ABSTRACT

Cloud computing is a modern form of computing technology that provides services in many areas, particularly in mobile environments. Due to the expansion in volume, capacity and quantity of data stored and transferred today, mobile cloud computing has assumed a pivotal vital role, since many challenges still exists that need to be addressed related to public trust in cloud services. Many studies have been proposed in this regard. The aim of this study is to conduct systematic mapping of recent literature on quality of service approaches in cloud computing based on mobile environments in order to identify deficiencies and future research possibilities. A systematic mapping study was conducted to determine the related literature, and consequently 16 articles published between 2010 and 2017 were selected as primary studies that were classified in relation to the focus, research type and contribution type. The majority of these articles follow the conceptual proposal research type (37%), Evaluation research (19%) and Validation research (19%), as well as Validation research (19%) and Solution proposals (25%). However, there were no Opinion articles or Experience articles (0%).. Cloud services providers (44), followed by cloud services consumers (19%) and Software as Service (19%), Infrastructure as a Service (12%), and Platform as a service (6%). The majority of contributions concerned models (50%), Metric (25%), Method (19%), Process (6%) and Tool(0%). The conclusion of this review confirms that QoS approaches in mobile cloud computing have developed into vital subject in the mobile cloud computing field in recent years and there are still existing challenges and deficiencies that require future research investigation and gaps which require future research exploration. In particular, research into the instruments, processes and tools and opinion articles and evaluation research are required with a specific end goal to provide valuable and reliable mobile cloud computing that conveys suitable QoS. Also a little bit of studies focused on IaaS and PaaS,

Keywords: Cloud computing; mobile cloud; mobile environments; QoS; systematic mapping

ÖZET

Bulut bilgiişlemesi, özellikle mobil ortamlarda birçok alanda hizmet sunan modern bir bilgi işlem teknolojisi şeklidir. Bulut hizmetlerine olan kamu güveni ile ilgili olarak ele alınması gereken pek çok zorluk mevcut olduğundan mobil cloud computing, bugün depolanan ve aktarılan verilerin hacmi, kapasitesi ve miktarının genişlemesi nedeniyle çok önemli bir rol üstlenmiştir. Bu konuda birçok çalışma önerilmiştir. Bu çalışmanın amacı, eksiklikleri ve gelecekteki araştırma olanaklarını belirlemek için mobil ortamlara dayalı bulut bilgi işleminde hizmet kalitesi yaklaşımları üzerine son literatürün sistematik haritalandırılmasını yapmaktır. İlgili literatürü belirlemek amacıyla sistematik bir haritalama çalışması yapılmış ve 2010-2017 yılları arasında yayınlanan 16 makale, odak, araştırma türü ve katkı türüne göre sınıflandırılan birincil çalışmalar olarak seçilmiştir. Bu makalelerin çoğunluğu kavramsal öneri araştırma türünü (% 37), Değerlendirme araştırması (% 19) ve Doğrulama araştırması (% 19) ile Doğrulama araştırması (% 19) ve Çözüm önerilerini (% 25) takip etmektedir. Bulut hizmetleri sağlayıcıları (% 44), bulut hizmetleri tüketicileri (% 19) ve Yazılım olarak Hizmet (% 19), Hizmet Olarak Altyapı (% 12), ardından Hizmet ve bir hizmet olarak Platform (% 6). Katkıların çoğunluğu modeller (% 50), Metrik (% 25), Yöntem (% 19), Süreç (% 6) ve Takım (% 0) ile ilgilidir. Bu incelemenin sonucunda, mobil bulut bilgi işleminde QoS yaklaşımlarının son yıllarda mobil bulut bilgiişimi alanında hayati bir konu haline geldiği ve ileride yapılacak araştırma soruşturması gerektiren eksiklikler ve gelecekteki araştırma araştırmaları gerektiren eksiklikler olduğu kanaatine varılmıştır. Özellikle, uygun QoS'yi ifade eden değerli ve güvenilir mobil cloud computing sağlamak için araçlar, süreçler ve araçlar ile fikir makaleleri ve değerlendirme araştırması için belirli bir amaç aranır. Ayrıca, IaaS ve PaaS üzerinde yoğunlaşan bazı çalışmalar yapıldı,

Anahtar Kelimeler: Bulut bilgi işlem; mobil bulut; mobil ortamlar; QoS;

QUALITY OF SERVICE APPROACHES IN CLOUD COMPUTING BASED MOBILE ENVIRONMENTS:

A SYSTEMATIC MAPPING STUDY

A THESIS SUBMITTED TO THE GRADUATE SCHOOL OF APPLIED SCIENCES

OF

NEAR EAST UNIVERSITY

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In Partial Fulfilment of the Requirements for

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To the hope that gives me strength and patience in this life, I give my father, mother and all my family all my love and thanks.

ABSTRACT

Cloud computing is a modern form of computing technology that provides services in many areas, particularly in mobile environments. Due to the expansion in volume, capacity and quantity of data stored and transferred today, mobile cloud computing has assumed a pivotal vital role, since many challenges still exists that need to be addressed related to public trust in cloud services. Many studies have been proposed in this regard. The aim of this study is to conduct systematic mapping of recent literature on quality of service approaches in cloud computing based on mobile environments in order to identify deficiencies and future research possibilities. A systematic mapping study was conducted to determine the related literature, and consequently 16 articles published between 2010 and 2017 were selected as primary studies that were classified in relation to the focus, research type and contribution type. The majority of these articles follow the conceptual proposal research type (37%), Evaluation research (19%) and Validation research (19%), as well as Validation research (19%) and Solution proposals (25%). However, there were no Opinion articles or Experience articles (0%).. Cloud services providers (44), followed by cloud services consumers (19%) and Software as Service (19%), Infrastructure as a Service (12%), and Platform as a service (6%). The majority of contributions concerned models (50%), Metric (25%), Method (19%), Process (6%) and Tool(0%). The conclusion of this review confirms that QoS approaches in mobile cloud computing have developed into vital subject in the mobile cloud computing field in recent years and there are still existing challenges and deficiencies that require future research investigation and gaps which require future research exploration. In particular, research into the instruments, processes and tools and opinion articles and evaluation research are required with a specific end goal to provide valuable and reliable mobile cloud computing that conveys suitable QoS. Also a little bit of studies focused on IaaS and PaaS,

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LIST OF ABBREVIATIONS

CC :	Cloud Computing
CSC:	Cloud Service Consumer
CSP :	Cloud Service Provider
IaaS :	Infrastructure as a Service
MC :	Mobile Computing
MCC:	Mobile Cloud Computing
MS:	Mobile service
PaaS:	Platform as a Service
QoS :	Quality of Service
SaaS :	Software as a Service
SM :	Systematic Mapping
VM :	Virtual Machine

CHAPTER 1

INTRODUCTION

1.1 Introduction

In the recent years of innovation development, people's lives have become highly dependent on mobile devices and this technology has become associated many aspects of daily life; the use of specialized devices and tools has removed obstacles imposed by restrictions of time and place. Additionally, users from different fields and specialisations who use mobile devices can utilise tools and programs that are stored on remote servers through wireless networks (Dinh, 2011). Mobile devices have become the necessities of life for many people; it is evident that the majority of people use such devices every day. For example, students use mobile technology in schools or at university to access the education system from any location and can realise numerous processes, such as verifying their grades, adding courses, checking a transportation schedule, or communicating with lecturers. Furthermore, businessmen use mobile devices in all aspects of their work, from reading emails and following the stock market to using banking services through financial applications. In fact, this technology still retains its importance for communications and making telephone calls, which means that people today cannot dispense of mobile devices (Rahimi, 2013).

Cloud computing is a revolution in the world of technology, as it is now possible to manage vast amounts of data and to conduct complex processes with this data. It uses resources that have very high specifications within a short timeframe and using minimal effort. To access cloud computing services and avail of the processes and resources, users are only required to have Internet access and a computer, mobile or tablet with appropriate access rights (Javied, 2017).

Due to the significant developments in technology and the increased speed of data transfer, quality has become particularly important to users. Quality of service (QoS) is the description or measurement of the overall performance of a service. For example,

billions of users on the YouTube website watch video clips and some of these videos offer quality that could be as high as (1080p); therefore, this level of quality needs resources and processors with large capacity and high speed Internet in order to preserve the quality of service (Lai, 2013). Also, people in modern society regular make video calls and this has become an important aspect of life; resultantly, this service requires the appropriate resources and high speed Internet to maintain the quality of contact. This mean that the vendors of this services should have effective QoS approaches in order to maximize the utilization of resources and provide effective service to customers (Misra, 2014.

Mobile cloud computing (MCC) consists of two main components: mobile computing (MC), which includes mobile phones and all other mobile devices, and cloud computing, which incorporates specialized services and tools. Mobile computing has become an important element in improving the utilization of information technology used in business and industry. Additionally, cloud computing has provided many specialized services and tools to users that are accessible from different wireless networks (e.g., servers, systems, and stockpiles), stages (e.g., middleware benefits and working frameworks), and programming (e.g., application programs) that are provided specifically by cloud suppliers (e.g., Google, Amazon, and Salesforce) that require little or no effort (Dinh, 2011). In this environment, online consumers can choose the best possible cloud benefit from significant specialist providers that can offer administrations using QoS. Consequently, cloud computing has become indispensable for consumers as it enables them to satisfy their purchasing desires in various business areas (Abdelmaboud, 2015).

Through multiple intelligent administrations, cloud computing provides multimedia information based on a planned and effectively implemented approach to quality of service, where the information preparing process and capacity are moved from the mobile phone to intense and combined processing stages that are situated in the cloud. Through wireless connections and networks and via the use user of a web browser or using a mobile device, users can access these services and applications (Dinh, 2011). Furthermore, it considers the general network environment and alters the interactive transmission frequency and the dynamic multimedia transcoding, to prevent the

inefficient usage of bandwidth and terminal power (Lai, 2013). The benefits of prolonged battery life, adequate discharge, and reduced data storage and handling issues have led to the increased importance of mobile cloud computing (MCC). Furthermore, the approach coordinated through layers is fundamental to understanding the mobile cloud computing ideas, which are the basic principles that are necessary to understand the remarkable advantages that are available when utilising the versatile cloud (Rahimi, 2013).

Through base stations, mobile cloud computing can connect mobile systems and services with mobile phones. Mobile clients' data solicitations (e.g., ID and area) are transmitted to the focal processors that are associated with servers, which affords versatile system administration to mobile clients. The clients' solicitations are conveyed to the cloud through the Internet (Lee, 2010). In the cloud, cloud controllers administer solicitations to furnish versatile clients with cloud computing services. These computing services are produced with the ideas of utility processing, virtualization, and computing-situated engineering (e.g., web, application, and database servers) (Dinh, 2011).

Systematic mapping display provides structure of the kind of research reports that have been distributed by sorting them and presenting them in a visible summary. It commonly requires less exertion while giving a more coarse-grained outline (Petersen, 2008). In this study research, Petersen used systematic mapping with 16 articles related to QoS approach in MCC. This methodology has not been widely used by researchers because it is a relatively new approach and has not sufficiently matured and there are a limited number of previous studies that can be accessed by researchers.

1.1 The Problem

To identify potential gaps that suggest areas for future research on QoS in mobile-based cloud computing.

There has been no research to date that has aimed to locate QoS in mobile cloud computing.

1.2 Aim of the Study

(1) Identification of the primary studies and their distribution sources.

(2) Systematic mapping of the current QoS approaches in cloud computing based mobile environments.

(3) To determine the issues, difficulties and future patterns of the QoS approaches in cloud computing based mobile environments.

1.2.1 Research Questions

RQ 1: What are the major topics in the QoS approaches for mobile based cloud computing?

RQ 2: What are the types of the research, the field and contribution to the field?

RQ 2: What are the types of research published in QoS for mobile based cloud computing studies?

1.3 Significance of the Study

This study will help mobile cloud computing providers to learn about the problems of cloud computing quality and what are the correct approaches that must be used to maintain the quality of services in mobile cloud computing. This study also will provide researchers with a comprehensive knowledge of previse studies, what topics have been highlighted, and what type contributions, and what gaps remain to be considered. Most previous studies focused on Qos in cloud computing in general, But this study is of great importance for two reasons, the first reason this study uses systematic mapping methodology , and the second reason it focuses on mobile cloud computing .

1.4 The Limitations of the Study

During this thesis, the researcher expected to face the following challenges and difficulties:

This thesis was characterized by research and only focussed on research on mobile cloud computing.

The study is limited to the mentioned databases only, between the years 2010-2017.

CHAPTER 2

LITERATURE REVIEW

2.1 Overview of Mobile Cloud Computing

In many areas, cloud computing has become the most powerful innovation and invention that facilitates all aspects of life and endeavours and increases business agility. To reduce the tools and resources required to run applications on mobile phones, mobile cloud computing has been linked to mobile networks (Narain, 2009). One of the most significant benefits of mobile cloud computing is that it helps to reduce the capacity of mobile devices can also reduce battery power consumption and eliminate the issue of redundancy. In order to achieve a superior push innovation, the MCC is utilized, because it allows simple access to the CC specialized interface (Tao, 2009). There are several meanings of a CC, for example it is a rich mobile computing innovation that uses combined flexible assets and system advancements to provide unlimited usefulness, storage, and portability.

Cloud computing has many important components and departments that enable it to perform operations properly and to deliver high-quality services, as can be seen in Figure 2.1.

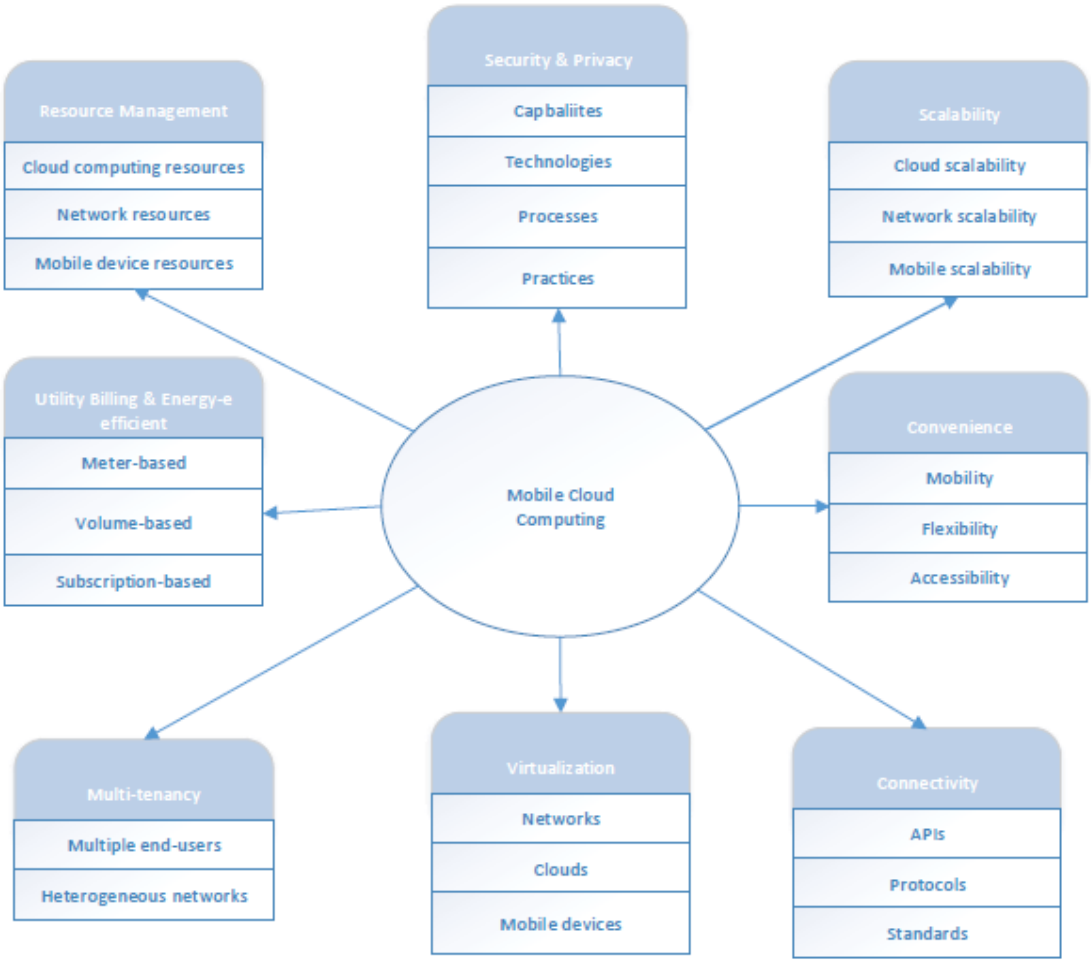

Figure 2.1: Cloud computing services (Sanaei , 2010)

Cloud computing is different from other services due to its distinct characteristics, which has provided it with significant importance in many different fields. These include:

- Scalability.

This property is divided into three different sections, which are the cloud, mobile devices and network

- Connectivity.
  Reliable communication system is among the various system benefits
- Privacy and Security.
  An important and necessary feature to ensure that access to clouds, mobile phones and information systems is secure.
- Virtualization
  This characteristic is additionally separated into mobile, cloud, and system virtualization.
- Management of resources
  CC can support the administration of PCs, device, or networks assets.
- Convenience :
  Ensuring simple access to cloud computing applications and services from any location and at any time.
- Utility Billing and Energy-efficient.
  This feature underpins several cloud administrations.
- Multi-tenancy

  This characteristic enables multiple clients to utilize the system cloud

  applications.

2.2 Architectures of Mobile Cloud Computing

To demonstrate the concept of mobile cloud computing, the general design of the technology is shown in Figure 2.2. In Figure 2.2, it can be observed that mobile devices are linked with the mobile networks by means of base stations (e.g., base handset station, access to point, or satellite) that establish and control the connections (air links) and functional interfaces between the networks and portable devices. Services are provided by cloud administrators to mobile users when they request, and the cellular user information is stored in a secure environment. Mobile users must have authorization (e.g., ID and location) on the mobile network and cloud in order to access the services (Rudenko, 1998).

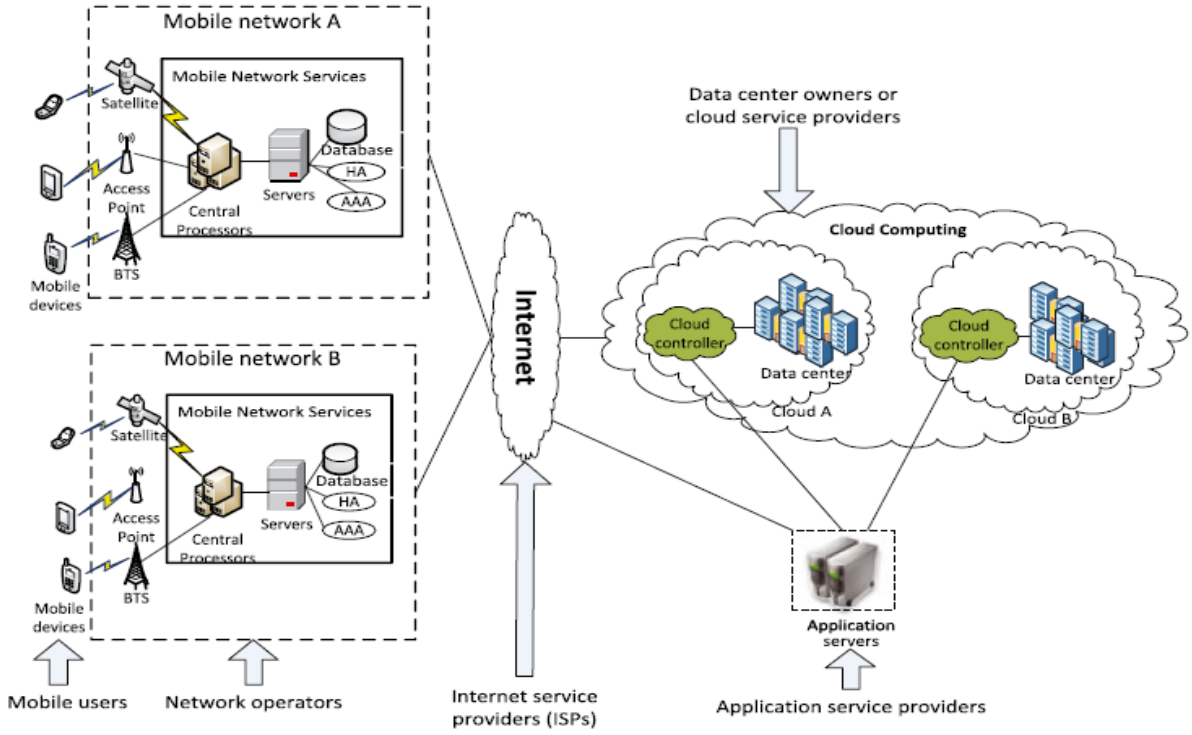

Figure 2.2: Mobile cloud computing architecture (Rudenko , 1998)

Primarily, a CC is an extensive scale network system executed through different servers in data centres. Cloud services operate based on the concept of different layers (Figure 2.3). In the upper layers of this system, Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS) are stacked.

- Data centre layer. Customers are managed through fast and different systems and servers. The data centre contains information that the cloud requires and this is where user data is saved. The data centre is protected from disasters and accidents (Berkin, 2012).

- IaaS. Infrastructure as a Service is situated at the top of the data centre layer. IaaS enables the arrangement of capacity, gear, servers, and networking parts. The client conventionally pays only when usage commences. Thus, this is cost effective for clients as they are only required to pay for the resources that they actually use. Foundation can be augmented or contracted logically as required. Examples of IaaS are Amazon Flexible Cloud Computing and Simple Storage Service (S3).
- PaaS. This offers an advanced composed condition for building, testing, and access to custom applications. Some examples of PaaS are Google Application Engine, Amazon and Microsoft Azure.

- Software as a Service (SaaS). Without direct contact and through an Internet connection, users pay to access services and information from the cloud. Salesforce is the first major company to provide this service paradigm. Microsoft Live also allows files to be accessed across multiple devices together and sharing of folders.

Figure 2.3 shows the order of the four layers of the cloud. Although these layers appear to be isolated, this does not prevent customers from using more than one layer on cloud computing, so that parts of the layers can be shared at the same time. For example, the

data centre can be used in the IaaS layer and this feature provides flexibility and effectiveness to cloud computing (Yang, 2010).

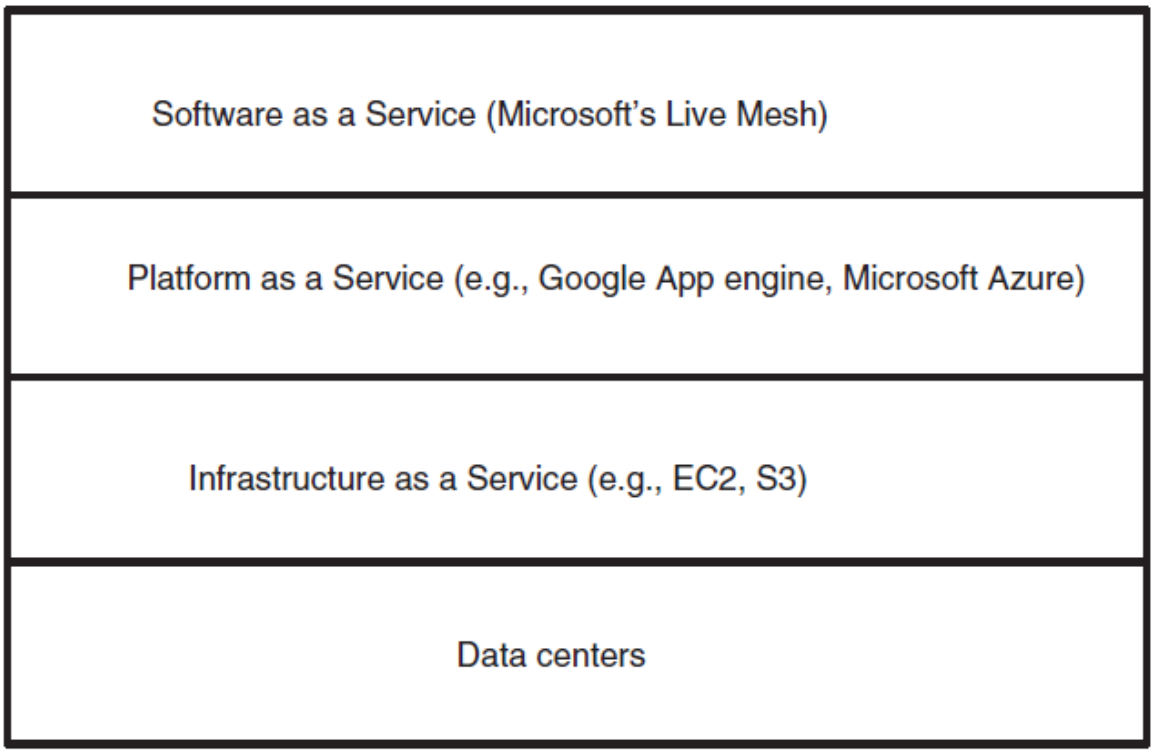

Figure 2.3: Service-oriented cloud computing architecture (Yang , 2010)

2.3 Quality of service in mobile cloud computing

When mobile users request any service from the cloud, they are required to comply with various operations such as verification of their user ID in order for access permission to be granted. QoS means achieving congruence and compatibility with customer requirements and can also be defined as measuring the extent to which the level of service reaching the customer is consistent with its expectations, and delivery of a good service means meeting the expectations set by the customer (Kakerow, 2003). Numerous problems could occur in the cloud when a mobile user submits a requests due to congestion because of the deficiencies in remote data transfer capacities, network disconnections, and signal reduction caused by the mobile client changing location and increasing the distance from an Internet access point. The quality of service provided in

the cloud can be reduced in the event of a delay in the customer connecting with cloud, and there are many approaches to resolving this problem. Two solutions that have been developed in this area are CloneCloud and Cloudlets, which have contributed to overcoming this problem (Hoang, 2011).

CloneCloud (Figure 2.4**)**: This system brings the ability of Cloud Computing to the mobile device. CloneCloud uses nearby computers or data centres to augment the speed of operating mobile device applications. The CloneCloud concept places data and information and an application copy on the cloud and performs some operations on this copy, re-incorporating results that are sent to the mobile device. CloneCloud is constrained to a certain extent by its powerlessness to move native state and to export distinctive native resources remotely. Restrictions of CloneCloud are that it does not include copies of the cloud services when searching for the nearest computer or data centre from the user requesting the service from the cloud. (Hoang, 2011).

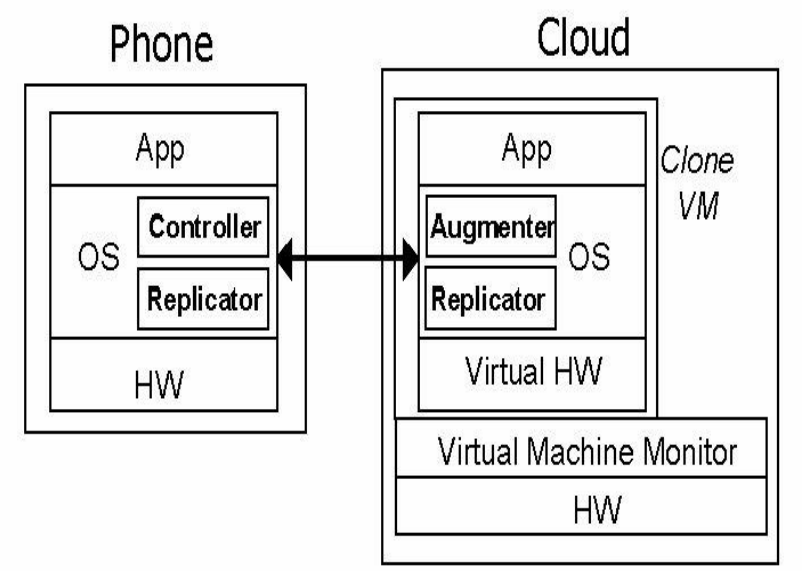

Figure 2.4: ColneCloud concept (Hoang , 2011)

Cloudlets (Figure 2.5): A cloudlet offers reliability, using a nearby computer group (cluster) connected together to the Internet. In the circumstance that mobile devices are unable to connect to the cloud (perhaps due to cost or delay), they can detect and utilize a cloudlet that is close by. In this way, mobile users can satisfy their need for consistent interactivity by one-hop, low-latency, high-bandwidth wireless access to the cloudlet. When a nearby cloudlet is unavailable, mobile devices will return to default mode, search for another cloudlet and send requests to the first available cloudlet that is found; in the worst case scenario, it will use its own resources (Hoang, 2011). Previous studies have designed architecture using VM developments to quickly instantiate modified service software on a cloudlet in the vicinity and subsequently used that software over a wireless LAN. However, further investigation and research should be conducted before this concept can be completely integrated into a real system.

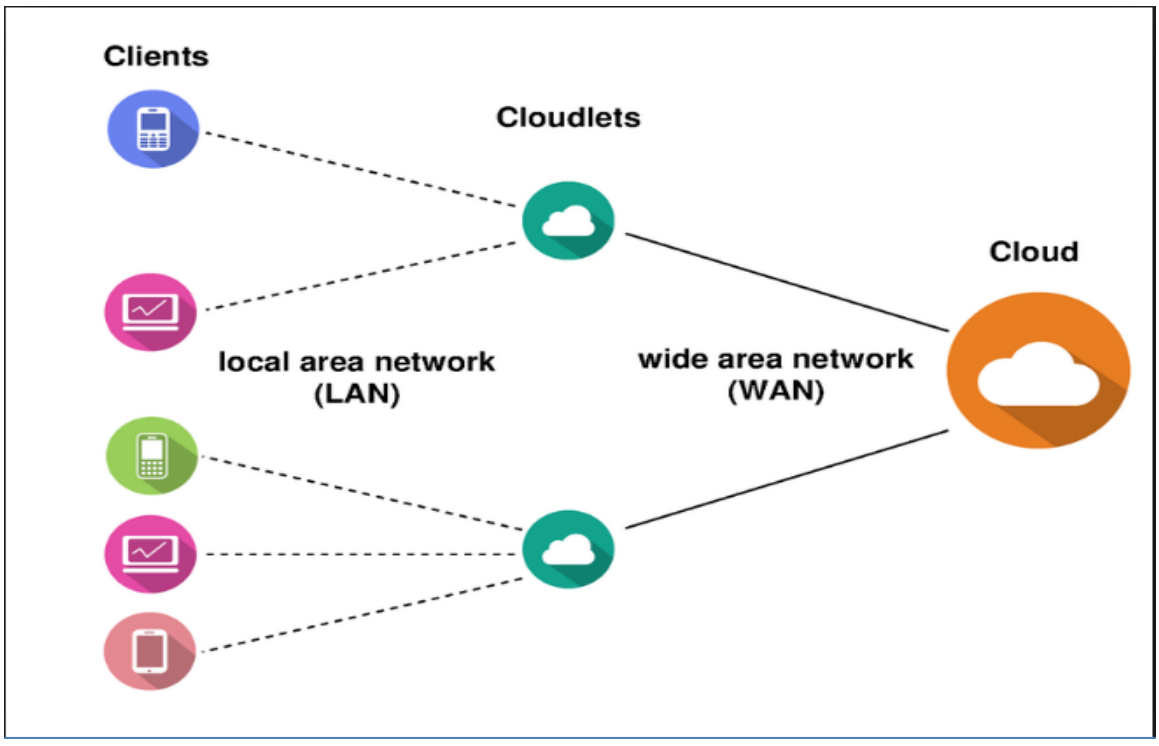

Figure 2.5: Cloudlet concept (Hoang , 2011).

2.4 Systematic Mapping is a Methodology

A systematic mapping display provides a structure of the kind of research reports and results that have been distributed by sorting them and presenting them in a visible summary. It commonly requires less exertion while generating more coarse-grained outline (Petersen, 2015).

2.4.1 The Systematic Mapping Process

Systematic mapping methodology involves five successive stages, as described in (Figure 2.6). Each stage has an outcome, with the final result of the operation being the systematic map.

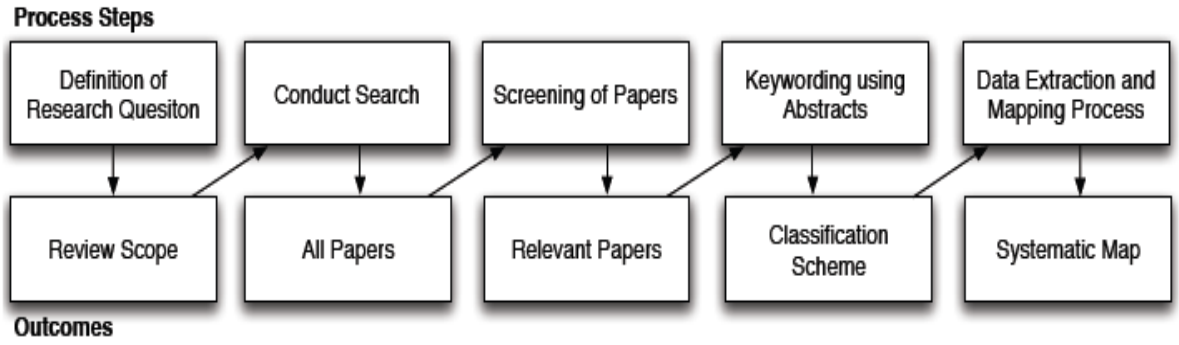

Figure 2.6*:* The Systematic Mapping Process (Petersen, 2008).

2.4.2 Definition of Research Questions (Research Scope)

The fundamental objective of systematic mapping studies is present a diagram of a research area, as well as to distinguish the amount and sort of research and the results that

are accessible. Normally, it is necessary to delineate the frequencies of publication after some time in order to observe patterns. An optional objective can be to distinguish the discussions by analysing the previously published research (Abdelzahir, 2015). These objectives are reflected in both research questions (RQs), which are comparative.

2.4.3 Conduct Search for Primary Studies (All Papers)

Researchers can use search strings on a database in order to identify the primary studies or, on the other hand, they can peruse manually through related conference or journal publications. An effective approach when formulating the search strings is to structure them in terms of populace, intercession, examination, and result (Kitchenham & Charters, 2007). Keywords should be the principal words in the study that are used for search purposes.

2.4.4 Screening of Papers for Inclusion and Exclusion (Relevant Papers)

Incorporation and avoidance criteria are utilized to eliminate articles that are not applicable to answering the research questions. At the same time, the reviewer distinguishes the context of the research. Once this is completed, the arrangement of keywords from various papers are combined to construct an understanding about the nature and commitment of the research (Clodoaldo, 2013).

2.4.5 Keywording of Abstracts (Classification Scheme)

The procedure of how the classification scheme followed a systematic process that was planned in advance. For the review, the researcher followed a methodical procedure, as described in (Figure 2.7). Keywording is an approach used to reduce the time required to construct the classification and guarantees that the plan considers the current reviews. Keywording is performed in two stages. In the first step, the reviewers read abstracts and search for keywords and ideas that mirror the objective of the paper. At the same time, the reviewers recognised the type of the research. This helps the reviewers to formulate an arrangement of classes that is illustrative of the basic populace. Whenever abstracts are of excessively low quality, rendering it impossible to enable significant keywords to be selected, reviewers can additionally consider the presentation or conclusion segments of the paper. When a final arrangement of keywords has been determined, they can be grouped and used to shape the classifications for the mapping (Carlo, 2013).

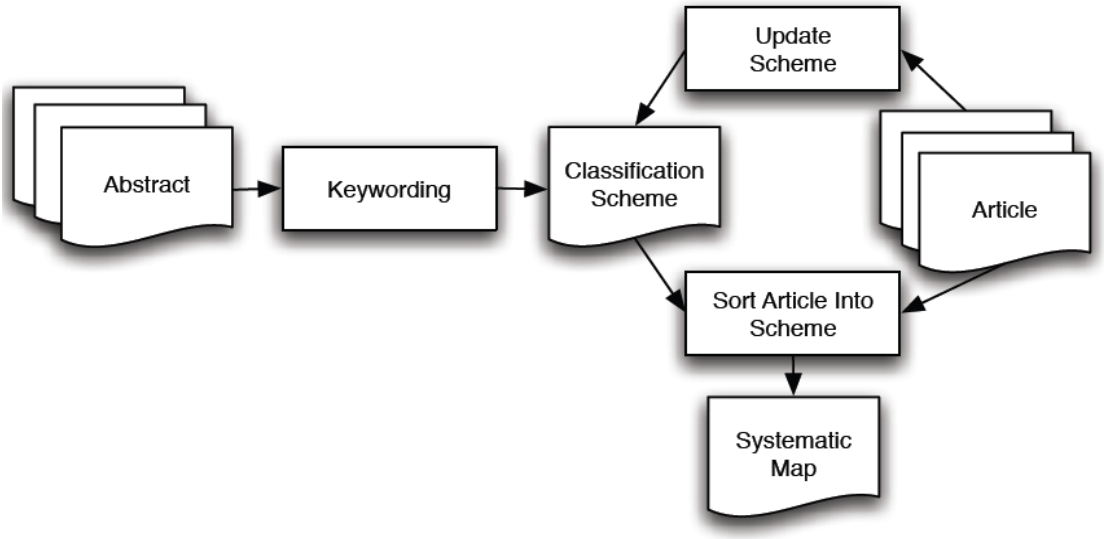

Figure 2.7: Building the Classification Scheme (Carlo , 2013).

2.4.6 Data Extraction and Mapping of Studies (Systematic Map)

When the arrangement classification scheme has been determined, the applicable articles are sorted into that scheme, i.e., the actual information extraction can be conducted. As demonstrated in (Figure 2.7), the classification scheme develops while the information extraction is implemented, such as the inclusion of new classifications or consolidating parts of existing classes. In this process, the researcher utilized a Microsoft Excel table to archive the information extraction operation, as displayed in Figure 2.8. Essentially, this involves two x-y scatterplots with bubbles in the class intersections. The size of a bubble is proportional to the number of articles that are in the pair of classes corresponding to the bubble coordinates.

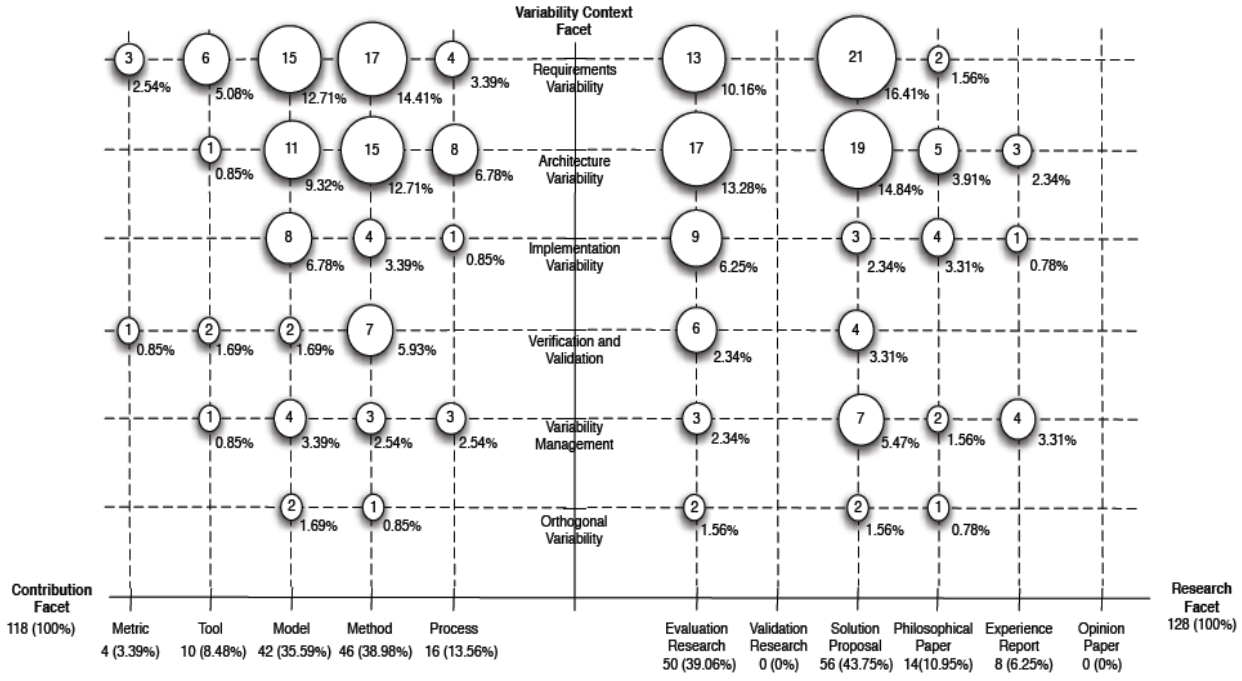

Figure 2.8: Visualization of a systematic map in the form of a bubble plot (Petersen , 2008)

2.5 Systematic Reviews and Systematic Mapping

Systematic reviews are a form of literature review in which various research studies or papers are gathered and fundamentally analysed, utilizing techniques that are chosen before. At least one of the research questions is detailed, and subsequently finding and dissecting ideas that identify with and answer those inquiries in an organized methodology. They are intended to give an entire, comprehensive outline of writing that is applicable to an investigative question. Methodical studies of randomized controlled experiments are used in evidence-based medicine, for example, and an review of existing research is generally quicker and less expensive than conducting another form of study. An understanding of previous studies and research, and how to implement the findings in practise, is recommended for experts in the field of medicine. A systematic mapping display gives a structure of the kind of research reports and comes about that have been distributed by sorting them and frequently gives a visible summary, the guide, of its outcomes. It regularly requires less exertion while giving a more coarse-grained diagram (Petersen, 2015). A comparison of systematic maps and reviews was presented already in (Kitchenham , 2007), focusing mainly on differences in breadth and depth. Researcher extends on that based the overview of systematic reviews and on experience from conducting systematic maps.

Difference in Goals: The systematic reviews focus on identifying best practices based on empirical evidence .This is not a goal for systematic maps, and cannot be since they do not study articles in enough detail. Instead, the main focus here is on classification, conducting thematic analysis and identifying publication fora. Both study types share the aim of identifying research gaps. The systematic reviews shows where particular evidence is missing or is insufficiently reported in existing studies. This is not possible in systematic map.

Difference in Process : Researcher see two main differences in the process. In maps, the articles are not evaluated regarding their quality as the main goal is not to establish the state of evidence. Secondly, data extraction methods differ. For the systematic mapping study, thematic analysis is an interesting analysis method, as it helps to see which

categories are well covered in terms of number of publications. In systematic reviews, the method of Meta analysis requires another level of data extraction in order to continue working with the quantitative data collected in primary studies (Kitchenham , 2007).

Difference in Breadth and Depth: In a systematic mapping study, more articles can be considered as they don't have to be evaluated in such detail. Therefore, a larger field can be structured. (Kitchenham , 2007) state the outcome and quality assessment of the articles as a major focus, which increases the depth and thus the effort required. This could require a more specific focus of the study and thus fewer studies being included. This difference was also recognized in (Kitchenham , 2007).

A systematic map can be conducted first, to get an overview of the topic area. Then the state of evidence in specific topics can be investigated using a systematic review.

CHAPTER 4

METHODOLOGY

4.1 Research methodology

Systematic mapping is the methodology utilized in this study, in which the researcher examined articles and research related with systematic mapping in order to understand the points and steps in this methodology to apply to the present study. The researcher found seven important articles that explained systematic mapping methodology.

The followings are some clarifications about the seven studies that have been adopted in this study:

"A systematic mapping study was performed to find the related literature ,and 67 articles were selected as primary studies that are classified in relation to the focus, research type an contribution type"(Abdelmaboud, 2015). " The Systematic mapping is conducted using the guidelines proposed by Petersen et al. authors posed three sets of research questions. That define selection and exclusion criteria. From the initial pool of 230 articles, published in years 1991–2011, theirs final pool consisted of 136 articles. Authors systematically develop a classification scheme and map the selected articles to this scheme" (Banerjee, 2013). "The good practices of systematic mapping study methodology were adopted in order to reach those objectives. Al though Cloud Computing is based on a business model with over 50 years of existence, evidences found in this study indicate that Cloud Computing still presents limitations that prevent the full use of the proposal on demand"(Carvalho, 2013). "We performed a systematic mapping study to categorize and to structure the research evidence that has been published in the area of mobile application testing techniques and challenges that they have reported. Seventy nine (79) empirical studies are mapped to a classification schema" (Zein, 2016). "We have conducted an informal review of a

number of mapping studies in software engineering, describing their main characteristics and the forms of analysis used"(Budgen, 2008). "The databases like IEEE Xplore, ACM digital library, Inspec, Springer and Google scholar were used to search for the relevant studies for our systematic mapping study. We followed basic inclusion criteria along with detailed inclusion/exclusion criteria for selecting the appropriate article" (Konda, 2010). "We have defined a systematic mapping process and applied it to complete a systematic mapping study. Furthermore, we compare systematic maps with systematic reviews by systematically analysing existing systematic reviews"(Petersen, 2008).

4.2 Data sources and search strategy

The researcher used primary sources to search for previous research that was related with the chosen study subject and these six primary search sources are shown in (Table 4.1). Furthermore, the researcher determined the search period to be 2010 to 2017, and this specific period was chosen because studies on the quality of service in CC based on MCC began to be published around 2010.

Table 4.1: The sources of database

Source	URL
IEEE Xplore	http://ieeexplore.ieee.org
ACM	http://portal.acm.org
Springer	http://www.springerlink.com
ScienceDirect	http://www.sciencedirect.com
Ethos	http://www. http://ethos.bl.uk
Google Scholar	http://scholar.google.com.

The keywords used in the operations search were (QoS, quality of services, cloud computing, mobile). The search was conducted using the following method: ("QoS" OR "quality of services") AND "cloud computing" AND "mobile" AND LIMIT-TO (years, "2010,2011,2012,2013,2014,2015,2016,2017").

4.3 Study Selection

With to the specific objective of choosing the most pertinent and critical articles, inclusion and exclusion criteria were created. Based on these criteria, the studies were chosen by examining the titles, concepts and full text of the articles to ensure that the results were connected to the research area. At the end of this study, criteria for inclusion and exclusion were identified and were relevant to this study.

Inclusion criteria:

- The study must report on the quality of service in MCC computing from programming and data framework perspectives.
- The study must address the computing QoS, foundation or stage given in cloud computing.
- The study must delineate the nature of cloud computing from the perspective of customers

Exclusion criteria:

- The focus of the article is on security and reliability

The primary studies selected using the aforementioned four steps are shown in Figure 4.1.

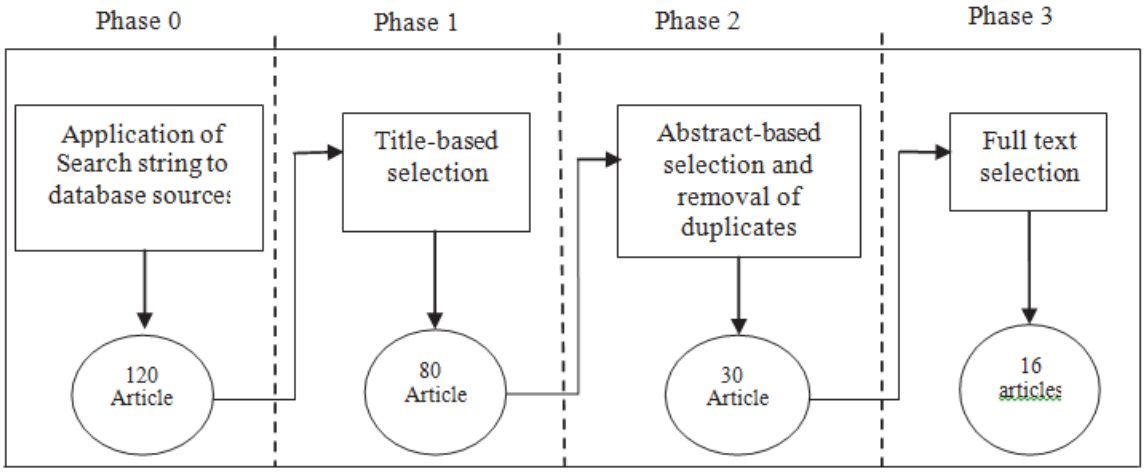

Figure 4.1: Selection process

Step 0: Application of search strings to database sources.

In total, 120 studies were retrieved from all sources (IEEE Xplore, ACM, Springer, Science Direct, Ethos, and Google Scholar) that were related with the researcher's study.

Step 1: Title-based Selection.

In this stage, the researcher read the articles of titles in order to determine the articles that were related with the objective or including or excluding the relevant articles. As a result of this process, a total of 80 articles were included and were moved to the subsequent stage.

Step 2: Abstract-based selection and removal of duplicates.

In this step, researcher analysed keywords and abstracts of previous studies to determine which studies were related with the present study, and ensured that there were no duplicates among these articles. As a result of this analysis, a total of 30 articles remained after this step, which was then transferred to the subsequent stage.

Step 3: Full text selection.

In this stage of the process, the researcher read of the entire text of the studies to determine which articles contained the principal keywords QoS, cloud computing and mobile. This process resulted in a total of 16 articles that contained these keywords. Table 4.2 lists the studies that remained after elimination during the third stage.

Table 4.2: Studies remaining after third stage

Study	Title	Source	Year
S18	(A Survey of Interactive Remote Rendering Systems)	ACM	2015
S77	(A Framework for Cooperative Resource Management in Mobile Cloud Computing)	IEEE	2013
S78	(A Framework for QoS and Power Management in a Service Cloud Environment with Mobile Devices)	IEEE	2010
S79	(A Network and Device Aware QoS Approach for Cloud-Based Mobile Streaming)	IEEE	2013
S80	(a qos-aware system for mobile cloud computing)	IEEE	2011

(continued)

Table 4.2 (continued): Studies remaining after third stage

Study	Title	Source	Year
S81	(A survey of mobile cloud computing: architecture, applications, and approaches)	IEEE	2013
S82	(On the Investigation of Cloud-Based Mobile Media Environments With Service-Populating and QoS-Aware Mechanisms)	IEEE	2013
S83	(QoS-Aware Dynamic Resource Management in Heterogeneous Mobile Cloud Computing Networks)	IEEE	2014
S84	(QoS-Guaranteed Bandwidth Shifting and Redistribution in Mobile Cloud)	IEEE	2014
S112	(A novel cloud scheduling algorithm optimization for energy consumption of data centers based on user QoS priori knowledge under the background of WSN and mobile communication)	Springer	2017

(continued)

Table 4.2 (continued): Studies remaining after third stage

Study	Title	Source	Year
S113	(Fault tolerance and QoS scheduling using CAN in mobile social cloud computing)	Springer	2014
S114	(Integrated Multi-service Handoff Mechanism with QoS-Support Strategy in Mobile Cloud Computing)	Springer	2016
S115	(Storage and computing resource enabled joint virtual resource allocation with QoS guarantee in mobile networks)	Springer	2017
S118	(Application Partitioning and Offloading in Mobile Cloud Computing)	Ethos	2017
S119	(Exploring Traffic and QoS Management Mechanisms to Support Mobile Cloud Computing using Service Localization in Heterogeneous Environment)	Ethos	2015
S120	(Volar Mobile Context-aware Adaptation for the Cloud)	Ethos	2014

4.4 Primary Studies

After following the aforementioned three steps, the researcher selected 16 studies as the primary studies as shown Table 4.3.

Table 4.3: Distribution of primary studies by publication type

Publication type	2010	2011	2012	2013	2014	2015	2016	2017	Total	%
Conference proceedings		1							1	6
Journal article	1	1		4	2	1	1	2	12	75
thesis					2			1	3	19
Total	1	2		4	4	1	1	3	16	100

Table 4.4 shows the publication type of the primary studies.

Table 4.4 : Distribution of the type of the primary studies

Source	Number
Journal on Selected Areas in Communications	1
International Symposium on Service Oriented System Engineering	1
Transactions on Multimedia	2
Cluster Comput	2
Cloud Computing and Intelligence Systems	1
ACM Computing Surveys	1
Wireless communications and mobile computing	1
Thesis	3

(Continued)

Table 4.4 : Distribution of the type of the primary studies

Source	Number
Wireless Personal Communications	1
China Communications	1
Transactions on Cloud Computing	1
Science China Information Sciences	1
Total	16

4.5 Research focus area and distribution

The compilation of the primary studies in terms of focus area depended on the separation of the exploration themes into five noteworthy research areas. The researcher identified the following five research focus areas: "Software as a Service (SaaS), Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Cloud Service Provider (CSP), and Cloud Service Consumer (CSC). Table 4.5 presents an outline of the distribution of the primary reviews by research area. Each of these research areas is defined as follows:

a) The SaaS research area is concerned with the delivery of applications and systems in the form of services to users via the Internet
b) The PaaS research area concentrates on the supply of resources for development platforms for services and applications via the Internet
c) The IaaS research area is centred around the delivery of data centres and resources for the purposes of virtualisation to businesses or organisations through the process of leasing these resources to the relevant service providers.
d) The CSP research is concerned with the service providers themselves who furnish cloud services to Internet users, including infrastructure services, software or platforms.

e) The CSC research area is focused on the companies or individual users who are the end-users of cloud computing services that are delivered by service providers

Table 4.5: Distribution of primary studies by research focus area**.**

Focus area	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**Total**	**%**
SaaS				1	1			1	3	19
IaaS		1				1			2	12
PaaS								1	1	6
CSP	1	1		2	1	1		1	7	44
CSC				1	1		1		3	19
Total									16	100

Table 4.6 lists the focus areas of the studies

Table 4.6: Studies with focus area

Study	Title	Focus area
S18	(A Survey of Interactive Remote Rendering Systems)	CSC
S77	(A Framework for Cooperative Resource Management in Mobile Cloud Computing)	CSC
S78	(A Framework for QoS and Power Management in a Service Cloud Environment with Mobile Devices)	CSC
S79	(A Network and Device Aware QoS Approach for Cloud-Based Mobile Streaming)	CSP
S80	(a qos-aware system for mobile cloud computing)	CSP
S81	(A survey of mobile cloud computing: architecture, applications, and approaches)	CSP
S82	(On the Investigation of Cloud-Based Mobile Media Environments With Service-Populating and QoS-Aware Mechanisms)	CSP

(continued)

Table 4.6 (continued): Primary Studies with focus area

Study	Title	Focus area
S83	(QoS-Aware Dynamic Resource Management in Heterogeneous Mobile Cloud Computing Networks)	CSP
S84	(QoS-Guaranteed Bandwidth Shifting and Redistribution in Mobile Cloud)	CSP
S112	(A novel cloud scheduling algorithm optimization for energy consumption of data centers based on user QoS priori knowledge under the background of WSN and mobile communication)	CSP
S113	(Fault tolerance and QoS scheduling using CAN in mobile social cloud computing)	Iaas
S114	(Integrated Multi-service Handoff Mechanism with QoS-Support Strategy in Mobile Cloud Computing)	Iaas
S115	(Storage and computing resource enabled joint virtual resource allocation with QoS guarantee in mobile networks)	Paas

(continued)

Table 4.6 (continued): Primary Studies with focus area

Study	Title	Focus area
S118	(Application Partitioning and Offloading in Mobile Cloud Computing)	Saas
S119	(Exploring Traffic and QoS Management Mechanisms to Support Mobile Cloud Computing using Service Localization in Heterogeneous Environment)	Saas
S120	(Volare Mobile Context-aware Adaptation for the Cloud)	Saas

4.6 Contribution Type and Distribution

With the objective of making meaningful progress on the QoS in CC, the research in this study was divided into five categories in terms of contribution (methods, tools, processes, metrics and models). Table 4.7 shows the distribution of these contributions to the studies, as follows:

a) The contribution of tools is related to previous studies that have proposed software tools that reinforce certain facets of the QoS approaches in the field of cloud computing
b) The method contribution type is related to studies that have proposed a model, algorithm or approach that delineate the QoS rule in cloud computing as well has how these rules can actually be applied
c) The processes contribution type is related to studies that delineate the actions or exercises of QoS approaches as well as their related workflows
d) The model contribution type is related to studies that focus on ideas, generate comparisons, investigate relations, determine obstacles or create classifications
e) The measurement contribution type to studies that suggest metrics or measurement standards for QoS approaches in the field of cloud computing

Table 4.7 : Distribution of primary reviews by contribution type

Contribution type	2010	2011	2012	2013	2014	2015	2016	2017	Total	%
Tool									0	0
Method				1	1	1			3	19
Process		1							1	6
Model	1			2	2	1	1	1	8	50
Metric		1		1				2	4	25
Total									16	100

Table 4.8 shows the studies by contribution type

Table 4.8: Primary Studies by contribution type

Study	Title	Contribution type	Explain
S18	(A Survey of Interactive Remote Rendering Systems)	Metric	study realized a prototype to validate the feasibility
S77	(A Framework for Cooperative Resource Management in Mobile Cloud Computing)	Model	Author develop an analytic model for the improved multi-service handoff Mechanism
S78	(A Framework for QoS and Power Management in a Service Cloud Environment with Mobile Devices)	Model	author proposed design the network as the integration of the mobile access part and the cloud computing part, utilizing the inherent heterogeneity to meet the diverse quality of service (QoS) requirements of tenants.
S79	(A Network and Device Aware QoS Approach for Cloud-Based Mobile Streaming)	Model	propose a framework for resource allocation to the mobile applications, and revenue management and cooperation formation among service providers

(continued)

Table 4.8(continued): Primary Studies by contribution type

Study	Title	Contribution type	Explain
S80	(a qos-aware system for mobile cloud computing)	Model	propose a QPM framework that tries to minimize the power consumption on the mobile device while satisfying the QoS requirements
S81	(A survey of mobile cloud computing: architecture, applications, and approaches)	Metric	Study gives a survey of MCC, which helps general readers have an overview of the MCC including the definition, architecture, and applications
S82	(On the Investigation of Cloud-Based Mobile Media Environments With Service-Populating and QoS-Aware Mechanisms)	Method	Study proposed dynamic resource provisioning algorithm with respect to the execution time, good put and bandwidth usage and compare the performance of the proposed scheduler against the exiting approaches.

(continued)

Table 4.8(continued): Primary Studies by contribution type

Study	Title	Contribution type	Explain
S83	(QoS-Aware Dynamic Resource Management in Heterogeneous Mobile Cloud Computing Networks)	Model	Study propose fault tolerance and QoS (Quality of Services) scheduling using CAN (Content Addressable Network) in Mobile Social Cloud Computing (MSCC)
S84	(QoS-Guaranteed Bandwidth Shifting and Redistribution in Mobile Cloud)	Method	Study proposed scheme, named as AQUM, each gateway aggregates the demands of all the connecting mobile nodes and makes a bid for the required amount of bandwidth
S112	(A novel cloud scheduling algorithm optimization for energy consumption of data centers based on user QoS priori knowledge under the background of WSN and mobile communication)	Metric	Study purposed the effective capacity as the metric to include the influence of service latency

(continued)

Table 4.8(continued): Primary Studies by contribution type

Study	Title	Contribution type	Explain
S113	(Fault tolerance and QoS scheduling using CAN in mobile social cloud computing)	Process	Study purposed a QoS management model based on Fuzzy Cognitive Map (FCM)
S114	(Integrated Multi-service Handoff Mechanism with QoS-Support Strategy in Mobile Cloud Computing)	Model	study proposed a new service delivery framework, centered on the convergence of Mobile Cloud Computing and 5G networks for the purpose of optimizing service delivery in a mobile environment
S115	(Storage and computing resource enabled joint virtual resource allocation with QoS guarantee in mobile networks)	Model	Author proposed model " end-to-end communication framework".
S118	(Application Partitioning and Offloading in Mobile Cloud Computing)	Metric	author has broken down observationally the execution of the proposed calculation utilizing the CloudSim test system Random resource use

(continued)

Table 4.8(continued): Primary Studies by contribution type

Study	Title	Contribution type	Explain
S119	(Exploring Traffic and QoS Management Mechanisms to Support Mobile Cloud Computing using Service Localization in Heterogeneous Environment)	Method	Using an analytical framework, this paper argues that as the demand for specific services increases in a location, it might be more efficient to move those services closer to that location.
S120	(Volare Mobile Context-aware Adaptation for the Cloud)	Model	the study introduce an adaptive mobile middleware solution that performs context-aware QoS parameter adaptation. When service discovery is initiated, the middleware calculates the optimal service requests QoS levels under the current context, policy requirements and goals and adapts the service request accordingly

4.7 Research Type and Distribution

The distribution of the primary studies by research type is shown in Table 4.9. These categories are incorporated into the researcher's methodical mapping study and the primary studies are organized into six research types, as follows (RQ 2):

a) Solution proposal: research resolves a problem using an innovative solution or, provides a significant extension to a existent method
b) Validation research: a system for researching something that has not previously been achieved or actualised in reality. It researches a suggested solution or process for mathematical investigation or presents experiments, simulations or innovative prototypes.
c) Evaluation research: the research explores whether a proposed solution can be actualised in practise. It examines the outcomes utilizing actual case studies or contextual analysis
d) Conceptual proposal: this research type aims to observe things that already exist from alternative perspectives in order to find solutions to problems using methods such as theoretical frameworks or classifications
e) Experience article: This type of article will provide a report on the researcher's own experience of actual projects they have conducted. The report will delineate how the project was implemented and what was achieved
f) Opinion article: This form of research article will describe the researcher's views on a particular method or tool as well as the development process.

Table 4.9 : Distribution of primary studies by research type

Research type	2010	2011	2012	2013	2014	2015	2016	2017	Total	%
Solution proposal				1	1		1	1	4	25
Validation research				1	1			1	3	19
Evaluation research		1				1		1	3	19
Conceptual proposal	1	1		2	1	1			6	37
Experience article									0	0
Opinion article									0	0
Total									16	100

Table 4.10 shows the Primary studies by research type.

Table 4.10: Primary Studies by Research type

Study	Title	Research type
S18	(A Survey of Interactive Remote Rendering Systems)	Validation research
S77	(A Framework for Cooperative Resource Management in Mobile Cloud Computing)	Solution proposal
S78	(A Framework for QoS and Power Management in a Service Cloud Environment with Mobile Devices)	Conceptual proposal
S79	(A Network and Device Aware QoS Approach for Cloud-Based Mobile Streaming)	Conceptual proposal
S80	(a qos-aware system for mobile cloud computing)	Conceptual proposal
S82	(On the Investigation of Cloud-Based Mobile Media Environments With Service-Populating and QoS-Aware Mechanisms)	Evaluation research

(continued)

Table 4.10 (continued): Primary Studies by Research type

Study	Title	Research type
S83	(QoS-Aware Dynamic Resource Management in Heterogeneous Mobile Cloud Computing Networks)	Conceptual proposal
S84	(QoS-Guaranteed Bandwidth Shifting and Redistribution in Mobile Cloud)	Solution proposal
S112	(A novel cloud scheduling algorithm optimization for energy consumption of data centers based on user QoS priori knowledge under the background of WSN and mobile communication)	Evaluation research
S113	(Fault tolerance and QoS scheduling using CAN in mobile social cloud computing)	Conceptual proposal
S114	(Integrated Multi-service Handoff Mechanism with QoS-Support Strategy in Mobile Cloud Computing)	Conceptual proposal

(continued)

Table 4.10: Primary Studies by Research type

Study	Title	Research type
S115	(Storage and computing resource enabled joint virtual resource allocation with QoS guarantee in mobile networks)	Validation research
S118	(Application Partitioning and Offloading in Mobile Cloud Computing)	Solution proposal
S119	(Exploring traffic and QoS management mechanisms to support mobile cloud computing using service localization in heterogeneous environments)	Solution proposal
S120	(Volare Mobile Context-aware Adaptation for the Cloud)	Validation research

CHAPTER 5

RESULT AND DISSCUSTION

5.1 Major Topics

Figure 5.1 represents the results of research focus area; in this study, the focus area was distributed between five classifications (SaaS, PaaS, IaaS, CSC, and CSP). The most studied research focus areas was CSP with seven articles (44%), and some examples are (Rakbong, 2013) and (Yengi, 2010). Three research studies focused on SaaS (19%), including (Zhenjun, 2017) and (Fragkisko, 2013).Three articles also focused on the CSC category (19%) with (Chin, 2013) and (Jianxin, 2016) as examples. Only two articles (12%) focused on the IaaS category, which were (Peng, 2011) and (Sardis, 2015). Finally, only one of the research studies (Janko, 2017) used PaaS as the research focus

area, which represented (6%)of the total.

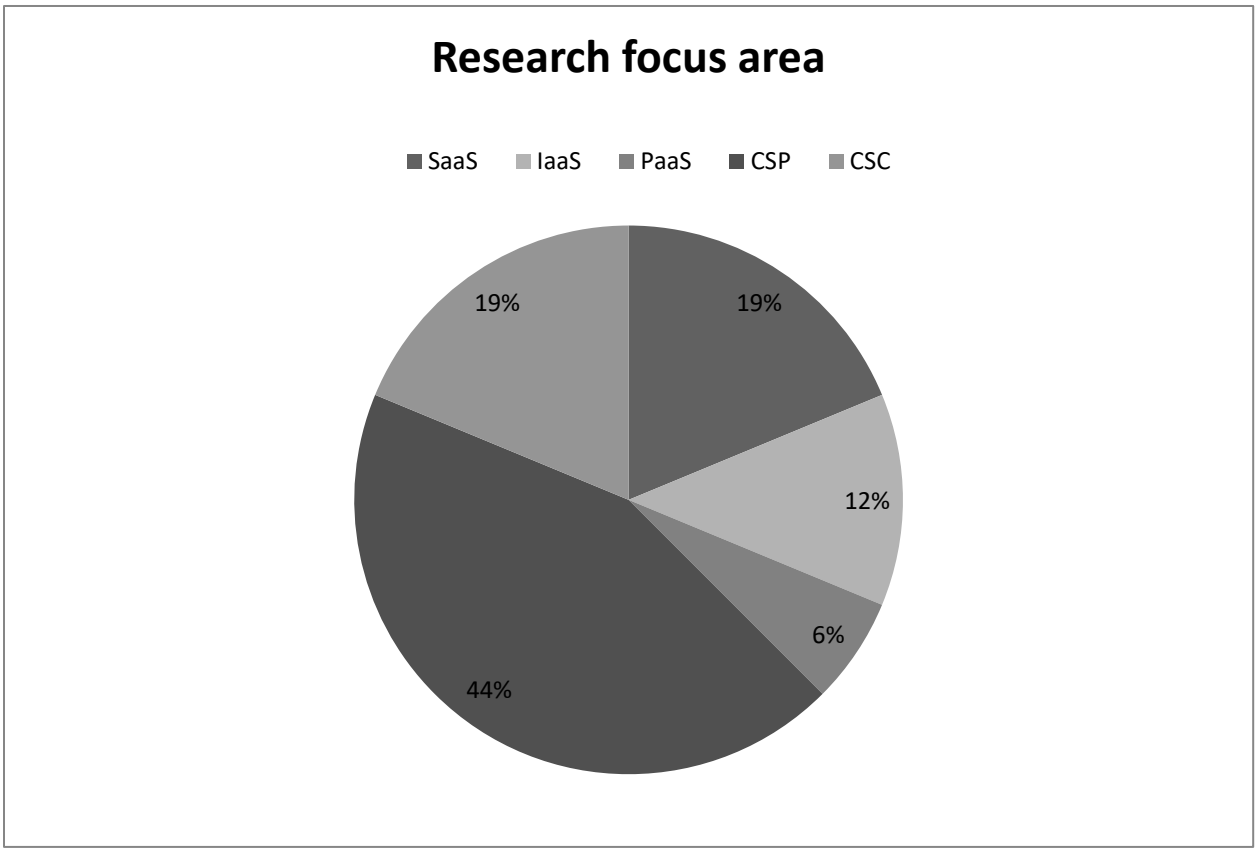

Figure 5.1: Distribution of primary studies by research focus area

5.2 Types of Research

In Figure 5.2, the researcher explains the distribution of the primary studies by contribution type, which are distributed between five categories (Tool, Method, Process, Model, Metric). It can be observed that models where found in the largest percentage of studies, with a total of eight (50%) including the study by (Jianxin, 2016). Furthermore, three research studies (19%) contributed methods including (Mohammad, 2015), and none of the articles (0%) contributed tools. Four of researches (25%) contributed metrics, for example (Hoang, 2011) and (Xiaodong, 2017). The lowest percentage (6%) of articles contributed process, with only one study.

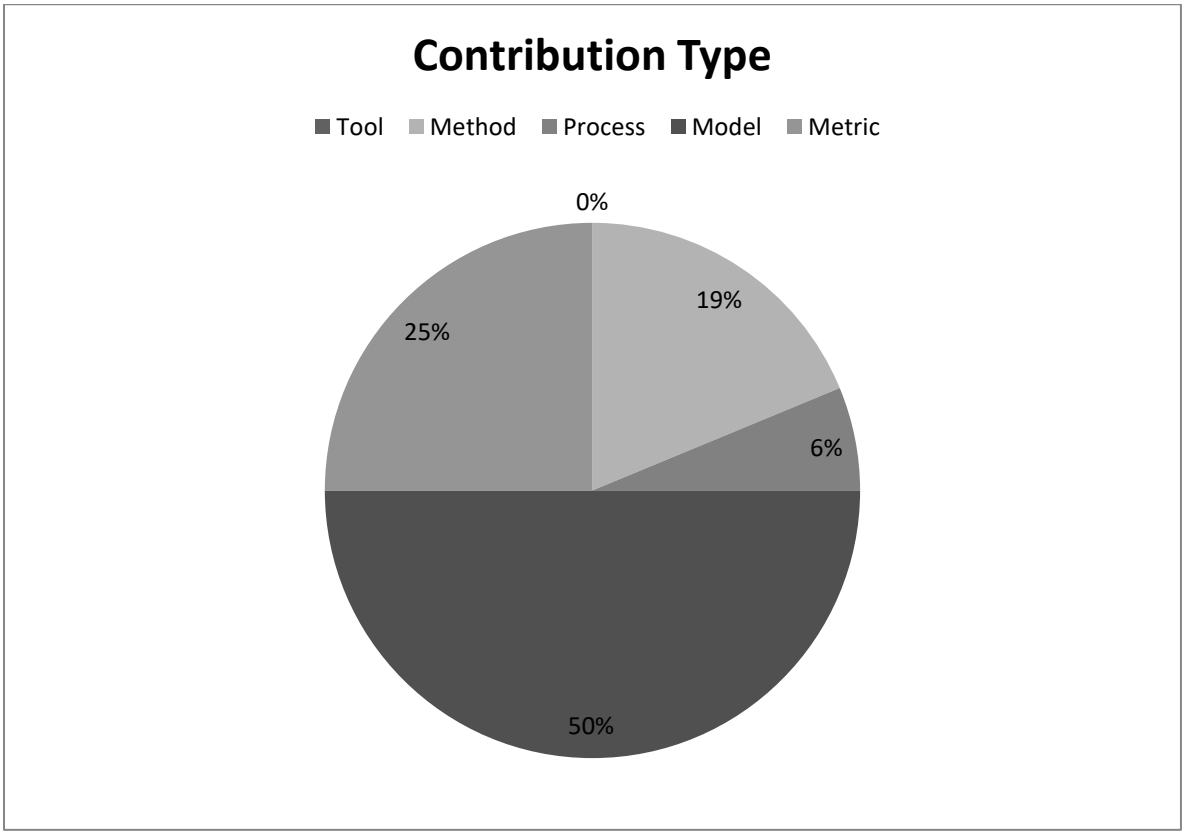

Figure 5.2: Distribution of primary studies by contribution Type

5.3 Types of Research published

The distribution of primary articles by research type is shown in Figure 5.3, in which the majority of the research studies were Conceptual proposals (37%), Evaluation research (19%), Validation research (19%), as well as Validation research (19%) and Solution proposals (25%). However, there were no Opinion articles or Experience articles (0%).

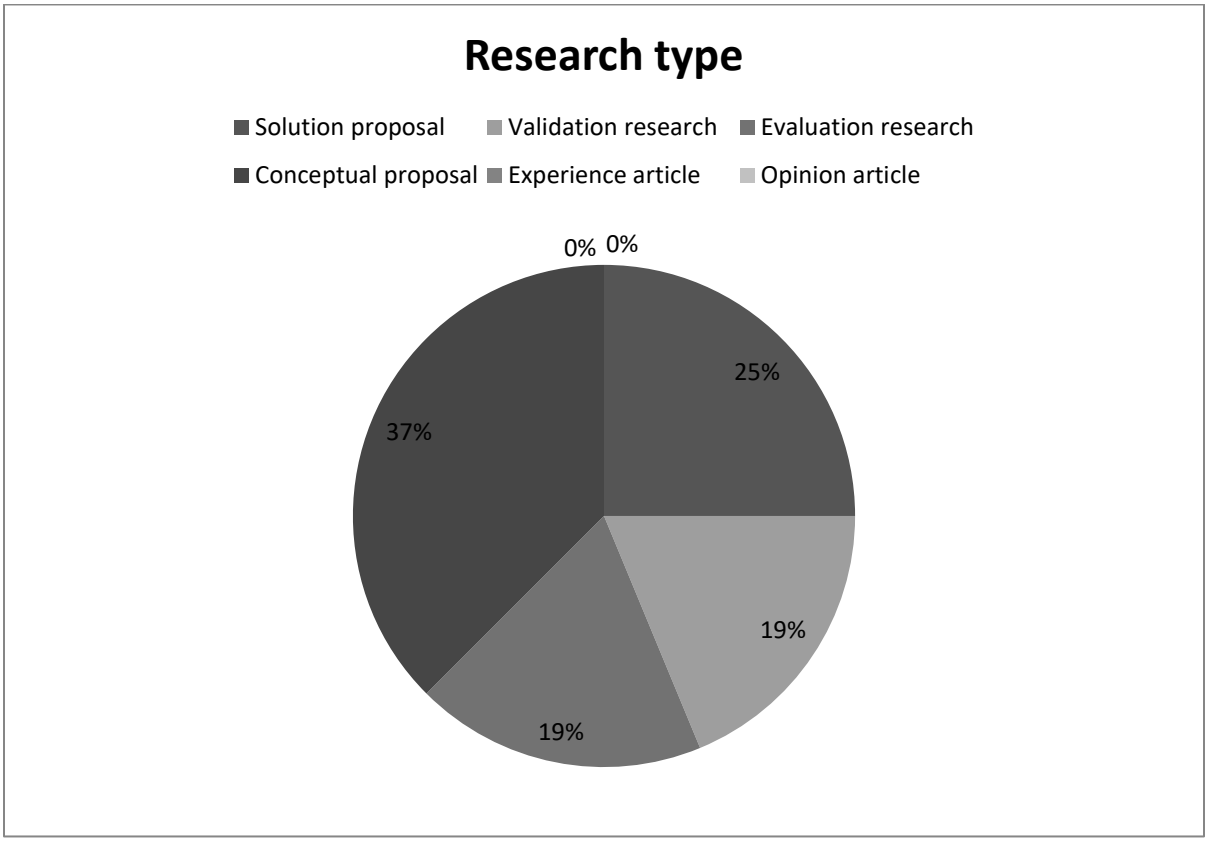

Figure 5.3: Distribution of primary studies by research type

Potential research gaps can be determined by the outline resulting from the mapping of the current studies. In order to quickly review the quality of service in cloud computing, the researcher used three aspects (the number of research studies relative to the bubble size) to plot a bubble chart. Moreover, a bubble plot is capable of displaying data more effective than recurrence analysis, which displays data through a table. In two dimensions, the bubble plot represents the result of the mapping conducted by the researcher (Figure 5.4). The concentration areas by contribution type (RQ1) are represented by the principal dimension, and the concentration areas by research type are represented by the second dimension.

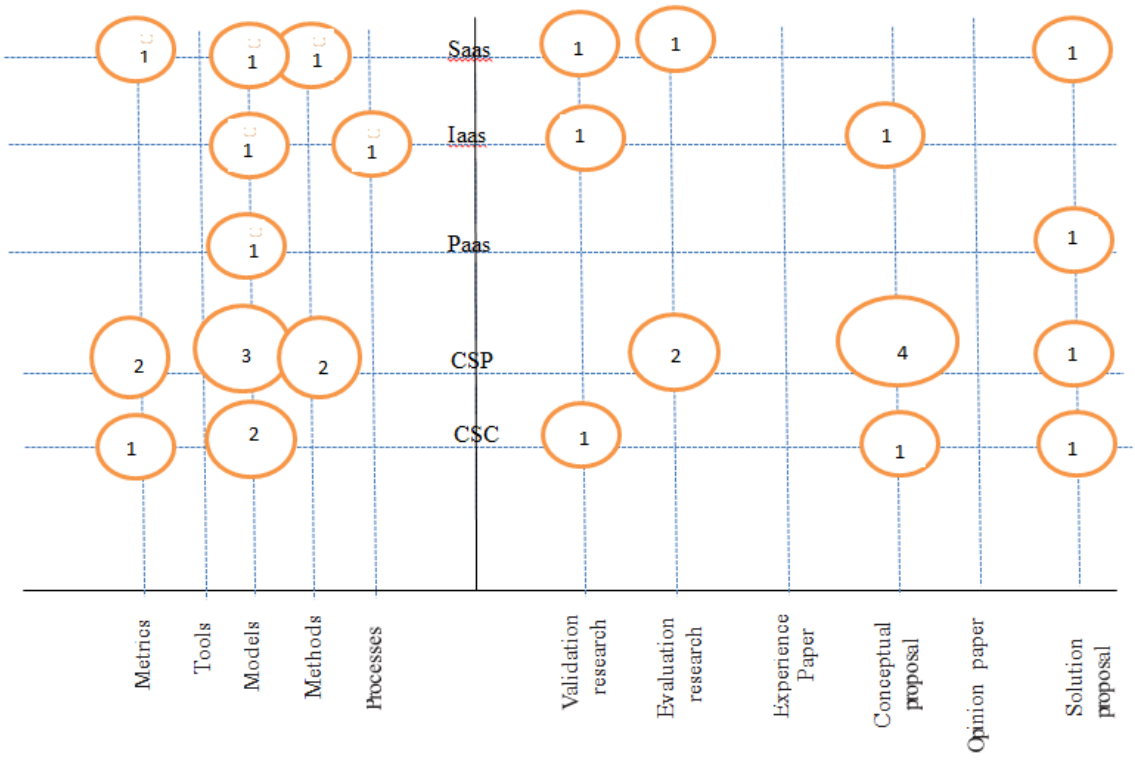

Figure 5.4: Bubble plot by contribution type and research type

5.4 Discussion

The outcomes of this Systematic Mapping underline that quality of service approaches in MCC are a fundamental issue and a vital target in MCC development, with growing attentiveness from various sectors, including industry and academia. Although mobile cloud computing is still not at as mature a stage as mapping, there is an increasing number of research studies in this area because of the developing interest in the benefits of cloud computing by organizations and customers. Furthermore, mobile cloud computing helps in decreasing the operating expenses for data intensive applications that can take a long time and consume vast amounts of energy when implemented on devices that offer limited resources. CC can efficiently reinforce different assignments for information warehousing, overseeing and synchronizing various records on the Internet (Dinh, 2011).

The devices that fill this gap and are at the forefront of mobile computing are advanced mobile phones and tablet PCs. With a design that is dissimilar to portable workstations and desktop PCs, smartphones are constructed with an extended battery life, small size and weight, a straightforward UI and can run essential computing tasks utilizing a minimal amount of resources, for example, memory, and so on. However, in general, they do not have the necessary capability to important to perform serious undertakings (Fragkiskos, 2013).

5.4.1 Challenges of SaaS area

The organization of numerous QoS approaches in cloud computing services can be extremely challenging as a result of the different cloud environments, which offer dynamic services via construct various workflows, as well as the existence of many service providers who incorporate diverse methods and procedures to oversee these services. Hence, satisfying QoS prerequisites requires simple methods that can enable the dynamic allocation of resources to each element or service. Furthermore, fulfilling and coordinating the QoS needs of diverse workloads necessitates cognisance and evaluation,

estimation methods and measurements, as well as the streamlining of resource allocation (Fragkiskos, 2013).

5.4.2 Challenges of CSP and PaaS areas

A minimal number of approaches have been found on PaaS in terms of the quality of service in MCC. In general, PaaS has confront many difficulties in the market and may not be the perfect solution. For instance, the comprehension of PaaS innovation is limited and the application must be extremely versatile with a specific objective to be facilitated and exclusive methodologies or languages can influence the development procedure. A certain number of methodologies have been suggested in relation to the subject of CSP, although there are still restricted SLA methodologies to coordinate the resources and service elasticity of QoS in MCC. Moreover, a standard method is required for the management of elasticity and complex SLA to allow the implementation of application flexibility (SookKyong, 2013).

5.4.3 Challenges of resources management and performance monitoring

Several was to deal with resource management and performance monitoring of QoS in MCC have been debated, yet designating and discharging resources to customers when they require it with superior quality and at minimal costs is still a challenging endeavor (Zhang, 2010). (Foster , 2008) identified the issues with guaranteeing that the QoS is capable of managing and observing resources in an appropriate manner Additional evaluation is required to coordinate resource and performance to prevent an negative impacts on the QoS (Javied, 2017).

5.4.4 Challenges of QoS application requirements

Many methodologies are associated to the application specifications, application performance and monitoring/adaptability of QoS. Nonetheless, only a limited number of these methodologies actually consider the QoS application prerequisites. The vast majority of these methodologies concentrate on demonstrating and portraying application workflows with QoS prerequisites. Likewise, there is a deficiency in the number of tools and measurements for the purpose of creating and deploying applications in regard to the QoS specifications (Papakos, 2014).

5.4.5 Application performance and monitoring management

The majority of the methodologies proposed in the literature are focused on application execution and observation. Nevertheless, there is no consensus over the solution to the difficulties related with administering and checking applications with QoS.

5.4.6 Future direction of Mobile cloud services regard to service providers and Consumer

In 2013, the International Data Corporation (IDC) cloud research reported that future direction in cloud service costs of IaaS, SaaS and PaaS services would include increment by 25% in 2014 (over US$ 100 billion). In fact, the IDC expected that the number of cloud data center players (cloud infrastructure providers) would grow to meet the global demand. Subsequently, similar extension will be seen in infrastructure services with numerous workloads, leading to difficulties in differentiating service providers. Therefore, intense competition will arise between developers to improve cloud applications and solutions to appease the market's needs and growth. The IDC also expected that 80% of new cloud based applications will be deployed on PaaS platforms. Furthermore, the IDC predicted a shift from IaaS to PaaS because PaaS enables

consumers to minimize their service costs. Perhaps soon there will be a significant change in the marketing strategies of some of the companies that are famous for providing Mobile cloud services such as Amazon and Google will provide prices for the exclusive use of the platform services (PaaS). Certainly will increase the complexity of cloud services as the growth and technological development and thus increase the level of competition between the providers of Mobile cloud computing services. Therefore, QoS approaches in Mobile cloud computing services will perform an more and more important role in differentiating service providers as well as providing consumers with optimal service solutions such as the efficient use of resources and services and cost saving.

5.4.7 Summary of Findings

Overall, the classifications of this mapping study indicate that the majority of the QoS approaches in MCC are implemented in academic rather than industrial environments. Nonetheless, these methodologies provide inspiration to experts and intriguing challenges for analysts to conduct investigations based on implementation of the technology in actual cloud scenarios.. A limitation of this study is that researcher has not attempted to examine the reported methods/models, although many of the primary studies reported some form of empirical validation of their proposals. Such an evaluation is considered to be outside the scope of a mapping study. However, it is advisable that any researcher intending to perform evaluation studies should assess the results of any validation exercises before attempting to complete the field evaluations.

CHAPTER 6

CONCLUISON

6.1 Conclusion

The objective of conducting this SM research was to implement a review on the cutting edge of quality of service methodologies in MCC. To this end, 16 research studies published between 2010 and 2017 were determined as the primary articles. The majority of these studies were distributed in journals. As a consequence, this MS and writing study has determined many difficulties and gaps and asserts that there remain possibilities for further study into the quality of service approaches in MCC. In general, a mapping of the primary reviews uncovered the absence of proof, tools and metrics for CS regarding quality of service. This presents opportunities for future studies, particularly in connection to the subjects of SaaS and IaaS. The areas of PaaS, CSP and CSC require additional investigation. Specifically, there is a requirement for programming conditions, devices and measurements to create and send applications, and also application administration and verification with QoS. In this study, the researcher divided the studies into five basic classifications (RQ1) which were categorised as follows: CSP (44%), SaaS (19%), CSC (19%), IaaS (12%), and PaaS (6%). The MS revealed that there are numerous difficulties which should be classified. Additional assessment research is required to give practical investigation using robust and unbiased information on QoS methodologies in MCC and more intensive studies are necessary into the subjects of cloud computing service providers, platforms that provide a service as well as customers who use close services. In regard to RQ2, Conceptual proposals was the most frequently used research type by the primary studies (37%), while Solution proposals were used by (25%) Validation research was used by (19%), and Evaluation research (19%); however, there were no studies that took the form of Experience article or Opinion articles were (0%). Furthermore, the results demonstrated that the majority of the primary studies were published in journals (75%), Conference proceedings (6%), theses (19%), and none were published as Workshop proceedings (0%) (RQ3).

After this study, the gap is still open for further studies and research to try to better understand the quality of services approaches in mobile cloud computing. Few researchers focused on their research topics on (PaaS) and (IaaS), also a few researchers contributed by their studies in Opinion articles and Evaluation research. Also a few researchers contributed by their studies in Tools and in Process.

In summary the QoS approach assumes an imperative role in improving cloud computing to ensure customers can trust cloud services. Since late, there has been a growing enthusiasm for the QoS approach in mobile cloud computing between modern experts. The researcher urges the researchers to try to carry out applicable tests to emphasize the conflicting methodologies and to encourage the researcher to exchange experiences and learn to build a strong institution to enhance the QoS approach in the MCC. This study provides guidelines to help researchers plan for future work by discovering areas of research that need more attention.

6.2 Recommendation

- As a result of this study, the researcher recommends that further research and studies should be conducted on the approach of the quality of service in mobile cloud computing because there is insufficient research in this particularly area, even though mobile cloud computing has become a necessity for daily life.
- Another recommendation is researchers undertake further research efforts in relation to themes (PaaS) and (IaaS), because there are still deficiencies in these areas due to the lack of research on these topics.
- The researcher recommends researchers further research that contributes through Opinion articles and Evaluation research by research type.
- The researcher recommends researchers further research that contributes through Tools and Process by contribution type.

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APPENDICES

APPENDIX A

ALL STUDIES FOUND AFTER SEARCH

Appendix A provides a list of the studies found after the search.

Table A.1: All studies found after search

Study	Title	Source	Year
S1	(Mobile Code Offloading: Should it be a Local Decision or Global Inference?)	ACM	2013
S2	(Analytical Models for QoS-driven VNF Placement and Provisioning in Wireless Carrier Cloud)	ACM	2016
S3	(A Framework of Knowledge Management as a Service over Cloud Computing Platform)	ACM	2015
S4	(Mobile Cloud Computing: Advantage, Disadvantage and Open Challenge)	ACM	2014
S5	(How the Cloud Computing Paradigm Could Shape the Future of Enterprise Information Processing)	ACM	2011

Table A.1 (continued): All studies found after search

Study	Title	Source	Year
S6	(A QoS aware Routing Protocol in Wireless Sensor Networks with Mobile Base Stations)	ACM	2016
S7	(Enabling Component-based Mobile Cloud Computing with the AIOLOS Middleware)	ACM	2014
S8	(Authentication in the Clouds: A Framework and its Application to Mobile Users)	ACM	2010
S9	(Mobile Cloud Applications: Opportunities, Challenges and Directions)	ACM	2013
S10	(ACM Workshop on Mobile Cloud Media Computing)	ACM	2013
S11	(Profitable Task Allocation in Mobile Cloud Computing)	ACM	2010
S12	(Methods to Utilizing Cloud Computing in Developing Mobile Internet Device (MID) Applications)	ACM	2016
S13	(Impact of routing protocols on the quality of transmission for video stramming	ACM	2016

Table A.1 (continued): All studies found after search

Study	Title	Source	Year
S14	(Vision: mClouds – Computing on Clouds of Mobile Devices)	ACM	2012
S15	(Fingerprint Verification through Cloud Computing)	ACM	2013
S16	(QRSF: QoS-aware resource scheduling framework in cloud computing)	ACM	2012
S17	(Cloudlets: Bringing the Cloud to the Mobile User)	ACM	2015
S18	(A Survey of Interactive Remote Rendering Systems)	ACM	2015
S19	(A task scheduling algorithm based on qos and complexity-aware optimization in cloud computing)	IEEE	2013
S20	(QoS-aware Service Selection in Virtualization-based Cloud Computing)	IEEE	2012

Table A.1 (continued): All studies found after search

Study	Title	Source	Year
S21	(Green MACC: An Architecture to Green Met scheduling with Quality of Service in Private Clouds)	IEEE	2014
S22	(Information Service Quality Evaluation Study of Cloud Computing Environment Based on Big Data)	IEEE	2017
S23	(An Adaptive Qos-Aware Cloud)	IEEE	2012
S24	(A Comprehensive review on QoS measures for Resource Allocation in Cloud Environment)	IEEE	2017
S25	(QoS Architecture for Cloud-based Media Computing)	IEEE	2012
S26	(A Resources Allocation Algorithm based on Media Task QoS in Cloud Computing)	IEEE	2013
S27	(On Demand Cloud Computing Performance Analysis With Low Cost For QoS Application)	IEEE	2011

Table A.1 (continued): All studies found after search

Study	Title	Source	Year
S28	(QoS-Aware Data Replication for Data Intensive Applications in Cloud Computing Systems)	IEEE	2013
S29	(QoS-Aware Single Service Selection Mechanism for Ad-Hoc Mobile Cloud Computing)	IEEE	2015
S30	(Q-MAC: QoS and Mobility Aware Optimal Resource Allocation for Dynamic Application Offloading in Mobile Cloud Computing)	IEEE	2017
S31	(A joint multiple resource allocation method for cloud computing environments with different QoS to users at multiple locations)	IEEE	2014
S32	(QoS and Performance Optimization with VM Provisioning Approach in Cloud Computing Environment)	IEEE	2012

Table A.1 (continued): All studies found after search

Study	Title	Source	Year
S33	(QoS-aware scheduling of Workflows in Cloud Computing environments)	IEEE	2016
S34	(A Stochastic Model to Investigate Data Center Performance and QoS in IaaS Cloud Computing Systems)	IEEE	2014
S35	(Virtual Machine Provisioning Based on Analytical Performance and QoS in Cloud Computing Environments)	IEEE	2011
S36	(Method of Device Matching for QoS based UPnP Framework in Cloud Computing Service)	IEEE	2011
S37	(A Task Scheduling Algorithm Based on Genetic Algorithm and Ant Colony Optimization Algorithm with Multi-QoS Constraints in Cloud Computing)	IEEE	2015
S38	(An Intelligent Approach for Virtual Machine and QoS Provisioning in Cloud Computing)	IEEE	2013

(continued)

Table A.1 (continued): All studies found after search

Study	Title	Source	Year
S39	(A Bi-criteria Algorithm for Low-Carbon and QoS-Aware Routing in Cloud Computing Infrastructures)	IEEE	2015
S40	(QoS-oriented Monitoring Model of Cloud Computing Resources Availability)	IEEE	2013
S41	(An Energy-Aware QoS Enhanced Method for Service Computing Across Clouds and Data Centers)	IEEE	2015
S42	(Toward Cloud Computing QoS Architecture: Analysis of Cloud Systems and Cloud Services)	IEEE	2017
S43	(A Qos Guided task Scheduling Model in cloud computing environment)	IEEE	2013
S44	(QoS-aware Resource Provisioning for Big Data Processing in Cloud Computing Environment)	IEEE	2014

(continued)

Table A.1 (continued): All studies found after search

Study	Title	Source	Year
S45	(Evolution of service composition based on QoS under the cloud computing environment)	IEEE	2016
S46	(An Optimistic Job Scheduling Strategy based on QoS for Cloud Computing)	IEEE	2010
S47	(Knowledge-Enhanced Mobile Video Broadcasting (KMV-Cast) Framework with Cloud Support)	IEEE	2017
S48	(Enhancing QoS and Energy Efficiency of Real time Network Application on Smartphone using Cloud Computing)	IEEE	2011
S49	(Applying Scheduling Algorithms with QoS in the Cloud Computing)	IEEE	2013
S50	(An End-To-End QoS Mapping Approach for Cloud Service Selection)	IEEE	2013
S51	(Profitable Task Allocation in Mobile Cloud Computing	IEEE	2016

(continued)

Table A.1 (continued): All studies found after search

Study	Title	Source	Year
S52	(Missing QoS-Values Predictions using Neural Networks for Cloud Computing Environments)	IEEE	2015
S53	(A QoS Assurance Middleware Model for Enterprise Cloud Computing)	IEEE	2012
S54	(A QoS-aware Dynamic Data Replica Deletion Strategy for Distributed Storage Systems under Cloud Computing Environments)	IEEE	2012
S55	(DFVisor: Scalable Network Virtualization for QoS Management in Cloud Computing)	IEEE	2014
S56	(Ant Colony Optimization Based Service flow Scheduling with Various QoS Requirements in Cloud Computing)	IEEE	2011
S57	(QoS-aware I/O schedule for virtual machines in cloud computing environment)	IEEE	2015

(continued)

Table A.1 (continued): All studies found after search

Study	Title	Source	Year
S58	(QoS-aware long-term based service composition in cloud computing	IEEE	2010
S59	(An Insurance Model for Guaranteeing Service Assurance, Integrity and QoS in Cloud Computing)	IEEE	2012
S60	(QoS Evaluation for Web Services In Cloud computing)	IEEE	2013
S61	(Deadline Based Virtual Machine Provisioning to Improve QoS in Cloud Computing)	IEEE	2011
S62	A meta scheduler architecture to provide QoS on the cloud computing)	IEEE	2010
S63	(Assessing Measurements of QoS for global Cloud Computing Services)	IEEE	2012

(continued)

Table A.1 (continued): All studies found after search

Study	Title	Source	Year
S64	(A Metascheduler Architecture to provide QoS on the Cloud Computing)	IEEE	2016
S65	(Integrated QoS Utility-Based Model for Cloud Computing Service Provider Selection)	IEEE	2014
S66	(Template-based Genetic Algorithm for QoS-aware Task Scheduling in Cloud Computing)	IEEE	2014
S67	(Access-efficient QoS-aware data replication to maximize user satisfaction in cloud computing environments)	IEEE	2017
S68	(QoS-Aware Dynamic Resource Management in Heterogeneous Mobile Cloud Computing Networks)	IEEE	2015
S69	(The Journey of QoS-Aware Autonomic Cloud Computing)	IEEE	2017

(continued)

Table A.1 (continued): All studies found after search

Study	Title	Source	Year
S70	(A QoS Evaluation Model for Test-Bed in the Cloud Computing Environment)	IEEE	2012
S71	(Minimum Unsatisfiability Based QoS Web Service Composition over the Cloud Computing)	IEEE	2015
S72	(Entropy-based Service Selection with Uncertain QoS for Mobile Cloud Computing)	IEEE	2015
S73	(Reputation-based QoS Provisioning in Cloud Computing via Dirichlet Multinomial Model)	IEEE	2010
S74	(An SDN-based cloud computing architecture and its mathematical model)	IEEE	2011
S75	(Cloud Technology and Performance improvement with intserv over differs for Cloud Computing)	IEEE	2014
S76	(A QoS-aware Task Allocation Model for Mobile Cloud Computing)	IEEE	2016

(continued)

Table A.1 (continued): All studies found after search

Study	Title	Source	Year
S77	(A Framework for Cooperative Resource Management in Mobile Cloud Computing)	IEEE	2013
S78	(A Framework for QoS and Power Management in a Service Cloud Environment with Mobile Devices)	IEEE	2010
S79	(A Network and Device Aware QoS Approach for Cloud-Based Mobile Streaming)	IEEE	2013
S80	(a qos-aware system for mobile cloud computing)	IEEE	2011
S81	(A survey of mobile cloud computing: architecture, applications, and approaches)	IEEE	2013
S82	(On the Investigation of Cloud-Based Mobile Media Environments With Service-Populating and QoS-Aware Mechanisms)	IEEE	2013

(continued)

Table A.1 (continued): All studies found after search

Study	Title	Source	Year
S83	(QoS-Aware Dynamic Resource Management in Heterogeneous Mobile Cloud Computing Networks)	IEEE	2014
S84	(QoS-Guaranteed Bandwidth Shifting and Redistribution in Mobile Cloud Environment)	IEEE	2014
S85	(Authentication in mobile cloud computing: A survey)	ScienceDirect	2016
S86	(Leveraging Software-Defined-Networking for Energy Optimizations in Mobile-Cloud-Computing)	ScienceDirect	2016
S87	(Research challenges in legal-rule and QoS-aware cloud service brokerage)	ScienceDirect	2016
S88	(Mobile cloud computing: A survey)	ScienceDirect	2013
S89	(A review on inter working and mobility techniques for seamless connectivity in mobile cloud computing)	ScienceDirect	2014

(continued)

Table A.1 (continued): All studies found after search

Study	Title	Source	Year
S90	(Managing Mobile Cloud Computing Considering Objective and Subjective Perspectives)	ScienceDirect	2015
S91	(Security and Privacy Challenges in Mobile Cloud Computing: Survey and Way Ahead)	ScienceDirect	2017
S92	(Resource usage optimization in Mobile Cloud Computing)	ScienceDirect	2017
S93	(Resource usage optimization in Mobile Cloud Computing)	ScienceDirect	2017
S94	(Attribute-based data access control in mobile cloud computing: Taxonomy and open issues)	ScienceDirect	2017
S95	(Secure integration of IoT and Cloud Computing)	ScienceDirect	2016
S96	(Efficient handover authentication with user anonymity and traceability for Mobile Cloud Computing)	ScienceDirect	2016

(continued)

Table A.1 (continued): All studies found after search

Study	Title	Source	Year
S97	(Energy-efficient service-oriented architecture for mobile cloud handover)	Springer	2017
S98	(Development and Analysis of a New Cloudlet Allocation Strategy for QoS Improvement in Cloud)	Springer	2015
S99	(Cost and energy aware service provisioning for mobile client in cloud computing environment)	Springer	2015
S100	(Multiple Context Based Service Scheduling for Balancing Cost and Benefits of Mobile Users and Cloud Datacenter Supplier in Mobile Cloud)	Springer	2017
S101	(An SLA-based Broker for Cloud Infrastructures)	Springer	2013
S102	(QoS Assessment of Mobile Crowdsensing Services)	Springer	2015

(continued)

Table A.1 (continued): All studies found after search

Study	Title	Source	Year
S103	(Multiservice Load Balancing with Hybrid Particle Swarm Optimization in Cloud-Based Multimedia Storage System with QoS Provision)	Springer	2017
S104	(Optimal collaboration of thin–thick clients and resource allocation in cloud computing)	Springer	2014
S105	(QoS constraints-based energy-efficient model in cloud computing networks for multimedia clinical issues)	Springer	2016
S106	(Efficient Computation Offloading Decision in Mobile Cloud Computing over 5G Network)	Springer	2016
S107	(Scheduling of big data applications on distributed cloud based on QoS parameters)	Springer	2015
S108	(A study on virtual machine deployment for application outsourcing in mobile cloud computing)	Springer	2016

(continued)

Table A.1 (continued): All studies found after search

Study	Title	Source	Year
S109	(Cloud resource provisioning: survey, status and future research directions)	Springer	2016
S110	(Resource provisioning and scheduling in clouds: QoS perspective)	Springer	2015
S111	(A Survey of Mobile Cloud Computing Applications: Perspectives and Challenges)	Springer	2016
S112	(A novel cloud scheduling algorithm optimization for energy consumption of data centers based on user QoS priori knowledge under the background of WSN and mobile communication)	Springer	2017
S113	(Fault tolerance and QoS scheduling using CAN in mobile social cloud computing)	Springer	2014
S114	(Integrated Multi-service Handoff Mechanism with QoS-Support Strategy in Mobile Cloud Computing)	Springer	2016

(continued)

Table A.1 (continued): All studies found after search

Study	Title	Source	Year
S115	(Storage and computing resource enabled joint virtual resource allocation with QoS guarantee in mobile networks)	Springer	2017
S116	(A survey of mobile cloud computing: architecture, applications, and approaches)	Google Scholar	2013
S117	(Mobile cloud computing: A survey)	GoogleScholar	2013
S118	(Application Partitioning and Offloading in Mobile Cloud Computing)	Ethos	2017
S119	(Exploring Traffic and QoS Management Mechanisms to Support Mobile Cloud Computing using Service Localizations in Heterogeneous Environment)	Ethos	2015
S120	(Volare Mobile Context-aware Adaptation for the Cloud)	Ethos	2014

APPENDIX B

STUDIES REMAINING AFTER THE FIRSET STAGE

Table B.1 : Studies remaining after the first stage

Study	Title	Source	Year
S2	(Analytical Models for QoS-driven VNF Placement and Provisioning in Wireless Carrier Cloud)	ACM	2016
S3	(A Framework of Knowledge Management as a Service over Cloud Computing Platform)	ACM	2015
S5	(How the Cloud Computing Paradigm Could Shape the Future of Enterprise Information Processing)	ACM	2011
S6	(A QoS aware Routing Protocol in Wireless Sensor Networks with Mobile Base Stations)	ACM	2016

(continued)

Table B.1 (continued): Studies remaining after the first stage

Study	Title	Source	Year
S8	(Authentication in the Clouds: A Framework and its Application to Mobile Users)	ACM	2010
S9	(Mobile Cloud Applications: Opportunities, Challenges and Directions)	ACM	2013
S10	(ACM Workshop on Mobile Cloud Media Computing)	ACM	2013
S11	(Profitable Task Allocation in Mobile Cloud Computing)	ACM	2010
S15	(Fingerprint Verification through Cloud Computing)	ACM	2013
S17	(Cloudlets: Bringing the Cloud to the Mobile User)	ACM	2015
S18	(A Survey of Interactive Remote Rendering Systems)	ACM	2015

(continued)

Table B.1 (continued): Studies remaining after the first stage

Study	Title	Source	Year
S19	(A task scheduling algorithm based on qos and complexity-aware optimization in cloud computing)	IEEE	2013
S20	(QoS-aware Service Selection in Virtualization-based Cloud Computing)	IEEE	2012
S21	(Green MACC: An Architecture to Green Meta scheduling with Quality of Service in Private Clouds)	IEEE	2014
S22	(Information Service Quality Evaluation Study of Cloud Computing Environment Based on Big Data)	IEEE	2017
S24	(A Comprehensive review on QoS measures for Resource Allocation in Cloud Environment)	IEEE	2017
S28	(QoS-Aware Data Replication for Data Intensive Applications in Cloud Computing Systems)	IEEE	2013

(continued)

Table B.1 (continued): Studies remaining after the first stage

Study	Title	Source	Year
S29	(QoS-Aware Single Service Selection Mechanism for Ad-Hoc Mobile Cloud Computing)	IEEE	2015
S30	(Q-MAC: QoS and Mobility Aware Optimal Resource Allocation for Dynamic Application Offloading in Mobile Cloud Computing)	IEEE	2017
S34	(A Stochastic Model to Investigate Data Center Performance and QoS in IaaS Cloud Computing Systems)	IEEE	2014
S38	(An Intelligent Approach for Virtual Machine and QoS Provisioning in Cloud Computing)	IEEE	2013
S40	(QoS-oriented Monitoring Model of Cloud Computing Resources Availability)	IEEE	2013
S41	(An Energy-Aware QoS Enhanced Method for Service Computing Across Clouds and Data Centers)	IEEE	2015

(continued)

Table B.1 (continued): Studies remaining after the first stage

Study	Title	Source	Year
S44	(QoS-aware Resource Provisioning for Big Data Processing in Cloud Computing Environments)	IEEE	2014
S45	(Evolution of service composition based on QoS under the cloud computing environment)	IEEE	2016
S46	((An Optimistic Job Scheduling Strategy based on QoS for Cloud Computing)	IEEE	2010
S52	(Missing QoS-Values Predictions using Neural Networks for Cloud Computing Environments)	IEEE	2015
S53	(A QoS Assurance Middleware Model for Enterprise Cloud Computing)	IEEE	2012
S54	(A QoS-aware Dynamic Data Replica Deletion Strategy for Distributed Storage Systems under Cloud Computing Environments)	IEEE	2012

(continued)

Table B.1 (continued): Studies remaining after the first stage

Study	Title	Source	Year
S55	(DFVisor: Scalable Network Virtualization for QoS Management in Cloud Computing)	IEEE	2014
S56	(Ant Colony Optimization Based Service flow Scheduling with Various QoS Requirements in Cloud Computing)	IEEE	2015
S62	(A meta scheduler architecture to provide QoS on the cloud computing)	IEEE	2010
S63	(Assessing Measurements of QoS for global Cloud Computing Services)	IEEE	2012
S64	(A Meta scheduler Architecture to provide QoS on the Cloud Computing)	IEEE	2016
S65	(Integrated QoS Utility-Based Model for Cloud Computing Service Provider Selection)	IEEE	2014
S71	(Minimum Unsatisfiability Based QoS Web Service Composition over the Cloud Computing)	IEEE	2014

(continued)

Table B.1 (continued): Studies remaining after the first stage

Study	Title	Source	Year
S72	(Entropy-based Service Selection with Uncertain QoS for Mobile Cloud Computing)	IEEE	2014
S74	(An SDN-based cloud computing architecture and its mathematical model)	IEEE	2011
S75	(Cloud Technology and Performance improvement with intserv over differs for Cloud Computing)	IEEE	2012
S76	(A QoS-aware Task Allocation Model for Mobile Cloud Computing)	IEEE	2013
S77	(A Framework for Cooperative Resource Management in Mobile Cloud Computing)	IEEE	2013
S78	(A Framework for QoS and Power Management in a Service Cloud Environment with Mobile Devices)	IEEE	210
S79	(A Network and Device Aware QoS Approach for Cloud-Based Mobile Streaming)	IEEE	2013

(continued)

Table B.1 (continued): Studies remaining after the first stage

Study	Title	Source	Year
S80	(a qos-aware system for mobile cloud computing)	IEEE	2011
S81	(A survey of mobile cloud computing: architecture, applications, and approaches)	IEEE	2013
S82	(On the Investigation of Cloud-Based Mobile Media Environments With Service-Populating and QoS-Aware Mechanisms)	IEEE	2013
S83	(QoS-Aware Dynamic Resource Management in Heterogeneous Mobile Cloud Computing Networks)	IEEE	2014
S84	(QoS-Guaranteed Bandwidth Shifting and Redistribution in Mobile Cloud)	IEEE	2014
S85	(Authentication in mobile cloud computing: A survey)	ScienceDirect	2016
S87	(Research challenges in legal-rule and QoS-aware cloud service brokerage)	ScienceDirect	2016

(continued)

Table B.1 (continued): Studies remaining after the first stage

Study	Title	Source	Year
S90	(Managing Mobile Cloud Computing Considering Objective and Subjective Perspectives)	ScienceDirect	2015
S91	(Security and Privacy Challenges in Mobile Cloud Computing: Survey and Way Ahead)	ScienceDirect	2017
S92	(Resource usage optimization in Mobile Cloud Computing)	ScienceDirect	2017
S95	(Secure integration of IoT and Cloud Computing)	ScienceDirect	2016
S96	(Efficient handover authentication with user anonymity and Un traceability for Mobile Cloud Computing)	ScienceDirect	2016
S97	(Energy-efficient service-oriented architecture for mobile cloud handover)	Springer	2017
S98	(Development and Analysis of a New Cloudlet Allocation Strategy for QoS Improvement in Cloud)	Springer	2015

(continued)

Table B.1 (continued): Studies remaining after the first stage

Study	Title	Source	Year
S99	(Cost and energy aware service provisioning for mobile client in cloud computing environment)	Springer	2015
S100	(Multiple Context Based Service Scheduling for Balancing Cost and Benefits of Mobile Users and Cloud Datacenter Supplier in Mobile Cloud)	Springer	2017
S101	(An SLA-based Broker for Cloud Infrastructures)	Springer	2013
S107	(Scheduling of big data applications on distributed cloud based on QoS parameters)	Springer	2015
S108	(A study on virtual machine deployment for application outsourcing in mobile cloud computing)	Springer	2016
S109	(Cloud resource provisioning: survey, status and future research directions)	Springer	2016
S110	(Resource provisioning and scheduling in clouds: QoS perspective)	Springer	2015

(continued)

Table B.1 (continued): Studies remaining after the first stage

Study	Title	Source	Year
S111	(A Survey of Mobile Cloud Computing Applications: Perspectives and Challenges)	Springer	2016
S112	(A novel cloud scheduling algorithm optimization for energy consumption of data centers based on user QoS priori knowledge under the background of WSN and mobile)	Springer	2017
S113	(Fault tolerance and QoS scheduling using CAN in mobile social cloud computing)	Springer	2014
S114	(Integrated Multi-service Handoff Mechanism with QoS-Support Strategy in Mobile Cloud Computing)	Springer	2016
S115	(Storage and computing resource enabled joint virtual resource allocation with QoS guarantee in mobile networks)	Springer	2017
S116	(A survey of mobile cloud computing: architecture, applications, and approaches)	Google Scholar	2013

(continued)

Table B.1 (continued): Studies remaining after the first stage

Study	Title	Source	Year
S117	(Mobile cloud computing: A survey)	Google Scholar	2013
S118	(Application Partitioning and Offloading in Mobile Cloud Computing)	Ethos	2017
S119	(Exploring Traffic and QoS Management Mechanisms to Support Mobile Cloud Computing using Service Localizations in Heterogeneous Environment)	Ethos	2015
S120	(Volar Mobile Context-aware Adaptation for the Cloud)	Ethos	2014

APPENDIX C

STUDIES REMAINING AFTER THE SECOND STAGE

Table C.1: Studies remaining after the second stage

Study	Title	Source	Year
S18	(A Survey of Interactive Remote Rendering Systems)	ACM	2015
S38	(An Intelligent Approach for Virtual Machine and QoS Provisioning in Cloud Computing)	IEEE	2013
S46	(An Optimistic Job Scheduling Strategy based on QoS for Cloud Computing)	IEEE	2010
S52	(Missing QoS-Values Predictions using Neural Networks for Cloud Computing Environments)	IEEE	2015

(continued)

Table C.1 (continued): Studies remaining after the second stage

Study	Title	Source	Year
S64	(A Meta scheduler Architecture to provide QoS on the Cloud Computing)	IEEE	2016
S76	(A QoS-aware Task Allocation Model for Mobile Cloud Computing)	IEEE	2013
S77	(A Framework for Cooperative Resource Management in Mobile Cloud Computing)	IEEE	2013
S78	(A Framework for QoS and Power Management in a Service Cloud Environment with Mobile Devices)	IEEE	2010
S79	(A Network and Device Aware QoS Approach for Cloud-Based Mobile Streaming)	IEEE	2013
S80	(a qos-aware system for mobile cloud computing)	IEEE	2011
S81	(A survey of mobile cloud computing: architecture, applications, and approaches)	IEEE	2013

(continued)

Table C.1 (continued): Studies remaining after the second stage

Study	Title	Source	Year
S82	(On the Investigation of Cloud-Based Mobile Media Environments With Service-Populating and QoS-Aware Mechanisms)	IEEE	2013
S83	(QoS-Aware Dynamic Resource Management in Heterogeneous Mobile Cloud Computing Networks)	IEEE	2014
S84	(QoS-Guaranteed Bandwidth Shifting and Redistribution in Mobile Cloud)	IEEE	2014
S85	(Authentication in mobile cloud computing: A survey)	ScienceDirect	2016
S96	(Efficient handover authentication with user anonymity and Un traceability for Mobile Cloud Computing	ScienceDirect	2016
S97	(Energy-efficient service-oriented architecture for mobile cloud handover)	Springer	2017

(continued)

Table C.1 (continued): Studies remaining after the second stage

Study	Title	Source	Year
S98	(Development and Analysis of a New Cloudlet Allocation Strategy for QoS Improvement in Cloud)	Springer	2015
S99	(Cost and energy aware service provisioning for mobile client in cloud computing environment)	Springer	2015
S108	(A study on virtual machine deployment for application outsourcing in mobile cloud computing)	Springer	2016
S109	(Cloud resource provisioning: survey, status and future research directions)	Springer	2016
S112	(A novel cloud scheduling algorithm optimization for energy consumption of data centers based on user QoS priori knowledge under the background of WSN and mobile communication)	Springer	2017

(continued)

Table C.1 (continued): Studies remaining after the second stage

Study	Title	Source	Year
S113	((Fault tolerance and QoS scheduling using CAN in mobile social cloud computing)	Springer	2014
S114	(Integrated Multi-service Handoff Mechanism with QoS-Support Strategy in Mobile Cloud Computing)	Springer	2016
S115	(Storage and computing resource enabled joint virtual resource allocation with QoS guarantee in mobile networks)	Springer	2017
S116	(A survey of mobile cloud computing: architecture, applications, and approaches)	Google Scholar	2013
S117	(Mobile cloud computing: A survey)	Google Scholar	2013
S118	(Application Partitioning and Offloading in Mobile Cloud Computing)	Ethos	2017

(continued)

Table C.1 (continued): Studies remaining after the second stage

Study	Title	Source	Year
S119	(Exploring Traffic and QoS Management Mechanisms to Support Mobile Cloud Computing using Service Localizations in Heterogeneous Environment)	Ethos	2015
S120	(Volar Mobile Context-aware Adaptation for the Cloud)	Ethos	2014