is adopted as a mediator variable in a number of empirical studies and continues to be developed and tested by IS researchers (Rai et al. 2002; French 2009; Wu & Chen 2015; Mohammadi 2015). Iivari (2005) and Lee et al. (2009a) found technology has a significant effect on the individual productivity and the quality of the performance. Researchers in the area of IS have attempted to explain and predict individual behaviours and have determined that behavioural intention (BI) is the dominant factor in the use of information systems (ISs) (Shiau & Chau 2016).

DeLone and McLean (2003), Al-Sabawy (2013), Alkhaldi (2013), Mohammadi (2015), Shiau and Chau (2016), and Esterhuyse et al. (2016) have aggregated more than eight theories to explain behavioural intention (BI), such as TRA, TAM, MM, TPB, a combined TPB and TAM (TAM 2), the model of PC utilisation (MPCU), UTAUT, IDT, and SCT. Table 2.13 summarises the existing theories that developed Intention to Use (ITU), and Behavioural Intention (BI) to depict the structure, as shown as below:

Table 2.13 Theories That Developed the Intention To Use Construct

Intention To Use Construct	**Used in Theories**
Behavioural Intention (BI)	Theory of Reasoned Action (TRA) (Fishbein & Ajzen 1975; Madden et al. 1992).
Behavioural Intention to Use (BITU)	Technology Acceptance Model (TAM) (Davis 1989).
Intention to Use (ITU)	Technology Acceptance Model 2 (TAM 2) (Venkatesh & Davis 2000).
Behaviour (B)	Social Cognitive Theory (SCT) (Bandura 1986).
Behavioural Intention (BI)	Theory of Planned Behaviour (TPB) (Ajzen. 1991).
Intention (I)	Decomposed Theory of Planned Behaviour (DTPB) (Taylor et al. 1995).
Behaviour Action (BA)	Motivational Model (MM) (Ryan & Deci 2000).
Affect Towards Use (ATU)	Model of PC Utilisation (MPCU) (Thompson et al. 1991).
Decision	Innovation Diffusion Theory (IDT) (Rogers 1983).
Behavioural Intention (BI)	Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al. 2003).

2.6.2 User Satisfaction Theory (UST) Approach in Other Theories

The origins of the concept of “user satisfaction” can be traced to the work of Cyert and March (1963) (Ives et al. 1983) that an information system which meets the needs of its user will reinforce satisfaction with that system (Ives et al. 1983; Nwankwo 2007; Käpylä et al. 2009). Following the same logic, Nwankwo (2007) and Alnanih et al. (2013) noted that perceived individual satisfaction is related to the positive outcome from the expenditure of scarce resources and/or the fulfilment of unmet needs, as well as a satisfactory level of the IS’s quality and content, efficiency, and effectiveness (Delone & McLean 2003; Ou et al. 2011; Urbach & Müller 2012; Othman & Musa 2014; Chiu et al. 2016). Satisfaction is the case felt by a user who has experienced performance or outcome that has fulfilled his or her expectations (Chin et al. 1988; Nwankwo 2007; Amin et al. 2014).

Figure 2.1 shows the Origin Model for Customer Satisfaction Theory (CST), which requires only the use or experience of a product or service and the purchase of services or product. Thus, the terminology of user satisfaction rather customer satisfaction is preferred by some theorists (Hom, 2002; Nwankwo 2007).

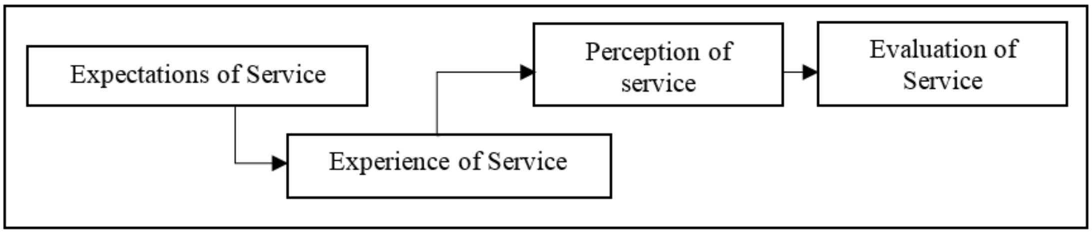

Figure 2.1 Basic Model for Customer Satisfaction or Dissatisfaction

Initial information systems researchers, for example, Ives et al. (1983) and Cronin et al. (2000), measure end-user satisfaction as a function of system characteristics. Thus, end-user satisfaction has become an important proxy for evaluating the success and performance of an information technology service department (Nwankwo 2007; Petter & McLean 2009; Putra 2014), and a widely accepted indicator of IS service success (Zhu 2012; Al-Sabawy 2013). There are of two types of user satisfaction measure. The first concentrates on the information system product (Bevan 1999). With such various names, such as “system acceptance” (Esterhuyse et al. 2016), “output quality” (Manchanda & Mukherjee 2014; Atoum &Bong 2015), and “Management information Service (MLS) appreciation” (Ives et al. 1983), these scales concentrate on the content of the information system (e.g., accuracy, relevance) (Wang et al. 2007; Yuvaraj 2014), and the way in which the information is presented (e.g., format, mode) (Manchanda & Mukherjee 2014; Ishak et al. 2014). The second type of multiple-item scale includes the provider support for developing and maintaining the system as well as the system product itself (Lee et al. 2000; Delone & McLean 2003; Mohammadi 2015; Rezaei et al. 2016). This type of instrument contains items concerned with training, documentation, development procedures, and system maintenance (Almutairi & Subramanian 2005; Kang et al. 2013; Rezaei et al. 2016). Finally, scholars have found that user satisfaction is related to user attitudes towards computer systems, adequacy, effectiveness, efficiency, and overall satisfaction (Igbaria & Toraskar 1992; Delone & McLean 1992; Delone &

McLean 2003; Wu & Wang 2006; Wang et al. 2007; Urbach & Müller 2012; Hsu et al. 2015; Chiu et al. 2016).

2.6.3 DeLone and McLean Model (D&M) Approach

a. The Original Model of DeLone and McLean (D&M) (1992)

The main objective of the original DeLone and McLean (1992) was to include IS success into a more consistent body of knowledge and to guide future researchers (Delone & McLean 1992; 2002; 2003). Shannon and Weaver (1949), in communications research, and Mason (1978) in the information "influence" theory, along with the empirical research studies from 1981 to 1987 of management information systems (MIS) contributed to developing a comprehensive, multidimensional taxonomy of the IS success model (Delone &McLean 2002; 2003).

Delone & McLean (1992). The taxonomy was three levels of communication (technical level, semantic level, and effectiveness level) based on Mason's (1978) modification of the Shannon and Weaver information model (1949) (Petter & McLean 2009; French 2009; Nguyen et al. 2015). This analysis yielded six variables of IS success, as shown in Figure 2.2. They are system quality, content/information quality, use, user satisfaction, individual impact, and organisational impact.

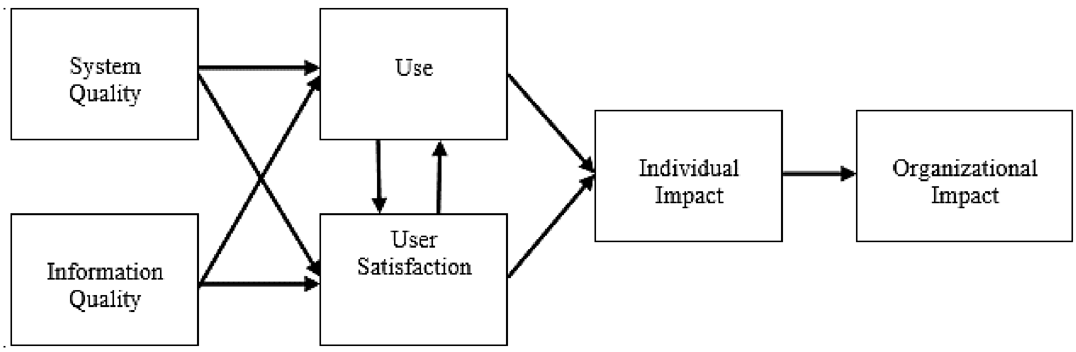

Figure 2.2 Original Model of DeLone and McLean IS Success: (Delone & McLean 1992).

On the technical level (accuracy and efficiency of the system that produces it) (Petter & McLean 2009), IS researchers focus on the desired characteristics of the IS which produces system quality. On the semantic level (system ability to transfer the purposed message) (Petter & McLean 2009), researchers select the information product for information quality. As for the influence or effectiveness level (system impact on the receiver) (French 2009; Petter & McLean 2009). Researchers analyse the information product interaction with its beneficiaries, by measuring "use, user satisfaction, individual impact, and organisational impact", and are concerned with the information being transmitted affecting conduct in a desirable way (French 2009; Petter & McLean 2009), as described in Figure 2.3. For developing this theory of IS, Mason modified and expanded the effectiveness level into information receipt, influence on the system, and influence on the recipient (Mason 1978; Petter & McLean 2009). It had a positive impact on the widening its popularity which is strong evidence of the need for a comprehensive framework in order to incorporate IS research findings during the last decade as the IS role has changed and progressed (Delone & McLean 2002; Nguyen et al. 2015).

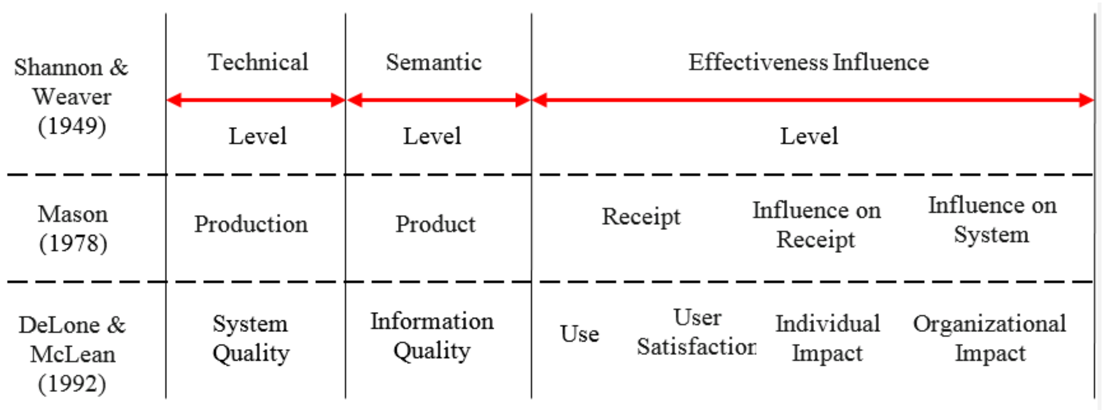

Figure 2.3 Categories of IS Success.

Source: (Delone & McLean 1992)

DeLone and McLean (1992) stressed that their taxonomy and model of IS success factors include all the work done before their study, but the model needs additional development prior to becoming a foundation for culling appropriate IS measurable (Petter & McLean 2009).

b. Updated Model of DeLone & McLean (D&M 2003)

Ten years after the publication of the original IS success model D&M (1992), some researchers claimed that the D&M is incomplete and recommended that more dimensions should be included in the model or proposed the other models (Iivari 2005; Urbach & Müller 2012; Nguyen et al. 2015). DeLone and McLean (2003) argue that Seddon's (1997) model complicates things, so they set out to develop a revised and parsimonious extension to their previous work (French 2009; Nguyen et al. 2015). This lead DeLone and McLean (2002, 2003) to propose an updated IS success model for recognising these potential improvements over their original model (1992). D&M acknowledged these modifications and revised their model accordingly (Petter & McLean 2009; Urbach &Müller 2012). The updated model is shown in Figure 2.4.

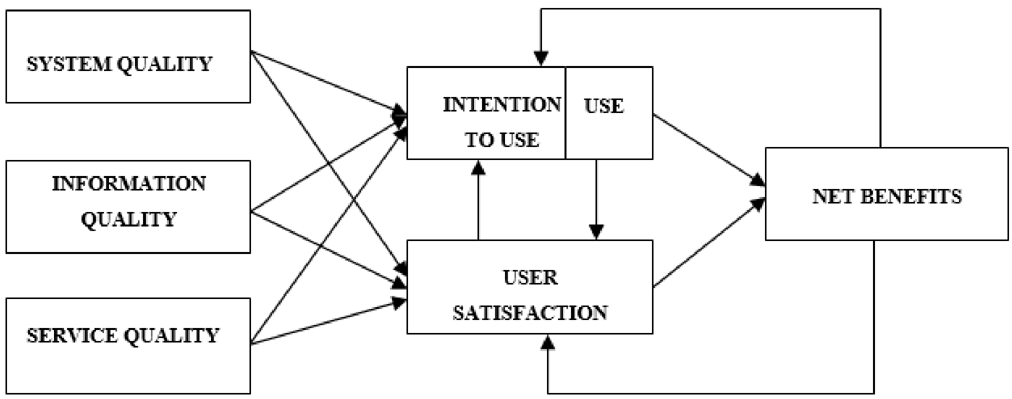

Figure 2.4 Updated of DeLone and McLean IS Success Model (2003)
Source: (Delone & McLean 2003)

DeLone and McLean (2003) pointed out that the impact of the IS system is based on the context in which it is being used or studied (French 2009). D&M also suggested assigning different weights to system quality, information quality, and service quality depends on the context and application of the model (Petter & McLean 2009).

Another adjustment was the removal of individual impact and organisational impact as separate variables, exchanging them for net benefits. This change addressed the criticism that IS can affect levels other than individuals and organisations (Petter & McLean 2009). The net benefits increased by the system should be determined based on the context of the information system (Seddon et al. 1998). In confirmed contexts, when individual impact is suitable, supposed usefulness would be highly related to individual perception of the net benefits gained by the system (Rai et al. 2002). Thus, the usefulness of the updated D&M model is viewed as the benefit gained as opposed to the reason of net benefits according to the Seddon (1997) model. While, Seddon et al. (1999) reported that the updated model accounted for benefits happening at any level of analysis (workgroups, industries, and societies); the choice of which level was to be determined by the researcher using the model (Petter & McLean 2009; Urbach & Müller 2012).

Since the development of the D&M model (1992 and 2003), various researchers altered or extended the model. Others adapted it for specific applications, such as information systems (Manchanda & Mukherjee 2014; Nguyen et al. 2015), e-commerce (Rouibah 2014; Hsu et al. 2014), knowledge management systems (Jennex & Olfman 2003; Chang et al. 2015; Gil Herrera & Martin-Bautista 2015), enterprise resource planning (Ifinedo & Nahar 2007; Bernroider 2008; Hsu et al. 2015)., e-government (Yousif et al. 2013; Rana et al. 2015; Chen et al. 2015). In return, many other studies have wanted to improve on the IS success factors by adding dimensions, changing the dimensions (e.g., Seddon & Kiew 1994; Seddon 1997; Delone & McLean 2003; Ou et al. 2011; Kang et al. 2013; Sundarraj & Venkatraman 2015) or by applying the D&M model in numerous contexts modifying the dimensions as needed (Molla & Licker 2001; Lin 2008; Wang 2008; Tam & Oliveira 2016).

2.6.4 The Interrelationship Between Productivity Improvement and DeLone and McLean Success Model (D&M SM)

There is evidence of a correlation between the productivity improvement indicators and Delone and McLean Success Model (D&M SM) through the seven dimensions of IS model (1992 & 2003): system quality, information quality, service quality, system use, user satisfaction, and individual impact. The productivity improvement dimensions are related to the optimum utilisation of product or service with of high-performance of high-quality, speed, delivery, flexibility in lower time and cost to "completeness user tasks that related to achieving specific goals and the creation of value for user" as an output ratio. It is achieved through the three levels of Delone and McLean model (1992).

1. Technical level focused on accuracy and efficiency of the system that produces it, "system itself" operational quality (Delone & McLean 1992; Petter & McLean 2009; Fernández-Alemán et al. 2016). It produces system quality (ease of use, system flexibility and reliability, navigation, and response times, etc.) (Delone & McLean 1992, 2003; Wang et al. 2007; Mohammadi 2015; Rezaei et al. 2016). In return, productivity compatible with this level means a user's productivity is increased if its resources have reduced time duration and economic terms through proper use (Bevan 2001, Nguyen et al. 2015, Atoum & Bong 2015, Fernández-Alemán et al. 2016). It is closely related to the usability and availability of resources or services (Bevan 1999; Azuma 2004; Alnanih et al. 2013; Cucus & Novelia 2013).

2. The semantic level refers to the system's ability to transfer the purposed message (Petter & McLean 2009). It refers to the quality of the performance to the extent that the information fits user (Urbach & Müller 2012; Ercolani 2013; Rezaei et al. 2016). It produces content/information quality related to how good the services or systems are in terms of its output, completeness, understandability, relevance, practicable, availability, timeliness and clear (Delone & McLean 2003; Wu and Wang 2006; Chen 2011a; Chiu et al. 2016). It is related to the productivity issue in terms of the need of a number of tasks performed at minimum cost and time by the user to complete the task (Nguyen et al. 2015; Atoum & Bong 2015; Fernández-Alemán et al. 2016). High productivity is achieved when resources add value to the user outputs (Tangen 2005; Srichuachom 2015; Nguyen et al. 2015).

3. The influence or effectiveness level refers to the system's impact on the receiver (French 2009; Petter & McLean 2009). DeLone and McLean (1992) reported all the measures of I/S success, "impact" is closely related to performance, and "improving user's performance" (Seddon 1997; Delone &

McLean 2003; Noorman Masrek et al. 2010). Researchers analyse the information product interaction with its beneficiaries by measuring “Use, User Satisfaction, Individual Impact, and Organisational Impact”, and are concerned with the information being transmitted (French 2009; Petter & McLean 2009). This level achieves productivity improvements through the achievement of users’ needs and creation of value to the users’ outputs (Tangen 2005; Srichuachom 2015; Nguyen et al. 2015). In this study, the “individual impact” factors as a “dependent variable” are compatible with research productivity indicators as presented in Table 2.9 (Wills et al. 2013; Sampath Kumar & Manjunath 2013; Nguyen et al. 2015; Wamala & Ssembatya 2015; Fernández-Alemán et al. 2016). It is frequently measured in terms of improving work performance, individual productivity based on time and cost, capability, improve outputs, usefulness and achieve user satisfaction (Lee et al. 2009a; Rewatkar & Lanjewar 2010; Ou et al. 2011; Gurunath & Kumar 2015; Ito 2016). Individual impact means benefits accruing to individuals from use and benefit to the user (Delone & McLean 1992; Seddon 1997).

4. Service quality is positively influencing use/intention to use and user satisfaction through the service provider’s responsiveness and technical competence (Delone & McLean 2003). Increased use and satisfaction leads to improved individual outputs and vice versa. Thus, increasing individual productivity leads to greater satisfaction and use (Lin 2008; Alnanih et al. 2013), which achieves the principle of continuous improvement (Delone & McLean 2003; Petter & McLean 2009). The quality dimensions impact on the level of users’ use and their performance and productivity. McGill et al. (2003), Iivari (2005), Wang and Liao (2008), Chen and Cheng (2009), Lee et al. (2009a), Noorman Masrek et al. (2010), and Al-Sabawy (2013) have empirically shown that the level of user satisfaction is a significant determinant of individual impact and productivity. Hence, the factors of quality reflect the individual impact, and the impact of IS on individual productivity (Tangen 2005; Ward & Zhou 2006; Srichuachom 2015; Rezaei et al. 2016).

5. The Delone & McLean success (2003) updated model includes the feedback loops from net benefits to user satisfaction and intention to use as shown in Figure 2.4. It means if the IS or service is to be continued, it is assumed that the net benefits from the perspective the system are positive thereby influencing and reinforcing subsequent use and user satisfaction (Delone & McLean 2003). The feedback loops represent the continuity of improvement to system quality through the positive of system usage and user satisfaction (Chiu et al. 2016). This is compatible with the principle of continuous improvement "Kaizen" or "change for the better". It is one of the fundamentals of Lean Thinking Theory (LT), which aims to achieve continuous productivity improvement (Mefford 2009; Jang et al. 2011; Michal Niezgoda &Yorkstone 2014; Aghakhani et al. 2016).

The studies that related issues of raising productivity emphasise the success of improving productivity is significantly related to ensuring the high-quality factor as the input to the activities or processes (Emiliani 1998; Bowen & Youngdahl 1998; Juarez 2014; Srichuachom 2015; Martin et al. 2015; Hu et al. 2016). Thus, good IS quality factors "reliability, functionality, security, usability and learnability" lead to improved productivity (Käpylä et al. 2009). Also, this model has been theoretically and empirically evaluated by many studies such as Iivari (2005), Noorman Masrek et al. (2010), Halonen et al. (2012), Ercolani (2013), and Salem & Salem (2015), which they also provided the real evidence of increased productivity through their results.

Delone & McLean IS Success Model (D&M ISSM) (1992, 2003) is the most comprehensive model that concentrated on measuring quality. The quality factor in D&M ISSM is a criterion for the system's success to improve the outcomes and supported by the scale of system use and user satisfaction. It is the primary requirement for productivity improvement (Tangen 2005; Ward & Zhou 2006; Åkerlind 2008; Balzer 2010; Shahin & Jonathan 2010; Juarez 2014, David E. Francis 2014; Srichuachom 2015; Martin et al. 2015; Hu et al. 2016; Rezaei et al. 2016). In addition, the success factors of D&M IS can be researched on many levels, such as individual, group, organisational, or societal impacts (Delone & McLean, 2003; French 2009).

2.6.5 Main Directions for the Development of DeLone and McLean Model to Measure the Success of Cloud Computing Services and Applications

The DeLone and McLean model are considered as a common technique used to evaluate information systems success (Al-Sabawy 2013). Use of this model is not restricted merely to evaluating traditional information systems (Sabi et al. 2016). There are many researchers studied and developed the model of DeLone and McLean (1992 & 2003) in different fields. For example, e-commerce (Hsu et al. 2014), the system of the banking sector (Tam & Oliveira 2016), and healthcare and medical informatics (Liu & Chang 2013). In the cloud computing field, DeLone and McLean's model has evaluated the success of cloud services and applications to achieve specific benefits (Ibrahim et al. 2015; Alharthi et al. 2016; Sabi et al. 2016). Studies of a cloud computing environment have adopted different methodologies to developing this model. Some studies adopted this model partially and assessed the validity of specific constructs. While others intended to extend the model to identify more factors affecting cloud solution success.

Al-Sabawy (2013) identified three major directions had been used by previous studies to develop the DeLone and McLean model. The first direction concentrated on the test of the validity of DeLone and McLean's model in assessing the success of cloud computing solutions, (e.g. Kang et al. 2014; Rezaei et al. 2016; Chiu et al. 2016). The second direction adopted the DeLone and McLean's model and added additional constructs (e.g. Ou et al. 2011; Kang et al. 2013; Sundarraj& Venkatraman 2015). Other studies examined the DeLone and McLean's model partially through concentrating on specific constructs (e.g. Lin 2008; Wu & Chen 2015). The third direction as formulated through studies that tried to combine DeLone and McLean's model with other theories such as TAM and UTAUT (e.g. French 2009; Chen 2011a; Chen 2015). The main purpose of this combination of the two models is to identify a wide range of factors that affect the success of cloud computing application.

Measuring DeLone and McLean's model through several directions will discover the new success factors that contribute to solving specific problems or identify a gap that has not been addressed. Table 2.14 illustrates these directions through the previous studies in the cloud computing field for identifying the main constructs and variables (dependent variable, independent variables and mediator variables) of the D&M model. Independent variables refer to the causes and factors used to justify the variation in the dependent variables. The mediating variables explain the relationship between the dependent variable and the independent variable. While, dependent variables act like the effects in research analysis, which are the phenomena that researchers aim to explain (Ragin & Amoroso 2010). These helps determine the research gaps and investigate the success factors in cloud computing through the DeLone and McLean's model.

Table 2.14 Empirical Tests of Cloud Computing through DeLone and McLean's Model Based on Three Directions

First Direction: Test the validity of the DeLone and McLean model in Assess the Success					
Reference Area of Study	**Objective of Study**	**Dependent Variable**	**Independent Variables**	**Mediator variables**	**The Successful Results of study**
Online Communities (Lin & Lee 2006).	This study adopted the updated D&M ISSM (2003) as a theoretical framework, to examine the determinants for successful use of online communities.	Member Loyalty	1.Information Quality. 2.System Quality. 3.Service Quality.	Intention to Use And User Satisfaction	The results identified the determinants of online communities. It showed system quality, information quality and service quality had a significant effect on member loyalty through user satisfaction and behavioural intention to use the online community.
Virtual learning environment (Conboy et al. 2009).	The study used the D&M (2003) model to describe the success of the virtual learning environment on completing degrees, through the six dimensions.	Net Benefits	1.System Quality. 2.Information Quality. 3.Service Quality.	Intention to Use And User Satisfaction	The results show that the virtual learning environment had succeeded. Five measures (System Quality, Service Quality, Use, User Satisfaction and Net Benefits) were interpreted as positive. 'Information Quality' was perceived better, but more material was desired into the environment.
Virtual learning environment (Halonen et al. 2012).	The study adopted the D&M (2003) to describe the success of knowledge sharing in an information system that included a part of the knowledge base of a private educational institute.	Net Benefits	1.System Quality. 2.Information Quality. 3.Service Quality.	Intention to Use And User Satisfaction	The study found that all the relationships among the model constructs were significant.
Cloud Computing SaaS Assessment (Ccsaasa) Ercolani 2013).	The study used the D&M (2003) create the "Computing SaaS Assessment" (CCSaaSA)	Net Benefits	1. System Quality 2.Information Quality.	Intention to Use/ Use and User Satisfaction	The results indicated that the cloud "user satisfaction" and "user use & intention to use" has been a direct connection with

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	success model. That with the intention of capturing and evaluating the "user satisfaction" and "user use and intention to use" of a cloud service introduction within a company.		3. Service Quality		cloud user net benefit. There is the correlation relation between "user satisfaction", "intention to use and use". In addition, the research explained the IS success is providing the benefit for organisation utilisation.
Cloud Learning System (Kang et al. 2014).	This study proposed the practical quality model for cloud learning system to determine the important factor for cloud learning system by adopting the D&M (2003)	Net Benefits (Cloud Learning System Benefits)	1. System Quality 2.Information Quality. 3.Service Quality	Intention to Use/ Use and user satisfaction	All the criteria effect on system use and user satisfaction and to cloud learning system benefits
A knowledge management system using cloud computing technology (Rezaei et al. 2016).	The study evaluated the success rate of "Service Quality" on knowledge management system based on cloud computing on a higher education system. That through using the successful models of D&M IS (2003).	Net Benefits	1. System Quality 2.Information Quality 3. Service Quality	Intention to Use & Use and User Satisfaction	The study found that the quality of service is an important factor in measuring the success of an information system and can satisfy users. Hence, the results found that the users observed significant differences after the implementation of this service.
Mobile e-books in a cloud bookcase (Chiu et al. 2016).	The study adopted the D&M IS (2003) to implement mobile e-books in a cloud bookcase and modifies the IS success model to make it capable of assessing this system.	Net Benefits	1. System Quality 2.Information Quality 3. Service Quality	Intention to Use & Use and User Satisfaction.	The results found that user satisfaction and intention with regard to using the system are positively related to net benefits. Thus, increasing user satisfaction and intention with the concern of using the system will have a positive effect on the benefits users receive from doing so. While, the information quality has no significant, positive influence on system use or user satisfaction.

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Reference Area of Study	Objective of Study	Dependent Variable	Independent Variables	Mediator variables	Results of study
Enterprises environment (Al-Shargabi & Sabri 2016).	This study aimed to apply the updated D&M IS (2003) mode to evaluate some components that need to be considered by an enterprise when deciding on adopting cloud computing.	Net Benefits	1.System Quality. 2.Information Quality. 3.Service Quality	Intention to Use/ Use and User Satisfaction	The results show the components of success that support plans that can help them to achieve the readiness required towards Cloud Computing success from an enterprise perspective.
Second Direction: Adopted DeLone and McLean's model as a Whole and Added Additional Constructs					
Reference Area of Study	**Objective of Study**	**Dependent Variable**	**Independent Variables**	**Mediator variables**	**Results of study**
Social Networking Applications (SNA) (Ou et al. 2011).	This study proposes a causal model to evaluate the success of Social networking applications (SNAs), based on D&M IS (2003).	Net Benefits	1.System Quality. 2.Information Quality. 3.Service Quality 4.Networking Quality	User Satisfaction and Use	The results show that the significant role of "networking quality" in determining the focal SNA's success. Along with the impact of networking quality on user satisfaction compared to the influence from information quality and service quality. In addition, system quality also plays an important role in use and user satisfaction, while information quality and service quality only have moderate impacts on use and user satisfaction.
Learning System in Cloud Computing Environment (Kang et al. 2013).	The study aims to propose a success model for learning system in a cloud computing environment to determine the important factor in the learning system. Also, proposed a new dimension of "networking quality" to measure the effect of this factor on model success.	Net Benefits	1.System Quality. 2.Information Quality. 3.Service Quality. 4.Networking Quality	Intention to Use/ Use and User Satisfaction	The study found that all the relationships among the model constructs were significant to success the learning system in cloud computing. Which information quality, System Quality, Service Quality and Network Quality had a direct impact on system use and user satisfaction, that effect on the Net Benefits

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Area of Study	Objective of Study	Dependent Variable	Independent Variables	Mediator variables	Results of study
Decision Support System (DSS) for cloud computing investment (Sundarraj& Venkatraman 2015).	This paper aims to create a decision framework for cloud computing technology investment by integrating the IS (2003) with preference elicitation techniques. Also, the study proposed a new dimension of "Risk Mitigation" into the original dimensions.	Net Benefits	1. System Quality 2.Information Quality. 3. Services Quality 4. Risk Mitigation	Intention to Use& Use and user satisfaction	The results show that the model dimensions success to decision model can be expanded as a vendor negotiation tool. Finally, based on the study model, it is describing a prototype Decision Support System (DSS) featuring this model.
Third Direction: Combine DeLone and McLean's Model with Other Theories and Factors					
Area of Study	**Objective of Study**	**Dependent Variable**	**Independent Variables**	**Mediator variables**	**Results of study**
Virtual Communities (Lin 2008).	The study aimed to understand the factors that measure virtual community success.	Member loyalty	1.Information quality. 2. System quality. 3. Trust. 4.Social usefulness.	Member satisfaction and Sense of belonging	Results showed that both member satisfaction and a sense of belonging were critical factors of member loyalty in the community. Likewise, information and system quality were found to affect member satisfaction, while trust influenced the members' sense of belonging to the community. The study found that all the relationships among the model constructs were significant.
Social Networking Systems (French 2009).	This study aimed to evaluate success factors of social networking site (SNS) usage within the United States. The study measured the net benefits as continued use intention with frequent future use of the Social Networking Systems	Continued Use Intention	1. Content Quality 2. System Quality 3. Trust	Social Capital and User Satisfaction	This research has demonstrated that user satisfaction is the primary component that affects continued use intention. Content quality and system quality, trust, and the user's perception of social capital are four factors that have positively affected user satisfaction, thus the effect on increase their continued use intention

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	(SNS), based on an individual level of analysis and the individual's perception of the community overall				
Cloud Computing in Case-Based Pedagogy (Chen 2011a).	This study utilises (IS) success theory to examine case-based pedagogy in a cloud computing environment. The study aims to examine factors that influence the viability of cloud computing technologies to support case-based pedagogy in higher education.	Cloud Computing Critical Mass.	1.Cloud Computing System Quality. 2. Cloud Computing information quality.	Use of Cloud Computing and Performance Expectation.	Results indicated that information quality has a significant influence on the use of cloud computing for case-based pedagogy and increases performance expectation and leads to critical mass. The findings suggested that cloud computing is a viable platform for case-based pedagogy.
Online Communities (Trembath 2011).	This study modified version of the model developed by Lin (2008), through the context of "Sense of belonging".	Member loyalty	1.Information quality. 2. System quality. 3. Trust.4. Social usefulness.	The sense of belonging and Member satisfaction	The study found that all the relationships among the model constructs were significant to achieve the loyalty factor.
Mobile social networking service (SNS) (Gao & Bai 2014).	This study examines the factors that affect mobile SNS users' continuance intention. And use flow as our focal construct and include the effect of perceived usefulness and user satisfaction on continuous usage.	Continuance intention	1. System Quality 2.Information Quality. 3.Referent network Size. 4. Perceived complementarity	Flow, Satisfaction and Perceived Usefulness	The results show that flow, perceived usefulness and satisfaction determine the continuance intention of mobile SNS. As well as, the study found that referent network size and perceived complementarity are the main factors affecting flow, while information quality is the main factor affecting perceived usefulness. Only system quality significantly affects satisfaction.
Facebook applications (Wu & Chen 2015).	The purpose of this study is to conceptualise a framework	Usage	Social influence	1.Information Quality	The study found that social influence and

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	that integrates information quality, system quality, function quality, and social influence based on the (IS) success model, to explore the relationship among these factors, which might be the key determinants of Facebook educational usage intention.	Intention	2.System Quality 3.Function Quality	information quality are critical and direct determinants that affect users' continuous intention to use Facebook in learning. Social influence also indirectly affects Facebook usage intention through the mediating effect of information quality. The relationships among these defining factors in the suggested model are constant.

In summary, as shown in Table 2.14, the DeLone and McLean model has been studied and evaluated in many different directions with different objectives. However, the evaluation of cloud computing technology still faces problems, as there is a lack of measurements to evaluate the success of its services and applications for individual productivity and output. The model is believed to be one of the most important contributions that can be used to address this issue (Ercolani 2013; Chiu et al. 2016). Integrating DeLone and McLean's model with other theories and other directions will investigate newly developed constructs to achieve additional needs (Urbach & Müller 2012).

2.7 DISCUSSING THE VARIABLES OF DELONE AND MCLEAN'S MODEL THROUGH EMPIRICAL STUDIES

Development of the DeLone and McLean Success Model has created concrete indicators for the evaluation of ISs' "success. And thus, it has been applied by many scholars and researchers (Chiu et al. 2016). The results of ISs evaluations are often associated with system development decisions. However, evaluating "success" is difficult. As shown in Table 2.14 this study identified two gaps that have not been addressed through the previous literature of the DeLone and McLean model related to the success of cloud computing services and applications. The first gap is related to the dependent variable, while the second gap is related to the independent variable for added additional constructs. They will be discussed and compared with other studies through the following sub-sections.

2.7.1 Dependent Variable Gap "Individual Impact"

So far, all the dependent variables of the D&M ISS model in a cloud computing environment were focused on the Intention to Use, Member Loyalty and they had mostly adopted the Net Benefits Level as shown in Table 2.14 and Table 2.15. In order to measure the impacts of cloud computing solutions as on an individual, group, organisation, industry, society, etc., (beneficiaries of the system) (Delone &McLean 2003). It is often measured in terms of organisational performance, perceived usefulness, and effect on work practices (Delone & McLean 2003; Kang et al. 2013). Table 2.15illustrates the lack of recent studies focused on the individual level independently as a dependent variable that is related to the cloud computing success model. Other studies adopted the individual impact as a dependent variable, but not in cloud computing, such as Seddon (1997), Iivari (2005), Lee et al. (2009b), Noorman et al. (2010), and Hsu et al. (2015). Lee et al. (2009b) and Noorman et al. (2010) used "individual impact" to measure the job performance, individual productivity, capability of problem identification, decision-making effectiveness and positive outcomes for the user. While, Iivari (2005) explains the individual impact as a unit of analysis to identify the beneficiary of the IS impact. Norzaidi et al. (2007) measure individual impact through the indicators of efficiency and effectiveness. Whereas, Hou (2012) measures it through individual productivity, decision-making speed, decision-making quality, problem identification speed, job effectiveness, job performance, and the extent of analysis in decision-making. All these studies evaluated the success of the different systems in IS, but not in the field of cloud computing.

Table 2.15 Dependent Variable in the Empirical Studies of IS Success Model in Cloud Computing Environment

Dependent Variable	**Dependent Variable description**
Member Loyalty	• Refers to the member satisfaction and a sense of belonging (Lin & Lee 2006; Trembath 2011). • Measures the member's involvement in a virtual community, i.e., participation in community operations and communication with other members (Lin 2008).
Continued Use Intention	• Refers to continued use intention that concerned as net benefits with frequent future use of the Social Networking Systems (SNS) by the members of the community (French 2009). • Refers to users' continued intention towards mobile social networking service (SNS) (Gao & Bai 2014).
Cloud Computing Critical Mass.	• Refers to users perceive that using cloud computing lead to aid in their performance as it relates to case-based pedagogical activities (Chen 2011a).
Usage Intention	• Refers to factors that influence the Facebook educational usage intention for researchers and practitioners (Wu & Chen 2015).
Net Benefits	• Refers to the user's perceived benefits brought by the focal Social networking applications (SNA) in terms of expanding the user's social networks, acquiring desired knowledge and information, the reduction of time and efforts to exchange information, the quality improvement of the user's social life (Ou et al. 2011). • Refers to measure the benefits of contents and to use of the virtual learning environment for students in computing or information systems (Conboy et al. 2009).

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- Refers to measure system outcomes, which measures such as improved learning, increased possibilities to study and to save time. (Halonen et al. 2012).
- Refers to the effect of IS on organisational performance, perceived usefulness, and effect on work practices (Kang et al. 2013).
- Refer to the impact of "user satisfaction" and "user use & intention to use" of SaaS on cloud user net benefits (Ercolani 2013).
- Refers to the impact of cloud learning system on studies and completion for students and teachers (Kang et al. 2014).
- Refers to the benefits of the systems and information quality of could to create benefits for the organisation and has formed the basis of some prominent works (Sundarraj& Venkatraman 2015).
- Refers to the success of Cloud Computing to improve organisational outcomes, cost reductions, and user interests (Al-Shargabi & Sabri 2016).
- Refers to the success of Service Quality factors to increase the quality of management system based on cloud computing on a higher education system (Rezaei et al. 2016).
- Refers to the benefits for users from using the cloud e bookcase (Chiu et al. 2016).

This study differs from previous studies that had concentrated on the "Net Benefit Level" as a unit of analysis of the dependent variable. This is the first study that focuses on the individual impact level as a dependent variable. Based on the studies of DeLone and McLean's (1992), Seddon (1997), Iivari (2005), Lee et al. (2009b), Noorman et al. (2010), and Hsu et al. (2015) that measure the individual impact, this study will measure the individual impact through the impact of cloud-based application usage on academic researchers' productivity. It measures the output effectiveness, improved productivity, improved performance, satisfaction with outputs, usefulness (quickly, increase innovation, efficiency, work simplification, increase learning, quality of work, reducing costs, and time) based on measurements of Davis (1989); Delone and McLean (1992); Iivari 2(005); Lee et al. (2009b); Noorman et al. (2010); Yuvaraj (2014); Manchanda and Mukherjee (2014); Ishak et al. (2014); Mohammadi (2015); and Hsu et al. (2015).

2.7.2 Data Centre Network Quality Gap

This study adopts the extended independent variables in the updated model of D&M ISS (2003) by adding a new dimension of 'Data Centre Network Quality. According to Ou et al. (2011) and Kang et al. (2013) that emphasised there is a need to conceptualise "Networking Quality" in the DeLone and McLean's ISSM, because if the user utilises the cloud environment they must examine whether networking quality provides a significant and new explanation for the success of cloud computing solutions beyond DeLone and McLean's ISSMs.

As seen in Table 2.14, in the second direction, there were two studies emphasised the importance to include "Networking Quality" as a new dimension in the D&M ISSM for cloud environments. The first study of Ou et al. (2011) argued that a D&M ISS model related to the social network domain require conceptual modification given the typical features of Social networking applications (SNAs). The results further confirm the overwhelming role of networking quality on use and user satisfaction, which reflected positively on the net benefits. Its effect is the strongest among all the independent variables determining user satisfaction. The second study of Kang et al. (2013) provided a success model for learning system in a cloud computing environment to determine the important factors in the learning system that contribute to students' outputs. Kang et al. argued it is very important to add the factor to network quality in D&M ISSM to access the Internet or network, where the author discussed the addition of the new dimension from a connectivity perspective. The study found that network quality plays an important role in use and user satisfaction and led to raising the net benefits.

Both studies add specific types of networks, and the dependent variable was net benefits. Table 2.14 illustrates the lack of current studies investigate and verify the impact of Data Centre Network Quality on D&M ISSM as an important dimension of intention to use/use and user satisfaction. It also measures its effect on the individual level. In addition, Chiu et al. (2016) confirmed that the quality dimensions of system quality, service quality, and content quality might influence the use of a cloud application and user satisfaction. Petter et al. (2008) and Ou et al. (2011) said these dimensions are not sufficient, since other core elements may also contribute to cloud computing success. While, Cisco (2011), Qi et al. (2014), and Wang et al. (2015) argued it is very important to assess the quality of the data centre network for cloud-based application environments, which will impact on the success of utilising cloud computing applications. Data Centre Network is a set of servers, storage and network devices, power systems, and communication services (Han et al. 2014). Moreover, data centre networks are intended for large-scale service applications such as online businesses, Smart Grid and scientific computation (Wang et al. 2015). The factors of cost and time in terms of availability of applications, on-demand services, free resources, flexible control, and remotely accessing which the storage spaces built in the cloud computing application networks are the key indicators and catalysts for use this technology (Bansal et al. 2012; Yadav 2014; González-Martínez et al. 2015).

According to Ou et al. (2011), Ojala and Tyrväinen (2011), and Kang et al. (2013) that measure the network quality, this study will measure the Data Centre Network quality as a new dimension in D&M ISSM. Table 2.14 shows this is the first study that adds the Data Centre Network quality as an independent variable to measure its influence on cloud application use, user satisfaction, and individual impact. It is achieved by measuring users perceived focal cloud application's quality of data centre networks feature of flexible infrastructure, easy management, services management, mobility, infrastructure integration, automation, and availability (Lee et al. 2009a; Cisco 2011; Benson et al. 2011; Networks 2012; Qi et al. 2014; Wang et al. 2015). The other dimensions of independent variables that the study adopted are the same as the updated Model of DeLone and McLean ISS (2003), namely service quality, system quality, and information quality. They are as follows:

2.7.3 Service Quality

Service quality refers to the overall support delivered by the information system service provider (Delone & McLean 2003). This dimension of quality measures the service provider's responsiveness and technical competence (Lee et al. 2009a; Ding 2010b; Ou et al. 2011; Urbach & Müller 2012; Mohammadi 2015). As stated by Cronin et al. (2000), Lam et al. (2004) and Chiu et al. (2016), customer satisfaction is based on the expectation of assistance from the system service or its provider. If a user is dissatisfied with the service encounter, this will negatively influence the overall product. Service quality evaluation hence, poor user support will translate into lost service users (Delone & McLean 2004; Lee & Yoo 2000). Additionally, there is considerable evidence that service quality has a significant influence on individual satisfaction as well as their performance (Seddon 1997; Lee et al. 2009a). Myers et al.

(1997) and DeLone and McLean (2002) agreed on service quality as one of the composite measures of IS success.

Various researchers have successfully adapted this dimension for evaluating the e-service environment such as e-commerce (Chong et al. 2010; Rouibah 2014; Hsu et al. 2014), E-learning support systems (Wang & Chiu 2011; Mohammadi 2015; Salem & Salem 2015), and e-banking (Manchanda & Mukherjee 2014; Tam & Oliveira 2016). Especially in the cloud computing field, as clarified by the study of Rezaei et al. (2016), service quality is one of the factors of organisation measurement from which other factors could be derived (Wu & Wang 2006; Ardagna et al. 2014; Gupta et al. 2015). Chiu et al. (2016) emphasised the success of cloud computing services depends on the information generated and exchanged by users. Besides, the cloud computing that provides a better quality of service to others is likely to be more competitive and outperform other providers (Lee et al. 2009a; Ding 2010b). From the ability side, the application's ability to be changed by service consumers is based on the individual requirements. This characteristic allows service providers to meet the different needs of each customer (Lee et al. 2009a).

Based on these arguments, this study expects that service quality should have an influential effect on both intention to use/use and user satisfaction, as well as a significant influence on individual outputs and performance (Seddon 1997; Lee et al. 2009a). It is achieved by measuring competence (assurance), empathy, security, reliability, responsiveness, tangible, and availability. (Delone & McLean 2003; Chen & Tan 2004; Lee et al. 2009a; Ou et al. 2011; Urbach & Müller 2012; Mohammadi 2015).

2.7.4 System Quality

System Quality as conceded by DeLone and McLean (1992, 2003), Ou et al. (2011), Urbach and Müller (2012), Chiu et al. (2016), and others, is a success dimension that constitutes a desirable characteristic of an IS. It includes measures of the information processing system, reliability, ease of use, joy of use, support, accessibility and choice (Noorman et al. 2010). System quality is concerned with errors in the system, the reliability of the user interface, the response rates of the system, quality documentation as well as the maintainability of the program code (Seddon, 1997; Tajuddin et al. 2013). Hence, system performance requirements are significant to ensure productivity improvement (Käpylä et al. 2009; Chiu et al. 2016). Productivity has both efficiency and effectiveness dimensions. Efficiency implies the efficient use of resources and effectiveness to the ability to achieve desired outcomes. Seddon and Kiew (1994) suggested that 'Increases in system quality will cause an increase in usefulness for user' (Al-Sabawy 2013).

Multiple studies have consistently displayed that system quality is the degree in which the functionalities of the system can address customer needs (Bari & Djouab 2014), with minimal problems (Delone & McLean, 2003; Chen et al. 2015). Cloud computing solutions provide users with the flexibility in the amount of requests resources, e.g. size of the storage and the number of the processors/ machines (Pocatilu et al. 2010). Poor usability and slow response times can discourage customer usage of such Cloud services and application and lead to user dissatisfaction (Lee et al. 2009a; Pérez-Mira 2010; Ou et al. 2011; Chiu et al. 2016). DeLone and McLean (2003) asserted that the quality of the system of the IS success model is positively affecting intention to use the system and user satisfaction. Seddon and Kiew (1994), Iivari (2005), Wu and Wang (2006), Petter et al. (2008), Tajuddin et al. (2013), and Tam and Oliveira (2016) empirically confirmed this assertion. Various studies examined the system quality influence on other D&M ISSM dimensions in a cloud computing environment as shown in Table 2.14. For example, Lin & Lee (2006), Ou et al. (2011), Halonen et al. (2012), Ercolani (2013), Kang et al. (2014), Chiu et al. (2016), Rezaei et al. (2016), and Al-Shargabi and Sabri (2016) found that the system quality has a significant effect on system use and user satisfaction, thus effect on system benefits.

According to the previous evidence, this study also expects that system quality should have an influential effect on both intention to use/ use and user satisfaction, and the effect on individual outputs and performance (Seddon 1997; Lee et al. 2009a). It is achieved by assessing system ability, accessibility, and usability (Ease of Use). Each of these factors include numerous items (Davis 1989; Delone & McLean 2003;

Wang et al. 2007; Manchanda & Mukherjee 2014; Ishak et al. 2014; Urbach & Müller 2012; Orehovački et al. 2013; Hsu et al. 2015; Mohammadi 2015).

2.7.5 Content Quality

DeLone and McLean (1992, 2003) defined information quality as measuring the IS output and focus on the quality of the information that the system produces (Salem & Salem 2015). Content quality is defined as a user's perception of the collective application content quality of a specific application network service (Wu & Chen 2015). According to Noorman et al. (2010), the content quality is a function of the value of the output produced by a system as perceived by the user. The study empirically showed that characteristics of the content quality of a digital library as perceived by computer science students include relevance, reliability, understandability, adequacy, openness and scope.

Besides that, Seddon and Kiew (1994), Rai et al. (2002), Iivari (2005), Wu and Wang (2006), Noorman et al. (2010), Manchanda & Mukherjee (2014), Salem and Salem (2015), and Chiu et al. (2016) discovered that content quality was a significant predictor of system use and user satisfaction in a significant and positive manner. This means when academics are concerned about the quality of content, they will inevitably become satisfied with the system (Salem & Salem 2015). Thus, they are likely to use this system for their tasks, due to their belief that the system is beneficial to their outputs. When the academics find they understand better, they show improvements in their performance. Hence, the most powerful path for IS begins with of content quality leading to academic satisfaction and finally to perceived usefulness (Salem & Salem 2015).

The previous literature examined the significant role of the content quality in the various fields and content quality of cloud computing as seen in Table 2.14 summarises the empirical tests of cloud computing through the DeLone and McLean Model. Lin and Lee (2006), French (2009), Halonen et al. (2012), Ercolani (2013), Kang et al. (2013), Kang et al. (2014), Sundarraj and Venkatraman (2015), Rezaei et al. (2016), and Al-Shargabi and Sabri (2016) emphasised that the content quality had a significant influence on user satisfaction and behavioural intention to use. Hence, had a significant and successful effect on beneficiaries' outputs. Other studies stressed the impact of content quality on satisfaction such as Lin (2008) and Trembath (2011) and affected perceived usefulness (Gao & Bai, 2014). Ou et al. (2011) found the content quality only to have moderate impacts on use and user satisfaction. Chiu et al. (2016) indicated that content accuracy and comprehensibility do not have a positive influence on intention to use or user satisfaction.

Previous studies also pointed towards the importance of content quality as a success measure should ideally also include measures of user attitudes, satisfaction factor and output benefits. This study also expects that content quality should have an influential effect on both intention to use/ use and user satisfaction, and the effect on individual outputs and performance (Seddon 1997; Iivari 2005; Lee et al. 2009a). It is achieved by measuring accuracy, availability, completeness, understandability, relevance, reliability, and timeliness (Davis 1989; Delone & McLean 1992; Delone & McLean 2003; Ding 2010b; Urbach & Müller 2012; Kang et al. 2013; Manchanda & Mukherjee 2014; Mohammadi 2015).

In short, the model of DeLone and McLean (2003; 1992) assumed that system quality, content quality, and service quality directly affects user satisfaction and intention to use (Satu-Maria & Markova 1995; Al-Sabawy 2013). Based on D&M ISSM, this study will evaluate the influence and success of four constructs: System Quality, Services Quality, Content Quality and Data Centre Network Quality of cloud-based applications on the Intention to Use, and User Satisfaction.

2.7.6 Intention to Use/ Use as a Mediating Variable

Mohammadi (2015) stressed that the positive intention to use dimension could provide a higher level of user outputs. Shiau and Chau (2016) found cloud computing provides academics with access to software and product services. Therefore, academics must be able to use these resources, thus plays a critical role in their behaviour. As reported by Rai et al. (2002), Wang et al. (2007), and Urbach and Müller (2012) the features of cloud computing related to more accurate, updated, meaningful and useful content lead to enhancing the users to participate and continue to use these technologies in their work. Several studies that believe the system usage leads to user satisfaction and user satisfaction leads to system usage, and positive relationship between these two factors (DeLone and McLean 2003; Käpylä et al. 2009; Ou et al. 2011; Kang et al. 2013; Ercolani 2013; Salem and Salem 2015; Nguyen et al. 2015; Chiu et al. 2016; Tam & Oliveira 2016). Details about this approach and the studies that adopted it are presented in subsection (2.6.1).

2.7.7 User Satisfaction as a Mediating Variables

As mentioned in subsection 2.6.2, user satisfaction is defined as the individuals' perceptions of the extent to which their needs, goals, and desires have been fully met when utilising applications of cloud computing (Amin et al. 2014; Mohammadi 2015). It refers to their overall view of applications of cloud computing (Wang & Wang 2009; Kang et al. 2014). Therefore, studies which include user satisfaction as a success measure should ideally also include measures of user attitudes so that the potentially biasing effects of those attitudes can be controlled for in the analysis (Delone & McLean 1992; Salem & Salem 2015). Bolton and Lemon (1999), Cronin et al. (2000), Lam et al. (2004), and Tor Guimaraes and Paranjape (2014) stressed that when academics consider that cloud applications can increase their outcomes, and its efficiency and effectiveness can satisfy academic requirements, they will use the cloud applications more frequently. It is more likely that the user will continue using the cloud applications and it is likely to lead to higher consumer loyalty to cloud computing.

The mediating variables of increased use and satisfaction lead to improve individual outputs, and vice versa (Ercolani 2013; Mohammadi 2015). Increasing individual productivity leads to greater satisfaction and use (Lin 2008; Alnanih et al. 2013). As stressed by Lee et al. (2009a), Chiu et al. (2016) and Sharma et al. (2016), the construct of "intention to use" impacts on the level of students' use. This will impact on their performance and productivity. Also, studies such as McGill et al. (2003), Iivari (2005), Wang and Liao (2008), Chen and Cheng (2009), Lee et al. (2009a), Noorman et al. (2010), and Al-Sabawy (2013) have empirically shown that the level of user satisfaction is a significant determinant of individual impact and productivity. The relationships between data centre network quality, system quality, information quality, and service quality with the intention to use/use will appear to work equally at both levels of analysis. Those relationships will work equally when paired with user satisfaction (Pérez-Mira 2010). According to the correlation between the intention to use and user satisfaction (DeLone and McLean 2003), the satisfaction factor plays a significant role as a mediator relationship between the quality factors and the individuals outputs improvement (Lin 2008; Noorman et al. 2010; Pérez-Mira 2010; Alnanih et al. 2013; Manchanda & Mukherjee 2014). Mohammadi (2015) stressed that the intention to use/use as the primary key of individuals' perceptions of the extent to achieve their needs, goals, and desires had been fully met. It is influenced using the system (information, service, and system quality) and actual benefits. In turn, satisfaction influences users' intention to use the system (Chiu et al. 2016).

In summary, the main gap identified by this study that has not been addressed by the previous literature is the lack of focus on improving productivity at the micro level. Along with the lack of practical study identifying the most important wastes affecting academic researchers' productivity and their performance. Besides, determines the actual needs of academic researchers to eliminate waste and contribute to increasing their productivity. Studies have overlooked individual impact as a dependent variable in the success model related to cloud computing field. Accordingly, there is a lack of measures for the quality of data centre networks and examining its effect on improving individual outputs. Thus, there is no success model of cloud-based applications that connect between the dimensions of DeLone and McLean's model (1992 & 2003) and the indicators of productivity improvement at the individual level.

2.8 CONCLUSION

This chapter identified the important wastes that affect academic researchers' productivity and the most important needs of academic researchers to eliminate wastes. Additionally, this chapter provides the overviews of cloud computing technology environment, which focused on the cloud-based applications as a tool to improve productivity. Having established a clear picture of cloud computing solutions, the study explored the current situations of cloud computing in higher education sectors to identify the research gap. It discussed the issue of productivity improvement and its measurement in research productivity by adopting the theory of Lean Thinking (LTT) principles to values identification. Also, it reviewed the relevant studies that success to adopt Lean in the higher education sector. Besides that, this chapter offers evidence related to the ability of a cloud-based application to create value and improve productivity from the empirical studies. It reviews the literature related to Information System Success Model (ISSM) and the related theories to build the research model. It covered and discussed the relation between Productivity Improvement and Delone and McLean Success Model (D&M SM), as well as the empirical tests of cloud computing success through the DeLone and McLean Model based on the three directions. Finally, the chapter discussed the research gaps and the relation between research variables through successful implementation of the D&M ISSM in different fields and cloud computing environment to validate the success factors related to productivity improvement. The next chapter highlights the research methodology for this study.

CHAPTER III

RESEARCH METHODOLOGY

This chapter explains the phases of this research used to study the research problem and strategies to solve these problems as well as the logic behind them. It explains the research methodology, hypotheses' testing and the methods used, followed by the rationale behind their choice. This chapter also presents in detail, the methods used in collecting and analysing data which includes extensive literature review, interviews discussions and surveys. The study used the mixed methods approach techniques which includes both quantitative and qualitative data collection. The details of data collection methods, followed by the discussion of the Researchers-Cloud Software Productivity Platform (R-CAPP) development as well as productivity evaluation methods are presented in this chapter.

3.1 INTRODUCTION

Research design plays an important role in any study as it presents a clear structure of the main research processes in data collection, preparation for analysis and the level of importance of various study dimensions involved in a study (Bryman & Bell 2015). This research attempts to identify the factors that contribute to productivity improvements of university researchers using cloud computing applications. For this, it adopts the mixed approach of data collection consistent with the studies of Malanda (2015) and Srichuachom (2015) that used the same theory to improve productivity.

Exploratory research is mostly applied in a qualitative study (Creswell 2013). The main reasons for conducting an exploratory study is to understand and discover the most important factors affecting university researchers' outputs and needs (Auerbach & Silverstein 2003; Alvesson & Sköldberg 2009). Hypothesis testing explains the nature of specific relationships and testing the research model to explain the variance in the dependent variable. It proves the validity of the developed model in both theoretical and practical applications (C. R. Kothari 2004; Saunders et al. 2011). The quantitative methods will not help investigate university researchers' needs, requirements, wastes, experiences, and ideas in terms of searching the truth since they must be measured numerically (Auerbach & Silverstein 2003; John Creswell & Clark 2007).

As illustrated in Figure 3.1, the research design of this study is based on three phases. The first phase applied a qualitative approach that includes a literature review and in-depth interviews. The second phase explains the model development by applying the quantitative approach related to survey study use questionnaire of the online university researchers to validate the research model. The third phase pertains to development test-bed and evaluation methods of the Researchers-Cloud Application Productivity Platform (R-CAPP).

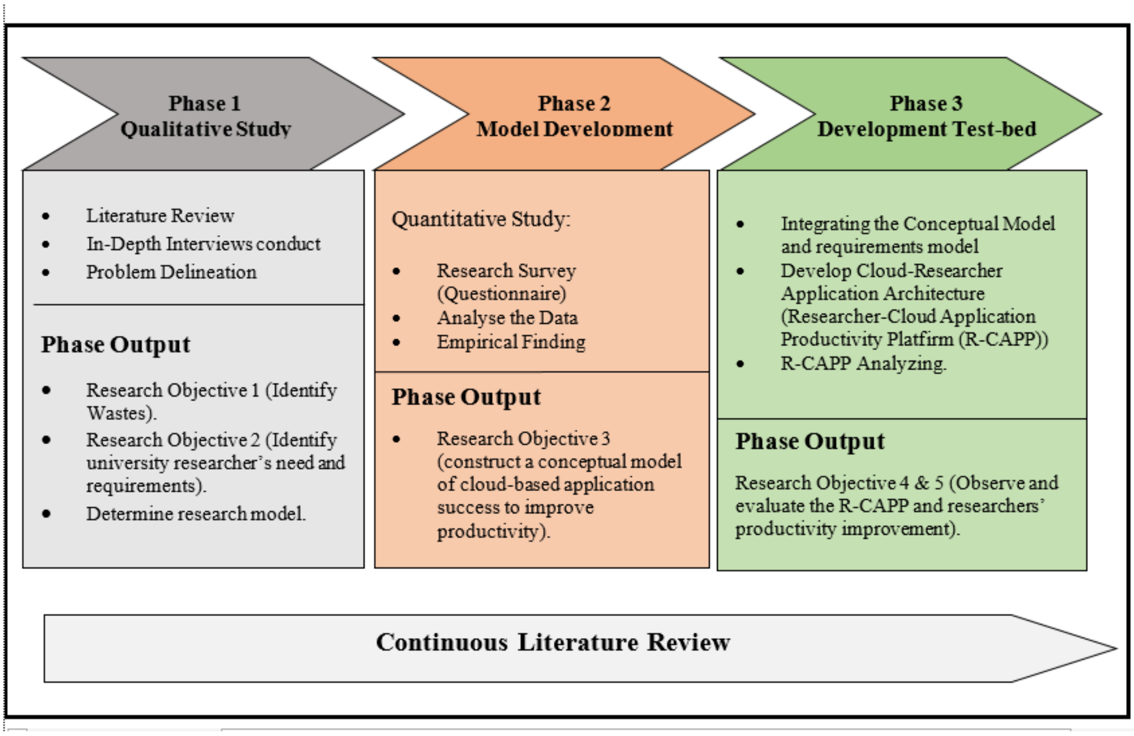

Figure 3.1 Research Design and Phases

(Developed for this study)

3.2 FIRST PHASE OF STUDY (QUALITATIVE STUDY)

Qualitative research is a naturalistic and interpretative approach concerned with understanding the meanings which people attach to phenomena (actions, decisions, beliefs, thoughts, behaviour, concerns, motivations, aspirations, and values etc.) (Denzin & Lincoln 2000; Maxwell 2012). There are several types of this approach such as review studies, focus groups, interviews, and observations.

In this phase, the study applied a qualitative approach by reviewing the literature, along with conducting in-depth interviews. This phase aims to identify the factors affecting “wastes” faced by university researchers during research. In addition, it investigates the potential needs of university researchers and all related issues (e.g. problems, limitations, improvement) of cloud-based applications to eliminate wastes and improve productivity.

3.2.1 Literature Review

The literature survey offers a foundation for the proposal of a new conceptual model to conceptualise the research problem in a theoretical manner (Sekaran 2006; Sekaran & Bougie 2013). During this phase, attempts are made to identify gaps and issues that are still ambiguous, and the significance of carrying out the study is defined (Sekaran & Bougie 2013). Gathered information collected in Chapter II and IV was used to develop the theoretical research proposal underlining the research objectives, questions and enhancing the survey.

3.2.2 In-Depth Interviews Method

The research interview is a means of acquiring information from respondents about the dyadic information (Hove & Anda 2005). The three main types of interviews include structured-direct interviews, unstructured-direct interviews and semi-structured (Hove & Anda 2005; Bollineni & Neupane 2011).

In-depth interview method that conducted by this study falls under the unstructured-direct interview type. This phase was followed by the studies of Kennedy (2011), Meyer and Mcneal (2011), Srichuachom (2015), and Alharthi et al. (2016) which adopted the in-depth interview method with the same model of D&M ISSM and Lean Thinking theory to improve productivity. Guion et al. (2001) and Smith and Albaum (2010) reported that in-depth interviews are used to explore the underlying predispositions, needs, desires, feelings, and emotions of the users towards specific issues. This results in rich background information that can shape further questions relevant to the topic. It reveals the extent of interaction between productivity and applications of cloud computing.

In this phase, we adopted the guidelines for in-depth interviews of Guion et al. (2001) and Boyce and Neale (2006) where they identified seven stages of conducting these interviews as shown in Figure 3.2. The main constructs (axes) of this interview are derived from the theory of Lean Thinking (LT), Waste (Non-Value added), Needs (Value Added), and Requirements (Comm & Mathaisel 2003; Juarez 2014).

The Lean Thinking Theory (LT) is used as a criterion for interviews as it is one of the standards for systematic productivity improvement using specific principles and success tools (Emiliani 2004; Balzer 2010; Pearce 2014). Lean thinking is interested in beneficiary values (Balzer 2010; Srichuachom 2015). It has an objective to work efficiently and manage different, unexpected requirements from the beneficiaries. Lean has started to be a new way to provide the quality performance to the service providers (Emiliani 2004; Juarez 2014). Moreover, it supports the principle of continuity of improvement “kaizen” to change for the better. It aims to strike change that results in improvement. It could be related to quality or other factors that users judge to be of value, such as innovation, ease of use, on-time delivery, durability, low cost, etc. (Emiliani 2004; 2005; Mefford 2009; Jang et al. 2011; Juarez 2014).

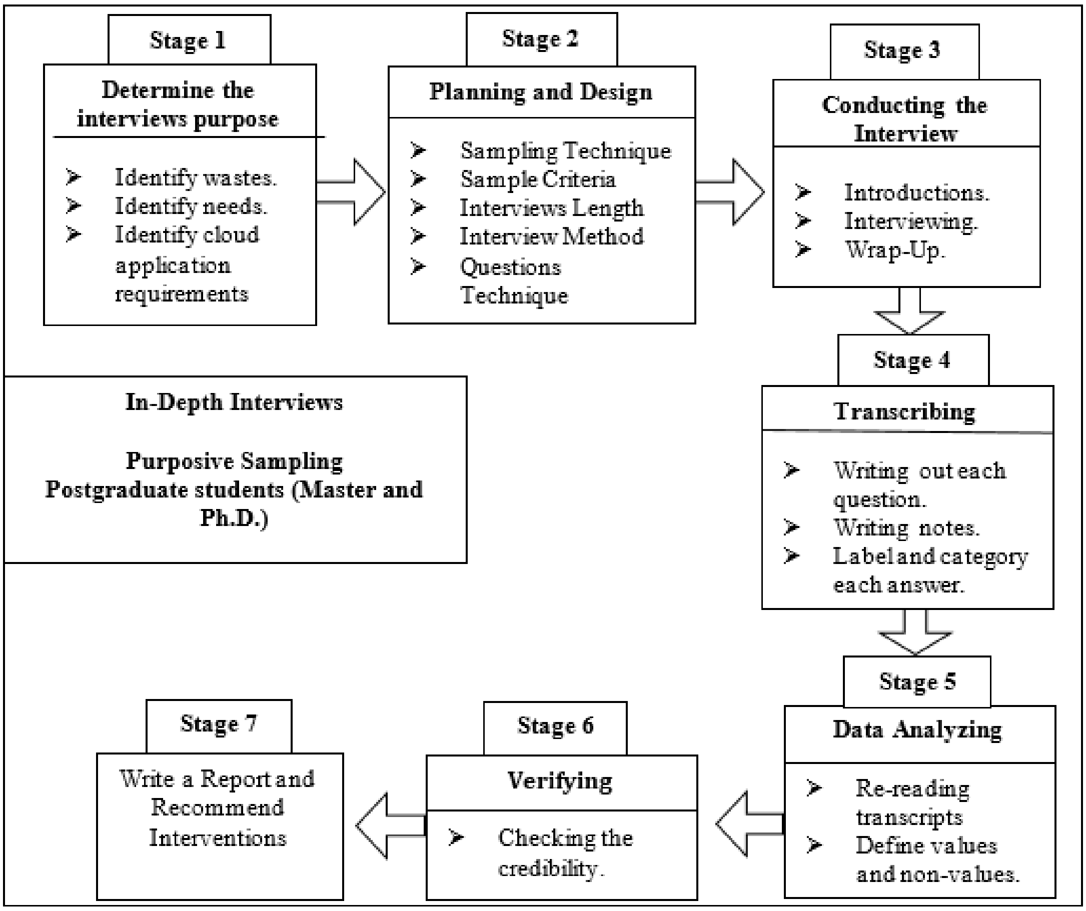

Figure 3.2 Summary of Key Stages in Conducting an In-Depth Interview

(Developed for This Study)

In-depth Interview Stages:

Stage 1: Determine the Interviews Purpose as Detailed in Chapter IV.

This stage aims to clarify the purpose of the interviews by exploring and identifying the level of cloud applications usage. It also identifies the factors affecting "wastes" that university researchers face during research perform, which affected on their research outcomes and cloud applications usage. The interviews also explore and determine the academic researchers' needs to eliminate waste in order to build the cloud applications requirements that meet the needs of university researchers.

Stage 2: Planning and Designing

The second stage of planning is the process of interviews by designing the target sample (sampling technique, sample criteria, sampling design and size), the duration and length of interview, interview method and questions technique (Guion et al. 2001; Boyce & Neale 2006; Smith & Albaum 2010; Ritchie et al. 2013). The following sub-sections describe these processes.

i. Sampling Technique

This phase is based on non-probability sampling, which uses convenience sampling for selecting the population for an interview to reflect the particular features of the sampled population as reported by Wilmot (2005), Ritchie et al. (2013) and Srichuachom (2015). The study selected the "sampling unit" from postgraduate students (Master and PhD) as the purposive sampling as they are an important category of the university research community as mentioned by the studies of Braman (2006), Kyvik (2013), and Zeglat et al. (2016). Based on Smith and Albaum (2010), Ritchie et al. (2013) and Lucas (2014), the sampling members are chosen based on their relative ease of access for conducting interviews and less expensive. It is this feature that makes them well suited to small-scale and in-depth studies (Small 2009; Ritchie et al. 2013).

ii. Sample Criteria

Sample criteria are the characteristics that need to be reflected in the sample population to address the research questions (Wilmot 2005; Ritchie et al. 2013). The main criteria for selecting the sample of this phase were based on the years of study, specialisation, and they should be postgraduate students. We conducted the interviews with Master and PhD students in computer science and information technology who have exceeded the studied period of two years and above. The postgraduate student was chosen because they have the particular features, characteristics and represent an important target group of the cloud applications portal, as confirmed by these studies (Sasikala & Prema 2011; Taylor & Hunsinger 2011; Tan & Kim 2015; Zeglat et al.

2016). They are less experienced than members of the faculty “e.g. Lectures and professors”, which makes them more susceptible to waste during research. Thus, we can identify wastes more accurately. Schepers and Wetzels (2007) and Al Thunibat et al. (2011) reported that the students are typically a homogeneous group that permits the precise prediction and a strong test of theories. They are more technology-ready and sensitive to trends, and they have a greater readiness along with role to embrace the new technology and services. Furthermore, they are more easily influenced by characteristics of technology and peer opinions than non-students or older users.

In terms of the reason for targeting these students particularly in the field of computer science and information technology, which they possibly have their opinions about current cloud applications and services or understanding of the technical needs as well as future expectations (Al Thunibat 2012). They are an appropriate sample to understand their needs and discuss the requirements for cloud applications that contribute to raising research productivity. The required years of study allow for a clear picture of the research process, along with their exposure to waste. These researchers who have spent many years at the university have a better understanding to provide information and opinions under the respective constructs of the study.

iii. Sampling Design and Size

In this phase, we selected the interview sample from five Malaysian universities comprising University Kebangsaan Malaysia (UKM), University Technology Malaysia (UTM), University of Malaya (UM), International Islamic University Malaysia (IIUM), and University Tenaga National (UNITEN). These universities were selected because they rank highly in the specialisation of computer science and information technology in Malaysia (Abroad 2013). We chose six students from every university, four of them were PhD students, and two were Master students. We selected PhD students more than Master students due to our focus on the experience factor in computer science and information technology and scientific research field. PhD students confronted several wastes during their research process more than Master students.