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A FRAMEWORK FOR CLOUD COMPUTING IN RESOURCE-CONSTRAINED ENVIRONMENTS TO FACILITATE eGOVERNMENT SERVICES: A CASE STUDY IN ETHIOPIA

By

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ABSTRACT

In the past decade, an accelerated uptake, provision and use of public eService delivery has been noted. The trend can partly be ascribed to the phenomenal rate of broadband internet uptake on the one hand, and the exponential increase in the affordances of reasonably priced Information and Communication Technology (ICT) on the other. As a result, there is an expectation amongst governments, various public and private organisations, and other stakeholders regarding the role of eGovernment service delivery.

The requirement of effective and efficient eGovernment service delivery in particular, seek to use the Internet and emerging technology, such as Cloud Computing, to enhance government service, reduce the implementation cost of Government service delivery and the cost to end users. However, despite the accelerating accessibility of the Internet and Cloud Computing technology, there exists a dearth in literature related to research publications on frameworks for Cloud Computing for the enhancement of eGovernment services provision in Resource-Constrained Environments (RCEs) in general, and more specifically for the Ethiopian context.

The purpose of this study is to explore the notion of, and develop A Framework for Cloud Computing in Resource-Constrained Environments to facilitate eGovernment services in Ethiopia. The research is guided by the main research question: How can a Cloud Computing framework support RCEs to facilitate eGovernment services in Ethiopia? In order to address the purpose, and answer the research questions, a qualitative exploratory single case study was applied. An interpretive philosophy, guided by hermeneutics and triangulation, were operationalised through this case study.

The framework, presented as research artifact in this study, was development over three phases: the initial phase entailed scoping literature studies to identify components relevant to, firstly, Cloud Computing; secondly, eGovernment services; and thirdly, RCEs. Different research frameworks that exhibit appropriate theoretical concepts on Cloud Computing, eGovernment services and RCEs, were considered. Identified key components were then synthesised towards the formation of an *a priory* theoretical framework. These were refined and validated through expert review to present interim Theoretical Frameworks. During the second phase of this study, the theoretical framework was further refined and validated through expert interviews that reflected on Cloud Computing within the Ethiopian context in general, and to the WoredaNet context in particular. The outcome of this phase presented a Framework for Cloud Computing in Resource-Constrained Environments to facilitate e-Government Services in Ethiopia. Phase three of the study outlines concluding remarks and recommendations.

The findings of this thesis provide new insights into the diverse complexity of the adoption and implementation of Cloud Computing in RCEs in fostering eGovernment services, based on Ethiopia's WoredaNet as example. It also provides insight into the potential benefits of Cloud Computing, as well as the risks and challenges, which may influence the adoption and implementation of Cloud Computing for facilitating RCE eGovernment services.

The particular contributions of the findings of this research include: providing background information and enabling an understanding of the existing body of knowledge regarding Cloud Computing concepts; developing research methodologies, models, and a framework for this study that can be adopted, modified, or developed for future studies of the sector; and providing recommendations for future research and contributing to the existing body of knowledge.

KEYWORDS: Cloud Computing; eGovernment; RCE; electronic service; government cloud; public cloud; community cloud; hybrid cloud; software-as-a-service; infrastructure-as-a-service; platform-as-a-service.

Abstrak (Afrikaans)

In die afgelope dekade is 'n versnelde opname, voorsiening en gebruik van openbare dienslewering opgemerk. Die neiging kan deels toegeskryf word aan die fenomenale tempo van breëband-internetopname enersyds, en die eksponensiële toename in die bekostigbaarheid van billike inligting- en kommunikasietegnologie aan die ander kant. As gevolg hiervan is daar 'n verwagting onder regerings, verskillende openbare en private organisasies en ander belanghebbendes rakende die rol van dienslewering deur die regering. Die vereiste van effektiewe en doeltreffende lewering van e-regeringsdienste, veral om die internet en opkomende tegnologie, soos *Cloud Computing*, te gebruik om die regering se dienslewrering te fasiliteer, die implementeringskoste van die regering se dienslewering te verlaag en om die koste vir eindgebruikers te verlaag. Ondanks die versnelde toeganklikheid van die internet en Cloud Computing-tegnologie bestaan daar egter 'n gebrek in die literatuur wat verband hou met navorsingspublikasies oor raamwerke vir Cloud Computing vir die verbetering van die voorsiening van e-regeringsdienste in hulpbron gestremde gemeenskapsomgewings in die algemeen, en meer spesifiek vir die Ethiopiese konteks. Die doel van hierdie studie is om die idee van 'n raamwerk vir *Cloud Computing in Resource-Construined Environments* te ondersoek en te ontwikkel om e-regeringsdiens verskaffing in Ethiopië te vergemaklik.

Die navorsing word gelei deur die navorsingsvraag: Hoe kan 'n Cloud Computing-raamwerk hulpbron gestremde gemeenskapsomgewings ondersteun om e-regeringsdienste in Ethiopië te vergemaklik? Ten einde die doel aan te spreek en die navorsingsvrae te beantwoord, is 'n kwalitatiewe ondersoekende enkele gevallestudie toegepas. 'n Interpretatiewe filosofie, gelei deur hermeneutiek en triangulasie, is deur hierdie gevallestudie geoperasionaliseer. Die raamwerk, wat in hierdie studie as 'n navorsingsinitiatief aangebied is, is oor drie fases ontwikkel: die aanvangsfase het bestekliteratuurstudies behels om komponente te identifiseer wat relevant is vir, eerstens, Cloud Computing; tweedens, e-regeringsdienste; en derdens hulpbron gestremde gemeenskapsomgewings. Verskillende navorsingsraamwerke wat toepaslike teoretiese konsepte oor Cloud Computing, e-regeringsdienste en hulpbron gestremde gemeenskapsomgewings vertoon, is oorweeg. Geïdentifiseerde sleutelkomponente is daarna gesintetiseer vir die vorming van 'n teoretiese raamwerk. Dit is verfyn en bekragtig deur kundige oorsig om tussentydse teoretiese raamwerke aan te bied. Gedurende die tweede fase van hierdie studie is die teoretiese raamwerk verder verfyn en bekragtig deur kundige onderhoude wat weerspieël is oor Cloud Computing binne die Ethiopiese konteks in die algemeen, en veral in die WedaNet-konteks. Die uitkoms van hierdie fase het 'n raamwerk vir Cloud Computing in die hulpbron gestremde gemeenskapsomgewings aangebied om e-regeringsdienste in Ethiopië te vergemaklik. Die drie fases van die studie gee 'n uiteensetting van die gevolgtrekking van opmerkings en aanbevelings. Die bevindinge van hierdie proefskrif bied nuwe insigte in die uiteenlopende kompleksiteit van die aanvaarding en implementering van Cloud Computing in RCE's in die bevordering van e-regeringsdienste, gebaseer op Ethiopië se WodaNet as a voorbeeld. Dit bied ook insig in die moontlike voordele van Cloud Computing, sowel as die risiko's en uitdagings, wat die aanvaarding en implementering van Cloud Computing vir die fasilitering van hulpbron gestremde gemeenskapsomgewings e-regeringsdienste kan beïnvloed.

Die besondere bydraes van die bevindinge van hierdie navorsing sluit in: die verskaffing van agtergrondinligting en die begrip van die bestaande kennisgroep rakende Cloud Computing-konsepte; ontwikkeling van navorsingsmetodologieë, modelle, en 'n raamwerk vir hierdie studie wat aangeneem kan word, gewysig, of ontwikkel vir toekomstige studies van die sektor; en aanbevelings te lewer vir toekomstige navorsing en om by te dra tot die bestaande kennisgroep.

I-Thesis abstract (Isizulu)

Eminyakeni eyishumi edlule, ukwamukelwa okusheshayo, ukuhlinzekwa, kanye nokusetshenziswa kokulethwa kwezinsiza zomphakathi kuye kwabonakala. Ientshisakalo engaka yokuthathwa kwe-inthanethi ebanzi ngakolunye uhlangothi, kanye nokwanda okubonakalayo kokukhokhelwa kweLwazi neTekhnoloji Yezokuxhumana (i-ICT) ngakolunye uhlangothi kungabangelwa yikhono lokuyikhokhela kwabayisebenzisayo. Ngenxa yalokhu, kukhona okulindelekile phakathi kohulumeni, izinhlangano ezahlukahlukene zomphakathi nezizimele, kanye nabanye ababambe iqhaza maqondana nendima yokulethwa kwezidingo zikahulumeni ezilethwa ngeTechnology. Isidingo sokulethwa kwezidingo zikahulumeni okunempumelelo futhi okusebenzayo ikakhulukazi, kufuna ukusebenzisa i-Intanethi nobuchwepheshe obuqhamukayo, njengeCloud Computing, ukuthuthukisa izinsizakalo zikahulumeni, ukunciphisa izindleko zokulethwa kwezinsiza zikaHulumeni kanye nezindleko zabasebenzisi bokugcina. Kodwa-ke, ngaphandle kokusheshisa ukufinyeleleka kwe-Intanethi nobuchwepheshe beCloud Computing, kusekhona izidingo zokhukhulisa lomkhakha, lokho kubonakala ezincwadini ezihlobene nezifundo zocwaningo ngezinhlaka ze-Cloud Computing zokwenziwa ngcono kwezinsizakalo ze-eGovernment ezindaweni ezingenazo izinsiza, futhi ikakhulukazi umongo wase-Ethiopia. Inhloso yalolu cwaningo ukuthola umbono kanye nokuthuthukisa nokukhiqiza uhlaka lwe cloud computing ukwenza lula izinsizakalo ze-eGovernment e-Ethiopia. Ucwaningo luqondiswa ngumbuzo omkhulu wokucwaninga othi: Uhlaka lweCloud Computing lungawasekela nokuwithuthukisa kanjani ama-RCE ukwenza lula izinsizakalo ze-eGovernment e-Ethiopia? Ukuze kubhekwane nenhloso, futhi kuphenduleke imibuzo yocwaningo, kusetshenziswe ucwaningo lwamacala olulodwa lokuhlola. Ifilosofi yokuhumusha, eqondiswa yi-hermeneutics kanye noxantathu bolwazi, yasebenza ngalolu cwaningo lwamacala. Uhlaka, olwethulwe njengocwaningo lobuciko kulolu cwaningo, lwakhiwa ngaphezu kwezigaba ezintathu: isigaba sokuqala sasihlanganisa izifundo zokubhala izincwadi ukukhomba izakhi ezifanele, okokuqala, iCloud Computing; okwesibili, izinsizakalo ze-eGovernment; okwesithathu, izinqazelo ngokuswelakala kwezinsiza ezibalulekile. Kwacatshangelwa izinhlaka ezahlukahlukene zokucwaninga ezibonisa imiqondo efanelekile ye-Cloud Computing, izinsizakalo ze-eGovernment, kanye nezinqazelo ngokuswelakala kwezinsiza ezibalulekile. Izakhi ezibalulekile ezihlonziwe zabe sezihlanganiswa ekwakhiweni kohlaka lokuhlinzekwa kwezindingo zomphakathi ngokusizwa yi eGovernment e-Ethiopia. Ehlandleni lwesithathu lokhu kwahlanzwa futhi kwaqinisekiswa ngokubuyekezwa kwesazi ukwethula izinhlaka zesikhashana zezolwazi. Ngesikhathi sesigaba sesibili salolu cwaningo, uhlaka lolwazi lwabuye lwahlaziywa futhi lwaqinisekiswa ngokuxoxisana nochwepheshe nosaziwayo abaphawula nge Cloud Computing ne WoredaNet ngaphakathi komongo wase-Ethiopia. Umphumela walesi sigaba wethule Uhlaka Lwama-Cloud Computing ezindaweni ezinezinsiza ezinganele ukwenza lula izinsizakalo ze-e-Government Ethiopia. Isigaba sesithathu sohlu lokufunda luveza izinkulumo nezincomo. Ukutholwa kwalombalo wecwaningo kuhlinzeka ngemininingwane emisha yokuhlukahlukana kokutholwa kanye nokusetshenziswa kweCloud Computing ezindaweni ezinezinsiza ezinganele, nasekwandiseni izinsizakalo ze-eGovernment, ngokususelwa ku-WoardaNet yase-Ethiopia njengesibonelo. Ibuye futhi inikeze ukuqonda ngezinzuzo ezingaba khona zeCloud Computing, kanye nobungozi nezinselelo, ezingaba nomthelela ekwamukelweni nasekusetshenzisweni kwe cloudComputing yokwenza lula izinsizakalo nge e-Government nasekuhlinzekweni kwezidingo zomphakathi ezindaweni ezinezinsiza ezinganele Amagalelo athile kokutholakele kwalolu cwaningo afaka: ukuhlinzeka ngemininingwane yangemuva kanye nokwenza amandla ukuqonda komzimba okhona wolwazi maqondana nemiqondo ye-Cloud Computing; ukwakha izindlela zokucwaninga, amamodeli, nohlaka lwalolu cwaningo olungamukelwa, kushintshiwe, noma eyenzelwe izifundo ezizayo zomkhakha; kanye nokunikeza izincomo zocwaningo lwesikhathi esizayo kanye nokunikela emzimbeni okhona wolwazi.

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Time and space limitations cannot allow me to mention every person who contributed in one way or another to the success of this study. I wish to stress, however, that I am utterly grateful to all these unmentioned names. Thank you very much!

DECLARATION

I hereby declare that this document: A FRAMEWORK FOR CLOUD COMPUTING IN RCEs TO FACILITATE eGOVERNMENT SERVICES: A CASE STUDY IN ETHIOPIA, submitted for evaluation towards the requirements of the subject: Information Systems, as part of the PhD qualification at the University of South Africa, is my own original work and has not previously been submitted to any other institution of higher learning or subject for evaluation. All sources used or quoted in this document are indicated and acknowledged by means of a comprehensive list of references.

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Proposal: WoredaNet Cloud computing and its Contribution to the Development of E-governance in Ethiopia: A Structurational analysis

Qualification: PhD

Thank you for the application for research ethics clearance by the Unisa College of Science, Engineering and Technology's (CSET) Research and Ethics Committee for the above mentioned research. Ethics approval is granted for a period of five years from 4 October 2017 to 4 October 2022.

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3. The researcher will ensure that the research project adheres to any applicable national legislation, professional codes of conduct, institutional guidelines and scientific standards relevant to the specific field of study.
4. Only de-identified research data may be used for secondary research purposes in future on condition that the research objectives are similar to those of the original research. Secondary use of identifiable human research data require additional ethics clearance.

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Yours sincerely

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ACRONYMS AND ABBREVIATIONS

Abbreviation	Acronym
ACM	Association for Computing Machinery Digital Library
AU	African Union
CC	Cloud Computing
CPS	Cyber-Physical Systems
CRM	Customer Relationship Management
CSP	Cloud Solution Provider
DaaS	Database as a Service
DC	Data Centre
EC2	Elastic Compute Cloud
EICTDA	Ethiopian Information and Communication Technology Development Agency
ERP	Enterprise Resource Planning
FBI	Federal Bureau of Investigation
GIS	Geographical Information System
GNU	GNU's Not Unix
HaaS	Hardware as a Service
HPC	High Performance Computing
IaaS	Infrastructure as a Service
ICT	Information and Communication Technology
IEEE	Institute of Electrical and Electronics Engineers
IP	Internet Protocol
IS	Information System
ISSN	International Standard Serial Number
MCIT	Ministry of Information and Communication Technology
MiNT	Ministry of Innovation and Technology
MOCB	Ministry of Capacity Building
MRQ	Main Research Question
NIST	The National Institute of Standards and Technology
NGO	Non-Governmental Organisation
PaaS	Platform as a Service
PSO	Public Service Organisation
QoS	Quality of Service
RCE	Resource-Constrained Environment
ROI	Return on investment
S3	Simple Storage Service
SaaS	Software as a Service
SLAs	Service Level Agreements
SLR	Systematic Literature Review
SOA	Service-Oriented Architecture
SRQ	Sub-Research Question
UN	United Nations
UNISA	The University of South Africa
US	United States
VUSSC	Virtual University of Small State of the Commonwealth
WEF	World Economic Forum

TABLE OF CONTENTS

ABSTRACT ii

ACKNOWLEDGEMENTS iv

DECLARATION vi

ACRONYMS AND ABBREVIATIONS vii

TABLE OF CONTENTS viii

LIST OF FIGURES xiv

LIST OF TABLES xvi

Chapter 1 INTRODUCTION 1

1.1 BACKGROUND 2

1.2 PROBLEM STATEMENT AND RESEARCH QUESTIONS 4

1.2.1 Research Aim 6

1.2.2 Research Questions 6

1.2.3 Importance of the Study 7

1.3 LITERATURE REVIEW 8

1.3.1 Cloud Computing 8

1.3.2 EGovernment and eGovernment services 9

1.4 RESEARCH METHODOLOGY 12

1.5 DELINEATIONS AND LIMITATIONS 15

1.6 ETHICAL CONSIDERATIONS 16

1.7 CHAPTER OUTLINE/OVERVIEW 16

1.8 CHAPTER SUMMARY 17

Chapter 2 RESEARCH METHODOLOGY 18

2.1 INTRODUCTION AND OVERVIEW OF THE CHAPTER 18

2.2 PROBLEM IDENTIFICATION AND MOTIVATION 19

2.3 RESEARCH AIM, QUESTIONS, AND OBJECTIVES 20

2.4 PHILOSOPHICAL ASSUMPTION 20

2.4.1 Theories applicable to this study 24

2.4.1.1 Affordances theory 24

2.4.1.2 Socio-technical systems theory 25

2.5 QUALITATIVE RESEARCH ... *25*
2.5.1 Exploratory research ... 27
2.6 RESEARCH DESIGN ... *27*
2.6.1 Case Study Strategy ... 28
2.6.2 Case study site, participant selection, sampling ... 29
2.6.3 Data Collection Techniques ... 32
2.6.3.1 Interviews ... 33
2.6.3.2 Document analysis ... 34
2.6.3.3 Observation ... 35
2.6.3.4 Expert Reviews ... 35
2.6.4 Data Analysis Techniques ... 35
2.7 TRIANGULATION IN THIS STUDY ... *38*
2.8 ETHICAL CONSIDERATIONS AND TRUSTWORTHINESS ... *39*
2.9 LIMITATION OF THE STUDY ... *41*
2.10 DEFINING A FRAMEWORK ... *41*
2.11 TRUSTWORTHINESS ... *42*
2.12 CONTRIBUTION OF THIS STUDY ... *42*
2.13 CHAPTER SUMMARY ... *42*
Chapter 3 SCOPING REVIEW: CLOUD COMPUTING ... 46
3.1 OVERVIEW OF THE LITERATURE REVIEW CHAPTERS ... *46*
3.2 PREFERRED LITERATURE REVIEW ... *46*
3.2.1 For a scoping review, conducting a systematic review protocol ... 48
3.2.2 Literature sources and study exclusion criteria ... 49
3.2.3 Searching the literature ... 50
3.2.4 Data analysis and selection ... 50
3.2.5 Literature Sources ... 51
3.3 OVERVIEW OF Chapter 3 ... *52*
3.4 THE VALUE OF A LITERATURE REVIEW ... *53*
3.4.1 Searching the literature ... 53
3.4.2 Data analysis and selection ... 53
3.5 CLOUD COMPUTING ... *55*
3.5.1 Introduction ... 55
3.5.2 The History of Cloud Computing ... 57
3.5.3 Theoretical Approaches of the Basic Concepts of Cloud Computing ... 62

3.5.4 Prerequisites of Cloud Computing 64
3.5.5 Characteristics of Cloud Computing 65
3.5.6 Existing Models and Frameworks 68
3.5.6.1 Service models: 69
3.5.6.2 Deployment models: 72
3.5.7 Definition of Cloud Computing 73
3.5.8 The general use of Cloud Computing 79
3.5.8.1 Technical Perspective: 79
3.5.8.2 User Perspective: 80
3.5.8.3 Companies Perspective: 81
3.5.8.4 Environmental Perspective: 81
3.5.9 Users of Cloud Computing 81
3.5.10 Opportunities, Risks, and Challenges 83

3.6 SUMMARIZING PREVIOUS RESEARCH FINDINGS AND STRUCTURING THE COMPONENTS OF CLOUD COMPUTING 86
3.6.1 Component: Characteristics 88
3.6.2 Component: Models 89
3.6.3 Component: Technology Architecture 90
3.6.4 Component: Considerations 93
3.6.5 Component: Principles 93
3.6.6 Component: Interaction interfaces 94

3.7 EVALUATING the COMPONENTS OF CLOUD COMPUTING 95
3.7.1 Experts who evaluated the components of V1 of the interim theoretical framework 97
3.7.1.1 Gender 98
3.7.1.2 Age range of Ethiopian experts in Cloud Computing 98
3.7.1.3 Occupation of experts in Cloud Computing 98
3.7.1.4 Years of Experience of experts in Cloud Computing 98
3.7.1.5 Education of experts in Cloud Computing 98
3.7.1.6 Work Context of Ethiopian experts in Cloud Computing 98
3.7.1.7 Development of the Questionnaires for the Components on Cloud Computing 99
3.7.1.8 Findings from the Questionnaires of Cloud Computing 99

3.8 VERSION 1 OF THE INTERIM THEORETICAL FRAMEWORK 106

3.9 CHAPTER SUMMARY 106

Chapter 4 SCOPING REVIEW: eGOVERNMENT FRAMEWORKS 107

4.1 OVERVIEW OF CHAPTER 107

4.2 SCOPING REVIEW IN CHAPTER 4 108
4.2.1 Identifying the Research Question 109

4.2.2 Identifying Relevant Studies ... 109
4.2.3 Data Chart ... 112

4.3 CONCEPTUALIZING eGOVERNMENT ... 112
4.3.1 Theoretical Approaches and History ... 115
4.3.2 Basic Concepts and Principles of Existing Models and Frameworks ... 117
4.3.3 Prerequisites of eGovernment and Technological Aspects ... 119
4.3.4 Characteristics of eGovernment ... 121
4.3.5 Defining eGovernment and e-Governance ... 122
4.3.6 Physiognomies and General use of eGovernment and eGovernment Services ... 128
4.3.7 Rewards (Opportunities), Risks and Challenges (Shortcomings) of eGovernment ... 130
4.3.7.1 Rewards and Opportunities ... 130
4.3.7.2 Risks and Challenges (Shortcomings) ... 130

4.4 SUMMARIZING FINDINGS OF PREVIOUS RESEARCH AND STRUCTURING THE COMPONENTS OF eGOVERNMENT ... 132
4.4.1 Component: Stakeholders ... 136
4.4.2 Component: Legal Framework and Information security ... 137
4.4.3 Component: Principles and Guidance ... 138
4.4.4 Component: Common Systems Architecture ... 139
4.4.5 Component: Technology ... 141
4.4.6 Component: Application and Services ... 142
4.4.7 Component: Interaction Communication ... 143
4.4.8 Component: Interaction Interfaces and Portals ... 144
4.4.9 Component: Challenging Factors ... 144

4.5 EVALUATING THE COMPONENTS OF eGOVERNMENT SERVICES ... 145
4.5.1.1 Gender ... 147
4.5.1.2 Age Range of experts in eGovernment and RCEs ... 147
4.5.1.3 Occupation of experts in eGovernment and RCEs ... 147
4.5.1.4 Years of Experience of experts in eGovernment and RCEs ... 147
4.5.1.5 Education of experts in eGovernment and RCEs ... 148
4.5.1.6 Work Context of experts in eGovernment and RCEs ... 148
4.5.1.7 Findings from the Questionnaires of eGovernment Services ... 148

4.6 VERSION 2 OF THE INTERIM THEORETICAL FRAMEWORK ... 162

4.7 ADVANTAGES OF CLOUD COMPUTING IN eGOVERNMENT SERVICES ... 164

4.8 CHAPTER SUMMARY ... 168

Chapter 5 SCOPING REVIEW: RCEs ... 169

5.1 CHAPTER OVERVIEW ... 169

5.2 INTRODUCING RCEs ... *169*

5.3 SCOPING LITERATURE REVIEW: RCEs ... *170*

5.3.1 Identifying the Research Question ... 171

5.3.2 Data Chart ... 172

5.4 CONCEPTUALIZING RCEs ... *172*

5.4.1 Concepts of RCEs ... 173

5.5 RELEVANT COMPONENTS FROM RCEs ... *175*

5.5.1 RCE challenges for Cloud Computing facilitating eGovernment Services ... 176

5.6 SUMMARIZING THE CHALLENGES BY RCEs WITHIN WOREDANET ... *178*

5.7 POSSIBLE OPPORTUNITIES TO ADDRESS CHALLENGES POSED BY RCEs ... *180*

5.8 COMBINING THE COMPONENTS AND CHALLENGES FOR RCE AND WOREDANET ... *181*

5.9 EVALUATING THE COMPONENTS OF RCEs ... *184*

5.9.1.1 Findings from the questionnaires of RCEs ... 185

5.10 CATEGORIZING WOREDANET CHALLENGES AS RCEs ... *190*

5.11 STRATEGY FOR DEVELOPING THE THIRD VERSION OF THEORETICAL FRAMEWORK ... *191*

5.12 THE THIRD VERSION OF THE THEORETICAL FRAMEWORK FOR CLOUD COMPUTING FOR FACILITATING eGOVERNMENT SERVICES IN RCEs ... *196*

5.12.1 Existing possible opportunities of sharing ICT resources ... 197

5.12.2 High availability of computing resources with non-human interaction ... 197

5.12.3 Confidentiality and reliability of service ... 197

5.12.4 The opportunities of minimizing up-front cost ... 197

5.12.5 The opportunities of ensuring security in Cloud Computing ... 197

5.12.6 The opportunities of using diverse client platforms ... 198

5.13 CHAPTER SUMMARY ... *200*

Chapter 6 FRAMEWORK DEVELOPMENT ... 201

6.1 INTRODUCTION ... *201*

6.2 DEFINING A THEORETICAL FRAMEWORK ... *202*

6.3 THE FIRST TO THIRD VERSIONS OF THE PROPOSED INTERIM THEORETICAL FRAMEWORK ... *203*

6.4 VALIDATING THE COMPONENTS OF THE THEORETICAL FRAMEWORK ... *205*

6.5 IMPLICATIONS OF THE FINDINGS ... *220*

6.6 OUTCOMES OF THE ANALYSIS ... *221*

6.6.1 WoredaNet Contributions ... 221

6.7 THE FINAL FRAMEWORK ... *227*

6.8 DISCUSSION ... 230

6.9 SUMMARY ... 235

6.10 RECOMMENDATIONS ... 245

6.11 CHAPTER SUMMARY ... 249

Chapter 7 CONCLUSIONS AND RECOMMENDATIONS ... 250

7.1 INTRODUCTION ... 250

7.2 CHAPTER OVERVIEW ... 250

7.3 OVERVIEW OF THE RESEARCH STUDY ... 250

7.4 ADDRESSING THE RESEARCH QUESTIONS AND RESEARCH OBJECTIVE ... 251

7.4.1 Main research question answered ... 253

7.5 RESEARCH METHODOLOGY ... 253

7.6 RESEARCH STUDY EVALUATION ... 255

7.7 RESEARCH CONTRIBUTION ... 258

7.7.1 Practical Contributions ... 258

7.7.2 Theoretical Contributions ... 259

7.8 LIMITATIONS OF THE STUDY ... 260

7.9 FUTURE RESEARCH ... 260

7.10 RESEARCHER'S REFLECTION ... 260

7.11 WHAT HAS BEEN LEARNED? ... 261

7.12 SUMMARY AND RECOMMENDATIONS ... 261

References ... 264

LIST OF FIGURES

Figure 1-1: Map of Ethiopia 2
Figure 1-2: Research onion applied in this study (Adapted from Saunders, Lewis and Thornhill, 2016) 14
Figure 1-3: Different Phases of Literature Review 14
Figure 1-4: The general map of sites location 16
Figure 2-1: Phases, Chapters and development of the framework 19
Figure 2-2: Research process onion (Knox, 2004; Saunders et al., 2016) **........ 21**
Figure 2-3: Main characteristics of Interpretivism as a philosophy (Maree, 2007) **........ 23**
Figure 2-4: Selected sites for the case study in Ethiopia (VUSSC, 2013) 31
Figure 2-5: Coding and triangulation 39
Figure 3-1: Three literature reviews addressing the RQs and contributions of each **........ 46**
Figure 3-2: Information flow through different phases of a systematic review (David et al., 2009). **........ 51**
Figure 3-3: Chapter 3 Literature Review on Cloud Computing **........ 52**
Figure 3-4: Identification and Screening Process Adapted from Liberati, Altman, Tetzlaff et al. (2009) **........ 54**
Figure 3-5: A diagram outlining the basic concepts of Cloud Computing 89
Figure 3-6: The most relevant components of Cloud Computing 106
Figure 4-1: The literature review in Chapter 4 and its contribution 107
Figure 4-2: Chapter 4 scoping review on eGovernment 107
Figure 4-3: Search strategy and process for gathering the relevant publications 110
Figure 4-4: The diagrammatic representation of the components of eGovernment 160
Figure 4-5: The Second Version of the theoretical framework for Cloud Computing for facilitating eGovernment services 166
Figure 5-1: The phases of Chapters 5 as Circled. 169
Figure 5-2: The different phases of Chapter 5. 170
Figure 5-3: Different phases of the scoping review search for studies on RCEs 171
Figure 5-4: Categories of Studies challenges that may be posed by RCEs 178
Figure 5-5: Components of RCEs combined with the challenges 180
Figure 5-6: Categories of challenges that may be posed by RCEs 184
Figure 5-7: Literature review contributions to develop the theoretical framework 196
Figure 5-8: The third version of the theoretical framework for Cloud Computing for facilitating eGovernment services in RCEs 198
Figure 5-9: Process of adoption and use of Cloud Computing for facilitating eGovernment services in RCEs 199
Figure 6-1: Phases of framework development 201
Figure 6-2: Diagrammatic representation of the proposed theoretical framework for Cloud Computing (V1) 203
Figure 6-3: The first phase of V2 of the interim theoretical framework 203
Figure 6-4: Version 2 of the interim theoretical framework for Cloud Computing for facilitating eGovernment services 204

Figure 6-5: V3 of the interim theoretical framework for Cloud Computing for facilitating eGovernment services in RCEs 205
Figure 6-6: Number of users of the Ethiopian Government e-mail facility in different sectors 211
Figure 6-7: The final version of the theoretical framework for Cloud Computing for facilitating eGovernment services in RCEs. 229

LIST OF TABLES

Table 2-1 Research questions and Research objectives 20
Table 2-2: Selected participants in the study 32
Table 2-3: Documents used for data collection 34
Table 2-4: Steps in the coding process 36
Table 2-5: Summary of principles for evaluation of Interpretive Field Research (Klein and Myers 1999c,p.72) 40
Table 2-6 Summary of research design, based on the research process onion 43
Table 3-1 Difference between a systematic and scoping literature review (Grant and Booth 2009) 48
Table 3-2: Summary of search criteria for each chapter in the literature review. 49
Table 3-3: An outline of the sub-sections of Chapter 3 (Source: the researcher) 52
Table 3-4: The 12 Full-text articles excluded and reasons for exclusion 54
Table 3-5: Summary of the current state of the art of Cloud Computing 60
Table 3-6: Characteristics of Cloud Computing 65
Table 3-7: Summarised Characteristics of Cloud Computing 66
Table 3-8: Summarised known examples of SaaS, PaaS, and IaaS 69
Table 3-9: Summarised key features, advantages, and preference conditions of SaaS, PaaS, and IaaS 70
Table 3-10 Summary of definitions of Cloud Computing 75
Table 3-11: Summary of advantages and challenges of Cloud Computing 84
Table 3-12: Summary of the most relevant components of Cloud Computing to this study 86
Table 3-13: Success factors affecting Cloud Computing services 95
Table 3-14: Framing the theoretical framework of Cloud Computing 96
Table 3-15: Experts selected for Cloud Computing compo 97
Table 3-16: Attributes for expert reviews for Cloud Computing components 99
Table 3-17 Experts rating of the factors of Cloud Computing 102
Table 3-18: Responses of experts expressed as percentages 104
Table 4-1: Summarised outline of the sub-sections into which Chapter 4 is divided 108
Table 4-2: The 11 full-text articles excluded and reasons for exclusion 110
Table 4-3 Characteristics of eGovernment 121
Table 4-4 Summary of the definitions of eGovernment 124
Table 4-5: United Nations' eGovernment Index (2014 & 2008) as (UNPAN, 2014; UNPAN, 2018) 128
Table 4-6 Summary of some of the facets of eGovernment 129
Table 4-7: Advantages and challenges of eGovernment arena 132
Table 4-8: The most relevant components of eGovernment to this study 133
Table 4-9: The stakeholder components of eGovernment 136
Table 4-10: Experts selected for eGovernment components 146
Table 4-11: Experts' rating of the factors of eGovernment 149
Table 4-12: Responses of experts expressed as percentages 153
Table 4-13 Summary of the relevant components of the eGovernment arena 161

Table 4-14: The components of Cloud Computing and eGovernment and their relationships 162

Table 5-1: Categories of challenges that may be posed by RCEs 177

Table 5-2: Challenges that may be posed by RCEs 179

Table 5-3: Groups of categories of challenges that may be posed by RCEs 182

Table 5-4: Experts' rating of the factors of RCEs 184

Table 5-5: Experts rating of the factors of RCEs 186

Table 5-6: Responses of experts expressed as percentages 188

Table 5-7: Categories of Possible Challenges and descriptions 191

Table 5-8: Relationships among various components..192

Table 6-1: Expert Interview participants...206

Table 7-1: Main research question answered 253

Table 7-2 Principles used for evaluation of Interpretive Field Research 255

Table 7-3: Reliability, Validity, and Trustworthiness of the Research 257

CHAPTER 1 INTRODUCTION

In recent years, there has been a rapid development of computing services; computing resources have become cheaper and more powerful by applying various information technologies, among which Cloud Computing has been commonly used to replace the traditional standalone computer system. The application of Cloud Computing has increasingly become the concern of various sectors, both in developed and developing countries; accordingly, researchers of the field are providing their work by discussing aspects such as the challenges, benefits, and risks of the adoption and deployment of Cloud Computing (Dahiru, Bass, & Allison, 2014; Deb, 2017; 2012; Taylor Sr, 2018).

Nevertheless, a research gap exists in the field, particularly for a commonly agreed and accepted theoretical framework for Cloud Computing for facilitating eGovernment services in RCEs. According to Tichapondwa (2013), a theoretical framework is a structure or scaffolding that can support research and provide a guidance foundation consisting of an interrelated and coherent set of explanatory concepts, providing research impetus to their definitions and meanings and existing theories. A framework in this research thesis is considered a means of presenting relevant components and their relationship within Cloud Computing.

This study contributes to the field of interest and addresses this gap by exploring, synthesising, refining and validating a *Framework for Cloud Computing in Resource-Constrained Environments (RCEs) to facilitate eGovernment service in Ethiopia*. It contributes by providing a wide-ranging understanding of selected theoretical frameworks of technology to adopt a specific framework for Cloud Computing as the technology chosen.

The study is framed by Cloud Computing in RCEs, such as WoredaNet[a], to facilitate eGovernment service; in so doing, the study provides further insights into the potential and opportunities present in adopting and deploying Cloud Computing to facilitate eGovernment services. The study engages with the Ethiopian Government Network (WoredaNet: see Section 1.2.1) as a specific instantiation. However, the contribution of the study extends to similar contexts and developing

[a]WoredaNet is the Ethiopian government network, structurally it is a three-tier architecture (federal, regional and Woreda/district level) which is implemented by Ministry of Communication and Information Technology (MCIT)in collaboration with Ethio-Telecom and regional local governments

countries. The inclusion of various fundamental constructs of Cloud Computing and their relations within eGovernment, and eGovernment services in RCE, is also explored.

1.1 BACKGROUND

Ethiopia is located in the Horn of Africa (Eastern Africa). The 2015 Ethiopian census estimated its population at approximately 100 million people. Ethiopia is a member of many worldwide organisations such as the African Union (AU) (Yangui, Glitho, Belqasmi et al., 2016) and the United Nations (Ahmed, Chowdhury, Ahme, & Rafee, 2012), with headquarters in the capital city Addis Ababa.

Figure 1-1: Map of Ethiopia

Around fifteen years back, the government of the Federal Democratic Republic of Ethiopia adopted many strategies in an attempt to accelerate development. One of those strategies was the empowerment of local governments at Woreda[b] (Komba) level through a process known as decentralised development (Ethiopian Information and Communication Technology Development

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[b]Woreda/District is the smallest government administration sector in Ethiopia; a region is a larger government administration sector consisting of many Woredas. Federal administration centres are the largest government administration sectors; two federal states are found in the country, one of them is the capital of Ethiopia (Addis Ababa), and the other is known by the name DireDawa federal state.

Agency (EICTDA), 2009). With this vision, an initial government effort was the implementation in 2003 of a government network known as WoredaNet. This network was aimed at being a central location and connectivity network platform for the delivery of shared Information and Communication Technology (ICT) resources, with some selected services (video conferencing, e-mail and Web hosting services) for facilitating the day-to-day work activities, and enabling convenient and efficient network access for those shared resources (e.g., networks, servers, storage, and applications). The WoredaNet continued to deliver services over the past decade. Some efforts have been made to modernize the infrastructure and services and host more Web portals to deliver information to citizens — even though the majority of these Web portals are static in nature.

However, with rapidly changing global technologies, particularly Web and Internet-based, an increasing need for dynamic and continuous access to resources exists among citizens, specifically for reliable and timely information about government, availability of online forms to be filled with personal and other information, and access to transactional Web and Internet-based applications. In addition, widely available mobile technologies such as smart phones have enabled citizens to easily access global information and gain an understanding of the technology status and information and service availability in other countries, including developed economies; this enabled them to make comparisons with their own country.

As a result, access to information and communications technology has become a challenging issue for governments of developing economies. It may require significant investments in the modernization of the backend infrastructure to facilitate service delivery and realize the availability of timely and reliable information to citizens. The investment cost of modern information and communications technology — such as the adoption, deployment, management, and maintenance of modern and recent information and communication technologies — is thus widely claimed as a serious challenge by Ethiopia and many other developing economies.

The adoption and implementation of Cloud Computing may be one useful option for addressing the investment challenge, as well as other challenges that governments are facing in delivering effective and efficient government services to their citizens (Bassett, 2015; Mubarik & Zainal, 2012; Taylor Sr, 2018; Twum-Darko & Sibanyoni, 2014). More recently, authors claimed that government cloud-based service delivery has brought undeniable benefits, particularly in many developed countries, and has become vital in developing economies for the facilitation of eGovernment services via the adoption and deployment of Cloud Computing as tools to enhance work activities and service delivery (Abid, Bahri, Haddouti, & Gerndt, 2013; Sharma & Thapliyal, 2011).

However, without a generally accepted standardized theoretical framework that can be adopted according to the diverse contexts of different governments, the exploration of issues such as the role that Cloud Computing can play in fostering the delivery of eGovernment services to citizens, as well as identifying risks and challenges in terms of security, privacy, and data location, may continue to challenge the adoption and implementation of Cloud Computing technology.

For the potential success of Cloud Computing in enhancing service delivery by the governments of developing economies and of the Ethiopian Government Network, it is thus becoming of significant concern to have a framework for Cloud Computing that can easily be adopted and used to minimize risks.

1.2 PROBLEM STATEMENT AND RESEARCH QUESTIONS

Documents of the Ministry of Capacity Building (MOCB) and the Ethiopian Information and Communication Technology Development Agency (EICTDA) (grey literature[c]) indicate that the WoredaNet is a combination of people and technology (social-technical in information system) that constitutes the Ethiopian government network that was implemented for the purpose of transforming the government (Ethiopian Information and Communication Technology Development Agency (EICTDA), 2008; Ministry of Capacity Building, 2003). It comprises various data centres implemented in 11 regions at regional and federal government level, which are considered as powerful tools of transforming services in Ethiopia's public sector by attempting to replace the traditional paper-based system with an efficient online service delivery to citizens in various development sectors, including agriculture, health, and education.

Apart from major achievements and successes registered within WoredaNet and the Ethiopian eGovernment ICT sector during the past decade (as will be discussed in Section 5.6 later), the

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[c] Grey literature refers for this study to documents of government policies, strategies, project documents, and internal documents (memoranda, newsletters), as well as reports (technical reports or statistical reports) — primarily government reports and working papers written in Amharic language, including WoredaNet's policy documents and technical documentation since its inception and implementation in 2003. It includes technical specifications and standards in print and electronic formats. The researcher translated all the source documentation written in Amharic into English.

current service delivery and day-to-day work activities in various government offices and Public Service Organisations (PSOs) is still largely characterized as manual-based. Some government documents indicate that, regardless of the existence of the government network (WoredaNet) in the Ethiopian ICT sector, paper-based transactions are still undertaken. This applies to many government offices, including the Ethiopian Ministry of Communication and Information Technology (MCIT, 2017) that owns and manages the entire WoredaNet and ICT-related aspects of the country. However, with the wider availability of ICT artefacts around the globe, various opportunities exist for leveraging many government offices, including PSOs, by improving the day-to-day work activities and service delivery to employees, citizens, and other stakeholders through emerging technologies such as Cloud Computing (MCIT, 2017).

Governments and PSOs may require the adoption and deployment or modernization of their existing ICT by including appropriate models to enhance tools for service delivery-related work activities, where Cloud Computing technology can be one preferred option; the success of its adoption and deployment may rely on a standardized framework that can be adapted by various sectors for different contexts.

In this regard, a researcher in this domain, who aims to focus on improving and fostering eGovernment services, may be required to conduct an analysis of the diverse perceptions of people, in instances where the application of a relevant and appropriate theoretical framework of Cloud Computing can substantially help to understand and interpret the effectiveness and efficiency of eGovernment services in Resource-Constrained Environments (RCEs) to the general public, and to the PSO in particular. This can be possible through a lens of an appropriate theoretical framework that can be used for the analysis of the intended contributions of Cloud Computing, as well as the possible risks and challenges within eGovernment services in terms of fostering service delivery.

The current unavailability of such a theoretical framework is one motivator for research into the development of a framework for Cloud Computing that can support the success of adoption and implementation of Cloud Computing in government departments/agencies and PSOs and foster the delivery of eGovernment services.

In addition, further motivations may exist to research a particular context such as that of Ethiopia. For example, working from documents of MCIT (2017), there are some promising initiatives in Ethiopia such as the current motivation and acceptance of modern information and communication technology by the Ethiopian government. With government identifying cloud-based ICT services as a key factor in civil service reform and public sector improvement they adopted a national strategy for eGovernment. In addition, basic broadband infrastructure is in the process of being upgraded which will include the implementation of a new National Data Centre by the government (MCIT, 2017). Furthermore, some government institutions have already adopted cloud-based applications such as the e-Office. All of these represent the government's commitment to driving the eGovernment initiative.

Ethiopian Government is likewise showing a strong motivation to leverage existing infrastructure and services in fulfilling its readiness to adopt Cloud Computing and to improve service delivery to citizens; this aspect is recognised by this thesis as the real motivation for researching the field of interest.

1.2.1 Research Aim

Based on the arguments narrated above, this thesis aims:

To explore and develop a Framework for Cloud Computing in RCEs to facilitate eGovernment services in Ethiopia.

Aligned with the sub-research questions presented in this thesis (see Section 1.2.2), the objectives of the study are to:

- Explore and investigate the components of the State-of-the-Art of Cloud Computing;
- Explore and investigate existing frameworks for facilitating eGovernment services; and
- Explore and identify challenges that the resource-constrained environment (RCE) can pose for Cloud Computing facilitating eGovernment services.

1.2.2 Research Questions

The following main research question (MRQ) will guide this study, so as to address the research aim presented in the previous section:

How can a Cloud Computing framework support RCEs to facilitate eGovernment services in Ethiopia?

SRQs: the three sub-research questions in this thesis are:

- SRQ 1: What is the state of the art of Cloud Computing?
- SRQ 2: What frameworks exist for facilitating eGovernment services?
- SRQ 3: How do the challenges of an RCE influence Cloud Computing to facilitate eGovernment services for Ethiopia?

1.2.3 Importance of the Study

Facilitating eGovernment services via the development of a Framework for Cloud Computing in RCEs such as that in which the Ethiopian WoredaNet has been deployed may require that the vital and closely related components of Cloud Computing are explored, identified, and incorporated; the current state of the art of Cloud Computing and various aspects of eGovernment services should be considered. This is particularly relevant as the conceptualisation of Cloud Computing is still a growing concept in many developing countries, including Ethiopia.

With the current scarcity of research publications around the Ethiopian ICT sector, particularly the Ethiopian Government Network (WoredaNet), and the concept of Cloud Computing and the government cloud for resource constrained areas being still an emergent phenomenon, a Cloud Computing framework in RCEs would provide a starting point to conceptualise, develop, and implement the intended government-wide Cloud Computing system for Ethiopia and its potential to address service delivery by enhancing eGovernment services in this country.

Within the aim of this study, the WoredaNet in Ethiopia will be used as a case study. It is anticipated that it will be possible to generalise findings to guide other developing countries in similar situations. This generalisation is argued to be more applicable then applying developed context case studies to developing context scenarios.

The findings of this thesis will then provide new insights into the diverse complexity of the adoption and implementation of Cloud Computing in RCEs in fostering eGovernment services, based on Ethiopia's WoredaNet as example. It also provides insight into the potential benefits of Cloud Computing, as well as the risks and challenges that may influence the adoption and implementation of Cloud Computing for facilitating eGovernment services.

Insights from this thesis is of particular importance, not only for the Ethiopian government but also for governments in other developing countries in their own contexts. The outcomes of this research can similarly help decision makers to improve planning, goal setting, and resource allocation activities. Findings may allow executives of federal and state agencies in Ethiopia to better examine the framework for Cloud Computing during the adoption and implementation of Cloud Computing for facilitating eGovernment services in RCEs.

The particular contributions of the findings of this research include: providing background information and enabling an understanding of the existing body of knowledge regarding Cloud Computing concepts; developing research methodologies, models, and a framework for this study that can be adopted, modified, or developed for future studies of the sector; and providing recommendations for future research and contributing to the existing body of knowledge. The study can also serve as a reference for students and scholars of the sector by establishing a baseline of data for future studies.

In a more generalized view, the results of the study can add value to the study of framework development for Cloud Computing to foster eGovernment services in RCEs. The establishment of a conceptual base around a framework of Cloud Computing will allow for responsive understandings of the research of the field. The results of the study thus lie the foundation for further studies, and also contributes to individuals, organisations, institutions, and governments in providing concepts, frameworks, theoretical models, and data for their Cloud Computing research.

This research involves a variety of aspects, namely, Cloud Computing, RCEs, and eGovernment services, and hence covers a complex and wide range of scope. This study alone cannot fully address all those aspects, including models, frameworks, components, and architecture of the research field. Further research on the topic of interest is thus proposed.

1.3 LITERATURE REVIEW

The study was contextualised by applying a scoping review method (Chapters 3, 4, and 5) to address each of the research questions (Cloud Computing, eGovernment services, and RCEs).

1.3.1 Cloud Computing

It is known that ICT artefacts, more specifically Internet and Web technologies, have changed the way in which internal core activities are carried out by organisations, departments, agencies, and institutions of governments. With this in mind, many governments of developing economies aim to foster good governance, service delivery and enhance access to and deliver government services to employees, citizens, businesses, and other stakeholders. It is becoming necessary to have a new state of affairs in which public service organisations, including departments, agencies, and institutions of governments, are expected to integrate service delivery for their stakeholders.

This situation requires implementing modern information and communication technologies as tools to enhance work activities and foster government service delivery. Cloud Computing as one form of information and communication technology in the current age may be preferred for its benefits in modernizing governments' technology infrastructure and facilitating government service delivery.

A variety of Cloud Computing benefits have been offered by published literature in the field. For example, Deb (2017); Mustafa, Baveja, Vijayan et al. (2015) and Mwansa (2015) commonly cited some of the popular benefits of Cloud Computing, including: rapid implementation, anytime access from anywhere, little or no cost of hardware maintenance and implementation, easier upgrades, reduced cost for support and better backup capabilities and disaster recover. Other benefits include on-demand access to computer infrastructure, services, and software with minimal user involvement in terms of management. In addition to outlining the benefits and advantages of Cloud Computing, existing literature also offer various Cloud Computing concepts and technologies, such as: Grid Computing, Utility Computing, virtualisation, and clustering (Michael, Armando, Rean et al., 2010; Zhang, Cheng, & Boutaba, 2010).

Though Cloud Computing has been offering such benefits by incorporating the technologies mentioned above, it cannot be denied that the process of adoption and implementation of any new technology in general, and Cloud Computing in particular, may face various challenging factors at different stages of the processes of adoption and implementation, starting from design to the processes of implementation and further to the process of making the technology available for use.

Authors such as Mustafa et al. (2015); Mwansa (2015); Shahzad (2014); and Youssef (2012) put forward a number of challenges of Cloud Computing, some of which include: security-related issues such as ownership of data and privacy of personal information, as well as issues related to data interoperability, data lock-in, online connectivity, policies, guidance, and standards; these challenges may influence a wide range of sectors during the adoption and deployment of Cloud Computing. These challenging factors still require further research.

1.3.2 EGovernment and eGovernment services

Many scholarly researchers of the Information Systems (IS) field discussed that, during the past decade, a large number of projects have been implemented for the purpose of realization of work effectiveness and to foster government services (Deb, 2017; Elbadawi, 2011; Hanna, Mohamed, & Al-Jaroodi, 2012; Hashemi, 2013; Mell & Grance, 2011; Wyld, 2009). This can be a demonstration of the current relevance and role of ICT in various sectors in terms of work efficiency and service delivery. Thus, the relevance of ICT artefacts, including Cloud Computing, can be discussed from the perspectives of the roles of Cloud Computing technology in government service delivery and work efficiency and effectiveness.

It can be observed from current literature that there is a continuous increasing requirement for the adoption and implementation of ICTs as tools to enhance work activities (Almarabeh, Majdalawi, & Mohammad, 2016; Cordella & Tempini, 2015; Dash & Pani, 2016; Gongolidis, Evangelia, Loucopoulos, & Christos, 2016). This can be considered one of the drivers of the growth of eGovernment in many developing economies of the world. The continuing motivation of effective and efficient service delivery by various sectors in the past decades has brought the current growing need for the adoption and implementation of eGovernment and facilitating eGovernment services around the world.

The past decade can thus be recognised as the eGovernment era, as many public sectors started to view eGovernment services as a vital solution for effective and efficient government service delivery with the use of ICT artefacts to automate internal and external government work processes and for establishing linkages across various departments that relate to the structures and processes pertinent to the delivery of public electronic government services (Hashemi, 2013; Okot-Uma & London, 2000; Ornager & Verma, 2005).

Additionally, one of the drivers of the current growing acceptance of eGovernment services may be the information age, which has opened the opportunity for the ultimate revolution in bringing together all the stakeholders around eGovernment services (citizens, private organisations, Non-Governmental Organisations (NGOs), research community) to link with the government via the implementation and adoption of eGovernment services (Michiel, 2001; Taipale, 2013; Veeramootooa, Nunkoob, & Dwivedic, 2018). As discussed by existing published literature, this may be due to the distinguishing characteristic of eGovernment, which enables government departments, agencies, and other organisations to share their objectives across organisations and within their boundaries, as well as the characteristics of reducing the digital-divide (Abid et al., 2013; Mubarik & Zainal, 2012).

Another reason for developing eGovernment is that the eGovernment system is now considered a system that can provide front-end services, which are usually supported by technology-based back-end processes and systems that may help maximise cost savings to improve government service delivery. This has led the public sector to adopt information technology systems in an effort to facilitate service delivery and enhance their internal work activities (Cordella & Tempini, 2015; Okot-Uma & London, 2000; Ornager & Verma, 2005).

In addition, the acceptance of eGovernment systems could have been leveraged by the potential that it can offer to improve and advance the interactions between citizens and government, as eGovernment can act as an endless wire that electronically threads together citizens and all levels of government in a nation (Komba, 2013; Ornager & Verma, 2005). Komba (2013) and Verma and Ornager (2005) offered their assessment on the impact of eGovernment systems at different levels of government by discussing the advantages, challenges, and risks of the eGovernment arena.

Based on the discussion offered in the literature, eGovernment can generally be considered the public sector's use of ICT implemented and adopted to improve information and services, thereby encouraging citizens' participation in the decision-making process and making government more effective, transparent and accountable.

It is widely observed that many researchers discussed particular aspects such as the status, the challenging factors, and the potential benefits of eGovernment in an attempt to provide useful insights into how the factors are posed on various sectors, including PSOs, municipal government departments, smart cities, cloud government, and rural areas (Abid et al., 2013; Cortés-Cediel, Cantador, & Gil, 2017; Khare, 2012). However, seen from the perspective of the scope of research, such an approach may face limitations. This is illustrated by the observation by the researcher that, rather than to include general eGovernment concepts, some studies focus on a particular area of eGovernment, such as information and service quality (Alcaide–Muñoz, Rodríguez–Bolívar, Cobo, & Herrera–Viedma, 2017; Janita & Miranda, 2018), while others focus on other particular aspects such as a thrust towards eGovernment service delivery (Janita & Miranda, 2018; Pani, 2016). The thesis argues that such fragmentation may widen the gap, restricting the research of the field in achieving a standardized framework for facilitating eGovernment services.

Moreover, while many authors argue that eGovernment is a growing phenomenon within public sector institutions around the world and has been developing and emerging as a significant discipline within the field of public administration, these authors vary in their choice of an appropriate term for their research.

In summary, it can be observed from existing published literature that most of the researchers around topics of interest (Elbadawi) capture the fundamental nature, characteristics and core spirit of Cloud Computing and eGovernment services with some similarity. However, there are also enormous gaps in existing research, particularly on the contributions of Cloud Computing, such as WoredaNet, towards fostering eGovernment services in RCEs. This may be because most of the existing literature around the topic has not applied a systematic evaluation of the aspects of eGovernment and only applied anecdotal evidence.

Most importantly, viewed in terms of more generic aspects and those closely related to the main aim of this thesis, there is a gap in presenting general Cloud Computing concepts in RCEs to facilitate eGovernment services in Ethiopia. This could have resulted in or contributed to the current lack of a commonly accepted standardized framework for Cloud Computing to enable eGovernment services, particularly in RCEs.

It is quite clear that such gaps need to be filled by independent research, thus implying the current requirement for further research in the field. However, it is not to say that common understandings do not exist among researchers of the field; rather, based on the discussions offered by many current publications, it can be argued that eGovernment involves the use of ICT (especially Internet) as a point of interaction between the public and government. Some useful suggestions are presented regarding implementation and deployment focus on integrating internal management work mechanisms and systems with customer preferences and sentiments through the effective use of information technology systems to enable improved performance.

In terms of seeking a particular context that is mainly related to the focus of this thesis, *WoredaNet* is considered as an appropriate government context in which to research the topic of interest. The Ethiopian government implemented the WoredaNet to serve as the backbone and central hub of eGovernment services where citizens can interact with the government, both directly and indirectly (MiNT[d]: http://www.mcit.gov.et). As a vital ICT sector of the country, particularly for eGovernment aspects, a continuous assessment is required to measure the extent to which the expected aims are addressed. It needs to be evaluated in terms of its contribution to fostering a more transparent, accountable, inclusive, and efficient governance system in the country.

Unfortunately, the current state of its effectiveness and contribution has not been well researched, with fewer published literature studies. A clear understanding has thus not been offered due to a scarcity of scholarly research on WoredaNet and its potential contribution to fostering eGovernment services and the lack of assessment of the potential roles of its data centres that implement and adopt Cloud Computing technology that facilitates eGovernment services. This implies gaps among existing studies of WoredaNet, particularly concerning the concepts of Cloud Computing.

To contribute to the research field by filling these gaps, this study offers a theoretical framework for Cloud Computing for facilitating eGovernment services in the RCE of Ethiopia in the WoredaNet context by exploring the data centre dynamics within WoredaNet and their contributions to fostering eGovernment services. This study develops its own definitions and framework for Cloud Computing in RCEs for facilitating eGovernment services.

1.4 RESEARCH METHODOLOGY

Based on the research questions of this study (see Section 1.2.2) and an interpretive paradigm followed by this study, a qualitative research method was used to investigate and obtain answers

[d]MiNT is the current government sector responsible for the country's ICT; it is abbreviated as Ministry of Innovation and Technology)The owner and governor of the WoredaNet is formerly named by EICTDA (Ethiopian ICT Development Agency), and then Named as MCIT (Ministry of Communication and Information Technology), and currently becomes MiNT (Ministry of Innovation and Technology)

to the questions and to sufficiently address, unravel, and interpret data obtained in social, cultural, and institutional contexts. A framework of this type may allow for studying issues in detail and depth, and permit description and analysis of people's individual and collective actions and perceptions of the WoredaNet system around the concepts of Cloud Computing and eGovernment services.

Similarly, through a single case study, this thesis applied a research method that involves close contact between the researcher and participants in this research. WoredaNet was the single case, and the units of analysis were the WoredaNet sites (30) and the experts (30) used for interview-based data collection and for evaluating every version of the framework. This required an analysis of qualitative data, which implies that this thesis's primary data collection method was mainly qualitative, carried out through interviews, observations, and open-ended questionnaires to rank components by purposively selected participants from WoredaNet (Ethiopia). Documents analysis was also done by applying within and holistic case analyses, supported by hermeneutics and triangulation.

Figure 1-2 summarises the detail of the research methodology applied in this study:

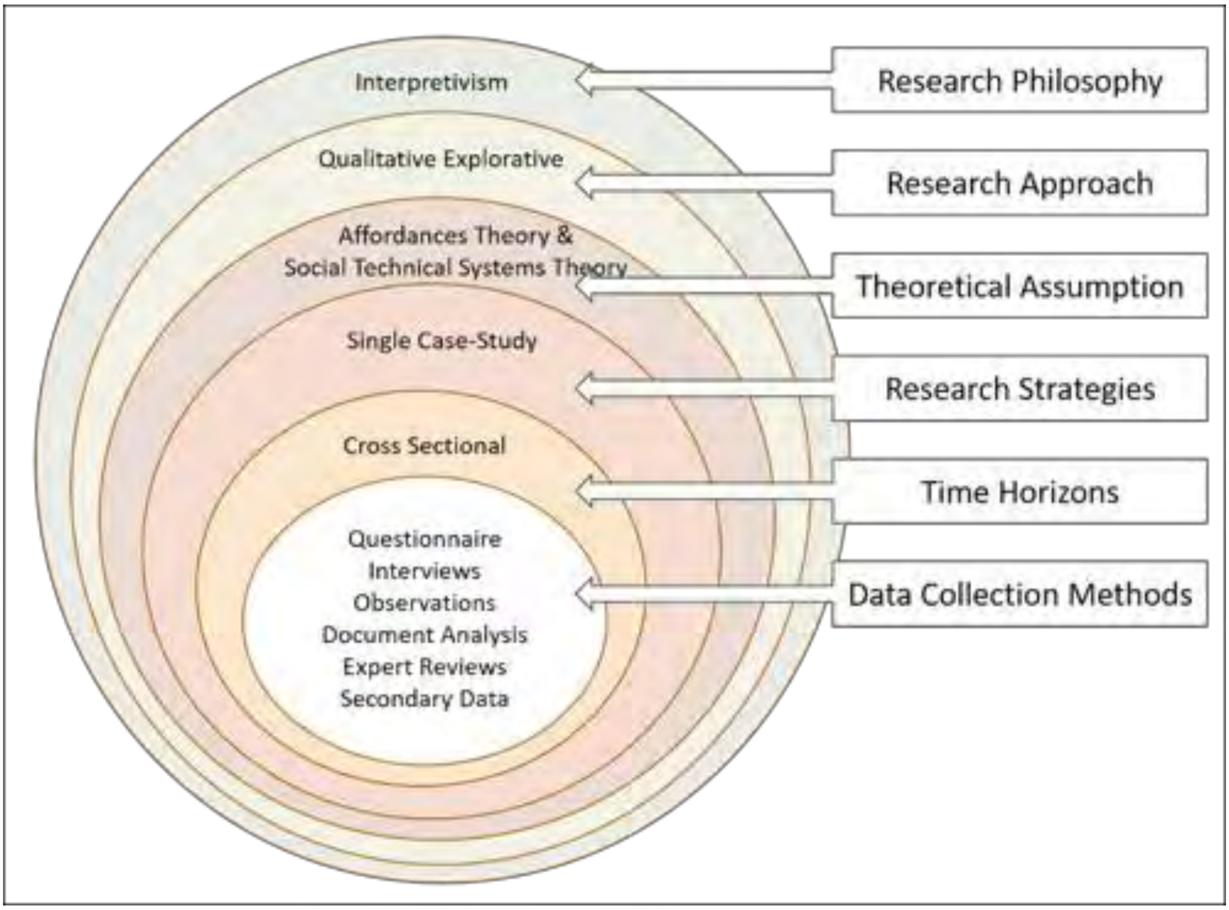

Figure 1-2: Research onion applied in this study (Adapted from Saunders, Lewis and Thornhill, 2016)

The framework for Cloud Computing for facilitating eGovernment services in resource-constrained environments was developed through three phases (adapted from Yin, 2009), as depicted in Figure 1-3:

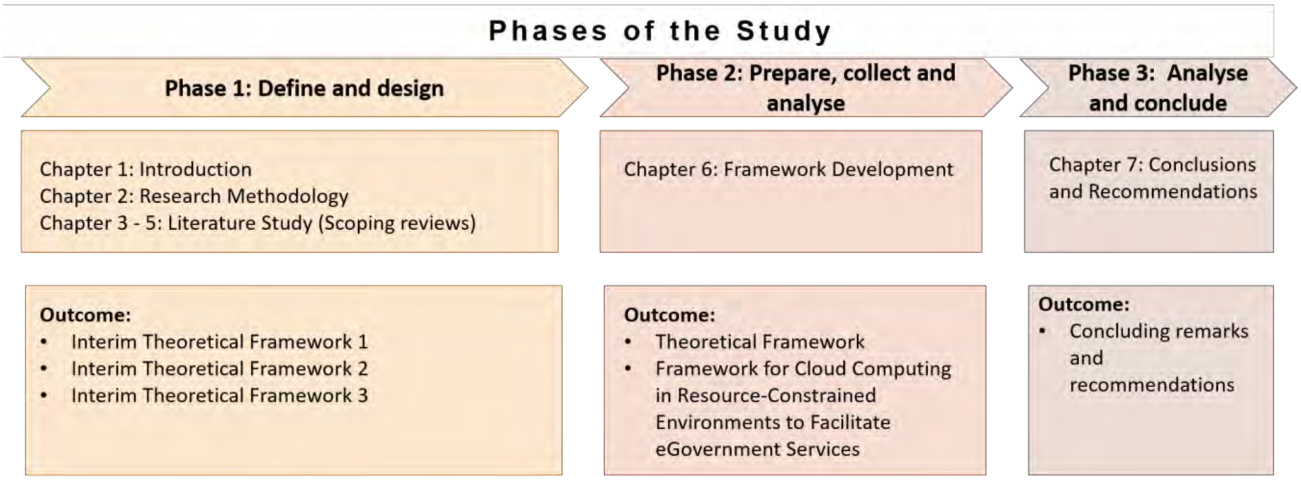

Figure 1-3: Different Phases of Literature Review

As depicted in Figure 1-3, in the first phase (Define and design), scoping literature reviews were conducted and are presented in three Chapters (3, 4, and 5); each addressed a specific research question and research contribution. Chapter 3 resulted in developing the interim Theoretical Framework (v1) for Cloud Computing for facilitating eGovernment services in RCEs by exploring, identifying, and including all relevant components from Cloud state-of-the-are-of-Cloud Computing.

In Chapter 4, a scoping review method was similarly adopted and used to address the exploration and investigation of existing frameworks of eGovernment services and the components of eGovernment services. The findings from this chapter resulted in the development of the second interim Theoretical Framework for Cloud Computing (v2).

In Chapter 5, the review focused on exploring and identifying the various components of the RCE and on identifying the possible challenges that the RCE could pose for Cloud Computing that facilitates eGovernment services. The findings from Chapter 5 resulted in the interim Theoretical Framework V 3, and this completed Phase 1 (by combining all findings from Chapters 3-5). Each version of the Interim Theoretical Framework was evaluated by using experts (purposively sampled from WoredaNet). These experts had to rank the components; this provided a Theoretical Framework that can be applied in Ethiopia and other RCEs to support WoredaNet.

In Phase two of the study (prepare, collect, and analyse), the theoretical framework was evaluated through interviews of 10 participants who were purposively sampled from the WoredaNet in Ethiopia. The findings from Phases 1 and 2 led to the development of the final version of the framework for Cloud Computing in RCEs for facilitating eGovernment services.

More detail on the research methodology can be found in Chapter 2 of this study.

1.5 DELINEATIONS AND LIMITATIONS

This study was limited to a number of selected WoredaNet sites in Ethiopia. Other RCEs were not selected. A total of 30 sites were selected from 11 regions across the country for the analysis. The data centres (Prahonoa & Elidjena) were selected from different levels of government administration sectors, while the analyses mainly depended on documentation and reports concerning the National Data Centre (the command post of the WoredaNet network).

The findings from interviews, questionnaires, expert reviews, and document analysis were used as reference material for scholarly research by establishing a baseline of data that can be used for future studies; in policy development and decision making; in improving planning activities, goal setting, and resource allocation; in examining the contributions of Cloud Computing for facilitating eGovernment services and practices in RCEs by executives of federal and state agencies in Ethiopia; or in making the Ethiopian government more accessible while portraying areas that have not been fully exploited in terms of eGovernment development.

Future research can include how best to implement Cloud Computing that facilitates eGovernment services in RCEs within the WoredaNet context and provides guidelines on how individual components of Cloud Computing facilitate eGovernment services in RCEs.

Figure 1-4: The general map of sites location

1.6 ETHICAL CONSIDERATIONS

This PhD research has received ethics clearance. The University of South Africa's (UNISA) College of Science, Engineering and Technology (CSET) Research Ethics Committee approved the research (see Appendix I).

More detail is provided in Chapter 2 of this study.

1.7 CHAPTER OUTLINE/OVERVIEW

Chapter 1: presents the introduction to this study. This chapter offers the research problem, research questions, and research objectives.

Chapter 2: explains the research methodology adopted for this study. It discusses different research approaches in existing literature and describes the specific approaches preferred and applied by the study.

Chapter 3: presents the literature review and answers the first sub-research question of this study: what are the components of *the State-of-the-Art of Cloud Computing*? The chapter also addresses the first objective of the study: *to explore and investigate the components of the state of the art of Cloud Computing.*

Chapter 4: presents the literature review as a scoping review on existing frameworks for facilitating eGovernment services and answers the second sub-research question of this study:

what frameworks exist for facilitating eGovernment services? The chapter also addresses the second objective of the study: to explore and investigate existing frameworks for facilitating eGovernment services.

Chapter 5: discusses RCEs in terms of facilitating eGovernment services and answers the third sub-research question of this study: what challenges can the RCE pose for Cloud Computing in facilitating eGovernment services? The chapter also addresses the third objective of the study: to explore and identify challenges that the RCE can pose for Cloud Computing in facilitating eGovernment services.

Chapter 6: discusses the development of the theoretical framework and summarises all relevant components of thereof for Cloud Computing for facilitating eGovernment services in RCEs.

Chapter 7: presents the summary, conclusions, and recommendations of this thesis. It presents future work.

1.8 CHAPTER SUMMARY

This chapter provided an overview of the research presented throughout this study towards developing a theoretical framework for Cloud Computing for facilitating government services in RCEs.

The following Chapter discusses the research methodology employed by this thesis the research questions of the thesis, and applied to develop the different versions of the framework.

CHAPTER 2 RESEARCH METHODOLOGY

2.1 INTRODUCTION AND OVERVIEW OF THE CHAPTER

A research methodology is not an encyclopaedic gathering of assorted fact techniques; it is rather a purposeful method of investigation that defines what a research project is about, how a research study is to be conducted, and how the performance of a study, its findings, and successes or failures can be measured while providing an evidentiary base for theory-building. As described by Blaikie (2007, p. 9), a research methodology refers to “discussions of how research is done or should be done, and to the critical analysis of methods of research. Methodology also deals with logics of enquiry, of how new knowledge is generated and justified”. It can also be considered a strategic framework of action that can serve as a bridge between research questions and the execution of a research project; thus, it refers to the entire plan and execution of the research process (Creswell & Miller, 2000).

This chapter discusses the research methodology employed by this thesis for addressing the research questions. The first sub-sections present the problem identification and motivation of the study and the research questions set by the thesis. The relationship between these research questions and the research objectives is presented consecutively. Next, the preferred philosophical orientation applicable to this study will be discussed. Subsequent sections outline the essence of the case study strategy, as applied to this study. This is followed by a discussion on case selection design, data collection, and analysis strategies. The chapter also discusses trustworthiness and ethical issues, and theoretical framework.

Figure 2-1 provides the high-level summary of the study phases and the outcomes from the chapters that were applied in this study. It reflects the process that was followed to develop the framework.

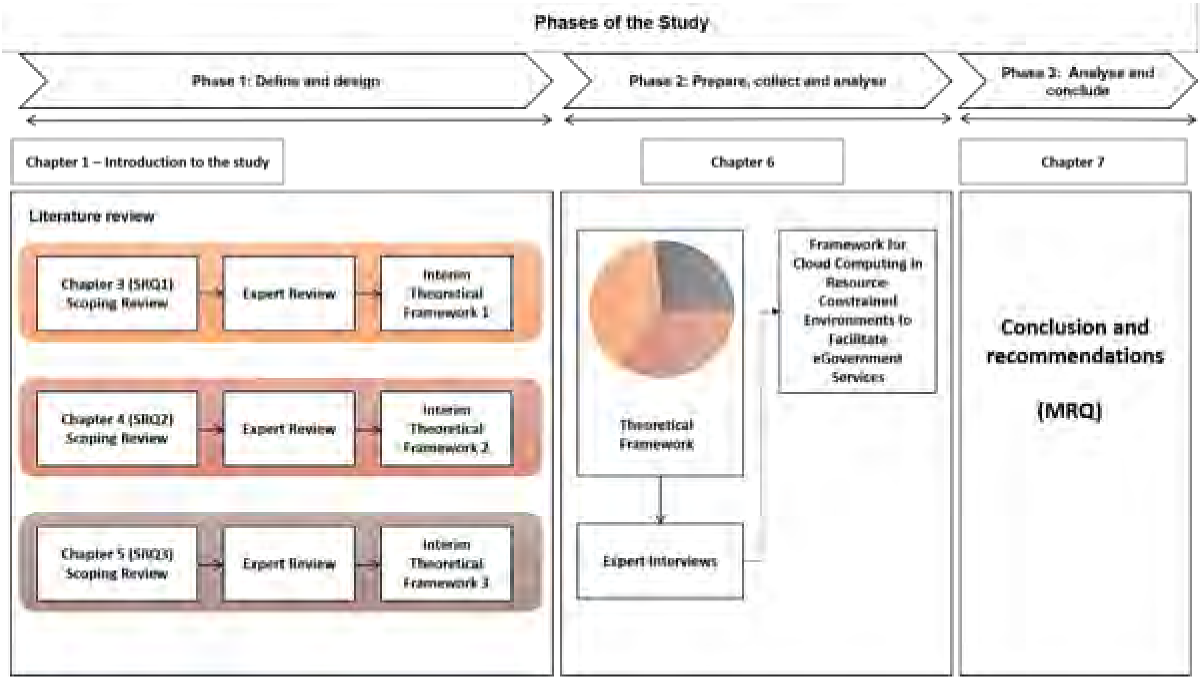

Figure 2-1: Phases, Chapters and development of the framework

The phases and the detail behind this figure were explained in Section 1.4 (Chapter 1).

2.2 PROBLEM IDENTIFICATION AND MOTIVATION

The motivation for this thesis was sourced from the current eGovernment status in Ethiopia, the WoredaNet electronic service delivery mechanisms, and related ICT aspects, as indicated in Section 1.2.2.

The research was initiated to study the WoredaNet system to address the various issues that are considered as constraining challenges of eGovernment service delivery; the engagement further developed to a broader concern on addressing the current requirements of citizens' access to eGovernment services offered by the public. Deeper and careful examinations and exploration was conducted on Ethiopian government documents and related sources of information, from which it became apparent that the current public services (eGovernment electronic services) are deployed and implemented at different places in a scattered manner within WoredaNet, and are still not integrated and organized into a Cloud system.

Accordingly, a number of possible challenges were raised from the current status of WoredaNet and its technologies, which were regarded as constraining factors for the facilitation of eGovernment services through Cloud Computing. The WoredaNet system is currently obsolete, comprising scattered and stationary data centres that cannot support the fast-growing requirements of citizens for access to a variety of government services with reliable data and information.

Hence, it was necessary to conduct research on the topic, explore and examine existing frameworks and currently available technological opportunities, to provide a framework for Cloud Computing that can facilitate eGovernment services and address the challenges that an RCE may pose.

2.3 RESEARCH AIM, QUESTIONS, AND OBJECTIVES

This study explores and develops a framework for Cloud Computing (CC) in RCEs to facilitate eGovernment services in Ethiopia. Table 2-1 summarises the research questions and applicable objectives, as outlined in Chapter 1 (see Section 1.2).

Table 2-1 Research questions and Research objectives

MRQ and main objective	Sub-research questions	Objectives that need to be addressed
MRQ: How can a Cloud Computing framework support RCEs to facilitate eGovernment services in Ethiopia? Main Objective: To explore and develop a framework for Cloud Computing in resource-constrained environments to facilitate eGovernment services.	What is the state of the art of Cloud Computing?	To explore and investigate the components of the state of the art of Cloud Computing.
	What frameworks exist for facilitating eGovernment services?	To explore and investigate existing frameworks for facilitating eGovernment services.
	How do the challenges of RCEs influence Cloud Computing to facilitate eGovernment services for Ethiopia?	To explore, investigate, and identify challenges that RCEs can pose for Cloud Computing in facilitating eGovernment services.

A qualitative exploratory single case study was applied; this was operationalised through three phases (define and design; prepare, collect and analyse; and analyse and conclude) as Yin (2004) suggested.

The research onion of Saunders, Lewis, and Thornhill (2016) was applied, as was indicated in Chapter 1 (Figure 1-2 and 2-2). Each layer of the onion will now be discussed.

2.4 PHILOSOPHICAL ASSUMPTION

Guba (1990:17) explains that philosophy has to underpin a research study as “the basic set of beliefs that guide action”. This is done based on the assumptions of ontology, epistemology, and methodology. A researcher’s beliefs about what constitutes reality and how that reality is understood may be the main indication for the type of research philosophy that the researcher adopts (Blaikie, 2005). How the world is viewed may also indicate the assumptions of the research, which constitutes the adopted research philosophy where the particular view of the relationship between knowledge, and the process by which it is developed, can be the main influence (Klein & Myers, 1999).

This thesis adopted an interpretive research philosophy together with the fundamental methodological aspect of hermeneutics, known as the 'hermeneutic circle'. The latter was applied to understand the complex whole of WoredaNet from preconceptions about the meanings of its parts and their interrelationships; the process was guided by and is consistent with this study's research questions. According to (Klein & Myers, 1999, p. 71), "The idea of the hermeneutic circle suggests that we come to understand a complex whole from preconceptions about the meanings of its parts and their interrelationships".

Research concerned with facts is likely to have a very different view on how the research should be conducted compared with, for example, research concerned with peoples' attitudes. This implies that different research philosophies can be adopted based on the type of research to be conducted.

Saunders, Lewis, and Thornhill (2016) offer the diagram below, termed the research process onion, which depicts the different types of research philosophies that are available to a researcher. Among the variety of research philosophies depicted in the circle (research process onion), three major research philosophies are mentioned (positivism, objectivism, interpretivism).

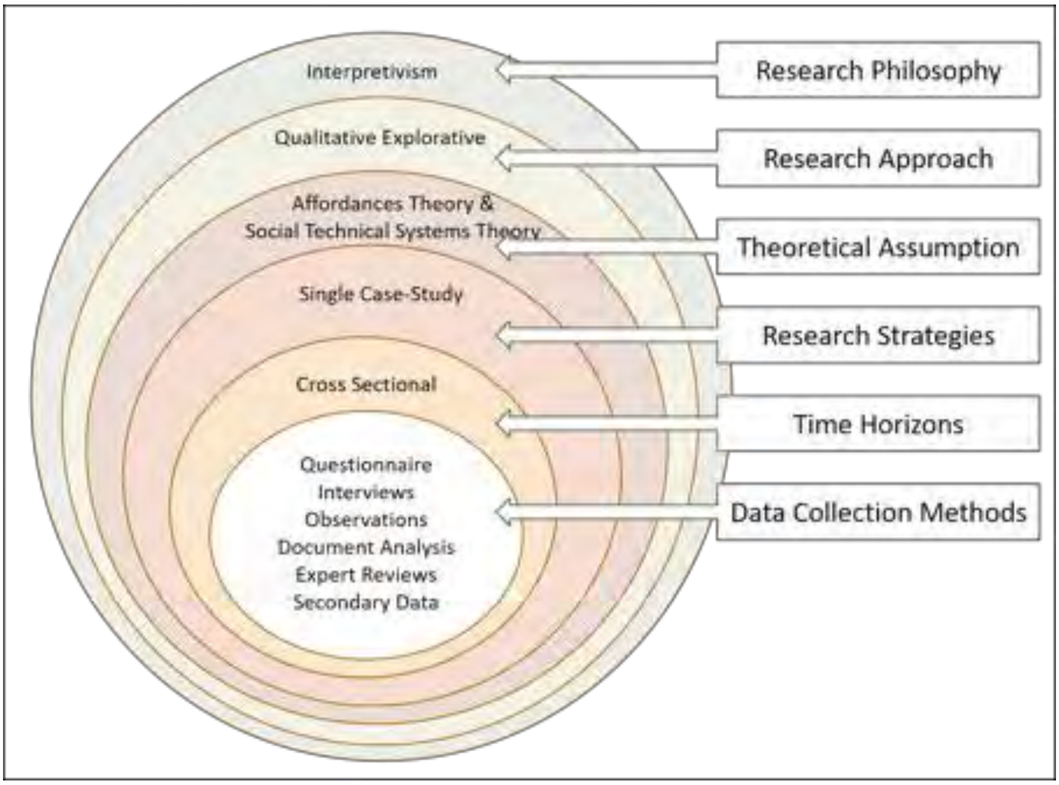

Figure 2-2: Research process onion (Knox, 2004; Saunders et al., 2016)

The interpretive epistemological stance perceives knowledge as multiple, and relative realities gained as a researcher focuses on different views on the development of knowledge (Creswell, 2017). The interpretivist approach argues that objective reality depends on other systems for meanings, which are more difficult to interpret than fixed realities that are objectively determined and perceived; the knowledge acquired is considered socially constructed (Blaikie, 2007).

Through the meanings that people attach to concepts, the interpretive approach makes this approach more suited to this thesis. It provided the opportunity to understand the motives, meanings, and other subjective experiences of people in WoredaNet social contexts. It helped in obtaining knowledge of reality and knowledge about the diverse complexity of human sense-making, which is central to the determination of humans' behaviour, views, and perspectives (Blaikie, 2005).

The notions of the interpretivist research philosophy also allowed the researcher and participants to be interdependent in the domain where peoples' action is a social construction; this is applied equally to the researcher, as there is no objective reality that can be discovered by the researcher and replicated by others (Walsham, 2006).

This thesis is subject to fieldwork (during phase 1 and 2 to refine the theoretical framework), which remains one of the reasons that the interpretive approach was favoured. Walsham (2006) described fieldwork as the fundamental basis of any interpretive study by which a researcher gains the opportunity to conduct an in-depth investigation of a phenomenon. According to Klein and Myers (1999), for humans to make sense in their situation is the focus of interpretive research. The people interact with the real-life context of the social contexts within which their activities occur. The notion of human sense-making engages ongoing situations and the interplay of action and interpretation, where action can begin with local context and immediate actions.

In a more generic view, an interpretive stance was preferred because it assumes that people create and associate their own subjective meanings as they interact with the world around them. In particular, a qualitative, interpretive method is best suited to this research, because it was found appropriate, as suggested by (Blaikie, 2005; Klein & Myers, 1999), in studying:

- The diverse perceptions of individuals within WoredaNet social contexts;
- The diverse complexity of human views, perceptions, and social contexts of the WoredaNet system;
- Motives and meanings that people attach to their day-to-day activities within a particular context like WoredaNet, during their interaction with technology;

- Meanings and interpretations of the diverse views of people about the topic of research in a particular context like the WoredaNet;
- Mutual knowledge, symbolic meanings, motives, and rules that may provide useful guidance for the adoption and use of technology artefacts, as mutual knowledge is continually being used and modified by social actors as they interact with each other and/or with technology artefacts; and
- How people in their social context produce social reality, and how they reproduce and re-configure through their responsive and reactive activities.

Finally, the level of descriptive detail and depth of interpretive, social, and cultural situations have been impossible to achieve with other types of research approaches. The Interpretivist approach allowed this research to examine the diverse beliefs of administrative and technical practices, such as: 1) practices related to public accountability and transparency; 2) practices regarding efforts made to become a value-adding contributor; 3) practices in WoredaNet service provision activities; 4) technology use practices in general; and 5) practices of newly emergent technologies such as e-governance and Cloud-based Web services in particular in WoredaNet system.

Figure 2-3 illustrates the main characteristics found in the interpretivist philosophy:

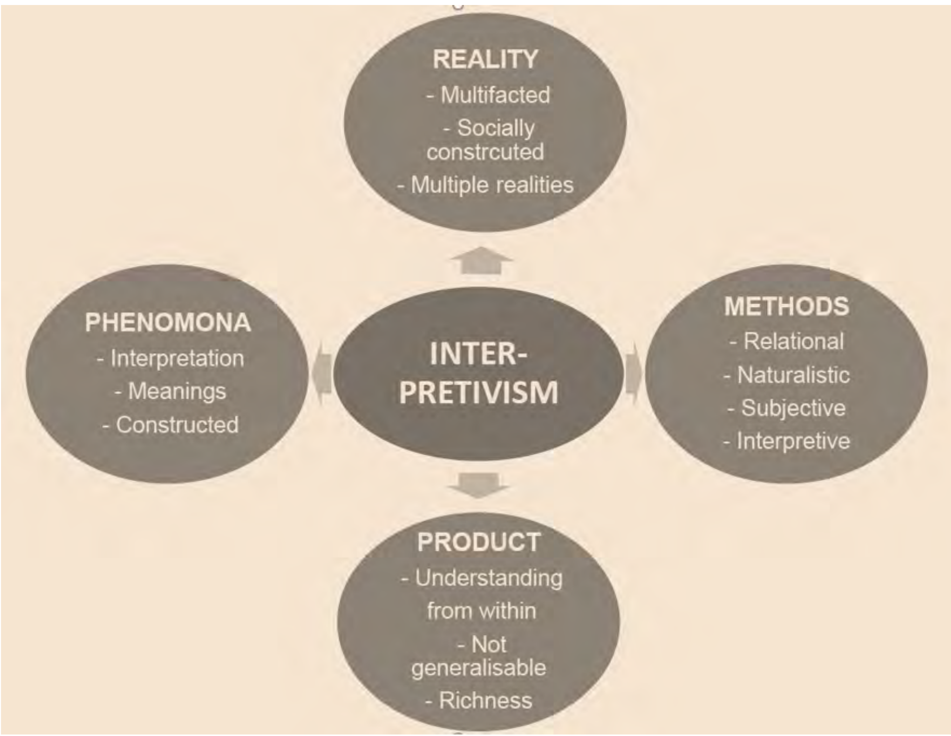

Figure 2-3: Main characteristics of Interpretivism as a philosophy (Maree, 2007)

This thesis has hence adopted the interpretivist approach, and defined interpretive research as:

The study of 'everyday life' by observation and interpretation focusing on how social reality is understood, theorized and experienced by people. There are social realities that can be studied using an interpretive method that can help us in ascertaining the way people make sense of their surroundings and social situations by means of interaction, experience, and reflective means as well as verbal and non-verbal communication with their meaningful actions (Becker & Niehaves, 2007).

With interpretivism as philosophy, the choice of research is inductive reasoning (Figure 2-2). According to Creswell and Creswell (2017), inductive reasoning is best suited to interpretivism and allows the researcher to move from a specific observed viewpoint to broader, general ideas or theories where patterns and themes are identified from the phenomena and tested, leading to the development of theories and conclusions.

2.4.1 Theories applicable to this study

Theories are important lenses to use in a study to understand, predict, and explain phenomena within boundaries (Sein, Thapa, Hatakka, & Sæbø, 2016). Therefore, two theories will be applied as lenses to explain the intersection between technology and society that use or apply the technology. These are the affordances and socio-technical systems theories.

2.4.1.1 Affordances theory

When one wants to investigate the adoption of IS systems within an organisation, where the focus is on work practices and features offered by the innovative use of the IS system, this theory is applicable (Aronin & Singleton, 2012). Wagman (2019) explains that affordance describes the action possibilities that can be allowed by the properties within an information system; it functions as a bridging concept to explain the intersection between IT systems and organisational systems. Thus, this theory examines how goal-oriented individuals interpret properties within information systems to produce changes in organisational practices (Sein et al., 2016). These changes enable outcomes that an organisation seeks to achieve its goals (Blin, 2016). Affordances refer to the individual level and the potential for action at a collective level within an organisation to help the organisation achieve its strategic goals (Aronin & Singleton, 2012).

According to Stendal, Thapa, and Lanamäki (2016) a network of social, technical and human objects involved in affordances and specific combinations of these objects can enable actions at different levels of granularity. Therefore, affordances arise from social practices that involve technology and are linked to the user's experiences, skills, and cultural understandings that are relational and situated (Thapa & Zheng, 2019). Therefore, affordances are relevant to the study of users with specific needs, goals, and practices in a particular historical, cultural, and social context

(Blin, 2016). It is suggested that affordances provide a way forward in developing conceptualizations of organisations in an era with a focus on ICT (Wagman, 2019; Sein et al., 2016).

This theory is applicable in this study as the participants all have experiences, skills, and goals that they want WoredaNet to achieve for Ethiopia to address the goals of this country and of WoredaNet as an organisation. The affordances theory is also related and can support the socio-technical systems theory.

2.4.1.2 Socio-technical systems theory

Trist in 1981 recorded this theory for the first time (Trist, 1981), and explained that two systems are involved. These systems are open, and there is a constant interplay between them: a social system (people, group processes, and shared work norms) and a technical system that incorporates tools and physical infrastructure to accomplish tasks in an organisation. In this theory, social and technical systems interact, are interdependent, and are mutually significant (Mumford, 1987). Thus, change in one system affects change in the other, and this theory postulates well within the ICT4D arena (Avgerou, 2017; Sein et al., 2016) — mainly as humans interact with an ICT system and can affect changes in these systems if their needs and requirements are met.

Socio-technical systems theory has continually acted as a conceptual framework to understand how ICTs are implemented in society and in organisations (Bourquard, Le Gall, & Cousin, 2015; Karam, Straus, Byers et al., 2018). Both the social and the technical entities in the system has to be investigated as they influence each other and adapt differently to change in their contexts. Amir and Kant (2018) refer to them as ‘hybrids’ and ‘social constructs’ that can affect how the system functions. As human’s knowledge change, their activity in their contexts, as well as their decision making, are affected. Therefore, the structures in society should be flexible to handle change (Amir & Kant, 2018).

This theory will influence the way in which participants perceive WoredaNet in Ethiopia as an ICT system. It will also highlight the way in which this system has influenced their daily working activities to support the society of Ethiopia better.

2.5 QUALITATIVE RESEARCH

In order to address the objectives of the study, a qualitative research approach was applied. This is because a framework of qualitative nature allows for detailed and in-depth study, by describing and analysing individual and collective social actions and perceptions of people to sufficiently decode, interpret and address the collected data from cultural, institutional and social contexts.

(Guba & Lincoln, 1994; Myers, 1997; Yin, 2003). Qualitative research was the most useful approach for studying the views and perceptions of people within the social contexts of the WoredaNet system; it allowed for data collection by interacting with people, which allowed an interpretive and naturalistic approach to investigate the diverse views of people onsite.

Several recent studies have provided various definitions for qualitative research. Leedy and Ormrod (2015) and Allen (2005), for example, define qualitative research as a fundamental technique in exploring people's values, beliefs, attitudes, and behaviours and discuss it as a naturalistic approach that facilitates an understanding of human experiences and processes in a specific context where researchers do not try to manipulate experiences of interest. Qualitative research is interactive and developmental, allowing for exploration of emerging issues; it emphasises experiences, interpretations and words instead of numbers. It is important to reflect and interpret people's understandings and meanings of social worlds, realities and past lives.

Creswell (2009) and Myers (1997) also define qualitative research as research that involves close contact between the researcher and participants in the study.

The working definition of qualitative research for this study was adapted from Lincoln, Denzin, and Lincoln (2005, p. 3), who indicate that qualitative research discovers the one who observes, and it entails various material and interpretive exercises that visualise the world. These exercises transform the world and turn the world into a series of representations where the data and information of these representations can be sourced from various sources, including interviews, photographs, conversations, and field notes. At this level, qualitative research involves an interpretive naturalistic approach to the world, which means that qualitative researchers study things in their innate context and interpret phenomena in terms of the meanings that people give them.

Thus, the qualitative research approach was preferred since it presents a valuable technique for providing a level of descriptive detail and depth that could have been impossible to achieve with other research methods, such as short closed-ended questions and surveys. In addition, the qualitative research was found with strengths such as: 1) allowing a wider degree of flexibility in research design; 2) avoiding reliance on pre-determined assumptions of a researcher; 3) enabling a focus on meanings of key issues in terms of perspectives and responses of participants for understanding the wider social context, such as views and experiences, including sensitive issues (Myers, 1997). Further, it was found to be the best form of research for answering the 'how' and 'why' research question types, which are likely to favour the use of case studies, experiments, or histories.

The qualitative research approach aspired to focus on the views of users, ICT professionals, and managers of data centres in order to evaluate and understand technology services as perceived by them, and also to rely on their opinion on views and perceptions of people about new services. This helped to examine and understand the social structures and institutional cultures of the Ethiopian government network domain, known as WoredaNet, from the perspective of views and perceptions of people on ICT-related issues in general, and Cloud Computing and its potential advantages to facilitating eGovernment services in particular, within the WoredaNet research context; the applicable research design and data collection techniques are explained below. As this is a qualitative exploratory study, it is important to explain the concept of exploratory research.

2.5.1 Exploratory research

When there are few or no earlier studies to refer to or rely upon to predict an outcome, and research problems are in a preliminary stage of the investigation, an exploratory design can be preferred or undertaken (Trochim & Donnelly, 2001; Yin, 2003; Yin, 2009). The focus here can be to gain an insight that can lead to other investigations, where the following insights can be produced:

- Theories or hypotheses can be developed tentatively;
- Refining issues through systematic investigations and new research questions can be formulated;
- Basic details, contexts, and concerns can become familiar;
- New ideas and assumptions can be generated;
- The feasibility of a future study can be determined;
- A logical picture of scenarios can develop; and
- Future research and techniques can be developed.

Exploratory studies are flexible and can address different types of research questions (when, where, etc.); it uses exploratory design, which can be a valuable method to gain background information on topics (Saunders et al., 2016). It is normally applied to develop more specific research problems. Studies that explore assist with prioritising research and allocating resources (Trochim & Donnelly, 2001).

In this thesis, exploratory research was applied to explore the literature on the phenomena that can inform framework development and use WoredaNet staff's feedback to refine the framework.

2.6 RESEARCH DESIGN

To understand the overall strategy that a researcher chooses for a study, a research design is necessary to coherently and logically identify the components of the study. This will ensure that research problems are effectively addressed, and it forms the blueprint for the data analysis, collection and measurement (Creswell & Creswell, 2017, p. 35). Based on the research experience gathered, the research questions can be sourced from the research problem. For example, in research design, sample sizes can be as small as one. The process of data collection may involve interview, observation, and/or archival (content) data (Myers, 1997).

2.6.1 Case Study Strategy

This research study adopted a case study strategy. It was chosen because it is the appropriate strategy in IS research to capture practitioners' knowledge and document participants' views, perceptions, and experiences of practice; furthermore, case study research has become an acceptable research strategy for IS research. (Klein & Myers, 1999; Myers, 1997; Yin, 2003). Yin (2003) argued that a case study strategy is a strategy employed to answer specific research questions in a given situation or natural context about projects, events, government, and other social situations, and also pointed out that the case study strategy is preferred where there is an intention of a comprehensive and in-depth examination of events, phenomena, or observation in a holistic manner in a real-life context. This thesis has aimed to examine agents of WoredaNet in accordance with their social contexts and conduct an in-depth examination of phenomena within WoredaNet's real-life context.

A case study approach can provide rare and specific cases and is the preferred choice to understand complex phenomena when contexts are analysed and where a researcher can apply various methodologies to investigate research problems (Flyvbjerg, 2006).

One can also distinguish between single and multiple case studies (Creswell & Creswell, 2017). This study applied a single case study, where the case was WoredaNet as a system in Ethiopia. Leedy and Ormrod (2015) indicate that a single case has unique qualities that can promote understanding or inform practice for similar situations. The three units of analysis within the single case study (Woreda) will be:

- The multiple sites (n=30 — see Figure 2-3) of WoredaNet;
- Various levels of management (top, middle and administrators) as participants (n=20), who ranked the components of every interim version of the theoretical framework (V1-3); and
- The 10 experts were interviewed to refine the theoretical framework to become the final framework.

Consequently, a case study was preferred by this research so that observation of views and perceptions of people in the WoredaNet with various scenarios sourced from different regional, federal, and Woreda (district) level PSOs could be effective with a case study strategy that allows for in-depth examinations of the socio-technical contexts of the WoredaNet.

Further, a case study strategy was preferred, as it was argued that the case study could provide an opportunity to the researcher to include himself in, and to obtain a better understanding of, general phenomena in WoredaNet's natural context. It allowed for systematic data collection, information analysis, and reporting of results from the case of regional and federal level data centres with distinctive backgrounds of agents and sites. It also helped in obtaining a variety of human perspectives to WoredaNet technology in general, and to Cloud Computing for facilitation of eGovernment services in particular, within the real and natural situation of the WoredaNet and its socio-technical environment (Yin, 2009).

The time horizon of this case study is cross-sectional rather than longitudinal, as the specific phenomena are observed as a 'snapshot-in-time', within time constraints (Saunders et al., 2016).

2.6.2 Case study site, participant selection, sampling

Given the aim of this thesis with its particular focus on Cloud Computing to facilitate eGovernment services in RCEs, the study had a specific interest in a variety of views and perceptions, including a description of activities for which people in a given PSO differentiate their approach to technology from people in another PSO. For this reason, the study was conducted in the major areas of WoredaNet, at federal, regional, and Woreda-level contexts.

Non-probability purposive sampling was the applicable sampling technique for selecting WoredaNet sites and participants (Oates, 2006). According to Creswell and Creswell (2017, p. 56), purposive sampling "selects individuals or sites (or documents or visual material) who will best help them understand the research problem and the research questions".

This research is conducted sites that were purposively selected from eleven data centres of regional government administration sectors (ICT agencies); eight organisational data centres ('back office DCs') of ministries, agencies, and other government offices that are located in the capital Addis Ababa; and eleven Local Woreda centres, for a total number of 30 sites (Figure 2-4).

The selected sites are:

1. Addis Ababa[e] (Capital City of Ethiopia); National Data Centre (NDC) - the heart of the WoredaNet, where all services are centrally coordinated, managed, and monitored. It is located in Addis Ababa, the capital of Ethiopia. This includes the Addis Ababa city administration Data centre, which is also located in the capital.
2. Tigray region; Mekelle Data Centre: the regional data centre of Tigray regional state, which is located 800 km north of the capital Addis Ababa.
3. Amhara region; Bahir Dar Data Centre: the regional data centre of Amhara regional state, which is located 600 Km North West of the capital Addis Ababa.
4. Oromia region; Finfine Data Centre: the regional data centre of Oromia regional state. It is located in the capital Addis Ababa.
5. SNNPR region; Hawassa Data Centre: the regional data centre of Southern Nations, Nationals and People's regional state, located 400 km south of the capital Addis Ababa.
6. Harari region, which is located 380 km from the capital Addis Ababa: Harar Data Centre.
7. Dire Dawa Region, which is located 346 km from the capital Addis Ababa: Dire Dawa Data centre.
8. Gambella region, which is located 466 km from the capital Addis Ababa: Gambella Data centre.
9. Benishangul Gumuz region: Assossa Data centre, which is located 476 km from the capital Addis Ababa.
10. Afar region, which is located 388 km from the capital Addis Ababa; Semera Data centre.
11. Somali region; Jigjiga Data centre, which is located 446 km from the capital Addis Ababa.
12. Eight ministries, agencies, and government offices with organisational data centres ('back office DCs'), which are located in the capital Addis Ababa.
13. Eleven Local Woreda centres selected from each of the 11 regions listed above (nr. 1–11).

[e]Addis Ababa is the capital city of Ethiopia. Ethiopia is governed by a type of federal administration and the country is administratively divided with 9 regional and 2 federal states with a total of 11 administrative divisions, each with its own local government administration sector. The 9 regions are named as: 1) Tigray region 2) Afar Region 3) Amhara Region 4) Oromia region 5) SNNPR region 6) Harrari region 7) Gambella region 8) Benishangul Gumuz and 9) Somali region while the 2 federal states are named as: 1) Addis Ababa and 2) Dire Dawa

Figure 2-4: Selected sites for the case study in Ethiopia (VUSSC, 2013)

Participant selection for interviews was guided by the objectives of the study, and more attention was given to those who comprehensive participated in WoredaNet ICT planning and development activities, specifically IT directors (policy and decision makers), including team leaders or IT managers, IT administrators (Network/system/security), and ICT professionals in the PSOs. The PSOs to which more focus was given were those who are the owners of main regional data centres (RDCs), and back office data centres (DCs of the PSOs of government offices) with a relatively significant influence on ICT policy and decision making, and administrative and technical activities.

Technical and administrative skills, experience, and knowledge were the most important selection criteria for participants' selection. Therefore, different IT professionals, managers, and directors at the technical and managerial levels were identified. Table 2-2 provides the regions and participants (n=20):

Table 2-2: Selected participants in the study

Participants					
Location	**Sites**	**Category**			**Experts**
		Top level management	**Middle level management**	**Lower level (technical staff)**	
Regional and federal government administration sectors (ICT agencies)	11	2 directors	2 middle level managers		4
Federal ministries, agencies, and government offices	8	6 directors	6 middle level managers	2 IT administrators	14
Local Woreda centres selected from each of the 11 regions	11	-	-	2 IT administrators	2
Total	30 Sites	8 top-level managers	8 middle level managers	4 low-level technical staff	20

Given the WoredaNet services and the research questions of this particular study, there were many underlying issues that this thesis sought to explore and that added value to the refinement of the various versions of the framework. This required an investigation to obtain answers from the various views and perceptions of participants such as: 1) practices of the use of WoredaNet services; 2) users' access preference to communication channels; 3) the diverse nature of the frequency of contact to services and service user types; 4) the service users' background experience levels and education types as well as the diversity of culture; 5) the social working behaviour, attitude, ethical standards, and religion of the service users; 6) the responsibilities of service users and their levels of involvement in an organisation's process; 7) the service users' styles or applications when approaching problem solving or public service provision; 8) the type and number of public services that are delivered to citizens by WoredaNet; and 9) the new services that are assumed to be needed by public servants. In terms of these aspects, the variations within WoredaNet ICT practices from one WoredaNet site can provide deeper insights into how the local structures can constrain and enable the different activities around the same technology artefact.

Blaikie (2005) describes that issues related to representativeness and generalizability need not be the major concern of a researcher; rather, the focus should be on appropriateness or reliability. This thesis thus considered the reliability of a case as more critical than the generalizability.

2.6.3 Data Collection Techniques

When considering validity in qualitative research, researchers apply various data collection techniques that can include focus groups interviews, observations and document reviews (Creswell

& Creswell, 2017; Marshall & Rossman, 2014). To reduce misinterpretation, this thesis employed multiple methods of data collection to achieve triangulation. This was necessary to understand the phenomenon in this study; it was also used to strengthen the study by combining data collection techniques (Klein & Myers, 1999).

The qualitative data collection techniques that were applied in this study were interviews, document analysis, and observation. Literature studies are also regarded as a data collection technique, and this will be discussed in Chapter 3 (see Section 3.3).

2.6.3.1 Interviews

When assessing participants' interpretations, interviews are essential for most interpretive studies (Walsham, 2006, p. 323). Semi-structured interviews were conducted, comprising in-depth discussions to obtain all relevant information on aspects of existing ICT-related issues, as well as issues related to Cloud Computing and eGovernment services. According to Creswell and Creswell (2017), interviewers in semi-structured interviews apply open-ended questions to elicit more information from the participant; a formalised list of questions is not always followed. The interviews were guided by the research questions, research aims, and objectives of this thesis as part of semi-structured interviews seeking more complete information. This could be achieved by allowing participants to respond more comfortably to obtain respondents' real views, perceptions, and experiences about this specific phenomenon under study.

This technique was preferred because the thesis was built on understanding views and perceptions of people, rather than on statistical comparisons among the statistical data. A researcher carrying out a study mainly through interviews, with physical involvement in action in the field as a participant, can gain the advantages of personal involvement such as in-depth investigation into people and related issues and enabling observation or participation in action (Walsham, 2006). In this research, face-to-face individual interviews were conducted with participants on-site in the WoredaNet context, in order to understand the views and perceptions of Cloud Computing for facilitating eGovernment services. The face-to-face interview approach was preferred for the purpose of understanding body gestures; further, personal presence reduces any fears of participating in interviews.

The interview sites were carefully selected to ensure quiet, private conversation spaces with minimal interference from external noise.

Before conducting the interviews, all participants were informed about the purpose of the study and their roles in the study; all respondents were also provided with consent forms in writing.

Confidentiality was guaranteed as all participants were assured that they could not be identified by real names during the documentation of the interviews, as all activities were conducted through the use of pseudonyms for real names. In addition, the participants were guaranteed that any personal user information (e.g., names, phone numbers, or addresses) would not be linked to the data collected from the participant; they were also guaranteed that their names would not be used for any other purposes. The participants had the opportunity to provide detailed responses.

Each interview was conducted for about an hour and a half, in a carefully selected site or the interview environment. The interviews were conducted in Amharic and English, and the Amharic part was translated into English. The types of questions involved technical and administrative aspects and were prepared in manners that are suitable to technical and managerial individuals. Directly after each interview was completed, essential observations were documented. Pencils and notebooks were used to write notes on what was observed from respondents' behaviour and from the actual sites; these observations were properly documented.

2.6.3.2 Document analysis

For reviewing or evaluating documents, document analysis is applied (Bowen, 2009). Through document analysis, one wants to comprehend the document by exploring elements in it (Creswell & Creswell, 2017).

Based on the qualitative approach, the data for this study were also sourced from both published and unpublished documentary evidence written in Amharic and English languages; these included: internal documents, reports, the organisation's publications, technical documents, and newspaper articles as well as reports of other information available in these documents that matched the questions to be asked (see Table 2-4).

More than 174 written documents were examined from various sources. To learn more about situations, people, or events being investigated, documents were gathered before and immediately after the study had begun. Cross-referencing of interview data was done with the documents gathered to support the case study conclusions.

Table 2-3: Documents used for data collection

Documents as data source		
Document as source of data	**Year**	**Source**
Office Documents	2002	Ministry of Finance and Economic Development (MOFED)f
Documents of the Ethiopian government network (WoredaNet)	2003	MOCB

Information and Communication Technology policy documents and strategies	2008-2009	Formerly named the Ethiopian ICT Development Agency (Ethiopian Information and Communication Technology Development Agency (EICTDA)), and then named MCIT, now becomes MiNT (Ministry of Innovation and Technology)
Project documents	2008-2009	Similar to above
Policy documents and project documents	2010-2017	Similar to above
Monthly and weekly management reports	2010-2017	Similar to above
	2008-2009	Similar to above

2.6.3.3 Observation

Marshall and Rossman (2014) indicate that the researcher will scrutinise a phenomenon without directly involving the participant when conducting observations. Observation involves the act of keeping track of certain events and taking notes of what is observed. Marshall and Rossman (2014) note that this approach allows the researcher to have an insider view on what is happening, and enables data to be collected at the point of occurrence.

In this study, the researcher applied observation and kept notes on incidents that might influence participant feedback. The notes were also coded in order to identify themes. These themes were then compared to the themes from the interviews and document analysis so as to refine version 1 of the framework.

2.6.3.4 Expert Reviews

With expert reviews, one can evaluate the usefulness of an artefact (framework) without including an end user (Carlsson, Henningsson, Hrastinski, & Keller, 2011). Expert reviews provide reasons why a framework is valid and useful, and this adds to its validation (Xiao & Mujumdar, 2017). This study applied expert reviews in Chapters 3, 4, and 5 to verify if the intended solution addresses the problem. The findings from the expert reviews helped to finalise the framework. Expert interviews were also done to develop the final framework; these are discussed in Chapter 6.

2.6.4 Data Analysis Techniques

During and after the process of data gathering, data should be analysed so as to fully comprehend what the findings indicate. A number of researchers identify different forms of data analysis, which commonly include descriptive statistics, hermeneutics, within-case analysis, cross-case analysis and content analysis (Abulad, 2007; Creswell & Creswell, 2017; Klein & Myers, 1999; Yin, 2009).

As Creswell and Creswell (2017) indicate in case studies, one can do either within-case analysis (the researcher searches for themes in the data collected from the various WoredaNet sites), cross-case analysis (data from various multiple case studies) and holistic case analysis (where the whole case is examined for interpretations) In this study both within-case analysis and holistic case analyses were applied to determine themes.

According to Klein and Myers (1999), interpretative research applies hermeneutics during analysis as a way to understand text-related data (Klein & Myers, 1999).

Abulad (2007) describes hermeneutics as the sculpture of interpretation (Abulad, 2007) that researchers and participants must draw.

Being an interpretive case study, the qualitative analysis was indispensable for obtaining different views and perceptions of participants about what the participants in WoredaNet have observed, experienced, and reported in documents on which notes could have been taken and coded, categorised, and compared for adherence to patterns. The analytical framework preferred by this thesis for qualitative data analysis was the open coding approach, which underpinned the triangulation of data. The open coding approach (through NVIVO 10)(NVIVO, 2017) was preferred because it enabled the analysis of interview, observation and expert review transcripts. Table 2-5 depicts the steps followed during the coding process. It also presents a summary of the validity and results of the study.

Table 2-4: Steps in the coding process

Coding process	Electronically through applying Nvivo 10
Steps	Recorded interviews were transcribed Transcribed interview responses were carefully examined, searching for regularities Printed data of interview transcripts and notes taken during observation were transferred into Nvivo 10 A number of codes were listed under the data categories Patterns and relationships were established using data categories The data were aggregated into core concepts The number of themes was identified Patterns and relationships were established using aggregated data categories Triangulation was used to bring together multiple data sources
Validity	The researcher recognises the reliability of the research based on the subjective nature of qualitative research The recorded interview transcripts add to the validity of the research findings and conclusions Nvivo 10 was used for coding Triangulation was used for validity to assess bias or potential other problems The use of pattern matching and explanation building addressed the issue of internal validity

The data analysis consisted of a number of steps, including identifying, coding, and categorizing patterns found in the data, through the analysis that underpinned data triangulation; the various steps are discussed below. The data analysis in this study was started before the data collection process was completed. Data collection and data analysis were thus conducted in parallel.

First, all the recorded interviews (10 recorded interviews) were transcribed in MS Word and repeatedly and carefully read. The primary and preliminary stage of the data analysis was to write down notes on data collected from interviews and observations which, according to Borrego, Douglas, and Amelink (2009) are termed 'cooked notes'.

The cooked notes helped to draw attention to what was important in the data, and also helped when transferring the information to Nvivo 10. This assisted in developing themes. Coding or labels are a concise or more descriptive way of developing new thinking about data. (Williamson & Johanson, 2013), discussed that research studies use coding for the identification of smaller categories.

Effort was made to ensure that each of the coding categories answered the research question in some way.

The reviewed literature revealed that, for an interpretive qualitative study, comparisons and contrasts between patterns of categorized data help to obtain meaningful information (Yin, 2003).

For effective data management at the interview recording stage, the following basic requirements were applied:

- Data was recorded promptly;
- Data was made available for duplication;
- Data was made available for coding;
- Coded categories were made accessible (Nvivo 10) for examination and analysis; and
- Data was made accessible for revised coding, because coding categories could have emerged and been revised over time.

In general, the result of the analysis of data gathered via interviews enabled the attainment of outcomes that have connections, and to look for patterns. It also provided guidelines and frameworks for expressing the findings from the analysis which assisted to create, modify, discard, or confirm these models.

2.7 TRIANGULATION IN THIS STUDY

Different authors refer to various approaches that a researcher can employ to address rigour, quality, and trustworthiness in qualitative studies. In general, the validity of research and dependability can be considered research reliability (Rolfe, 2006; Trochim & Donnelly, 2001). Triangulation is a research strategy that ensures validity by identifying convergence among multiple methods and data sources that can form themes in a study. Triangulation is a widely applicable approach for qualitative studies as a procedure for ensuring research validity, where a researcher explores to identify convergence among multiple methods and data sources to develop themes in a study (Creswell & Miller, 2000; Farmer, Robinson, Elliott, & Eyles, 2006).

In order to provide more credibility for research findings, different forms of triangulation can be adopted. Based on the explanations provided by Yin (2009), the following forms of triangulation are applicable (Denzin, 1970):

Data triangulation: supports the process of gathering data via several techniques so that data were gathered on a variety views and perceptions of people. In the process of data gathering, this thesis used primary data sources such as expert reviews, interviews, observation, and document analysis from a secondary data source (literature review).

Theory triangulation: refers to the use of various theories as lenses to view the results of the study. In this study, two theories were applied: affordances and socio-technical systems theory.

Borrego et al. (2009) discussed that triangulating data adds to the validity and scalability of qualitative research. The comparison of data reduces the bias of data as well as its potential problems. Triangulating data allows for insightful interpretations.

Figure 2-5 summarises how coding and triangulation assisted in addressing the research objectives:

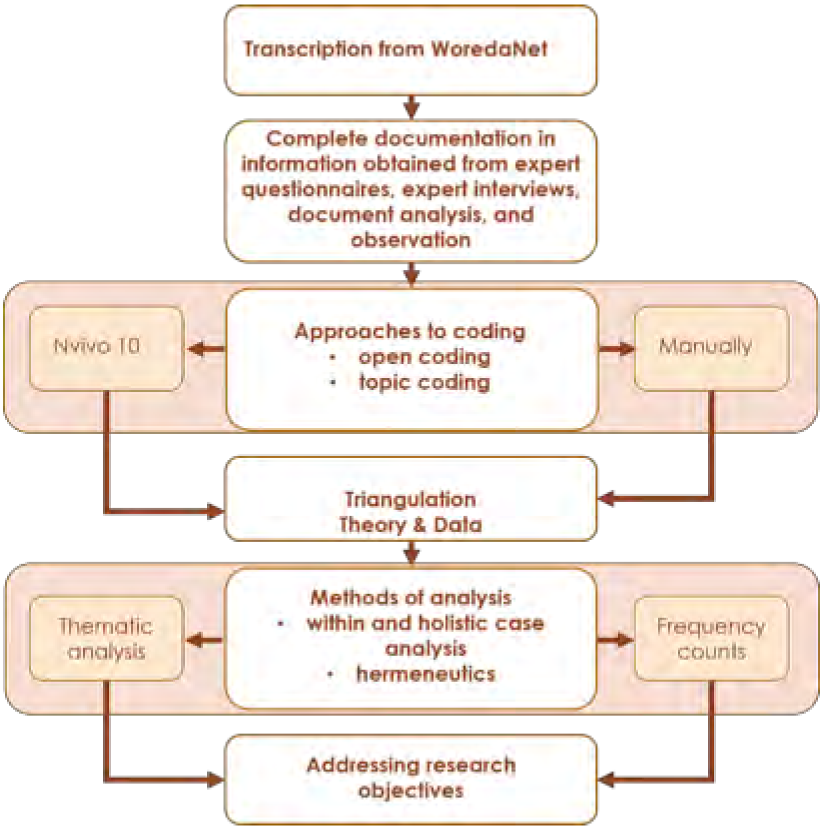

Figure 2-5: Coding and triangulation

2.8 ETHICAL CONSIDERATIONS AND TRUSTWORTHINESS

This research is compatible with UNISA's ethical requirements; ethical approval was received (see Appendix J).

In terms of research ethics, the following issues are important to address (Marshall & Rossman, 2014):

Confidentiality: Confidentiality was guaranteed in the process of data collection, as participants were guaranteed that they could not be identified by name in the write-up. They were briefed that all activities would be conducted through the use of pseudonyms for real names.

Formal permission: Before commencing the fieldwork, ethics approval was obtained from UNISA as well as from WoredaNet (Ethiopian government).

Consent forms: All participants had to sign the informed consent forms, by which they were informed about anonymity, that they voluntarily take part in the study, and that they will not be remunerated. They could also withdraw from the study at any time and without giving a reason.

Relevant literature shows that, while validity and reliability in scientific research require precise measurement, there are still no such absolute rigorous measures in a qualitative study; the study under investigation focused on trustworthiness of findings to ensure the reality and credibility of those findings with the highest degree of in-depth analysis (VUSSC, 2013).

The principles of Klein and Myers (See Table 2-6), offered for interpretive field research, were followed to evaluate this study that is hermeneutic; these were adopted to ensure the trustworthiness of the research findings (Klein & Myers, 1999).

Table 2-5: Summary of principles for evaluation of Interpretive Field Research (Klein and Myers 1999c,p.72)

#	Principles	Description
1	The Fundamental Principle of the Hermeneutic Circle	This principle suggests that all human understanding is achieved through iterative consideration of the interdependent significance of the parts and the whole they form. This principle of human understanding is fundamental to all other principles.
2	The Principle of Contextualization	Requires critical reflection on the historical and social background of the research context so that the target audience can see how the situation under study came about.
3	The Principle of Interaction Between the Researchers and the Subjects.	Requires critical reflection on how research materials (or "data") have been socially constructed through interaction between researchers and participants.
4	The Principle of Abstraction and Generalization	Requires linking the details revealed by data interpretation, through the application of principles one and two, to theoretical, general concepts describing the nature of human understanding and social action.
5	The Principle of Dialogical Reasoning	Requires sensitivity to possible contradictions between the theoretical assumptions guiding the research design and the actual results ("the story the data tell") with subsequent cycles of revision.
6	The Principle of Multiple Interpretations	Requires sensitivity to possible differences in participants' interpretations, as typically expressed in multiple narratives or stories about the same sequence of events under investigation. It is similar to multiple testimonies, even if all tell it as they saw it.
7	The Principle of Suspicion	Requires sensitivity to possible "bias" and systematic "distortion" in the narratives elicited from participants.

Four test techniques, with concepts that include trustworthiness, credibility, conformability, and data dependability, are suggested by Yin (2003) and adopted by this thesis to establish the quality of the case study and the entire research.

In this thesis, the triangulation of multiple sources was comparable with the quality tests suggested by Yin (2003) for social research, that is also relevant to case studies. The result of the qualitative analysis in this thesis was compared with the literature and to the theoretical framework being tested. Construct validity tests were confirmed by using the triangulation of multiple sources of evidence; this helped to address the critiques of subjectivism in a case study. A clear description of the general methods was provided to further validate the research. Issues of internal validity were addressed by the use of pattern matching and explanation building. The researcher recognised the reliability of the qualitative research, as qualitative research is by nature subjective — demonstrating that the data collection procedures applied by this thesis can further be repeated by other researchers of the topic of interest.

2.9 LIMITATION OF THE STUDY

The interpretive case study of this qualitative research is based on the researchers gaining an understanding of the meaning of theory in a social context. However, the research is based on the understanding and views of 30 participants.

Due to time and resource constraints, this study had been conducted at a specific set of sites. The data centres (sites) were selected from regional level government administration sectors that included eleven organisational data centres of various government administration sectors ('back office DCs' of federal PSOs), Woreda Centres of regional sectors, legal court system (e-trial), and e-trial education centres, while the analyses mainly depended on documented/reports on or from the National Data Centre (the command post of the WoredaNet network) and MCIT.

Although a framework for Cloud Computing in RCEs to facilitate eGovernment services in the Ethiopian context was provided, this thesis recognises that there were limitations to the study, which required further research on the topic of interest. This study was limited with respect to the focus on specific Woreda sites, as well as specific selected participants at these sites. Further, the study only focused on Ethiopia and did not include other countries. However, it can be assumed that the researcher did include all necessary concepts and components in the theoretical framework through literature reviews.

2.10 DEFINING A FRAMEWORK

Hassan (2014) definition of a framework will be applied in this study which indicates that a framework acts as the map for the researcher to indicate the important concepts and constructs, and how these relate to one another.

More detail on the definition of a theoretical framework will be provided in Chapter 6 (Section 6.2).

2.11 TRUSTWORTHINESS

According to Morse and Richards (2002), trustworthiness is concerned with the accuracy of the collected data. In qualitative research, two issues are primarily considered in this regard: credibility, which is the ability of the study findings to fit into a given theoretical framework, and transferability, which is the ability to generalise the findings from the study (Guba & Lincoln, 1989). Credibility in this study was attained by ensuring that the derived codes were extracted from the literature and checked against the themes. The expert opinions on each version of the interim theoretical framework matched the suitable themes that were found after coding. Leedy and Ormrod (2015) also indicate that trustworthiness is evident when triangulation is applied and experts are requested to interpret data.

2.12 CONTRIBUTION OF THIS STUDY

This research is relevant and contributes to developing a framework for Cloud Computing in RCEs to facilitate government services in Ethiopia. This is a practical contribution to the body of knowledge in Cloud Computing and eGovernment services in general and can be applied in developing contexts to improve access to government services.

Extant literature reviews were done (and summarised in three chapters) to develop this framework; it was critically reviewed by experts for inputs and refinement. The two theories (affordances and socio-technical systems) that will be applied also provides a strong theoretical contribution.

Finally, this thesis confirmed that the findings from the analysis of interview data and notes on observations serve as a baseline that could be used as a reference for scholarly materials in future studies. This would be especially relevant to studies that relate to policy development and decision making; in improving planning activities, goal setting and resource allocation; in examining the contributions of e-governance practices by executives of federal and state agencies in Ethiopia; or in making the Ethiopian government more accessible while portraying areas that have not been fully exploited in terms of eGovernment development.

2.13 CHAPTER SUMMARY

This chapter presented the research questions and research objectives as well as their relationships and explained the research design.

The interpretivist research paradigm was selected, and a qualitative research approach was adopted for data collection and analysis in the first, second, and third phases of the theoretical development of the research. This chapter also presented the use of a case study as the main methodology, which was mainly supplemented by qualitative data collection techniques.

The hermeneutics and qualitative analysis used by the research was further presented as a means of analysing findings. The triangulation approach, as well as the ethical considerations, were outlined.

Table 2-6 summarises the research design, which was based on the research onion of Saunders, Lewis, and Thornhill (2009).

Table 2-6 Summary of research design, based on the research process onion

	Available choices	**Preferred by this Study**	**Reason for preference**	**Application to this study**
Research Philosophy	Interpretivism, Positivism, Objectivism	Interpretivism As an interpretive research of a hermeneutic nature	Interpretivism can facilitate an understanding of views and perceptions of people and their action in social and organisational contexts; it can facilitate deep insights into phenomena of information systems, including Cloud Computing	To understand the diverse views and interpretations of people in same or different regions, capital city or district/Woreda within WoredaNet regarding the same technology artefact
Research Approach	Inductive, Deductive, Abductive	Inductive research	Inductive research allows for starting the study from observations and data collection	Applied during data collection and analysis (coding process)
Research Type/method	Qualitative research, Quantitative research	Qualitative research	Qualitative research facilitates interviewing and observing participants to learn about their cultural and social contexts	Applied in the case study to collect data by interacting with people and interviewing them in an interpretive and naturalistic approach, and to investigate the diverse views of people on site
Research Design and Development				
Research Strategies	Action research, Experimental, Case study Survey, Ethnography, Grounded Theory	Case study strategy	In IS research using a case study is an accecptable and valid strategy, because case study use have developed methodological principles that can constantly be used in	Applied to refine the Version 1 of the framework. During document analysis, perceptions and experiences of people in the WoredaNet were examined within their social contexts, an in-

	Available choices	Preferred by this Study	Reason for preference	Application to this study
			all case studies (Klein & Myers, 1999)	depth examination of this phenomena within the real-life context of the WoredaNet was undertaken.
Research approaches	Mono methods, Mixed methods, Multi-method	Mono method	Use a case study to develop a high-level interretation framework to generate solutions or new comprehensions of the problem (Tashakkori & Creswell, 2007).	To understand the problems in WoredaNet and formulate a framework for Cloud Computing for facilitating eGovernment services in RCEs
Research technique (Kwofie)				
Data collection	Qualitative: Participant observation, Semi-structured interviews, Content analysis of documents	Qualitative data, with semi-structured interviews, including published and unpublished documentaries	Questionnaires, interviews, observation, fieldwork, and documents are regarded as some of the qualitative data sources (Myers, 1997)	To unravel and interpret data obtained in social, cultural and institutional contexts of WoredaNet, and to describe and analyse people's actions and perceptions of the WoredaNet system, the concepts of Cloud Computing, and eGovernment services
Data Analysis				
Analysis	Quantitative: Descriptive, Association, Causation, Inférence; Qualitative: Descriptive, Content analysis, Narrative analysis, Hermeneutics, within-, cross- and holistic case analyses	Qualitative data analysis	Adding objectivity, validity, and reliability to results.	Applied holistic and within-case analysis, hermeneutics, and triangulation to refine and improve the framework.
Coding process	Computer program aided, Manual	Nvivo 10 (NVIVO, 2017)	Enables interpretation of humans views and responses	Applied computer program (Nvivo 10) as coding mechanism for identification of themes

The following chapter provides the literature study where a scoping review, with rigorous methodology, was applied to identify the components and concepts of state of the art of Cloud Computing. It thus provides the first phase of the literature review, namely, a scoping review on Cloud Computing, and disseminates outcomes in tabular and a narrative form.

CHAPTER 3 SCOPING REVIEW: CLOUD COMPUTING

3.1 OVERVIEW OF THE LITERATURE REVIEW CHAPTERS

This thesis includes three separate literature review chapters, each with a different focus area. Figure 3-1 highlights the three focus areas, covered in Chapters 3, 4, and 5, respectively. This chapter provides a general outline and the first literature review: *A scoping review on Cloud Computing*.

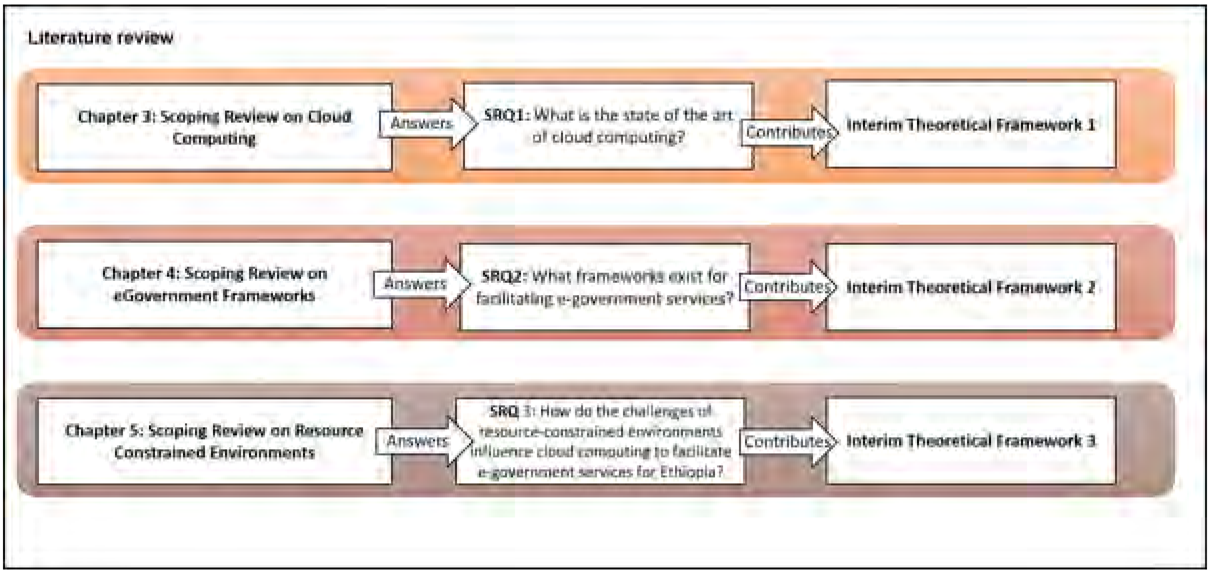

Figure 3-1: Three literature reviews addressing the RQs and contributions of each

3.2 PREFERRED LITERATURE REVIEW

A literature review can be conducted for various purposes, including: to create a firm foundation for the topic and research problem; to identify research gaps; to develop research methodologies, models, and frameworks for a study; and to provide recommendations for future research that can contribute to the existing body of knowledge (Grant & Booth, 2009; Levy & Ellis, 2006; Okoli & Schabram, 2010).

A literature review should not simply list what has been read or merely present a collection of summaries of existing published literature. It should clearly show why the research is needed, and should be structured by reviewing the valuable aspects of the literature. (Walsham, 2006, p. 327) suggested that “The literature review should not be a listing of what you have read from others on the topic. It should be a structured review of interesting aspects of the literature, but showing why your paper is needed”.

Okoli and Schabram (2010) indicate that literature reviews include the activities of summarizing existence evidence, identifying gaps in current research, and providing a framework. In this context, a literature review can provide a better understanding of what is already known and enable the establishment of the purpose and significance of the research and its contribution to existing knowledge (Levy & Ellis, 2006; Okoli & Schabram, 2010).

According to Levy and Ellis (2006), a literature review can be effective if it can possess the characteristics of: a) analysing and synthesizing quality literature methodologically; b) offering a strong foundation to the topic of a research; c) delivering a strong foundation to the selection of research methodology; and d) demonstrating the contribution of the proposed research to the overall body of knowledge.

A number of writers have mentioned different purposes of a literature review, including:

- Offering a theoretical background;
- Identifying research gaps;
- Helping to deeply understand the research on a topic of interest;
- Helping to understand what has been done by existing research and answering the research questions;
- Developing research methodologies, models, and frameworks; and
- Providing recommendations for future research that can contribute to the existing body of knowledge.

Based on the purpose of the research and its goals, different types of literature reviews can be undertaken. Research of various disciplines may thus follow different literature review approaches. These include, for example, a systematic literature review and a scoping review (Okoli & Schabram, 2010).

A scoping review, as described by Grant and Booth (2009, p. 95), is a "preliminary assessment of potential size and scope of available research literature that aims to identify nature and extent of research evidence (usually including ongoing research)". Okoli and Schabram (2010) argue that scoping reviews classify and compare studies that focus on the same general subject of interest. This is in contrast to other literature review types, which investigate the literature to answer a specific research question.

A scoping review has much similarity to a systematic literature review. However, comparisons between the two review types may enable an understanding of the vital components that can be extracted from the review types, or to select the one that can fit the required purpose. The differences between the two types of literature reviews are outlined in Table 3-1, by adapting from Grant and Booth (2009).

Table 3-1 **Difference between a systematic and scoping literature review (Grant and Booth 2009)**

Systematic review	**Scoping review**
Seeks to systematically search for, appraise, and synthesise research evidence, often adhering to guidelines on the conduct of a review.	Preliminary assessment of potential size and scope of available research literature. Aims to identify the nature and extent of research evidence (usually including ongoing research).
Search: aims for exhaustive, comprehensive searching.	Search: completeness of search determined by time/scope constraints. May include research in progress.
Appraisal: may or may not include quality assessment.	Appraisal: no formal quality assessment.
Synthesis: minimal narrative, tabular summary of studies.	Synthesis: typically tabular, with some narrative commentary.
Analysis: what is known; recommendations for practice.	Analysis: characterizes quantity and quality of literature, perhaps by study design and other key features. Attempts to specify a viable review.

Given this discussion, a scoping review, with the methodological rigour adopted from a systematic review, is considered an appropriate approach for this thesis. It meets the requirements of searching for relevant literature on the topic and providing general information related to frameworks for Cloud Computing. This approach thus best fits the objectives of this thesis, as it is more appropriate for analysing and synthesizing existing literature on a particular topic such as Cloud Computing and for identifying gaps in existing research.

3.2.1 For a scoping review, conducting a systematic review protocol

Eight crucial steps are applied to conduct a systematic literature review (Okoli & Schabram, 2010) that include 1) the *purpose of the review* where researchers need to maintain clear aims and objectives to manage their reviews that they communicate to readers. 2) *Training and protocol* are needed when reviews involve more than one person to ensure conformity of understanding. 3) *When searching for the literature,* present a process that contains the details of the searches. 4) *Practical screening* where a reviewer develops criteria to indicate what literature to exclude and include which literature to include and exclude and justify how the excluded literature will not compromise the review quality. 5) *Quality appraisal* should be added that adhere to criteria of quality for the included and excluded literature from supporting credibility (Hart, 1998). 6) *Extracting relevant data* after the inclusion of the selected literature 7) *Synthesis of studies* where the analysis of the information from literature is done either by using qualitative, quantitative or both methods. 8) *Writing the review* where writing up the final review focuses on detail to replicate the outcomes.

3.2.2 Literature sources and study exclusion criteria

The use of UNISA's library assisted in conducting the literature reviews in this study as it subscribes to several online journals. The databases that were consulted are: IEEE Xplore, Scopus, Web of Science, Wiley Online Library, Information Systems Research, MIS (Management Information systems) Quarterly and INFORMS.

To retrieve relevant information, keywords and phrases were applied as summarised in Table 3-2.

Table 3-2: Summary of search criteria for each chapter in the literature review.

Topic	**Chapters**		
	Chapter 3:	**Chapter 4:**	**Chapter 5:**
	Literature review: a scoping review on Cloud Computing	**Scoping review: eGovernment frameworks**	**Conceptualizing resource-constrained digital environments**
Keywords	Theoretical frameworks, Cloud Computing, public cloud, community cloud, hybrid cloud, software-as-a-service, infrastructure-as-a-service, platform-as-a-service	Theoretical frameworks, eGovernment, electronic service, government cloud	Resource-Constrained digital environments, public service, electronic service, government cloud
Keyword searches	"Cloud Computing", "frameworks of Cloud Computing", "components of Cloud Computing", "state of the art of Cloud Computing", and "components of state of the art of Cloud Computing"	"eGovernment"; "eGovernment services"; "components of eGovernment services"; "Cloud Computing and eGovernment services"; "framework for facilitating eGovernment services"; "characteristics of eGovernment services"; "advantages and challenges of eGovernment services"; "technologies of eGovernment"	"resource-constrained digital environments"; "resource-constrained digital environments and their challenges for Cloud Computing"; "resource-constrained digital environments and their challenges for Cloud Computing and eGovernment services"; "resource-constrained digital environments and their challenges for facilitating eGovernment services"
Literature review method	Scoping review, with the methodological rigour adopted from a systematic review	Scoping review, with the methodological rigour adopted from a systematic review	Scoping review, with the methodological rigour adopted from a systematic review
Databases used	UNISA Institutional repositories, IEEE xplore, ScienceDirect, ProQuest, ACM, and SCOPUS	UNISA Institutional repositories, IEEE xplore, ScienceDirect, ProQuest, ACM, and SCOPUS	UNISA Institutional repositories, IEEE xplore, ScienceDirect, ProQuest, ACM, and SCOPUS
Inclusion and exclusion principles	Inclusion: Publications written in both English and local Amharic languages; Studies referring to the components of Cloud Computing; Studies referring to the components of the state of the art of Cloud Computing;	Inclusion: Publications written in English; Studies within eGovernment and/or eGovernment services; Studies on technologies of eGovernment in a particular context; Studies on Cloud Computing, particularly related to	Inclusion: Publications written both in English and Amharic (Local language); Studies within the general resource-constrained digital environments; Studies within Cloud Computing regarding resource-constrained digital environments (only if the work

Topic	Chapters		
	Chapter 3:	**Chapter 4:**	**Chapter 5:**
	Literature review: a scoping review on Cloud Computing	**Scoping review: eGovernment frameworks**	**Conceptualizing resource-constrained digital environments**
	Studies referring to what constitutes Cloud Computing and state of the art of Cloud Computing; Studies in which technologies are indicated as components or elements relating to Cloud Computing and state of the art of Cloud Computing. Exclusion: Publications written in a language other than English; Studies outside the Cloud Computing domain; Publications without clearly stated publication date; Studies focusing on only very specific or particular Cloud Computing models, or focusing on a particular research field of study; Studies whose research questions differ from the questions of this thesis	eGovernment and/or eGovernment services; Studies conducted on the advantages of eGovernment and/or eGovernment services; Studies conducted on challenges and/or risks of eGovernment and/or eGovernment services. Exclusion: Studies that refer to a very specific context.	is related to resource-constrained digital environments); Studies within eGovernment services regarding resource-constrained digital environments (only if the work is related to resource-constrained digital environments); Studies regarding challenges that the resource-constrained digital environments may pose. Exclusion: Studies that did not refer to a specific context.
Number of papers used	63	69	39

3.2.3 Searching the literature

Well-cited and relevant articles regarding *Cloud Computing and resource-constrained environments* were identified in academic journals, as indicated in Table 3-2. As per the year of publication, articles from 2000 to 2018 were included. Older articles were only included if they were viewed often or highly cited by other publishing researchers.

3.2.4 Data analysis and selection

Figure 3-2 depicts the interactiveness and flow of information found in scoping reviews.

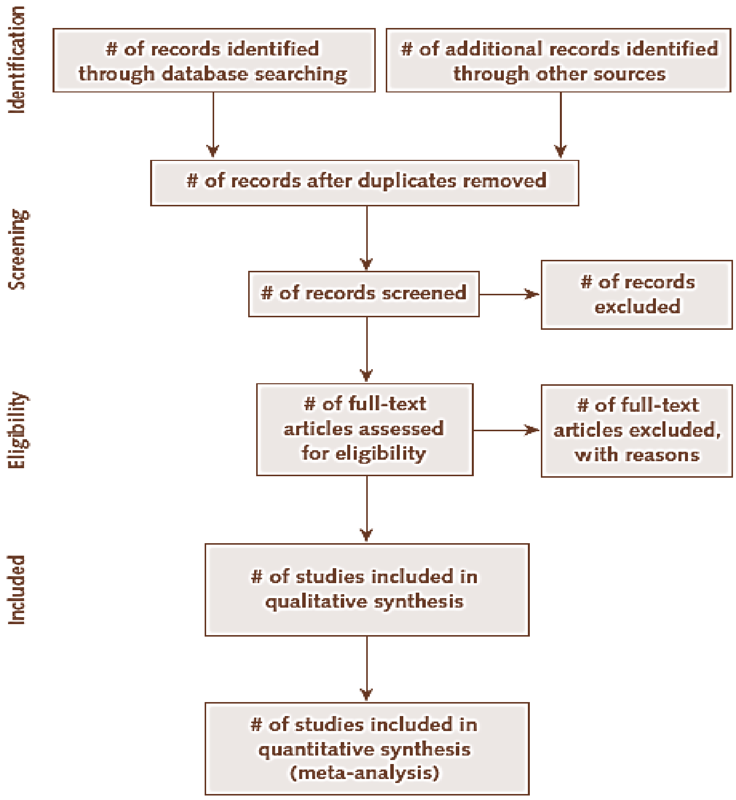

Figure 3-2: Information flow through different phases of a systematic review (David et al., 2009).

The above-explained general process was used in this study for every literature review (Chapter 3 to 5) to provide a narrative towards the creation of a theoretical framework to guide subsequent research (Okoli & Schabram, 2010). A systematic literature review was used to collect and evaluate relevant papers on the topic. The systematic approach enabled the aim of this research process (Seuring & Mueller, 2008), namely to contribute to the existing literature (Okoli & Schabram, 2010).

The application of the scoping review, with the rigorous methodology adopted from a systematic review, identifies the components, concepts, and state of the art of Cloud Computing.

3.2.5 Literature Sources

Various academic databases were searched for this application of a scoping literature review to provide a comprehensive overview of the concepts of Cloud Computing.

In order to select various research fields that are closely related to the research questions, the thesis has sourced previous research papers using online tools and sources such as the UNISA Institutional repositories and databases (IEE Explorer, ScienceDirect, ProQuest, ACM, and

SCOPUS). Google Scholar, hard copy texts, and suggestions from the researcher's advisors were also used to ensure that relevant literature was not omitted from the review.

Chapter 3 aims to answer the first sub-research question (SRQ 1): *What is the state of the art of Cloud Computing?* It identifies the components of Cloud Computing that can be used for the development of the proposed Theoretical Framework of Version 1 of the *Framework for Cloud Computing in RCEs Facilitating eGovernment Services,* which will be presented in Chapter 6.

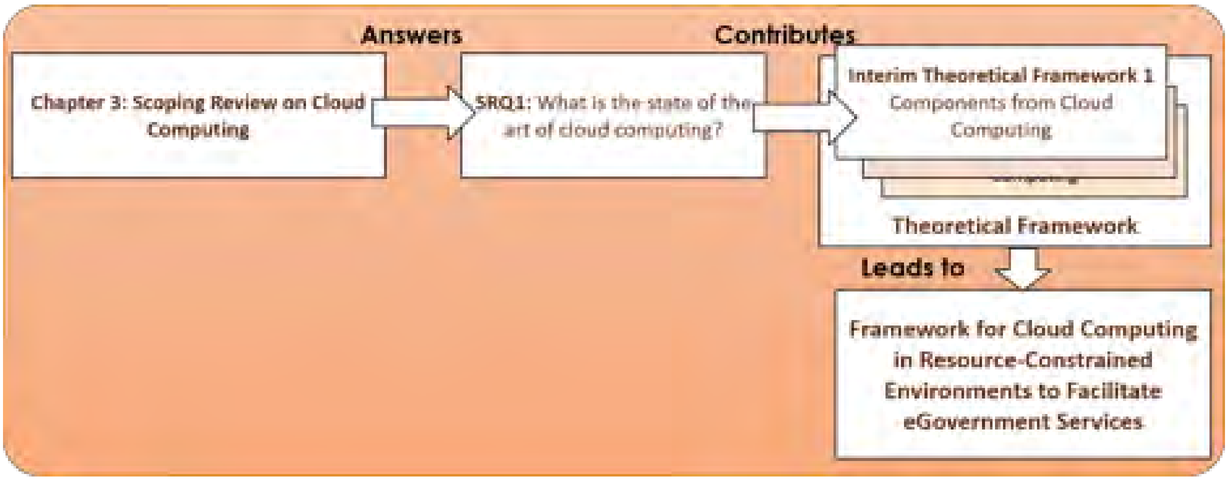

Figure 3-3: Chapter 3 Literature Review on Cloud Computing

3.3 OVERVIEW OF CHAPTER 3

The sub-sections of Chapter 3 are indicated in Table 3-3:

Table 3-3: An outline of the sub-sections of Chapter 3 (Source: the researcher)

Chapter	Sub-Section	Focus area
Chapter 3	3.1	Provides an overview on the literature review chapters
	3.2	Provides an overview of Chapter 3
	3.3	Presents the value of the literature review presented in this chapter
	3.4	Discusses selected literature review types
	3.5	Presents sources that were searched to identify relevant literature
	3.6	Presents the techniques followed by this thesis for searching relevant literature
	3.7	Discusses the inclusion and exclusion criteria that were followed by this chapter for identifying the most relevant literature for this thesis
	3.8	Discusses data analysis
	3.9	Introduces Cloud Computing
	3.10	Outlines the characteristics of Cloud Computing
	3.11	Summarises previous research findings and structures the vital components of Cloud Computing,
	3.12	Presents the evaluation approach
	3.13	Presents conclusions for Chapter 3

3.4 THE VALUE OF A LITERATURE REVIEW

The findings of this chapter contribute towards the development of an interim theoretical framework (Version 1) for Cloud Computing for facilitating eGovernment services in RCEs.

The particular contributions of the findings of this chapter are to:

- Provide a firm foundation for the topic, the research question, the theoretical framework, and the method to be used;
- Provide background information and help to understand the existing body of knowledge regarding Cloud Computing;
- Answer the main research question as well as the first sub-research question;
- Provide recommendations for future research and contribute to the existing body of knowledge; and
- Develop research methodologies, models, and a framework for this study.

3.4.1 Searching the literature

An online search was conducted of literature published between 2010 and 2018, using the search terms: “Cloud Computing”, “Frameworks of Cloud Computing”, “Components of Cloud Computing”, “State of the art of Cloud Computing”, and “Components of State of the art of Cloud Computing”. This resulted in the identification of 1187 research papers. More detail on the inclusion criteria, exclusion criteria, databases used, and keywords used to select articles in the scoping review can be found in Table 3-2.

3.4.2 Data analysis and selection

The 1187 publications that were retrieved from the online search were submitted to a process of identification -> screening -> eligibility -> inclusion, as adopted from *the PRISMA statement for reporting systematic reviews and meta-analyses* (see Figure 3-4).

To identify relevant components of the state of the art of Cloud Computing, and to answer the first sub-research question (*What is the state of the art of Cloud Computing?*), the review included studies in which Cloud Computing definitions, concepts, characteristics, and models are widely discussed, and in which outline the state of the art of Cloud Computing technologies. The review excluded studies that focus on one particular section of Cloud Computing, such as Platform as a Service (PaaS), which does not cover the essential aspects and components of Cloud Computing. The review also excluded studies that focus only on a particular field such as Accounting, Auditing, or Social Commerce, or on a particular area of application, such as schools or hospitals.

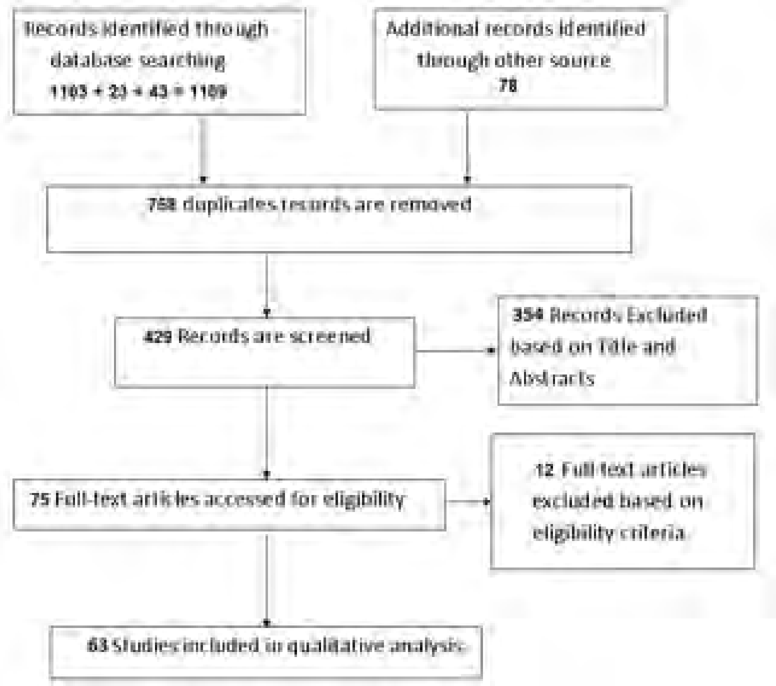

Figure 3-4: Identification and Screening Process Adapted from Liberati, Altman, Tetzlaff et al. (2009)

Table 3-4 provide the details pertaining to the articles that were excluded, with reasons for the exclusion:

Table 3-4: The 12 Full-text articles excluded and reasons for exclusion

Reference	Focus	Reason for exclusion
(Song, 2017)	European laws in the Cloud Computing industry; interoperability in Cloud Computing	It is based on the European context and focuses only on one particular research field of study (laws)
(Han & Trimi, 2017)	Social commerce business model as a subset of e-commerce, social media, Web 2.0, Cloud Computing, and service-oriented architecture.	The proposed framework, namely, the social commerce framework, is not closely related to this study
(Cura, Perret, & Paparoditis, 2017)	Data management in Point Cloud Geographical Information System (GIS)	Point Cloud and the GIS concept is not significantly related to the topic of interest
(Dey, 2016)	Audit and integrity of the Cloud	A particular area known as "audit" is focused on
(Wahid, Jenni, Mandala, & Supriyanto, 2015)	P2P video streaming in Cloud Computing and e-learning	Only P2P is focused on, particularly in video streaming
(Durillo, 2015)	State-of-the-art meta-heuristic	Customization of new algorithms, which is not the intent of this thesis
(Zhou, Yin, Li, & Wu, 2017)	Cloud-radio Access Network (C-RAN)	This is about a natural auction for inter-operator resource sharing, and bids a capacitated sub-network of the C-RAN (auction and bid become very specific)

Reference	Focus	Reason for exclusion
(Thangapandiyan & Anand, 2016)	Trust as a Service (TaaS)	Very specific and out of the scope of this thesis
(Michona, Gossa, Genauda et al., 2016)	A broker of IaaS cloud resources	The proposed automatic tool, named Schlouder, which is considered as a broker of IaaS resources for online provision and scheduling, is not related to the topic of interest
(Qasha, Cała, & Watson, 2015)	On TOSCA, termed as a new standard for cloud service management; workflows, workflow components, and templates.	Focused on a very specific study field known as scientific workflows, such as automated workflow deployment in the Cloud
(Mei & Qiu, 2016)	The concept of Cloud Computing in the medical information system	Small scope of research
(Fortino, Pathan, Fatta, & Vasilakos, 2014)	Body Area Networks (BANs) that involves wireless sensor nodes coordinated by a static or mobile device	Applicable domains like fitness, health care, sport, ergonomics, wellness, emergency, security, safety and security are not the intended domains for this thesis; the analysis of body sensor data streams in Cloud Computing is too specific

More detail on the 63 articles selected for this chapter's purpose on Cloud Computing can be found in Appendix F. The next section will provide an overview of this topic, based on the selected articles.

3.5 CLOUD COMPUTING

3.5.1 Introduction

People commonly call the current era the 'information age', and the best thing about today's technology is possibly its capability to transform the nature of our work activities and its interactions, due to the current availability of the enormous range of the things that we do and how we can work. In this information age, all kinds of data can be processed and stored through Cloud Computing technology. Obtaining any required information on the Cloud Computing environment is just a click away, where Cloud Computing has become a top-rated service across public service organisations and businesses. This may be because Cloud Computing can enable storing, sharing, and accessing data, and can also be a compelling communication environment for integrated service provision to public service organisations; Cloud Computing is now widely used and is emerging as a solution (Campeanu, 2018; Harmon, 2018; Mouradian, Naboulsi, Yangui et al., 2017).

Different authors discuss the concepts of Cloud Computing from different viewpoints. Campeanu (2018), for example, posits Cloud Computing as a solution to challenges faced by the Internet of Things (IoTs), such as problems related to computation power and storage, and also states that Cloud Computing can provide on-demand access to a pool of computing resources while elasticity, on-demand self-service, and resource pooling is regarded as its benefits. Mouradian et al. (2017) also point out that Cloud Computing is widely used and similarly offered the availability of on-demand resources, elasticity, and scalability as the vital advantages and capabilities of Cloud Computing. Harmon (2018) further even regard Cloud Computing as the standard practice of many organisations, users, and businesses to store, access, secure, and share resources and services.

As governments, businesses, and PSOs in many countries are now more concerned than ever about citizens' need for access to effective and efficient public services, they are attempting to implement modern information technology in order to improve public service delivery and to foster their internal work processes (Stefanovic, Marjanovic, Delic´ et al., 2016). For realizing such a vision, Cloud Computing can be considered a new way of presenting technology for governments, businesses, PSOs, and SMEs that can help change their business processes and reduce the cycle time required to provide public service. Accordingly, many organisations are now focusing on moving their information technology (IT) infrastructure to Cloud Computing technology, are making efforts to be the beneficiaries of the online service delivery potential of Cloud Computing, and are progressively endeavouring to implement different Cloud Computing initiatives (Alruwaili & Gulliver, 2018).

Due to its widely claimed potential advantages, the Cloud, which is considered as a model that enables on-demand network access to a shared pool of resources, has become widely accepted by enterprises and governments as a solution for managing their ICT infrastructure (reza Bazi, Hassanzadeh, & Moeini, 2017; Singh, Jeong, & Park, 2016; Stefanovic et al., 2016). According to Stefanovic et al. (2016), the recognition that Cloud Computing has gained is due to the Cloud's potential capabilities, such as greater accessibility to storage, communication, and process. Singh et al. (2016) point out that the advantages offered by Cloud Computing — such as availability of computing resources, scalability, and availability of cloud services — can be the initiating factors for organisations and personal users to move data, services, and applications to cloud infrastructure (server & storage). On the other hand, for the IT business sector, the driving initiative may be different. Singh et al. (2016) discuss that these sectors require delivery of efficient services while fulfilling user demand, based on agreed service-level agreements (SLAs), where Cloud Computing can be one of the vital aspects for them to consider. The general implication is that many organisations in both the business and government sectors can be initiated to adopt and use Cloud

Computing in order to gain its advantages. reza Bazi et al. (2017), highlight that organisations need to gain advantages such as no investment cost for infrastructure, licenses, and human resources, which can be possible by migrating their services and applications to Cloud Computing.

3.5.2 The History of Cloud Computing

The commonly stated discussions about the origin of Cloud Computing relates to the Advanced Research Projects Agency Network (ARPANET), which has developed the computer network that gave birth to the Internet (Khan & Alam, 2017; Kruger, 2014; Mwansa, 2015). The ARPANET claimed that the origin of Cloud Computing is related to the aim of interconnecting computers (computer network) so that people can be interconnected and become capable of accessing information from any place and at any time (day or night). Kruger (2014, p. 10) cites that "Cloud Computing was an idea which was first envisioned by J.C.R. Licklider, who was eventually responsible for enabling the development of ARPANET (Advanced Research Projects Agency Network) in 1969".

According to Mwansa (2015), 1969 was the year in which the first data was exchanged between two computers; this later gave birth to the Internet. Protocols such as TCP/IP and NCP, introduced by ARPANET in 1977, became the foundation of the Internet. In doing so, the ARPANET brought change to the activities performed on individual PCs, introducing computing activity on networked computers that are accessible over the Internet, and through which Cloud Computing is nowadays accessed. While the ARPANET can, in this regard, be considered as the first founder of the Internet and the basis for Cloud Computing, the year 1997 also became a year in which the computer network became capable of adding more and more computers. The Internet, as pointed out by Mwansa (2015), has been used for the development of cloud-based computing services, and the term Cloud Computing was introduced by an information systems professor named Ramnath Chellappa in Dallas, Texas.

On the other hand, some debates claim that the birth of Cloud Computing is related to the origin and development of technologies such as Grid Computing, Utility Computing, and Autonomic Computing. For example, Ghosh (2010) regard Grid Computing as the origin of Cloud Computing, while Mwansa (2015) similarly accept grid and Utility Computing as the technologies that gave birth to Cloud Computing, due to the growing service requirements of various sectors at the time. In general, its evolution seems to have passed through a series of stages in the technology eras, from individually used PCs to distributed, parallel, grid, and virtualisation, and Cloud Computing.

Ahmed et al. (2012), discuss Cloud Computing in a slightly different way and consider it as a technology that has characteristics akin to Grid Computing, Utility Computing, virtualisation, and autonomic computing technologies. They recognise that the concept of the grid relates to computing, while the concept of a measured utility service was similarly applied to computing aspects in the early 1990s, and has been transformed into the concept of Cloud Computing. This, according to Mustafa et al. (2015), could have been due to the development of Grid Computing, of which benefits such as resource elasticity and pay-per-use led to fulfilling the demands of computing and the needs for effective use of computer resources in terms of cost, particularly with respect to computing power.

Some literature sources (Ghosh, 2010; Kantarci, 2013; Sun, Dong, Hussain et al., 2014) agree that virtualisation has become the key technology in the 1970s, and has enabled the abstraction of physical machines (servers and storages) by creating virtual machines that resemble the real machines from which they are created. As Ghosh (2010) has indicated, the use of virtual machines became known in the 1990s, and led to the development of the modern Cloud Computing infrastructure. In this regard, virtualisation has been considered as one of the deriving concepts of Cloud Computing since, as illustrated by (Dong, Sun, Hussain, & Hussain, 2017), virtualisation is a vital technology in interconnecting and managing computers in a distributed architecture. From the architecture point of view, virtualisation is the abstraction that resides on top of physical machines, while VMs are in turn provided to cloud users.

It can thus be argued that when companies' understanding evolved regarding the dynamic delivery of cloud resources — managed with the help of virtualisation technology and accessed based on demand that meets specific service-level agreements from distributed systems — the concept of Cloud Computing also started to gain wider acceptance. This implies that many companies started to use Cloud Computing over time to offer their services to users via the Internet. As an example, Salesforce is one of the major companies that deliver a cloud service, named the enterprise cloud ecosystem and customer relationship management (CRM) software (Kruger, 2014). As pointed out by Kruger (2014), Sales force eventually became in 1999 the first successful provider to use Cloud Computing; it started to deliver business class applications that could be accessed from a Website, and became a known example of successful use of Cloud Computing.

These days not only are users (enterprises and governments) attracted to the Cloud, but business communities are also interested in using Cloud Computing. For example, Senyo, Addae, and Boateng (2018) mention the growing acceptance of Cloud Computing, both in the business sector and in academia, by pointing out the strong competition for a share in the business created among the major Cloud service providers known as Microsoft, Amazon, Google, and Salesforce. Senyo et al. (2018) also reveal that Cloud Computing nowadays attract a number of studies.

The increasing number of businesses in the field has ensured the current availability of various cloud services. Al-Ruithe (2018) explain in this regard that Internet-based cloud services are comprised of three formats: Software as a Service, Platform as a Service, or Infrastructure as a Service (IaaS). Today, different cloud service providers offer cloud services and resources based on a pay-per-use model. Bassett (2015), citing Armbrust (Josep, Katz, Konwinski et al., 2010), also provide examples of cloud services such as Microsoft Azure, Google AppEngine, and Amazon Web Services as generalized Utility Computing providers. Ghosh and Arce (2010) also present Amazon Elastic Compute Cloud (EC2) as a provider of Web hosting services and Google App-Engine as a provider of a platform for developing and deploying Web applications.

Different businesses are competing to provide these cloud services, and the sector has created a number of giant companies. Khan and Alam (2017) identified some of the companies and offer examples of general cloud service providers, as they compared the features of famous Cloud Computing services to be used to enable organisations to decide to select the service that is best suited to their needs. Deb (2017) similarly offer some examples, and attempted to categorize the providers into the service types that they provide, such as Platform as a Service, Infrastructure as a Service, and Software as a Service (SaaS). For example, Salesforce and Google Apps are considered as PaaS providers; AWS and Amazon Web Services as IaaS providers; and EC2 of Amazon Web Services and Microsoft Azure as SaaS providers.

Given this discussion of the literature, it can be generalized that these cloud service providers are now delivering a shared pool of resources (hardware and software application) to users based on their demand through a pay-per-use model that fosters the delivery of cloud-based electronic services from different cloud deployment models. This implies that a pool of computing hardware and network resources are now using Cloud Computing technology. Mwansa (2015) suggests that a pool of computing resources such as servers, storage, networks, and applications are made available by providers to be shared and accessed based on demand, where the providers maintain the shared resources from remote locations. Likewise, Patel, Singh, and Jaiswal (2015), emphasise this by regarding Cloud Computing as a model for accessing a shared pool of computing resources, including servers, networks, storage, services, and applications in a convenient and on-demand manner, while Singh and Chatterjee (2017), similarly agree with the availability of an on-demand configurable pool of shared resources in Cloud Computing.

In addition to the commonly agreed approach that accepts cloud providers by relating them to some common aspects of Cloud Computing, such as a shared pool of resources and an on-demand manner, cloud providers also differ from one another based on the service that they provide. However, the offered services may reside in different locations, as stated by Deb (2017). In

Amazon Web Services, Cloud Computing resources are hosted in more than one location across the world. Mwansa (2015) also indicated that data centres in the Cloud that are owned by technology companies such as Amazon and Google are deployed in many locations within different types of cloud deployment models.

The shared pools of resources are thus delivered by the technology companies from three different types of cloud deployment models: public, private, and community cloud. According to Ghosh (2010), Amazon for example, used the public cloud deployment model to offer EC2 and Simple Storage Service (S3) to its customers. EC2 is one form of cloud model that can provide the opportunity to process stored data in the cloud, while S3 can enable customers to store and access data in the cloud.

In general, it can be argued that Cloud Computing is becoming a widely accepted technology by many businesses for storing, sharing, and accessing data. Accordingly, with the current state of the art of Cloud Computing, electronic services and applications are made accessible via the Internet by major service providers, using the most widely discussed Cloud Computing components of cloud services. The major service providers are now using three types of service models and three cloud deployment models to provide a variety of cloud services.

A summary of cloud services and service providers in state of the art of Cloud Computing is depicted in Table 3-5.

Table 3-5: Summary of the current state of the art of Cloud Computing

Current Providers	Source	Discussion
Cloud services: IaaS PaaS SaaS Cloud service providers: Microsoft, Salesforce, and Google	(Younas, Jawawi, Ghani et al., 2018, p. 3)	Offered various service providers such as Microsoft Azure, and Google App Engine as PaaS service providers; Microsoft, Google Apps, and Salesforce as SaaS service providers; and IBM cloud and Amazon as IaaS service providers. It is discussed that IaaS provides physical servers and an instance of virtual servers in a dedicated manner Some of the cloud services are listed, as follows: SaaS services: Microsoft 365, Web-based email, and Google Apps PaaS services: Microsoft Azure and Google App Engine IaaS services: Amazon Web service and IBM cloud
Cloud services: SaaS PaaS IaaS Cloud services providers:	Deb (2017)	Defined the state of the art of CC as follows: SaaS: Salesforce Google Apps, Citrix GoToMeeting, Cisco WebEx, Workday. PaaS: Amazon Web Services, Elastic Beanstalk, AWS Cloud Formation.

Current Providers	Source	Discussion
Google, Salesforce, Amazon, Cisco, Google		IaaS: Cisco Metapod, Amazon Web Services EC2, Joyent Microsoft Azure, Google Compute Engine (GCE).
Cloud services as: IaaS PaaS SaaS Cloud services providers as: Amazon, Microsoft, Google	(Khan & Alam, 2017, p. 419)	Discusses that SaaS, PaaS, IaaS can be rented from Amazon cloud; SaaS, PaaS, IaaS from IBM cloud; PaaS, and IaaS from Microsoft Azure cloud, and PaaS, and IaaS from Google cloud
Cloud services as: SaaS Cloud services providers as: Google, Amazon, Microsoft, IBM and SalesForce	(Berge, 2016, p. 38)	Mentions Amazon, Google, Microsoft, IBM, and SalesForce as the current state of the art of CC of service providers. SaaS: Google Docs
Cloud services: SaaS IaaS PaaS Cloud services providers: Google, Salesforce, Yahoo, Amazon	(Mwansa, 2015, pp. 15-17)	Discusses SaaS providers: Hotmail, and Yahoo mail, Google and email services such as Gmail, Enterprise Resource Planning (ERP) and CRM systems from Salesforce; PaaS: Google App Engine; IaaS: Amazon Web Services and its Elastic Compute Cloud and Simple Storage Service (S3). It is also discussed that SaaS services include: applications as a service to end-users; PaaS services: tools and services for SaaS services and IaaS services: hardware and software (server, storage, network, operating system)
Cloud services SaaS PaaS IaaS Cloud services providers: Amazon, VMWare, Microsoft	(Mustafa et al., 2015, pp. 2-3)	Discusses SaaS services: applications as a service to end-users; PaaS services: tools and services for SaaS services; IaaS services: hardware and software (server, storage, network, operating system IT, computing resource as a service: VMWare, Microsoft Azure, Amazon EC2
Cloud services: PaaS IaaS SaaS Cloud service (Public Cloud) providers:	(Mohlameane & Ruxwana, 2014)	States public cloud providers as: Google Apps, Amazon Web Services, Salesforce. PaaS: Microsoft Windows Azure and Google App Engine IaaS: EC2 and Simple Storage Service

Current Providers	Source	Discussion
Google, Microsoft, Amazon, Salesforce		SaaS: Microsoft Office365, Google Apps, Hosted Exchange Server
Cloud services providers: Microsoft, Amazon, Dropbox, Apple, Google	(Shahzada, 2014, p. 360)	Lists Amazon S315, Dropbox16, Microsoft SkyDrive14, Google Drive8 and Apple iCloud as the state of the art of CC
Cloud services providers: Google, Microsoft, Azure	(Michael et al., 2010, p. 52)	Discusses Google AppEngine, Microsoft, Azure Amazon EC2 as cloud service providers

3.5.3 Theoretical Approaches of the Basic Concepts of Cloud Computing

Research with a sound theoretical foundation can help the researcher to choose relevant content for the study, in order to reach a conclusion that can be useful for the theoretical foundation. The development of a theoretical framework for Cloud Computing, which is the focus of this thesis, may require an investigation and evaluation of the existing theoretical approaches described by Cloud Computing researchers, since a number of scholars and experts have already offered their studies by discussing various Cloud Computing aspects, such as: concepts, definitions, characteristics, and models. This is also because, as revealed by Priyadarshinee, Raut, Jha, and Gardas (2017), the adoption of Cloud Computing is widely studied by many researchers.

Among the different issues raised by researchers, virtualisation and abstraction can form part of the conceptual aspect of Cloud Computing. Virtualisation is described as the abstraction of hardware computing resources or IT resources in general, through which computing infrastructure in data centres is virtualised to abstract the hardware infrastructure at different levels for the purpose of being available for access via Cloud Computing, based on demand as a configurable shared pool of resources. Meanwhile, the term abstraction is regarded as hiding details from users and developers. According to Mwansa (2015), highly scalable and managed infrastructure from a pool of abstracted hardware is made available as virtualised instances for the purpose of hosting applications for a customer, where billing is based on the consumption of Cloud Computing-based services.

Virtualisation is thus utilized by service providers to deliver virtual resources to users while, in accessing the resources, users are not expected to know how the technological aspects work, and they are also not expected to understand how the resources are managed and how the allocation of virtual resources is performed. Users' concern can only be to access the cloud services and virtual resources that are abstracted via the virtualisation technology. Liu, Sui, Li et al. (2018, p. 455) indicate that "Users only acquire the cloud services and virtual resources and they need not understand the specific distribution of resource nodes and the details of the virtual resources allocation".

In general, abstraction becomes a key component of the Cloud when administrators are concerned with how things are maintained in the Cloud, such as upgrading, installing, and virtualising physical machines and applications. In contrast, virtualisation of resources becomes a key component of Cloud Computing in terms of providing computing and storage services. However, it might be useful to note that cloud resources are not only provided as virtualised instances, but can also be provided as dedicated physical machines from the cloud.

In addition to virtualisation and abstraction, some literature studies also raised a variety of other concepts associated with Cloud Computing, such as models, characteristics, and definitions.

Both Yongsiriwit, Sellami, and Gaaloul (2016) and Bassett (2015) used The National Institute of Standards and Technology's (NIST) definition to commonly discuss concepts such as minimal interaction of service providers, shared pool of configurable resources, on-demand network access, rapid provision and release of resources, as well as the availability of ubiquitous, convenient, and on-demand cloud resources within Cloud Computing. Similarly, Stefanovic et al. (2016) and Santos, Marinho, Schmitt et al. (2016) also refer to NIST's definition to discuss concepts such as resource pooling; on-demand self-service; rapid elasticity; broad network access; and measured services.

This may be because the Cloud Computing discussion offered by NIST Berge (2016) is composed of a number of aspects, where its theoretical approach and presentation characterise important Cloud Computing concepts. It is intended to provide a baseline for identifying the most relevant concepts of Cloud Computing and how to best frame the different parts of the components of Cloud Computing.

In general, researchers of the Cloud Computing field have raised several useful concepts during the past decades. Nevertheless, due to researchers' diverse viewpoints in discussing the basic concepts, different perceptions are seen with respect to the term Cloud Computing. As a result, it seems that no commonly agreed approach to discuss Cloud Computing concepts have been provided. This constitutes a gap in the research field, where the effect can also be seen on the current approach of studying and offering conceptual frameworks. This may result in a lack of standards for Cloud Computing conceptual aspects as framework components.

3.5.4 Prerequisites of Cloud Computing

The ICT resources incorporated as technological prerequisite into the current state-of-the-art Cloud Computing paradigm can include: data centres that host and provide applications and services, the Internet over which the applications are delivered, and the hardware and systems software to be delivered as cloud services (Michael et al., 2010).

Among the various technological aspects, a data centre is regarded as one of the major prerequisites of Cloud Computing; it houses servers, network devices (such as firewalls, routers, switches, etc.), and storage systems. Mustafa et al. (2015, p. 2) present that "A typical cloud, today, relies on back-end data centres consisting of thousands of servers and switches, connected hierarchically". While data centres are recognised as the major prerequisite of Cloud Computing, there are also other technological aspects associated with the requirement of Cloud Computing deployment. Mwansa (2015), for example, point to Virtualisation (as abstraction and VM creation), Grid Computing, and Utility Computing as important components of Cloud Computing. Likewise, both Khana and Al-Yasirib (2016) and Senyo et al. (2018), regard virtualisation as the major technological aspect that forms the underlying foundation of Cloud Computing.

Moreover, Sun et al. (2014) also agree that virtualisation includes the core technological aspects of Cloud Computing, and explain that resources can be delivered dynamically from the distributed computers that are interconnected and managed. Youssef (2012) further agree by mentioning that virtualisation technology is used by IaaS to create virtual resources from physical resources that can be delivered and released dynamically. Virtualisation in this regard can be considered as one of the perquisites of the Cloud.

The consideration that virtualisation is the core element of Cloud Computing may be rooted in its vital advantages in the current ICT sector. This can be illustrated from the discussion offered by Michael et al. (2010), which mentions the management capability of virtualisation for complex infrastructure within the Cloud Computing environment, and also its opportunities in achieving elasticity and availability of infinite capacity on demand, which requires automatic allocation where management can be achieved by virtualisation. Mustafa et al. (2015) add that the availability of a platform for the delivery of IT resources in an optimized and scalable manner, and the delivery of services to users, can be simplified by virtualisation; they regard virtualisation as a key component of Cloud Computing,

In addition to virtualisation technology, Grid Computing and Utility Computing have been discussed as further technological aspects that may play vital roles within Cloud Computing. It has already been discussed that relationships exist between these technological aspects and the concept of virtualisation, since making computing services available based on user requirements has required the use of Cloud Computing to achieve availability of computing resources, which could originate from grid and Utility Computing technologies. Mustafa et al. (2015) pointed out that complex systems can be enhanced in various applications through Grid Computing, which can enable ubiquitous availability of computing resources, virtualised systems, and access to storage systems. Like other grid-based resources, such as electricity, Cloud Computing addresses the long-held dream of computing as a utility; this implies a direct relationship between the cloud and Utility Computing, that is, computing resources are made available in the manner of any other grid utility, such as telephone services or electricity (Michael et al., 2010).

Based on these discussions of technological aspects, it can be argued that back-end data centres (including servers and storage), high speed network connectivity, and virtualisation technology can be considered as perquisites of Cloud Computing.

3.5.5 Characteristics of Cloud Computing

Understanding the characteristics of Cloud Computing may help to identify the vital components relevant to this study, based upon which the term Cloud Computing can be better defined. Table 3-6 presents some of the literature sources that provided a variety of characteristics of Cloud Computing:

Table 3-6: Characteristics of Cloud Computing

Literature	Title	Characteristics of the Cloud Computing
(Zhang, 2010, p. 11 ,)	Cloud Computing: state of the art and research challenges	Shared resource pooling, Multi-tendency, Service-oriented, Geo-distribution and ubiquitous network access, Self-organizing, Utility-based pricing, Dynamic resource provisioning
NIST (Berge, 2016, p. 2 ,)	The NIST definition of Cloud Computing	Five essential characteristics are listed: Resource pooling, Broad network access, On-demand self-service, Measured service, Rapid elasticity
(Kruger, 2014, p. 15 ,)	Cloud Computing: an analysis of Cloud Computing issues & investigations	Refers to NIST and offers: resource pooling, broad network access on-demand self-service, measured service, and rapid elasticity

Literature	Title	Characteristics of the Cloud Computing
(Shahzada, 2014, pp. 358-389 ,)	State-of-the-art survey on Cloud Computing security challenges, approaches, and solutions	Refers to NIST and presents five essential characteristics: Rapid elasticity, Resource pooling, On-demand self-service, Broad network access, Measured service
(Mohlameane & Ruxwana, 2014, p. 9 ,)	The Awareness of Cloud Computing: a case study of South African SMEs	Acuity, cost of cloud, compatibility, usability, reliability, performance, availability of service as perceived challenge
(Mwansa, 2015, p. 13 ,)	Exploring the development of an agile methods framework to promote the adoption and use of Cloud Computing services in South Africa	Refers to Sitaram and Manjunath (2012). broad network access, on-demand self-service, resource pooling, measured service, rapid elasticity
(Mouradian et al., 2017, p. 416 ,)	A comprehensive survey on research challenges and fog computing	reduced management efforts, on-demand resource allocation, scalability, easy applications and services provisioning as capabilities of CC, flexible pricing model (pay-as-you-go)

To better identify the vital characteristics of Cloud Computing that are most relevant to this study, a variety of characteristics are summarised and presented in the Table 3-7.

Table 3-7: Summarised Characteristics of Cloud Computing

Characteristics	Discussion
On-demand self-service, broad network access, resource pooling, rapid elasticity, and measured service	Ali, Soar, and Yong (2016); Bassett (2015); Khana and Al-Yasirib (2016); Mohlameane and Ruxwana (2014) commonly offer broad network access, on-demand self-service, measured service, resource pooling and rapid elasticity as basic characteristics of Cloud Computing
Agility, virtualisation, independence, low cost, multi-tenancy, device and location, high scalability, sustainability,	Sun et al. (2014); Mustafa et al. (2015); Khan and Alam (2017); and Senyo et al. (2018) commonly offer low cost, agility, device and location independence, high reliability, multi-tenancy, security, high scalability and sustainability similar to the characteristics offered by (Mustafa et al., 2015, p. 2 ,) who pointed out that virtualisation is fundamental to several cloud characteristics. Ten characteristics are listed by (Mustafa et al., 2015), such as: scalability, user-friendliness, resource optimisation,

Characteristics	Discussion
high reliability and security	virtualisation, pay-per-use, infrastructure SLAs, Internet-centric, learning-based adaptation, variety of resources, and service SLAs
Five essential characteristics: broad network access, on-demand self-service, measured service, resource pooling and rapid elasticity	The NIST, Berge (2016, p. 3) offered and discussed five essential characteristics of Cloud Computing, namely: broad network access, on-demand self-service, resource pooling, measured service and rapid elasticity
Resource pooling, On-demand self-service, broad network access, measured service and rapid elasticity	Ahmed et al. (2012); Jing, Ali, She, and Zhong (2013); Kruger (2014); Mbuba and Wang (2014); Patel et al. (2015); Santos et al. (2016); Youssef (2012); Zhang et al. (2010); and Zhao, Zhang, Tian et al. (2012), commonly cited the NIST (Michael et al., 2010) in discussing the essential characteristics of Cloud Computing: broad network access, on-demand self-service, measured service, resource pooling and rapid elasticity
Infinite computing resources, up-front commitment, pay for the use	Michael et al. (2010, p. 50) have delivered the key characteristics of Cloud Computing as: "(1) the illusion of infinite computing resources available on-demand; (2) the elimination of an up-front commitment by cloud users whereby resource allocation can be adjusted; and (3) the ability to pay for the use of computing resources when needed".
Multi-tenancy, virtualisation, utility resource, scalability	Bassett (2015, p. 38) offered the characteristics of Cloud Computing as virtualised resources (hard and soft), a multi-tendency system, rapid on-the-go, resources with utility properties (pay-per-use), pooled resources, adjustable (scalable and on-demand) resources, available with an Internet connection and virtual computing service
Agility, High scalability, High availability, security, high reliability, pay-per-use, multi-sharing, virtualisation technology	(Wang, Laszewski, Younge et al., 2010), discussed the characteristics of Cloud Computing as: agility, high scalability, high availability, security, high reliability, virtualisation technology, services in the pay-per-use mode (Utility Computing), multi-sharing, support for all service oriented applications and automated resource management (e.g., automated backup)

As Table 3-7 depicts, many discussions in current literature about the characteristics of Cloud Computing are based on the NIST's composition of Cloud Computing. However, there are some authors who adopted slightly different approaches in offering the characteristics of Cloud Computing. For example, virtualisation is considered as a key and fundamental characteristic of Cloud Computing, together with other characteristics such as agility, low cost, device, location independence, security, and sustainability.

Some of the literature studies also summarised and generalized the characteristics of Cloud Computing. Mustafa, *et al*. (2015) can in this regard be mentioned, where they summarised and offered 10 characteristics:, scalability, user friendliness, resource optimisation, virtualisation, pay-per-use, Internet centric, variety of resources, infrastructure SLAs, learning based adaptation and service SLAs (Service Level Agreements).

However, a more simplified and better approach of discussing the characteristics of Cloud Computing is offered by Michael et al. (2010, p. 50), where the characteristics are presented in an easily understandable way. The key characteristics of Cloud Computing are stated as: “the illusion of infinite computing resources available on-demand; the elimination of an up-front commitment by cloud users whereby resource allocation can be adjusted; and the ability to pay for the use of computing resources when needed”.

Though some commonalities can be observed among authors in presenting the characteristics, it can also be observed that the characteristics offered by existing published literature came with diverse composition; however, it seems as if precise and globally accepted characteristics of Cloud Computing is still not being offered.

Indeed, no successful past efforts are observed at delivering clearly distinguishing characteristics, and it can easily be noted that, in each case, some seemingly critical characteristics were omitted or substituted by different types of characteristics. According to Kruger (2014), this could be due to the unrefined characteristics of Cloud Computing, as offered by many literature studies on Cloud Computing.

In order to properly deal with these variations of the characteristics of Cloud Computing, this study will identify the most relevant and easier to understand characteristics and present them in Section 3.10.1.

3.5.6 Existing Models and Frameworks

The cloud models offered by NIST Berge (2016) are considered by this study as a better approach of offering Cloud Computing models; the current state of the art of Cloud Computing relies on these two major types of models, known as service models and deployment models. The widely and commonly mentioned (Hudic, Smith, & Weippl, 2017; Khana & Al-Yasirib, 2016; Mustafa et al., 2015) service models include: Infrastructure as a Service, Software as Services, and Platform as a Service, while the widely and commonly mentioned cloud deployment model includes: private, public, community, and hybrid cloud models (Senyo et al., 2018; Younas et al., 2018).

3.5.6.1 Service models:

- ***Software as a Service (SaaS):*** the services delivered by Cloud Computing refers to Software as a Service (SaaS) (Michael et al. (2010). SaaS is one of the cloud service models where software and applications are made available by service providers to users through the Internet, to be accessed and used via Web browsers. These software and applications are deployed on providers' cloud infrastructure, such as networks, servers, storage, and operating systems, where users are not expected to manage the underlying cloud infrastructure (Hudic et al., 2017; Liu et al., 2018).
- ***Platform as a Service (PaaS):*** according to Mustafa et al. (2015), PaaS refers to the cloud service model from where programming platform resources (including programming tools, operating systems, middleware, and operating systems) are available to users to develop, execute, manage, and deliver applications. The underlying infrastructure is made available to them by cloud service providers.
- ***Software as a Service (IaaS):*** this refers to the third cloud service model, where virtualised resources, such as computers (servers), memory, processors, storage, and networking can be accessed by users to deploy and run arbitrary software, which can include operating systems and applications. According to (Mwansa, 2015), the user is not required to provide upfront investment, cost of servers, or cost of licensing for software. The user does not manage the hardware and network, which are provided by the provider, whereas users can manage operating systems, storage, and deployed applications.

Table 3-8 depicts known examples of cloud services (SaaS, PaaS, and IaaS)

Table 3-8: Summarised known examples of SaaS, PaaS, and IaaS

Cloud Service	**Known Examples**
SaaS	Google Apps, Gmail, Salesforce, Google Doc, Cisco WebEx, GoToMeeting, Concur, Dropbox, OneDrive, MyDrive.
PaaS	Windows Azure, Google App Engine, Yahoo and Aptana cloud, Heroku, OpenShift, Force.com, AWS Elastic Beanstalk, Apache Stratos,
IaaS	Amazon Web Service (Song), Google Compute Engine (GCE), Cisco Metapod, Linode, Microsoft Azure, Ocean, Rackspace

Table 3-9 depicts key features, advantages, and preference conditions of the cloud services SaaS, PaaS, and IaaS.

Table 3-9: Summarised key features, advantages, and preference conditions of SaaS, PaaS, and IaaS

Cloud service type	Key features	Advantages	Preference conditions	Relevant literature
SaaS	This is a type of cloud application service; it requires the Internet /Web to deliver applications to its users (delivered via Web interfaces). Users are not responsible for hardware or software updates. No need to download and install applications on every individual computer.	Facilitates automatic updates, enhances easy administration and patch management, enables availability of on-demand service and billed on the pay-per-use manner. Can reduce money and valuable time that could be spent on tiresome tasks, including installation, administration, and upgrading of software by technical staff, so that they can use their saved time to focus on more pressing issues within the organisation.	For a company requiring fast deployment of ecommerce without the need to spend time on hardware and software issues, or collaborative projects that require a short time; for applications that require Web and mobile to be accessed; applications that are not frequently on-demand (revenue applications).	(Khan & Alam, 2017; Senyo et al., 2018; Singh et al., 2016; Younas et al., 2018)
PaaS	Cloud platform (framework) delivered over the Web, upon which developers can develop certain software or applications. Management of resources such as networking, servers, and storage; networking can be done by the provider. Built on virtualisation technology that facilitates easier scale-up or scale-down of resources. Developers maintain focus on	Simplify applications development and deployment with less cost; minimize the requirement of programming codes, highly available and scalable. Services are provided to help with application development, testing, and deployment. Same application development can simultaneously be accessed by many users.	When the same development project is required to be accessed by multiple developers; When higher speed and flexibility are required for the process If it is customized application development is required; For the requirement of fast development and deployment of applications with simplified challenges.	(Deb, 2017; Khan & Alam, 2017; Sun et al., 2014; Yongsiriwit et al., 2016)

Cloud service type	Key features	Advantages	Preference conditions	Relevant literature
	the management of applications. Databases and Web services are integrated.			
IaaS	Automated computing resources or infrastructure are highly scalable. This is a type of complete self-service during accessing and monitoring resources such as networking, computing, and storage. Resources are available, based on demand. Virtualised cloud infrastructure, such as network, servers, storage and operating systems are delivered as a service via an API. Users have full control over the infrastructure. It represents a virtual data centre in the Cloud. Clients should manage applications, middleware, runtime, OSs, and data while network, servers, and storage are	Easier automated deployment of servers, networking, storage, and processing power. It is the most flexible and is highly scalable. Payment for hardware only, based on usage. Accessibility only as needed.	A company that does not have sufficient time or money for hardware and software. Large organisations are required to pay only for what they are using, and require full control over infrastructures and applications of their own. Organisations that are not sure of the amount of their demands for new applications, with flexibility to scale up or down as needed.	(Bassett, 2015; Kaur, 2017; Mwansa, 2015; Puthal, Sahooy, Mishraz, & Swainz, 2015; Singh & Chatterjee, 2017)

Cloud service type	Key features	Advantages	Preference conditions	Relevant literature
	managed by providers			

3.5.6.2 Deployment models:

- ***Private Cloud:*** a single organisation is exclusively provided with cloud infrastructure and/or services, where the organisation has the opportunity to manage and operate the cloud infrastructure or services (Younas et al., 2018).
- ***Community Cloud:*** Senyo et al. (2018) discuss the community cloud as a type of deployment model where multiple entities with a similar mission, policy, compliance, and security requirements (particularly specific community of user organisations) are provided with cloud infrastructure and/or services to be shared by them. One or more entities within the community have the opportunity to manage and operate the cloud infrastructure and/or services.
- ***Public Cloud:*** refers to a cloud deployment model, where multiple organisations are provided with cloud infrastructure and/or services that are shared using a multi-tenancy model (Alruwaili & Gulliver, 2018). The cloud infrastructure and/or services are made available and are open for use by the general public. This cloud infrastructure and/or service exists on the cloud provider's premises; it may be owned and operated by the cloud provider, or by a business or government organisation.
- ***Hybrid Cloud:*** a composition of two or more cloud infrastructures such as public, private, or community clouds that provide hybrid clouds. Standardized technology is used to bind the cloud infrastructure together so that it remains a unique entity that can be managed as a single unit; such an approach allows portability of data and application. Singh and Chatterjee (2017) pointed out that multiple clouds with similar capabilities and infrastructure can form a hybrid cloud.

In order to properly deal with the models of Cloud Computing, this study will identify cloud models that are regarded as its most relevant components and are easier to understand; these will be presented in Section 3.10.2.

In summary, as can be observed from published literature, field research shows some inconsistency and becomes uneven in providing cloud service models. For example, in addition to the most widely discussed components of the cloud service models, such as SaaS and IaaS, many other components have continuously been added, and are becoming additional fragmented parts. This trend may in future even widen the gap, as many research studies may continue to provide endless individual and fragmented parts of a computer system — such as RAM as a Service, Platform as a Service, Keyboard as a Service (KaaS), and Mouse as a Service (MaaS), as if a new cloud service model comes to the Cloud Computing market. That is, all existing ICT hardware parts are continued to be presented as if these artefacts are newly invented cloud service models. It has become unclear where such a trend of adding fragmented cloud service models should be stopped.

For instance, in recent years, many scholarly researchers have included a variety of terminologies such as PaaS, SaaS, IaaS, and Hardware as a Service (HaaS). As an illustration, Ahmed et al. (2012) referred to a detailed list of cloud service types, including Information-as-a-service, Storage-as-a-service, Testing-as-a-service, Database-as-a-service, Application-as-a-service, Process-as-a-service, Platform-as-a-service, Security-as-a-service, Integration-as-a-service, Infrastructure-as-a-service, and Management/Governance-as-a-service. This clearly implies variation among scholarly researchers in providing and discussing Cloud Computing terminologies, particularly cloud services.

The variation further goes beyond, and also touches on, cloud deployment models. For example, some literature studies used fewer terminologies to represent Cloud Computing deployment models. In this regard, Michael et al. (2010) identified only private and public models, while others listed a number of terminologies to represent Cloud Computing deployment models. Hashemi (2013) and Reixa (2012) commonly mention terms such as community, hybrid, private, and public cloud deployment models. Like cloud service models, the discussion about cloud deployment models also implies the existence of variation among researchers in providing standardized and worldwide-accepted Cloud Computing deployment models.

3.5.7 Definition of Cloud Computing

From the diverse viewpoints of scholars, practitioners, researchers, and other stakeholders, many definitions have been provided for the term Cloud Computing.

The World Economic Forum (WEF) defines the term Cloud Computing as a tool of transformation that can be used for management and delivery of technology-based services in various aspects, such as for eradicating redundancy and inefficiency, replacing standalone data silos, combining different database sources, reducing communication and maintenance cost, easing of maintenance, and propagation of technology with a single source of hardware, software, and physical infrastructures that have unlimited scalability and data storage capability (Gordon, Hayashi, Elron et al., 2010).

The National Institute of Standards and Technology (Laszewski) also defines Cloud Computing in broader aspects as “a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can rapidly be provisioned and released with minimal management efforts or service provider interactions” (Berge, 2016, p. 2).

Prasad and Atukuri (2012, p. 3265), citing the IEEE Computer Society, offer the definition of Cloud Computing as: "A paradigm in which information is permanently stored in servers on the Internet and cached temporarily on clients that include desktops, entertainment centres, tablet computers, notebooks, wall computers, handhelds, etc.”.

According to Bassett (2015), Cloud Computing is defined either by broad aspects that consider everything as virtual computing, or with narrower approaches that include Utility Computing. Michael et al. (2010) can also be mentioned, where the definition includes broader terminologies such as cloud services, data, physical media, and applications, and describes Cloud Computing in a relatively holistic and acceptable manner.

As illustrated through an extensive analysis of various research papers, in defining the term Cloud Computing, non-consistency is seen to imply that it has become difficult for current literature to define the term comprehensively, and that Cloud Computing still lacks a universally accepted definition. It can thus be argued that there is no globally accepted definition for Cloud Computing. According to Bassett (2015), this has created confusion with regard to understanding the concepts of Cloud Computing.

However, it can also not be denied that some attempts have been made to avoid such confusions among readers and researchers of the field. The NIST, for example, provided a relatively simplified approach that describes Cloud Computing as three types of cloud services, namely, PaaS, IaaS, and Software as Services (SaaS) (Berge, 2016); this overarching idea of SaaS has been very useful to this research.

Many relevant studies, which include especially that of US government offices such as the Federal Bureau of Investigation (FBI) (FBI 2012), revealed that the definition offered by NIST is considered as acceptable. However, this still does not mean that NIST’s definition of Cloud Computing is a globally accepted one. According to GNU's not Unix (GNU), the definition offered by NIST does not include storing data as online services; thus, it does not go along with the common use of Cloud Computing. GNU further argues that software as a service, as defined by NIST, considerably overlaps with the service as a software substitute, which is considered as confusing for users (researchers and readers), as this notion uses the same term for two dissimilar concepts, which do not have equivalent meanings in defining Cloud Computing (GNU 2014).

It can be argued that research in the field shows some inconsistency, and becomes uneven in defining the term Cloud Computing. The seriousness of the problem also widens in existing literature studies, as studies have continued to add a variety of definitions of Cloud Computing. As a result, it is still expected to deliver a standardized definition that may help to avoid confusion among readers and researchers of the subject. This study has made much effort to identify the most appropriate definition by further analysing related published literature in the field.

The variety of definitions offered by existing literature is summarised in Table 3-10.

Table 3-10 Summary of definitions of Cloud Computing

Study	**Title**	**Definitions of Cloud Computing**
(Deb, 2017)	Cloud as an Enterprise IT Infrastructure	The provision of computing services via the Internet, including: storage, servers, networking, software, and databases
(Mwansa, 2015, p. 12)	Exploring the development of a framework for agile methodologies to promote the adoption and use of Cloud Computing services in South Africa	Refers to resources based on task, but independent of devices accessed via the Internet; can be scaled dynamically
(Mustafa et al., 2015, p. 3)	Replicating the geographical cloud: provisioning omnipresence, omniscience, and omnipotence	"Clouds are large pools of virtualised resources which are easy to access, secure and reliable…"
(Shahzada, 2014)	State-of-the-art survey on Cloud Computing security challenges, approaches, and solutions	Commonly cited Mell & Grance (2011) provide the NIST's definition as "….a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction"
(Mohlameane & Ruxwana, 2014)	The awareness of Cloud Computing: a case study of South African SMEs	
(Kruger, 2014)	Cloud Computing: an analysis of Cloud Computing issues and investigations	
(Reixa, 2012)	Cloud Services evaluation framework	
(Zhang, 2010)	Cloud Computing: state-of-the-art and research challenges	

Study	Title	Definitions of Cloud Computing
(Ahmed et al., 2012, p. 202 ,)	An advanced survey on Cloud Computing and state-of-the-art research issues	"Cloud Computing is a way of leveraging the Internet to consume software or other IT services on demand. Users share processing power, storage space, bandwidth, memory, and software".
(Bollineni & Neupane, 2011, p. 14)	Implications for adopting Cloud Computing in e-Health	Peter *et al.* (2009) defined Cloud Computing as "Cloud Computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction".
(Michael et al., 2010, p. 50)	A view of Cloud Computing	"Refers to both the applications delivered as services over the Internet and the hardware and systems software in the data centres that provide those services"
The NIST (Berge, 2016, p. 3) The National Institute of Standards and Technology	The NIST definition of Cloud Computing	Defines Cloud Computing as "a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can rapidly be provisioned and released with minimal management efforts or service provider interactions"
The world economic forum (WEF) (Gordon et al., 2010)	Exploring the future of Cloud Computing	Defines Cloud Computing as a tool of transformation that can be used for management and delivery of technology-based services in various aspects, such as eradicating redundancy and inefficiency in replacing standalone data silos, creating homogeneous data by combining different database sources, reducing

Study	Title	Definitions of Cloud Computing
		communication and maintenance cost, easing of maintenance and propagation of technology with a single source of hardware, software, and physical infrastructures having unlimited scalability and data storage
(Brodkin, 2008)		Defines Cloud Computing as a form of computing utilities delivered as a service through Web technologies, in which scalability, allowed by elasticity of computation, can be obtained
https://tech.slashdot.org/story/08/07/17/2117221/multiple-experts-try-defining-cloud-computing		Different definitions are provided by different authors.

Table 3-10 depicts that the majority of definitions offered by researchers of the field lack the necessary explanations and illustrations. In addition, it can be identified that some definitions differ with explanation and illustration of services of Cloud Computing. However, it cannot be denied that some studies developed a different and better viewpoint of the concept of Cloud Computing compared to others. In this regard, the work of Michael et al. (2010, p. 50) can be mentioned, in which the term Cloud Computing is defined more broadly by referring to “both applications delivered as services over the Internet and hardware and systems software in data centres that provide those services”.

In addition, the definition offered by Brodkin (2008) also appears more concise and simplified, since Cloud Computing is defined as a form of computing utilities delivered as a service through Web technologies, where the characteristics of scalability are allowed by the elasticity of computation resources. However, though it seems more concise, the definition still does not enable end-users of Cloud Computing to clearly grasp and appreciate the real meaning of the term. As a result, this definition could not be considered as specific and comprehensive, like other definitions offered by literature.

Michael et al. (2010) also described Cloud Computing as a business revolutionising system and a mechanism through which people consume, share, and use information systems. It is indicated that Cloud Computing accelerates information sharing among organisations and individuals; via Cloud

Computing, clients are able to acquire ownership of their own data and they can avoid capital expenditure, upfront costs of hardware, software, and cyber defence. In terms of simplicity, Armbrust's (Josep et al., 2010) definition considers only one type of cloud service known as Software as a Service (SaaS), representing every application delivered over the Internet from the cloud environment. This thesis represents a rather simple approach and a more generic way of defining the term Cloud Computing and may simplify the current diverse and fragmented models of Cloud Computing.

The definition offered by Michael et al. (2010) has been used by various forums, such as the World Economic Forum (WEF), and is also accepted by UN agencies as a working definition Gordon et al. (2010). This definition was coined by 11 electrical engineers and computer science experts from the University of California at Barkley. The definition touches upon several operational, simple, and practical aspects of Cloud Computing technology, including: service, software, hardware, application, storage, and data centres, which makes it more comprehensive compared to the definitions mentioned earlier.

Though this study does not wholly disagree with all the definitions of Cloud Computing offered by researchers of the field, it has not found them particularly useful in the context of applied research, because the definitions lack the content explanation and research standardization that came with scope and role limitations. This study thus concurs that the definition offered by Michael et al. (2010) can notably further the discussion of the roles of Cloud technology in terms of one kind of service, known as Software as a Service (SaaS), where all the other types of service models are considered as only the vendors' concern.

Consequently, this study adopts the definition offered by Michael et al. (2010) and related literature, and comes up with its own concise definition that can be used for this particular study and other studies as well. Cloud Computing is defined as:

"A game-changing, fundamental transformation of Information Technology in the sphere of ICT that comes to existence by re-designing the use of stationary IT infrastructure into the use of re-configurable computing resources. This includes hardware, systems, software, and their housing, making infrastructure available any time and everywhere where applications are delivered as services over the Web in virtual environments. This introduces efficient utilization of resources and realization of new service delivery environments (models)".

3.5.8 The general use of Cloud Computing

A number of studies discussed the variety of use of Cloud Computing, including its use in big data management, file storage, accessing services in an on-demand self-service manner, for efficiency and reliability, for enabling access to broad networks, access to resources with rapid elasticity, access to measured services, and for reduced electric power consumption. Bassett Bassett (2015), for example, highlights that Cloud Computing can be used to foster innovation, and as an alternative to on-site storage and applications; further, it can be used to help improve access to records from any location.

Considering cloud service providers, Deb (2017, p. 499) indicates that Cloud Computing can be used "for managing their infrastructure which provides similar state of the art capabilities and considerably cuts down on various up-front costs, whether related to infrastructure procurement or managing it".

Cloud Computing use is also discussed with regard to users in a variety of government and non-government sectors. For example, the World Economic Forum (Gordon et al., 2010, p. 6) outlined the uses of Cloud Computing in different sectors such as industries, education/research, manufacturing, and health care:

- Access to global resources;
- Low cost simulation;
- Rapid prototyping and collaborative design;
- Highly interactive/collaborative learning;
- Supply chain coordination;
- Improved manufacturing processes;
- Real-time health monitoring;
- Platform for health and insurance services; and
- Massive and flexible computing power for drug discovery.

Seeking a generic view on the uses of Cloud Computing, it may be necessary to consider categorized perspectives such as the technical, user, companies, and environmental perspectives. These are outlined below.

3.5.8.1 Technical Perspective:

From the technical perspective, Cloud Computing use can include: big data, file storage, backup, disaster recovery, power management, and efficiency and reliability.

Big data: one of the technical aspects of the use of Cloud Computing is its capability associated with the process of handling big data, which refers to widely distributed large scale data; Cloud Computing nowadays represents a solution for issues related to storing big data (Bassett, 2015).

File storage: Cloud Computing is widely used for different activities associated with files and data. Storing files, as well as sharing and transferring files (data), can now safely be treated. The shared files these days can be safe in the Cloud, with the possibility of storing and retrieving files from anywhere at any time, using any kind of interaction interface that is capable of accessing Web applications (Hudic et al., 2017; Sabri, 2015).

Backup: data redundancy can be ensured by backing up data to another location within the cloud environment, where high availability can be ensured. Cloud service users can automatically move data to any location across the network, so that they have minimal fear of security and availability concerns. In addition, applications and software in the cloud should always be available and reliable for all services; this can be achieved via the cloud backup capability, which also allows for easy handling of hardware failure. The assessment of data can also be done at any time and whenever data needs to be recovered; this can make the IT industry highly beneficial by reducing workloads. Cloud service providers are usually regarded as the responsible agents for the backup of data and information, and can be used for data recovery during any accidental or natural disasters (Al-Ruithe, 2018; Hashem, Yaqoob, Anuar et al., 2015).

Disaster recovery*:* disaster recovery (DR) is another aspect that is derived from the use of Cloud Computing; it provides faster recovery, at a much lower cost, from data and information that is stored in different physical locations compared to the traditional fixed infrastructure DR site (Singh & Chatterjee, 2017).

Power Management: the Cloud applies virtualisation technology to create VMs from physical machines, and electricity consumption and management can be easier for virtual machines (VM), compared to physical (Mouradian et al., 2017).

Efficiency and reliability: many organisations are seeking Cloud Computing in order to achieve efficiency and reliability benefits, which can be regarded as another use of Cloud Computing; reliability within the cloud can also be another aspect associated with its use that can be achieved using redundant sites (Shahzada, 2014; Youssef, 2012).

3.5.8.2 User Perspective:

From the user's perspective, Cloud Computing can mainly be related to cost reduction.

Cost reduction*:* Cloud Computing may eliminate the cost requirement associated with expensive computing hardware, dedicated space, and software licences. In addition, users do not face the administration of technical challenges related to maintenance, such as updating software and maintaining hardware. Users can obtain resources and services in a relatively short time and at low cost in their latest form. The system configuration is handled and maintained by the cloud provider, while the user only rents the cloud services (Hashem et al., 2015).

3.5.8.3 Companies Perspective:

From companies' perspective, the use of Cloud Computing is similarly related to cost reduction.

Cost reduction*:* the cloud solution can reduce infrastructure costs, such as that of data centre and networking. This can help an organisation or a company to concentrate more on improvements of their core activities for improved competitiveness (Michael et al., 2010).

3.5.8.4 Environmental Perspective:

From the environmental perspective, the use of Cloud Computing can be related to the idea of going green.

Going Green: going green in Cloud Computing refers to the considerable reduction in electric consumption and carbon emissions, as Cloud Computing is based on a shared pool of resources that requires less energy, which is very important in the context of the environment; previously, more electricity was required for maintaining data centres. The operation of servers for continuous hours of work within an organisation can be reduced with the use of Cloud Computing, since power consumption management can be optimized. This can be termed as Going Green (Wyld, 2009).

The unique and general uses of Cloud Computing, as discussed by existing literature, were examined, and different perspectives on the categorization of Cloud Computing uses were developed for the purpose of this research. However, it may also be necessary to answer the question: Who are the *users of Cloud Computing*?

3.5.9 Users of Cloud Computing

Much research has been done on Cloud Computing, and different aspects were discussed, including concepts, models, characteristics, definitions, challenging issues, and potential advantages of Cloud Computing, which are associated with the users of cloud services. With respect to the cloud service, users can be individuals or groups of individuals, organisations, government departments, and businesses; these are regarded as end users of Cloud Computing services (Hailu, 2012; Sabri, 2015; Vasista, 2012). Hailu (2012) described a user as an individual or organisation that becomes a customer of a service provider, and that uses the Cloud Computing resources offered by the provider. Vasista (2012) similarly identified a user as a customer of Cloud Computing, which can be a business, an individual, or a government agency. Likewise, according to Sabri (2015, p. 2), the end user of Cloud Computing is a "client or customer who does not know or care about the technology in use". Harmon (2018) agrees that many users do not know about the process associated with accessing information or how the Cloud is working. Liu et al. (2018) similarly reveal that users of cloud services and resources are only concerned with how to access virtual resources and/or services, but are not expected to understand how the resources are allocated or where they are distributed.

It can thus be argued that the users of Cloud Computing can be the individuals, people, or organisations who want to perform different cloud activities such as storing, sharing, or accessing data and information using the cloud environment. As stated by Abdel-Basset, Mohamed, and Chang (2018), users of cloud services are involved in different cloud activities such as storing their own data in cloud applications or storage, whereas they may not be concerned with knowing how the underlying technology functions, or may not need to understand the technical aspects of the Cloud involved in their activities.

When individuals or groups want to perform different cloud activities, such as to centrally store and access data from any location at any time, the best way to achieve this can be by incorporating Cloud Computing into their day-to-day work activities. Accordingly, they may incorporate and use Cloud Computing for many reasons, such as not having the required ICT infrastructure to perform the day-to-day work activities, not possessing the capabilities to do so, or even possessing the capabilities without being able to become competitive. According to Ross (2010), organisations may also decide to adopt and use the Cloud to gain advantages such as centralized computing infrastructure, cost minimization, and reduced manpower requirements.

Cloud service providers can be organisations (individual, corporation or other business, government agency, or non-governmental agency) that offer the infrastructure and services of Cloud Computing. According to Senyo et al. (2018), service providers are businesses that own the cloud infrastructure on which applications reside and are delivered to users via Web interfaces. Vasista (2012) state that cloud service providers offer software such as databases as services and processing power or storage service as computer resources. The service providers provide these cloud services from different types of cloud deployment models, namely, public, private, or hybrid clouds. For instance, Abdel-Basset et al. (2018) point out that service providers in public clouds make their services available to the public via the Internet and Web applications.

Cloud providers manage, maintain, and secure the computing resources (Berge), and are responsible for the delivery of computing resources (servers, storage, databases, networking, software) over the Internet. They deliver scalable resources to users, where the payment amount depends on the available resources and users' requirements (Khan & Alam, 2017). Deb (2017) reveals that the user is charged by service providers for the Cloud Computing services that they offer, based on service usage.

3.5.10 Opportunities, Risks, and Challenges

In a situation where a user does not need to buy any hardware infrastructure, Cloud Computing can lower the investment cost of deployment. If the cloud is intended to be deployed by an organisation or a government to deliver ICT infrastructure as a service to users, then it can also minimize the total investment cost for the deployment of new hardware infrastructure; this is because, as discussed in the previous sub-section, the application of virtualisation can contribute to minimizing deployment or modernization costs.

Different authors agree that Cloud Computing can offer useful opportunities for both government and non-governmental sectors. Literature studies touch on a variety of aspects, such as the delivery of services and the work efficiencies of sectors. For example, Stefanovic et al. (2016) identify some of the advantages offered by Cloud Computing, such as: its opportunities in making storage, processes, and communication more accessible to organisations, government agencies, and individuals; the cloud service can become accessible from any place at any time, and particularly for addressing problems in rural areas, such as lack of institutional capacity and skills. Nieuwenhuisa, Ehrenhardc, and Prausec (2018) include that the opportunity of Cloud Computing is changing the traditional way of providing software and IT systems to users.

Deb (2017) also point to some of the advantages of Cloud Computing, including: low upfront cost; increased economies of scale; scale up/down of infrastructure based on requirements; speed and agility; lower IT infrastructure management; better reliability; improved security; and compliance.

Some commonalities is seen in providing the potential advantages of Cloud Computing among the published literature studies. For example, Bassett (2015) refers to 10 common potential advantages of Cloud Computing, some of which include flexibility and scalability; cost effectiveness, disaster recovery, and business continuity and security improvement; business processes improvement; reliability and availability; and Green IT.

Success in the adoption and implementation of Cloud Computing will require gaining a better understanding, not only of the potential advantages, but also of the risks and challenges that can be gained through an investigation into various issues associated with the adoption of Cloud Computing.

Similar to any other implementation and use of new ICTs, Cloud Computing can face challenges linked to successful adoption, implementation, and use. Puthal et al. (2015) mention that the use of Cloud Computing is facing emerging issues such as privacy and trust, security, Internet broadband, and economic development. Kruger (2014) also lists some of the challenges of Cloud Computing as: security concerns, lack of control, issues related to data protection, the vulnerability of Internet protocol, data recovery aspects, and billing evasion as new opportunities for criminals and terrorist groups.

A summary of the most common advantages, challenges, and risks of Cloud Computing, as identified from various literature studies and incorporated for the purpose of this research, is depicted in Table 3-11.

Table 3-11: Summary of advantages and challenges of Cloud Computing

Study	Cloud Computing advantages	Cloud Computing challenges and risks
(Deb, 2017, p. 497)	Low upfront cost; increased economies of scale; scale infrastructure up or down based on requirements; speed and agility; lower management of IT infrastructure; reliability, security, and compliance.	-
(Mwansa, 2015, p. 2)	Cost saving; access from anywhere; convenient; on-demand; collaboration; green computing.	Security concerns; data ownership; data interoperability and lock-in; maturity of service and support; online connectivity problems, guidance, and standard issues.
(Mustafa et al., 2015, p. 2)	Cost effectiveness, improved computation efficiency.	Security concerns (keys/passwords are managed poorly; service-level agreements are not clear; lack of service-oriented architectures); compliance issues; jurisdiction issues.
(Kruger, 2014, pp. 1-22)	Large amounts of data can be stored and privately accessed; cost savings.	Lack of control, security, and data protection. Vulnerability of Internet Protocol; data recovery; metering/billing evasion has a new means for criminals and

Study	**Cloud Computing advantages**	**Cloud Computing challenges and risks**
		terrorists groups to share and maintain information.
(Mohlameane & Ruxwana, 2014, p. 9)	Minimize capital expenditure; scalability; anywhere access; quick and easy implementation.	Issues of security, compatibility, usability, reliability performance and availability of cloud services; bandwidth cost, quality, connectivity speed; industry regulation and compliance (Song).
(Shahzada, 2014, p. 358)	Enhances collaboration; agility; scaling; availability; cost reduction; optimized and efficient computing.	Security and privacy concerns.
(Youssef, 2012, p. 838)	SaaS advantages: no need to buy licenses; no need to install, upgrade, maintain or run software; multitenant efficiency, configurability, scalability; PaaS advantages: enabling to design, model, develop and test applications on the Cloud, collaboration.	Issues of security and privacy.
(Bollineni & Neupane, 2011, pp. 17-18)	Easier to manage power; easily scale up or down; non-restricted data storage; proper disaster recovery; better efficiency; more reliable; minimized cost for user and provider; going green.	Lack of trust (privacy issue); data lock-in; lack of adequate security; high speed connectivity; greater bandwidth; licensing issues to Utility Computing; security issues.
(Michael et al., 2010, pp. 52-53)	Decrease in cost of electricity; network bandwidth, operations, software, and hardware available at very large economies of scale; increased utilization; access the service 'anytime, anywhere'; share data and collaborate more easily; and keep their data stored safely in the infrastructure	Business continuity and service availability; data lock-In; data confidentiality and auditability; performance unpredictability, bugs in large distributed systems; scaling quickly; reputation fate sharing; software licensing issues

Were the components are aimed at including not only the major models, but also other architecture components of Cloud Computing, these include other basic components that need to be considered, such as: security standards, and rules and regulations.

The thesis thus summarises the most relevant components and uses a combination of the characteristics, concepts, models, and various related aspects that are most relevant to the field of interest. This discussion is presented in the next section.

3.6 SUMMARIZING PREVIOUS RESEARCH FINDINGS AND STRUCTURING THE COMPONENTS OF CLOUD COMPUTING

Many authors have highlighted that the architectural components of Cloud Computing include hardware, software, as well as their residing data centres and Cloud Computing models: service models, deployment models, and business models. For simplicity, this thesis summarises the vital components of Cloud Computing, as extracted from existing research, in Table 3-13. This structures the most relevant components of Cloud Computing, and identifies the components that will be used in developing the initial Cloud Computing framework in RCEs for facilitating eGovernment services, which is presented in Chapter 6.

The seven most relevant components identified for the purposes of this research is based on Michael et al. (2010), and to some extent, on the National Institute of Standard and Technology, Berge (2016), together with other literature sources.

Among the following major components, issues to be considered during the adoption and deployment of the Cloud Computing are included as Consideration (see № 5) and Principles (see № 6); the Principles are included to help users to identify the principles that should be followed in the adoption, deployment, and use of Cloud Computing:

- Essential Characteristics;
- Models;
- Technology Architecture;
- Interaction interfaces;
- Considerations; and
- Principles.

Each major component consists of a number of sub-elements, as presented in Table 3-12.

Table 3-12: Summary of the most relevant components of Cloud Computing to this study

Vital Component	Source & Description
Essential Characteristics	
On-demand service Broad network access Rapid elasticity Resource pooling Measured service	These are the most widely mentioned Cloud Computing characteristics that essentially resemble the characteristics discussed by Berge (2016, pp. 2-3), and are referenced in many literature sources (Bassett, 2015;

Vital Component	Source & Description
	Khan & Alam, 2017; Mijumbi, Serrat, Gorricho et al., 2015; Mustafa et al., 2015).
Models	
SaaS and IaaS: Service models Public & Community: Deployment models	These are the most widely mentioned Cloud Computing models that are most relevant to this thesis. The models offered by the NIST (Berge, 2016) are considered by many as a widely accepted approach (Al-Ruithe, 2018; Kruger, 2014; Mohlameane & Ruxwana, 2014; Santos et al., 2016; Shahzada, 2014; Zhang, 2010).
Technology Architecture	
Data centres Virtualised hardware and network infrastructure Application software	These represent the most widely mentioned Cloud Computing technology that is most relevant to this thesis. Cloud service can be provided to users as an on-demand service that uses cloud technology and may include application software, virtualised hardware, and network infrastructure in data centres (Bassett, 2015; Ghosh, 2010; Jing et al., 2013; Khan & Alam, 2017; Michael et al., 2010; Mijumbi et al., 2015; Mohlameane & Ruxwana, 2014; Mwansa, 2015; Shahzada, 2014; Stefanovic et al., 2016; Sun et al., 2014; Wang et al., 2010; Wyld, 2009; Zhang, 2010).
Interaction interfaces	
Smart phones, tablets, notebooks & Personal computers	These are the most widely discussed interaction interfaces that are most relevant to this thesis. Users can access Cloud Computing services via interactive interfaces such as laptops, desktops, personal digital assistants (PDAs), and smart phones (Mouradian et al., 2017; Mwansa, 2015).
Considerations	
Risks and challenges Service Level Agreements (SLAs)	The adoption and use of Cloud Computing may require some aspects that need to be properly considered. Risks and challenges are the most widely discussed aspects that require a significant focus (Bassett, 2015; Majhia, Patrab, & Dhalc, 2016; Shahzada, 2014; Stefanovic et al., 2016). The adoption and use of Cloud Computing also require Service Level Agreements (SLAs) (Deb, 2017; Gunka, Seycek, & Kühn, 2013; Sabri, 2015).
Principles	
Availability Performance Security	The adoption and use of Cloud Computing also require basic principles to be followed. Availability, Performance, and Security are the most widely discussed principles that should be focused on during the adoption and use of the cloud (Deb, 2017; Gunka et al., 2013; Michael et al., 2010; Sabri, 2015).

3.6.1 Component: Characteristics

In order to generate preliminary insights into the characteristics of Cloud Computing, it may be useful to deeply investigate the papers presented in Table 3-12. These include one of the reference sources of this thesis, namely, the National Institute of Standards and Technology, Berge (2016), which presented the Cloud as a composition of five essential characteristics. It further includes some of the NIST's successions, which cited NIST in describing the characteristics of Cloud Computing.

Accordingly, by essential characteristics, Cloud Computing is classified as: on-demand self-service, broad network access, rapid elasticity, resource pooling, and measured services. The discussion of these essential characteristics is provided below.

On-demand self-service: refers to cloud services that are accessed when required and released when not required by users. In contrast, pay only for use (also known as pay as you go) refers to the cloud concept that, instead of buying and renewing licenses, users pay only for the service that they use (Khan & Alam, 2017).

Broad network access: refers to the capability of Cloud Computing that enables cloud users to access cloud services from a pool of resources by using a variety of devices or access media such as desktops, laptops, tablets, and smart phones (Bassett, 2015).

Rapid elasticity: Based on users' demand for access to computing resources, resources can rapidly be increased (provisioned) or decreased (released). Users can add and remove the services and/or infrastructure that they are accessing based on their needs and can pay only for what they use (Shahzada, 2014). In such circumstances, investment in idle computing resources is not required. Users gain significant cost savings.

Resource pooling: Refers to the physical and virtual computing resources that represent an easily accessible and usable pool of hardware, software, and applications. These resources are location-independent in the sense that the user generally has no control over, or knowledge of, the location of resources (Singh et al., 2016).

Measured service: The usage and quality of Cloud Computing resources can be monitored and controlled with the metering capability of services. This Cloud Computing characteristic can also report resource usage based on a pay-per-use model for both the user and the provider of the infrastructure (Mijumbi et al., 2015).

Cloud models are discussed here to provide a better understanding thereof and to assist with answering the first sub-research question.

In order to represent the various models of Cloud Computing in an easier and more understandable manner, two major end points of the Cloud Computing environment can be considered: the cloud provider who owns the shared pool of ICT infrastructure (hardware, network, storage, and application), and the cloud user who owns media devices to access cloud services and who pays based on demand for the scaled-up or scaled-down service. The intermediary between these two end points can be considered as the actual services offered to users via the Internet or Intranet, and made available from the shared pool of ICT infrastructure (hardware and software application), which includes SaaS or IaaS (see Figure 3-5) (Al-Ruithe, 2018; Al-Ruithe, Benkhelifa, & Hameed, 2018; Deb, 2017; Michael et al., 2010).

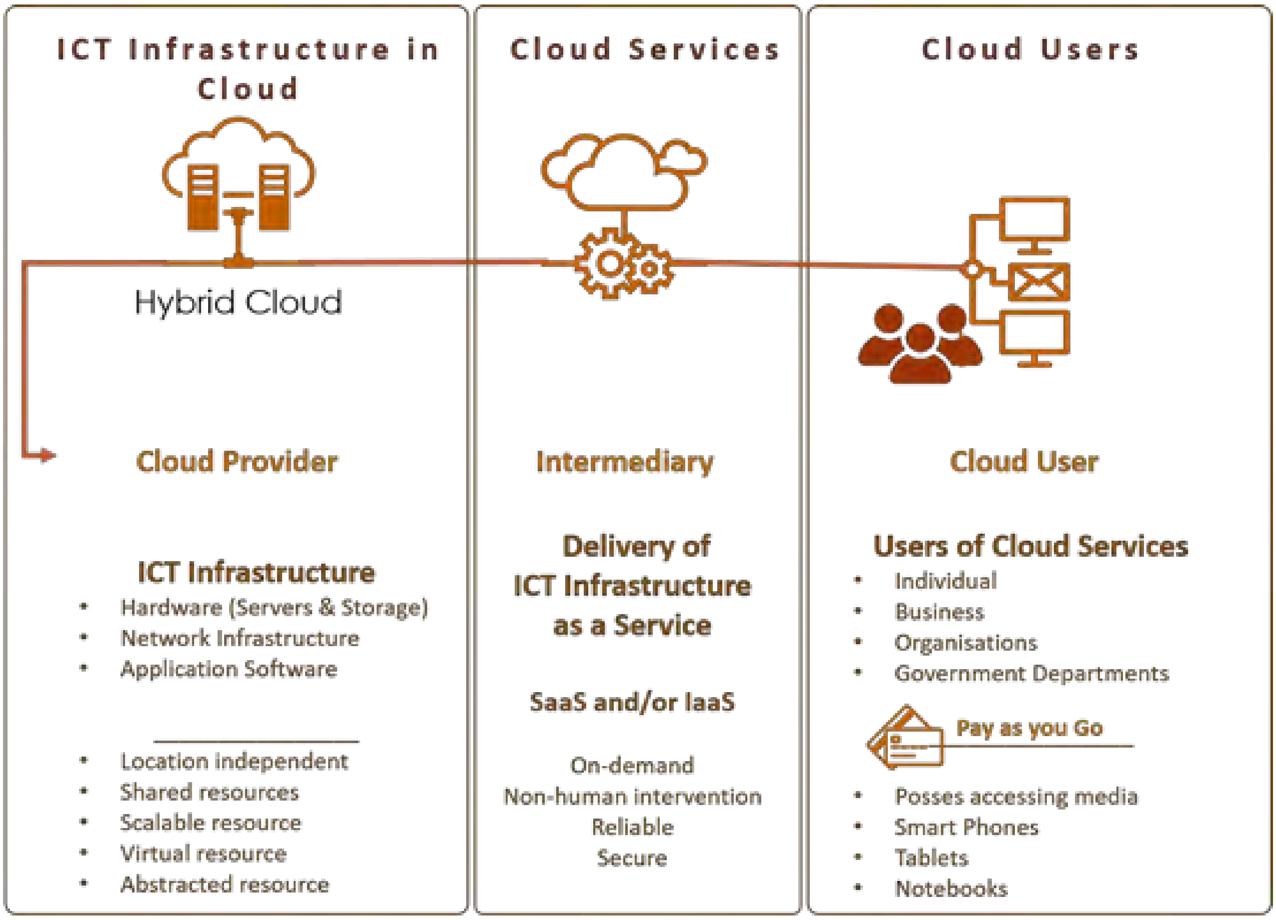

Figure 3-5: A diagram outlining the basic concepts of Cloud Computing

3.6.2 Component: Models

As this study preferred WoredaNet (the Ethiopian government network, which provides services, infrastructure, and applications) as unit of study, it focuses on hardware (including the data entries) and the applications/systems software that are delivered as services within this particular context.

This thesis thus considers the two most relevant major groups of models: the cloud service model and the cloud deployment model (see Figure 3-5). In this regard, one of the vital components of Cloud Computing becomes the cloud service model, which includes only two known service models (SaaS and IaaS); the preferred approach does not include other fragmented types of service models, such as PaaS or HaaS.

The cloud service models (SaaS and IaaS) are based on services offered by cloud service providers, such as application/software, tools for software development (operating systems, services, applications), and virtual machines such as virtual servers and storages (Almudarra & Qureshi, 2015).

While IaaS is considered as a large set of computing resources that are made available through dynamically managed (assigned and resized) virtualisation based on user needs, Software as a Service (SaaS) is considered as the model that provides the software applications that can be directly used, such as locally installed software applications.

The second major component of Cloud Computing models is the Cloud deployment model, which can be considered as a type of cloud environment (Mouradian et al., 2017).

The public or community cloud models are considered as the most relevant Cloud Computing deployment models for this thesis. In the public model, cloud services are made available to the general public over the Internet for public use. The service provider owns and manages the cloud (physical resources), and makes cloud services available in a pay-as-you-go manner. Via the multi-tenancy model, the cloud resources are shared by multiple organisations. The public cloud makes government cloud services available to the general public and resembles the WoredaNet context discussed in Chapter 5. The community cloud can include one sub-cloud for local users, and the cloud services can also be shared by multiple organisations that have the same requirements or similar policy, mission, and security requirements (Senyo et al., 2018; Youssef, 2012). Different Cloud Computing deployment models (private and public), with similar capabilities and infrastructure, can be combined to form the hybrid cloud (Singh & Chatterjee, 2017).

3.6.3 Component: Technology Architecture

The cloud technology architectures are discussed here to provide a better understanding of the technology architecture requirements of Cloud Computing and to assist with answering the first sub-research question.

Cloud Computing is a technology that enables access to applications and services via the Internet from devices housed at a data centre. Together with other technologies (virtualisation and abstraction), it is capable of dynamically allocating resources, including hardware, software, and the actual service and applications that are hosted by the data centres (Khan & Alam, 2017; Nieuwenhuisa et al., 2018).

The most relevant aspects of the technology architecture of Cloud Computing, as are widely discussed by different authors and as identified by this thesis, include: data centres (with Utility Computing including servers, storage, and network utility), virtualisation (virtualised data centre infrastructure), and application software (Hudic et al., 2017; Jing et al., 2013; Mbuba & Wang, 2014).

The most relevant technology architectures to this thesis are thus classified as:

- Data centres;
- Virtualised hardware and network infrastructure; and
- Application software.

Data centres: a data centre can be seen as one of the major parts of Cloud Computing technology architecture, which is used to house all other cloud infrastructure, such as the servers, network devices (such as firewalls, routers, switches, etc.), storage systems, hardware, and systems software that are used to provide cloud services. Mustafa et al. (2015) described today's Cloud Computing as an enabler of sharing computing resources based on back-end data centres, consisting of thousands of hierarchically connected devices such as switches and servers. Mwansa (2015) also describes data centres as infrastructure that is required by the services offered through Cloud Computing.

A data centre as a vital component of Cloud Computing, which comprises virtual and physical IT resources that can be designed and implemented with a composition of physical and/or virtual computing resources. Different authors agree that its building blocks usually include the house itself, a number of racks to hold servers, storage systems, and network devices such as firewalls, UTMs, routers, and switches, network connectivity cabling, and electric power cabling (Hudic et al., 2017; Mustafa et al., 2015; Singh & Chatterjee, 2017).

A data centre has the capability of dynamic capacity allocation to internally hosted applications, such that utility can be maximised or minimised based on the workload (Shojaiemehr, Rahmani, & Qader, 2017). For this purpose, a data centre's architecture may consist of modular architecture with different building blocks, which comprises different layers. According to Zhang (2010), an access layer consists of servers that are interconnected via access switches and housed in rack cabinets. A second layer, known as an aggregation layer, consisting of a number of aggregation switches connected to the access switches, core or other aggregation switches, accounts for server load balancing and domain name services. A third layer, the core layer, which consists of routers connected to the aggregation switches, manages traffic into and out of the data centre (Zhang, 2010).

Virtualised hardware and network infrastructure: according to (Shahzada, 2014, p. 359), "There need to be mechanisms to ensure strong isolation, mediated sharing and communications between virtual machines. This could be done using a flexible access control system to enforce access policies that govern the control and sharing capabilities of VMs within a cloud host".

As pointed out by some existing literature, virtualisation can enable the creation of virtual hardware and thus provide flexible and scalable computing platforms. VMware, Xen, and Microsoft's Hypervisor software platforms are used to create virtual machines and offer virtualised IT infrastructures on demand. Virtualisation techniques can thus be considered as the bases of Cloud Computing, also due to the capability of offering flexible and scalable hardware services that allow users to run operating systems and applications while restricting their ability to control the deployed applications that are available on virtual machines (Mustafa et al., 2015; Singh & Chatterjee, 2017). This implies that virtualisation can be considered as one of the major components of the cloud architecture that abstracts ICT resources of data centres (Vasista) and creates a pool of resources.

Mustafa et al. (2015) described the term abstraction as the encapsulation of infrastructure and the details of systems from users and developers. These authors further described the concept of abstraction in more detail as "While abstraction may traditionally refer to concealing details from the user, here, it is used in the sense that users are entitled to a significantly larger chunk of IT resources and abstract the unnecessary technical clutter behind services, but also offer a huge leap in device performance and user experience. Coupled with learning and growing self-awareness, networked devices of the future are expected to perform at par with small-scale data-centres" (Mustafa et al., 2015, p. 13).

Application software: Various sectors such as education, business, and health care are provided different online cloud application software, according to their needs. For example, Software as a Service (SaaS) provider is offering application software, including operating systems, where users can access software applications through the Internet by using a Web browser (Youssef, 2012). On the other hand, PaaS providers offer application platforms for multiple applications such as Java Virtual Machine (JVM) and .NET. The current well-known software providers have been offering their application software and services in the Cloud, for example, CRM, ERP, Office 365, Google doc, Dropbox, and others, as Utility Computing (Senyo et al., 2018; Singh et al., 2016).

3.6.4 Component: Considerations

Considerations in the adoption and use of Cloud Computing are discussed here to provide a better understanding of the vital factors in terms of the components of Cloud Computing, and to assist with answering the first sub-research question.

Considerations for the components of Cloud Computing can be classified as: risks and challenges and Service Level Agreements (SLAs). Risks and challenges may be considered during the adoption and implementation of Cloud Computing. Stefanovic et al. (2016) illuminate that the adoption process of Cloud Computing usually faces security challenges, privacy issues, and cloud service unavailability challenges. To address such risks and ensure high level security and privacy, users of cloud services and service providers may reach a Service Level Agreement (Singh & Chatterjee, 2017).

Security concerns could be one of the most widely considered issues for the users of Cloud Computing; these are created by breaches and hackers. Guarantees should be offered by cloud service providers to ensure confidentiality (Harmon, 2018; Hudic et al., 2017). According to (Michael et al., 2010, p. 55), “The cloud user is responsible for application-level security while the cloud provider is responsible for physical security and likely for enforcing external firewall policies”.

In terms of security issues, Singh and Chatterjee (2017), pointed out that Service Level Agreements (SLAs) can be a vital consideration due to the loss of direct control over data and information by users of the Cloud in the Cloud Computing environment. The SLA can thus be used as a basis for checks and balances in the expectations of the service between the cloud user and the provider. The agreement needs to state what services will be provided, how they will be provided, and what will happen if expectations are not met.

3.6.5 Component: Principles

The principles that might be focused on during the adoption and use of Cloud Computing are discussed here to provide a better understanding of the vital principles as components of Cloud Computing and assist with answering the first sub-research question.

The principles component of Cloud Computing can be classified as Availability and Performance considerations.

Availability: refers to the degree of accessibility of computing resources. For business-critical applications, high availability and performance need to be defined based on SLAs, as Cloud Computing can provide high availability of computing resources. Gunka et al. (2013) suggested in this regard that, during the implementation of the Cloud Computing to access applications, one of the objectives need to be to define high availability of the underlying infrastructure based on SLAs.

Performance: refers to existing useful opportunities of Cloud Computing, such as Improved VM Support; Flash Memory, and VMs for challenges of Cloud Computing performance (Michael et al., 2010). If performance becomes questionable in a system, it may degrade the entire service provision. In dynamic environments such as Cloud Computing, it is critical to reach a properly agreed SLA to ensure acceptable Quality of Service (QoS) for the required performance. Sun et al. (2014) discussed that when service users choose Cloud Computing services that best fit their requirements, QoS becomes key factors that should be guaranteed by service providers who allocate Cloud Computing resources dynamically for the service they provide.

Moreover, different authors commonly state that the application of virtual machines can be an opportunity in Cloud Computing that can significantly improve resource utilization for, and provide improved performance on resources and services (Bassett, 2015; Jing et al., 2013; Youssef, 2012).

Sun et al. (2014) discuss that experts need to be measured for defined attributes of QoS, and need to be compared with the Cloud Computing services for evaluation of the latter. Accordingly, this thesis argues that there should be key performance indicators as one component of the Cloud Computing environment so that Cloud Computing services or shared services can be monitored and measured and to determine whether or not Cloud Computing services are offered as per the contract agreement.

3.6.6 Component: Interaction interfaces

The interaction interfaces that might be used to access cloud services are discussed here in order to provide a better understanding of the available interaction interfaces as components of Cloud Computing, and to assist with answering the first sub-research question.

In terms of interaction interfaces, the components of Cloud Computing can include laptops, desktops, PDAs, and smart phones. These days, smart phones and laptops have become some of the most used interaction interfaces by which cloud services can be accessed. As elaborated by Mwansa (2015), users can now use their personal computers as well as smart phones and tablets to access computing services, computing storage, and applications from Cloud Computing, even for the purpose of application development and processing.

These components will now be evaluated and ranked by 10 experts from the WoredaNet sites.

3.7 EVALUATING THE COMPONENTS OF CLOUD COMPUTING

The framework development is carried out in three stages (Figure 3-1), and three versions of the interim theoretical framework are presented.

A number of factors can be used to determine the success of information systems, and particularly Cloud Computing. The measurement factors for the successful implementation and use of information systems can be classified into different major components, including: information quality, system quality, service quality, use, and user satisfaction (Sabri, 2015). According to Sabri (2015), technical issues such as speed of response, ease of use, flexibility, and reliability can be measured by system quality, while information quality can be used to measure accuracy, usability, timeliness, completeness and portability. Service quality is a measuring factor that refers to the quality of services accessed by users.

Cloud Computing is one form of the IS that similarly has a number of features that are commonly provided by some authors, including cost, broad network access, rapid elasticity, flexibility, scalability, availability, resiliency, performance, security, portability, and reliability, that can be assured based on service level agreements (SLAs) (Deb, 2017; Mohlameane & Ruxwana, 2014; Senyo et al., 2018). Such useful features can be used to measure success factors such as improvement in productivity, reduction of cost, and user interests, and can indicate the success of Cloud Computing outcomes (Sabri, 2015).

The factors that have to be considered when evaluating or ranking the identified components of Cloud Computing (Figure 3-5; Table 3-13) from the scoping review in this chapter are provided below. The experts (Table 3-15) from the selected WoredaNet sites ranked these based on the importance of each to adoption and use of Cloud Computing.

Table 3-13: Success factors affecting Cloud Computing services

Main Category	Factors that affect Cloud Computing services
Cloud Computing	Efficiency of service delivery
	Reliability
	Availability
	Cost
	Security
	Privacy and trust
	Management support

Main Category	Factors that affect Cloud Computing services
	Quality of service
	SLAs

Participants had to evaluate Cloud Computing in terms of success factors in order to answer the following question: What importance does this attribute have, in respect to the eGovernment service in evaluation, to meet the technical implementation of Cloud Computing for facilitating eGovernment services in RCE that accomplish WoredaNet needs and goals. Table 3-15 provides a summary of the identified components from the scoping review in this chapter. It also provides the principal factors that influence eGovernment services in the adoption and use of Cloud Computing.

Table 3-14: Framing the theoretical framework of Cloud Computing

Major component of Cloud Computing	Sub-component of Cloud Computing	Principle factors that will influence eGovernment services in the adoption and use of Cloud Computing
Characteristics	On-demand service Broad network access Rapid elasticity Resource pooling Measured service	Efficiency
		Reliability
		Cost
		Security
		Management support
		Security
	SaaS, IaaS,	Efficiency of service delivery
		Reliability
		Availability
		Cost
		Privacy and trust
		Quality of service
		SLAs
	Public Cloud Computing and Community Cloud Computing	Security
		Privacy and trust
		Management support
		Availability
Technology Architecture	Data centres Virtualised hardware and network infrastructure Application software	Availability
		Cost
		Management support
		Performance
Interaction interface	Smart phones, tablets, notebooks & personal computers Web portals	Availability
		Cost
		Usability
Consideration	Risks and challenges	Security
		Availability

Major component of Cloud Computing	**Sub-component of Cloud Computing**	**Principle factors that will influence eGovernment services in the adoption and use of Cloud Computing**
	Service Level Agreements (SLAs)	

3.7.1 Experts who evaluated the components of V1 of the interim theoretical framework

As stated in Section 2.6.2 (Table 3-15), 10 experts were selected for evaluating the components of Cloud Computing: four are top-level managers (directors), four are middle managers of different ICT sectors and PSOs, and two are ICT personnel or technical staff with low-level management responsibilities, selected from the local Woreda centres of different regions. The questionnaires provided to these experts are depicted in Appendix A.

Table 3-15: Experts selected for Cloud Computing compo

Participants	Occupation	Age	Gender	Level	Education	Workplace	Experience
Part 1	Director	> 50 Years	Male	Top level Mgt.	Doctorate degree	Federal Govt ICT sector	8-10 years
Part 2	Director	40-50	Male	Top level Mgt.	Master's Degree	Federal Govt Ministry office	8-10 years
Part 3	Director	40-50	Female	Top level Mgt.	Master's Degree	Federal Govt PSO	6-8 years
Part 4	Director	30-40	Male	Top level Mgt.	Master's Degree	Regional Govt ICT	6-8 years
Part 5	Manager	25-30	Female	Middle level Mgt.	BSc Degree	Federal Govt ICT	4-6 years
Part 6	Manager	40-50	Male	Middle level Mgt.	Doctorate degree	Federal Govt ICT sector	8-10 years
Part 7	Manager	40-50	Female	Middle level Mgt.	BSc Degree	Federal Govt Ministry office	8-10 years
Part 8	Manger	40-50	Male	Middle level Mgt.	BSc Degree	Federal Govt PSO	6-8 years
Part 9	ICT personnel	30-40	Male	Low level Mgt.	Master's Degree	Federal Govt ICT Sector	4-6 years

Participants	Occupation	Age	Gender	Level	Education	Workplace	Experience
Part 10	ICT personnel	25-30	Female	Low level Mgt.	BSc Degree	Local Woreda ICT Centre	4-6 years

3.7.1.1 Gender

Four (40%) females and six (60%) males participated in the study to evaluate the components of Cloud Computing.

3.7.1.2 Age range of Ethiopian experts in Cloud Computing

Two (20%) experts who participated in the component assessment of Cloud Computing were in the age range of 25 to 30 years, two (20%) were in the age range of 30 to 40 years, five (50%) were in the age range of 40 to 50 years, and one (10%) participant was over 50 years old. This indicates that experts of different ages participated in the assessment of the components of Cloud Computing.

3.7.1.3 Occupation of experts in Cloud Computing

Four (40%) directors, four (40%) managers, and two (20%) ICT professionals (technical staff with low-level management responsibilities) participated in evaluating the components of Cloud Computing, indicating that experts from different occupations and with different managerial levels participated in assessing the components of Cloud Computing.

3.7.1.4 Years of Experience of experts in Cloud Computing

Four (40%) experts had 8 to 10 years' experience in the ICT sector, three (30%) had 6 to 8 years' experience, and three (30%) had 4 to 6 years' experience in the ICT sector. It is evident that the experts who participated in evaluating the components of Cloud Computing in the study had different levels of work experience.

3.7.1.5 Education of experts in Cloud Computing

Two (20%) experts with PhD degrees, four (40%) with Master's degrees and four (40%) with BSc degrees rated the components of Cloud Computing. This shows that experts with different levels of qualification participated in the evaluation of the components of Cloud Computing.

3.7.1.6 Work Context of Ethiopian experts in Cloud Computing

All 10 (100%) experts who participated in ranking the components of Cloud Computing for this study work at WoredaNet and the government ICT sector.

3.7.1.7 Development of the Questionnaires for the Components on Cloud Computing

In order to validate the draft framework and the components of Cloud Computing and to get feedback, some questionnaires were generated based on a number of success factors of Cloud Computing, to assess the vital components of Cloud Computing that could be considered by various stakeholders of WoredaNet for the adoption and use of Cloud Computing for efficient eGovernment service delivery

The first version of the working draft of the interim theoretical framework was supplemented with the feedback obtained from the evaluators. The feedback is depicted in the feedback column of Table 3-16.

3.7.1.8 Findings from the Questionnaires of Cloud Computing

This section provides findings that the experts provided based on the different components of Cloud Computing.

Each of the three versions of the working draft of the conceptual frameworks are thus supplemented with the evaluator's feedback column in Table 3-16. The experts were requested to rate the stated factors (some of the factors are listed in the table) according to their opinion about the following rating scale:

- Very important;
- Important;
- Less Important;
- Not important; and
- Neutral

Table 3-16: Attributes for expert reviews for Cloud Computing components

Component of Cloud Computing	**Principle factors that will influence the eGovernment services with the adoption and use of Cloud Computing**	**Feedback from evaluator**				
		Please mark the column that express the importance of the factor in your opinion				
		Very Important	**Important**	**Less Important**	**Not Important**	**Neutral**
SaaS, IaaS	Efficiency of service delivery					
	Reliability					
	Availability					
	Cost					
	Security					

Component of Cloud Computing	Principle factors that will influence the eGovernment services with the adoption and use of Cloud Computing	Feedback from evaluator Please mark the column that express the importance of the factor in your opinion Very Important	Important	Less Important	Not Important	Neutral
	Privacy and trust					
	Management support					
	Quality of service					
	SLAs					
Public, Private, Community and Hybrid Cloud Computing	Security					
	Privacy and trust					
	Management support					
	Availability					
Technology for eGovernment	Availability					
	Cost					
	Management support					
	Performance					
Interaction interface	Availability					
	Cost					
	Usability					
RCEs	On availability					
	On Cost					
	On Quality of service					
	On Efficiency of service delivery					

Six experts ranked *on-demand service* as a very important component, while four experts ranked it as an important characteristic component of Cloud Computing relevant to the context of Ethiopia in general, and to the WoredaNet context in particular. All 10 experts ranked *broad network access* as a very important characteristic component of Cloud Computing relevant to the context of Ethiopia in general, and to the WoredaNet context in particular. Six experts ranked *rapid elasticity* as a very important characteristic component of Cloud Computing and three ranked it as an important characteristic component, while one expert responded as neutral. Six experts ranked *resource pooling* as a very important component and four experts ranked it as an important characteristic component of Cloud Computing relevant to the Ethiopian context in general, and to the WoredaNet context in particular. Three experts ranked *measured service* as a very important component and six experts ranked it as an important characteristic component, while one expert ranked it as a less important characteristic component of Cloud Computing relevant to the Ethiopian context in general, and to the WoredaNet context in particular. Five experts ranked *infinite computing resources* as a very important component, three experts ranked it as an important component, while two experts ranked *infinite computing resources* as a less important characteristic component of Cloud Computing relevant to the Ethiopian context in general and the WoredaNet context in particular.

The findings validate *on-demand service, broad network access, rapid elasticity, resource pooling, measured service*, and *infinite computing resources* as characteristic components of Cloud Computing that are relevant to the Ethiopian context in general, and to the WoredaNet context in particular. This is because the majority of the experts believe that these components are either highly or moderately important within the Ethiopian context. The concepts are thus retained.

Seven experts ranked *SaaS* as a very important model component of Cloud Computing, and two experts ranked it as an important model component, while one expert was neutral. Five experts ranked *IaaS* as a very important model component of Cloud Computing, three experts ranked IaaS as an important model component of Cloud Computing, and two ranked it as a less important component of Cloud Computing. Seven experts ranked PaaS as a less important model component of Cloud Computing, and two experts ranked it as an important model component, while one expert was neutral.

Nine experts ranked *public Cloud Computing* as a very important model component of Cloud Computing, while one ranked it as an important model component. Seven experts ranked *community Cloud Computing* as very important, and two experts ranked it as an important model component of Cloud Computing, while one expert was neutral. Eight experts ranked *private Cloud Computing* as a less important model component of Cloud Computing, while two ranked *it* as a non-important model component. Seven experts ranked *hybrid Cloud Computing* as very important and three experts ranked it as an important model component of Cloud Computing.

The findings validate *SaaS* and *IaaS*, as well as *public* and *community Cloud Computing*, as model components of Cloud Computing that are relevant to the Ethiopian context in general, and to the WoredaNet context in particular, because most of the experts believe that *SaaS*, *IaaS*, *public cloud* and *community Cloud Computing* are either highly important or moderately important within the Ethiopian context. The concepts are thus retained.

PaaS, and *private Cloud Computing* are moderately less important within the Ethiopian context. The concepts are thus excluded.

Table 3-17 Experts rating of the factors of Cloud Computing

#	Questionnaires	Cloud Computing components	Feedback/number of experts responded to:									
			Very important		Important		Less important		Not important		Neutral	
			Fq	%	Fq	%	Fq	%	Fq	%	Fq	%
1	…as characteristic component of Cloud Computing relevant to the context of Ethiopian in general and to the WoredaNet context in particular	'On-demand service'	6	60	4	40						
2		'Broad network access'	10	100								
3		'Rapid elasticity'	6	60	3	30					1	10
4		'Resource pooling'	6	60	4	40						
5		'Measured service'	3	30	6	60	1	10				
6		'Infinite computing resources'	5	50	3	30	2	20				
7	…as model component of Cloud Computing relevant to the context of Ethiopian in general and to the WoredaNet context in particular	'SaaS'	7	70	2	20					1	10
8		'IaaS'	5	50	3	30	2	20				
9		'PaaS'			2	20	7	70			1	10
10		'Public Cloud'	9	90	1	10						
11		'Private Cloud'					8	80	2	20		
12		'Community Cloud'	7	70	2	20					1	10
13		'Hybrid Cloud'	7	70	3	30						
14	… as technology component of Cloud Computing relevant to the context of Ethiopian in general and to the WoredaNet context in particular	'Data centres'	9	90			1	10				
15		'Virtualised hardware and network infrastructure'	7	70	1	10	2	20				
16		'Application software'	5	50	5	50						
17	…as interaction interface component of Cloud Computing relevant to the Ethiopian	'Smart phones'	10	100								
18		'Tablets'	10	100								
19		'Notebooks'	8	80	2	20						
20		'Personal computers'	6	60	4	40						

#	Questionnaires	Cloud Computing components	Feedback/number of experts responded to:									
			Very important		Important		Less important		Not important		Neutral	
			Fq	%	Fq	%	Fq	%	Fq	%	Fq	%
	context in general and to the WoredaNet context in particular											
21	…as considered component of Cloud Computing relevant to the Ethiopian context in general and to the WoredaNet context in particular	'Service Level Agreements (SLAs)'	5	50	3	30					2	20
22		'Availability of services'	7	70	3	30						
23		'Performance of infrastructure'	7	70	2	20	1	10				
24		'Security'	10	100								
25	Any relevant components of Cloud Computing that have not been mentioned here in the above questions		None of the experts identified any relevant components of Cloud Computing that have not been mentioned here in the above questions									

Nine experts ranked *data centres* as a very important technology component of Cloud Computing, while one expert ranked it as a less important component. Seven experts ranked *virtualised hardware and network infrastructure* as a very important technology component of Cloud Computing and one expert ranked it as an important technology component, while two ranked *it* as a less important technology component of Cloud Computing. Five experts ranked *application software* as a very important component, while five experts ranked *this component* as an important technology component of Cloud Computing relevant to the Ethiopian context in general and to the WoredaNet context in particular.

The findings validate *data centres, virtualised hardware and network infrastructure,* and *application software* as technology components of Cloud Computing that are relevant to the Ethiopian context in general, and to the WoredaNet context in particular, as the majority of the experts believe that these components are relatively important within the Ethiopian context. The concepts are thus retained; Table 3-18 provides a summary of the responses of the experts in percentages from Table 3-17.

Table 3-18: Responses of experts expressed as percentages

Major Component	Sub-component	Very important	Important	Less important	Not important	Neutral
The characteristic component of Cloud Computing	On-demand service	60%	40%			
	Broad network access	100%				
	Rapid elasticity	60%	30%			10%
	Resource pooling	60%	40%			
	Measured service	30%	60%	10%		
	Infinite computing resource	50%	30%	20%		
Model component of Cloud Computing	SaaS	70%	20%			10%
	IaaS	50%	30%	20%		
	PaaS		20%	70%		10%
	Public Cloud Computing	90%	10%			
	Private Cloud Computing			80%	20%	
	Community Cloud Computing	70%	20%			10%
	Hybrid Cloud Computing	70%	30%			
Technology component of Cloud Computing	Data centre	90%		10%		
	Virtualised hardware and network infrastructure	70%	10%	20%		
	Application software	50%	50%			
Interaction interface component of Cloud Computing	Smart phones	100%				
	Tablets	100%				
	Notebooks	80%	20%			
	Personal computers	60%	40%			
Consideration component of Cloud Computing	SLAs	50%	30%			20%
	Availability of services	70%	30%			
	Performance of infrastructure	70%	20%	10%		
	Security	100%	100%			

All 10 experts commonly ranked both *smart phones* and *tablets* as very important interaction interface components of Cloud Computing relevant to the Ethiopian context in general and to the

WoredaNet context in particular. Eight experts ranked *notebook* as a very important interaction interface component of Cloud Computing relevant to the Ethiopian context in general and to the WoredaNet context in particular, and two experts ranked it as an important interaction interface component of Cloud Computing relevant to the Ethiopian context in general and to the WoredaNet context in particular. Six experts ranked *personal computers* as a very important interaction interface component of Cloud Computing relevant to the Ethiopian context in general and to the WoredaNet context in particular, and four experts ranked *personal computers* as an important interaction interface component of Cloud Computing relevant to the Ethiopian context in general and to the WoredaNet context in particular.

The findings validate *smart phones*, *tablets, notebooks and personal computers* as relevant interaction interface components of Cloud Computing relevant to the Ethiopian context in general and to the WoredaNet context in particular, as the majority of the experts believe that these components are highly important within the Ethiopian context. The concepts are thus retained.

Five experts ranked *Service Level Agreements (SLAs)* as very important, and three experts ranked it as an important consideration component of Cloud Computing relevant to the Ethiopian context in general and to the WoredaNet context in particular, while two experts were neutral. Seven experts ranked the *availability of services* as very important, while three experts ranked it as an important component of Cloud Computing relevant to be considered to the Ethiopian context in general and to the WoredaNet context in particular. Seven experts ranked the *performance of infrastructure* as very important, while two experts ranked it as an important component of Cloud Computing relevant to be considered in the Ethiopian context in general and to the WoredaNet context in particular, while one expert ranked it as less important. All 10 experts ranked *Security* as a very important component of Cloud Computing relevant to be considered in the Ethiopian context in general and to the WoredaNet context in particular.

The findings validate *service level agreements (SLAs), availability of services, performance of infrastructure,* and *security* as consideration components of Cloud Computing relevant to the Ethiopian context in general and to the WoredaNet context in particular, as the majority of the experts believe that service level agreements (SLAs), availability of services, performance of infrastructure, and security are very important within the Ethiopian context. The concepts are thus retained.

In general, the questionnaires for Cloud Computing requested participants to rank 24 components of Cloud Computing, and also to indicate any relevant component not listed. A total of 10 responses were received in evaluating each of the components of Cloud Computing. Based on the percentages of their responses in Table 3-17, the 20 components of Cloud Computing that are considered as relevant and important to the Ethiopian context are depicted in Figure 3-5.

3.8 VERSION 1 OF THE INTERIM THEORETICAL FRAMEWORK

Based on the most relevant components of Cloud Computing explored and identified by this thesis — which includes the essential characteristics, models, technology architecture, considerations, principles, and interaction interfaces (see Figure 3-6) — the initial framework for Cloud Computing was developed and presented in Chapter 6. This is proposed as a first version (Version 1: V1); the components illustrated as relevant components of Cloud Computing are summarised and depicted in Table 3-12. A diagrammatic representation of the most relevant components of Cloud Computing is depicted in Figure 3-6.

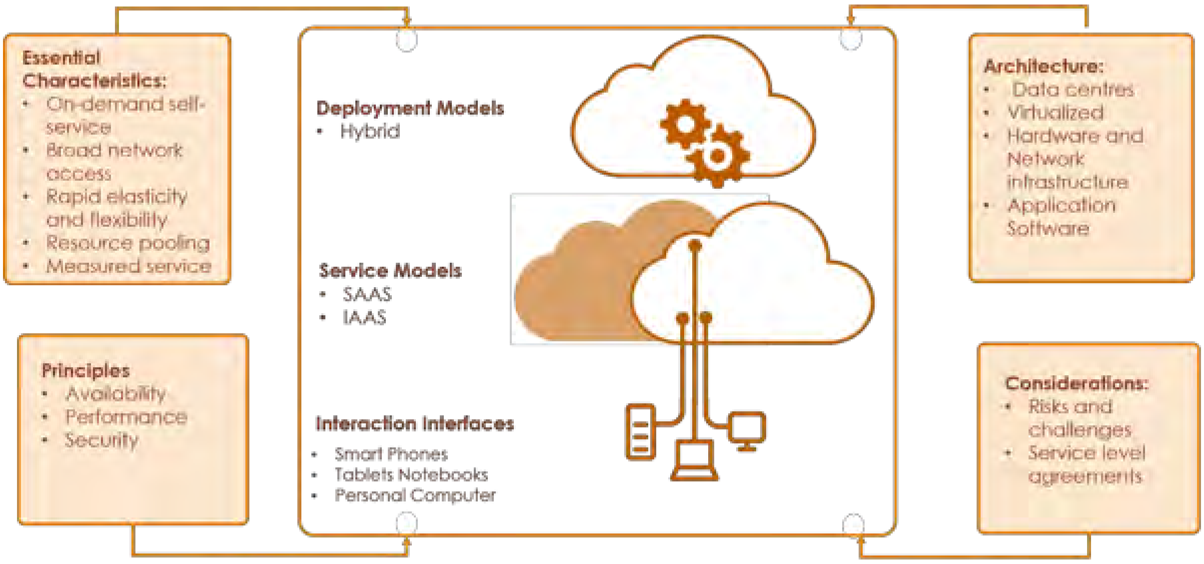

Figure 3-6: The most relevant components of Cloud Computing

3.9 CHAPTER SUMMARY

This chapter provided a scoping review, with rigorous methodology as adopted from a systematic review of the concepts Cloud Computing and state of the art of Cloud Computing. It offered a definition of Cloud Computing relevant to this study, and proposed a definition and the basic components for a Cloud Computing framework.

The following Chapter will provide an overview of the components and concepts of eGovernment services, as these are applied and used in the Ethiopian context and other developing countries. As a scoping review of existing frameworks of eGovernment services, the literature review provides answers to the second sub-research question of this study.

CHAPTER 4 SCOPING REVIEW: eGOVERNMENT FRAMEWORKS

4.1 OVERVIEW OF CHAPTER

This chapter contributes to the development of the revised version (second version) of the initial theoretical framework by including the relevant components from eGovernment concepts, as explored and identified in this chapter. To explore the most relevant existing frameworks for facilitating eGovernment services, the purpose is to determine which frameworks of eGovernment from the literature are relevant in practice within eGovernment services and to identify the most relevant components of eGovernment.

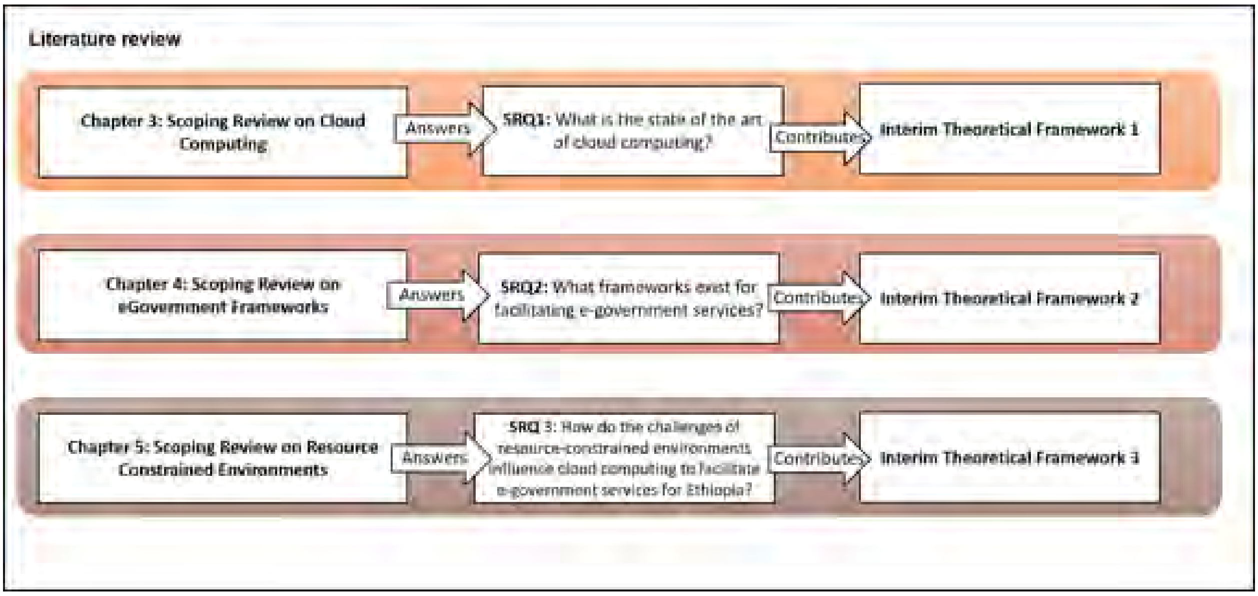

Figure 4-1: The literature review in Chapter 4 and its contribution

Figure 4-2 indicates the contribution of Chapter 4:

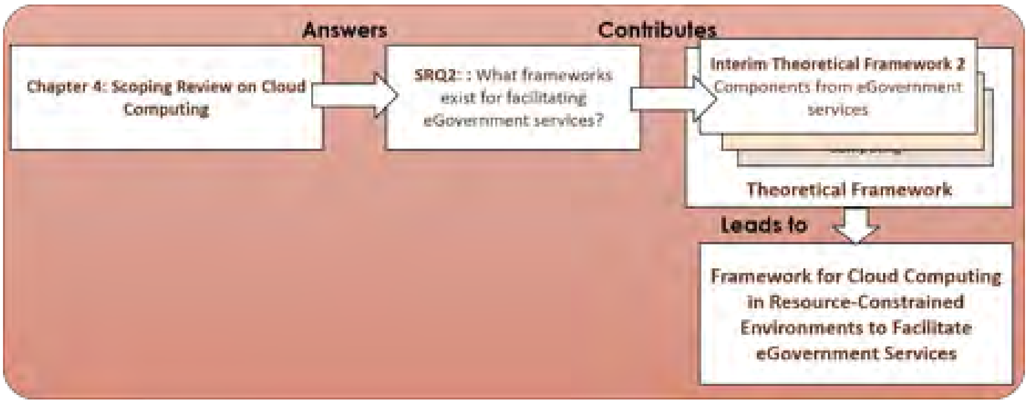

Figure 4-2: Chapter 4 scoping review on eGovernment

Table 4-1 summarises the sub-sections of Chapter 4.

Table 4-1: Summarised outline of the sub-sections into which Chapter 4 is divided

Chapter	Sub-Section	Focus area
	4.1	Provides an overview of the chapter.
	4.2	Presents and discusses the literature review method for this chapter.
	4.3	Conceptualizes eGovernment and presents a scoping review of eGovernment and eGovernment frameworks.
	4.4	Provides a summary of the research findings/existing frameworks with approaches for implementing Cloud Computing in eGovernment services.
Chapter 4	4.5	Based on the outcomes of Chapter 4, this sub-section outlines the advantages of Cloud Computing for eGovernment services.
	4.6	Presents the components of eGovernment that are applicable to this research.
	4.7	Presents conclusions and a summary of research findings, and proposes the most relevant components of eGovernment that can be used for the second revised version of the framework; it also discusses how the vital components (identified from Chapters 3 and 4) can be used as building blocks of the proposed frameworks.

4.2 SCOPING REVIEW IN CHAPTER 4

This chapter explores, identifies, and investigates the components of eGovernment, and also explores the uses, potential advantages, and possible challenges of eGovernment services.

The second objective of the thesis, as presented in the Introduction (see Section 1.2.1), is: "*to explore and identify relevant components of eGovernment*". In order to address this objective, a scoping literature review is preferred, with the methodological rigour adopted from a systematic review. Based on a rigorous methodology, the scoping literature review is an appropriate method because it meets the requirements of searching for relevant literature on eGovernment and eGovernment services. The scoping review is used to identify research studies that are very closely related to the topic of this thesis.

The scoping literature review is thus conducted to search, retrieve, and identify all relevant research about the evidence of *eGovernment* and *eGovernment services*, after which the publications were synthesised. The process of synthesizing the publications is exploratory and qualitative in nature. The findings of Chapter 4 are disseminated mainly in a tabular form and by some narrative presentation to frame the components to be used for the development of the second version of the proposed framework.

4.2.1 Identifying the Research Question

This Chapter aims to answer the second sub-research question:

What frameworks exist for facilitating eGovernment services?

The scoping literature review is applied to identify relevant models, concepts, and frameworks for facilitating eGovernment services among existing literature, and to address the second research question presented above; it intends to address the conceptualization of eGovernment services by:

- Identifying the scope and range of available literature;
- Summarizing and disseminating research findings; and
- Identifying the research gap in the existing literature.

4.2.2 Identifying Relevant Studies

The scoping review is conducted by searching various academic e-resources for research conducted on the various concepts related to eGovernment and eGovernment services. In order to select various disciplines, this thesis has sourced previous research theses and articles using online tools and sources such as UNISA's e-resources (IEEE xplorer, ScienceDirect, ProQuest, ACM, and SCOPUS). Google Scholar, hard copy texts, and suggestions from the researcher's advisors were also used to ensure that relevant literature was not omitted from the database search.

Endnote, together with the Publish or Perish (PoP) software, was used to identify high quality and relevant papers and documents on frameworks for facilitating eGovernment services. Publications between 2000 and 2018 were included, and the following keywords were used: 'eGovernment'; 'eGovernment services'; 'components of eGovernment services'; 'Cloud Computing and eGovernment services'; 'framework for facilitating eGovernment services'; 'characteristics of eGovernment services'; 'advantages and challenges of eGovernment services'; 'technologies of eGovernment'.

In addition, a search was conducted using the Google search engine, with the purpose of accessing all available relevant publications. More details on the inclusion and exclusion criteria can be found in Table 3-2 (Chapter 3).

The search retrieved 2291 results. After removing 2190 duplicate studies, screening for eligibility and relevance was conducted on the titles and abstracts of 101 studies.

Based on the exclusion criteria, 21 papers were excluded, leaving 80 studies. Next, 11 full-text papers of less relevance were also excluded (see Table: 4.3). This resulted in 69 full-text papers for inclusion in the exploratory qualitative analysis (see Table: 4.4).

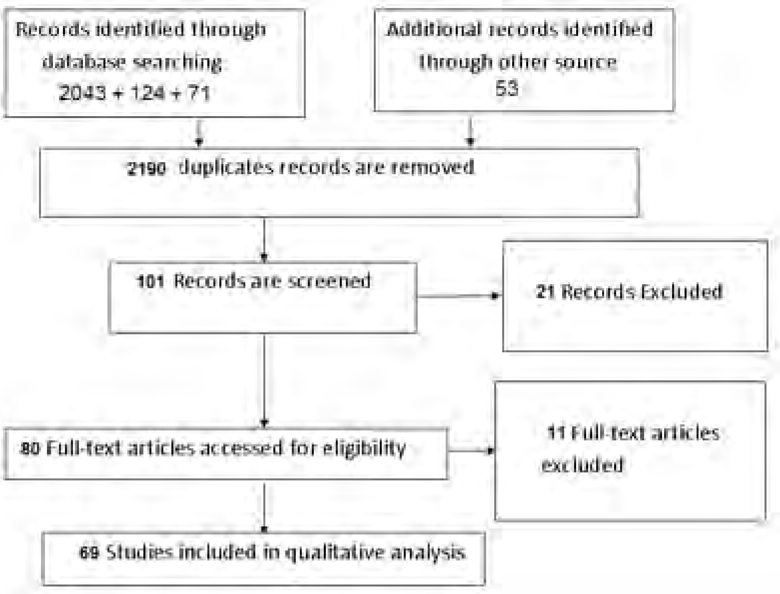

Figure 4-3: Search strategy and process for gathering the relevant publications

Table 4-2 outlines the 11 full-text publications that were excluded, and the reasons for their exclusion.

Table 4-2: The 11 full-text articles excluded and reasons for exclusion

Study	Title	Reason for exclusion
(Taipale, 2013, pp. 413-414) [pp.413-414]	The use of eGovernment services and the Internet	The focus of the study is not closely related to this thesis, "The role of socio-demographic, economic and geographical predictors, the study is premised on survey data (N=612) collected in Finland in 2011".
(Sideridis, 2013, p. 540)	eGovernment research and services in an era of economic crisis	The data collection is not closely related to this thesis (data collected from a U.S. municipal government; analysis was conducted on Websites). [p.540]
(Ayanso, Chatterjee, & Cho, 2011)	The global competitiveness report 2010-2011	Report is not recent.
(Chrysopouloua, Lefakisa, Andreopouloua, & Manosb, 2013, p. 629)	eGovernment and forest service: the case of the University Forest of Taxiarchis	Research field (Greek Forest sector) is to create a Web portal for the Forest Service of the University Forest of Taxiarchis. [p.629]

Study	Title	Reason for exclusion
(Stoicaa, Piticb, & Mihaescu, 2013, p. 760)	A novel model for e-Business and eGovernment processes on social Media	The purpose of the study (implications that social media have in the development of electronic business (e-business)) is not closely related to this study. [p.760]
(Thomasa, Basila, Christinaa et al., 2013, p. 372)	Measuring Users Satisfaction of an eGovernment portal	The focus of the study is not closely related to this thesis (the proposed multi criteria method the Multi Criteria Satisfaction Analysis (MUSA) is the synthesis of a set of customer preferences in a quantitative mathematical function value). [p.372]
(Diasa, 2014, p. 279)	Bibliometric analysis of Portuguese research in eGovernment	Articles analysed are not recent, and the focus of the paper is not closely related to this thesis (a bibliometric analysis of journal articles, conference papers, and book chapters in the subject of eGovernment). [p.279]
(Serra, Carvalho, Ferreira et al., 2015, pp. 348-349)	Accessibility evaluation of eGovernment mobile applications in Brazil	The focus of the study is too specific and also not closely related. The focus is on mobile applications (known as m-government): an evaluation of four eGovernment mobile applications in Brazil using mobile applications. [pp.349-348]
(Stefanovic et al., 2016, p. 719)	Assessing the success of eGovernment systems: an employee perspective	The aim of the thesis is not very closely related, and GIS is too specific (effectiveness of the Government Information System from the perspective of municipal government employees as the primary users). [p.719]
(Helingo, Purwandari, Satria, & Solichah, 2017, p. 406)	The use of analytic hierarchy process for software development method selection: a perspective of eGovernment in Indonesia	The purpose of the study is not closely related to this thesis (to determine the most suitable software development method for eGovernment in Kemlu). [p.406]
(Kassongo, Tucker, & Pather, 2018, p. 4)	Government-facilitated access to ICTs: adoption, use and impact on the well-being of indigent South Africans	The aim of the research is not closely related (to critically analyse the impact of the Cape Access intervention on the lives of poor citizens living in the Overberg region of South Africa). [p.4]

As depicted in Figure 4-3, the 69 full-text publications of studies chosen for inclusion in the exploratory qualitative analysis are summarised and presented in tabular form, based on the data chart outlined below.

4.2.3 Data Chart

The data chart for included publications is presented with information about the:

- Publication/title;
- Study (name of the author and publication date);
- Focus of publication;
- Purpose of publication;
- Basic concepts;
- Frameworks and models; and
- Findings of the study (characteristics, components, advantages, and challenges of eGovernment services).

The identified 69 full-text included papers can be found in Appendix G.

4.3 CONCEPTUALIZING eGOVERNMENT

As Kenenissa and Cho (2017) state, eGovernment has been suggested for better delivery of government service, so as to enhance citizens' trust in government through increased interactions and improved responsiveness. eGovernment is seen as closely related to the current growth of ICTs. In general, it can be recognised that the acceptance of ICTs by governments and non-government sectors has been increasing; this, in turn, has resulted in the current increased acceptance of eGovernment in various sectors (Zamani, Choudrie, Umeoji, & Adebola, 2017).

The growing acceptance of eGovernment may also be rooted in the benefits resulting from eGovernment around the world. Belachew (2010) and Gasovaa and Stofkovaa (2017) list some of the benefits of eGovernment, which might be the drivers of eGovernment acceptance: information and services can be made available to citizens and can easily be accessed via eGovernment; eGovernment work processes can be enhanced, as it can be supported with ICT artefacts; effective and efficient[f] government services can be made available; and the divide between urban and rural areas can be reduced.

[f] The word efficiency refers here to how well work processes are accomplished in government and PSOs, and effectiveness in its simplest form refers to the level of information and service that has an enormous impact on the quality of information or public services delivered to citizens, which often dictates user satisfaction. Efficiency in working processes is the time taken to conduct a particular working process in the general process of public service provision. Efficient working processes complete tasks in the shortest amount of time with the least possible resources by utilizing ICTs. Efficiency and effectiveness are quite interrelated, as efficiency improves working process and saves both time and money in successful and effective e-governance.

Given such benefits, many developing countries are giving more attention to the development and use of information and communication technologies (ICTs). As Lallmahomed, Lallmahomed, and Lallmahomed (2017) stated, the governments of developing economies are making efforts for the successful implementation of eGovernment through the application of ICTs, as they aim to deliver online electronic services to the general public and citizens.

Despite the considerable amount of effort that have been made during the past few decades, many developing economies have not had the same success rate from the implementation of eGovernment, compared to developed economies that usually have good implementation records and more successes. Komba (2013) mentioned that the success of adoption and use of eGovernment is better in developed than in the developing economies, as many of the developed countries have been successfully implementing eGovernment. Zhao, Shen, and Collier (2014) also highlighted a clear gap between developed and developing countries regarding the success of the development and use of eGovernment.

In addition, the economic growth and human development rankings of different countries, based on the assessment made by the United Nations' Division for Public Economics and Public Administration (Peña-López) in the year 2014, illustrate that the status of eGovernment was an indicator of the differing success rates among countries around the world in implementing eGovernment services (UNPAN, 2014).

While such rankings for economic growth and human development, which are usually set by NGOs such as the UNPAN, are recognised as implications for the success of eGovernment implementation, it seems that the governments of developing economies do not accept the measurements and ranks, which usually posits that the majority of the countries are unsuccessful.

This thesis argues that this non-acceptance may be due to the fact that, while NGOs, the United Nations, and other worldwide monetary organisations such as the World Bank have commonly set some success factors, many developing countries define their own different success factors (i.e., local measurement of success factors). As a result, developing economies' own rankings may not match those allocated to them by other parties.

This may create a debate between the governments of developing economies and many of the western organisations (e.g., NGOs), as the rank presented by the latter implies that the majority of developing countries are the least successful in the world matrix of eGovernment implementation, while many developing countries claim that they are indeed successful.

For future research, it can be argued that many of the developing economies have recognised the roles of ICT as vital to the improvement of internal work activities, and that they have been expending significant effort to implement the eGovernment system for improved efficiency and effectiveness of service delivery to citizens. In Ethiopia, as Woldemariam and Lessa (2011) mentioned, the government has recognised the vital role of ICTs and has been investing much to improve the ICT infrastructure and economy. They mention WoredaNet as an example of ICT initiatives made by government, and point out that WoredaNet was implemented to effectively and efficiently deploy eGovernment throughout the country. Adam (2014) illustrated this by discussing that the information and communication technology sector has shown remarkable growth over the past few years, and that the Ethiopian government has been investing significantly in communications infrastructure, human resources development, and e-applications.

This is not to say that all developing economies, including Ethiopia, have been successful in all aspects of eGovernment implementation and delivery of eGovernment services. Komba (2013) raised a number of factors, such as human development, ICT, political and economic concerns, and cultural environment as some of the challenging aspects that need to be considered for the adoption of eGovernment. According to Lallmahomed et al. (2017), eGovernment development among many governments of African countries is still characterized as unsuccessful because of a number of challenges, including lack of resources, infrastructure, and high costs of investment for eGovernment initiatives and projects.

Many other challenging factors of eGovernment implementation have recently been discussed, particularly in developing economies. Alameri, Bostan, and Akman (2017) raise lack of transparency, poor management in public, the existence of corruption, and the use of eGovernment as prevailing implementation issues faced by developing countries.

In an attempt to help the different government agencies to become successful in eGovernment implementation, many researchers have presented and suggested various approaches, and discussed a number of aspects that can facilitate a better understanding of eGovernment concepts. Starting from its inception, some researchers have been suggesting various options that need to be focused on before implementation of eGovernment services, while pointing out the reasons behind the success or failure of eGovernment systems. UNESCO can be mentioned in this regard as offering an action plan for eGovernment and suggesting the definition of laws and policies, awareness creation, building human capacity, and defining a vision at national level as some of the considerations that need to be focused on during eGovernment adoption.

The theoretical and conceptual approaches towards eGovernment in recent literature has also raised a variety of issues, including models, architectures, and frameworks of eGovernment. Hodijah (2017) points out that a comprehensive approach may be required, and also proposes an enterprise architecture (EA) model for the success of eGovernment and for achieving good governance.

4.3.1 Theoretical Approaches and History

The requirement and use of information and communication technology, such as the Internet and the Web, have been progressively growing all around the world. This growing need and use of the Internet has prompted many governments to focus on these technologies and become beneficiaries of their roles for availability and delivery of electronic services to citizens, aiming at citizen participation, improving rigid bureaucratic situations, and enhancing communication (Gongolidis et al. (2016). As Ornager and Verma (2005) revealed, many governments have already started to use ICT applications to enhance transparency and accountability, increase efficiency, and facilitate public sector reforms.

The historical growth of eGovernment is significantly related to the use of ICT applications that can positively influence the way in which citizens work and communicate with governments. This, together with the widely available eGovernment services that can be offered via the Internet, has led to the current acceptance of eGovernment (Gongolidis et al., 2016). This implies that the birth and growth of eGovernment is aligned with the current global shift of technology use towards the Web, where eGovernment has become one of the driving initiatives of economic growth and development among various sectors around the globe.

Veeramootooa et al. (2018, p. 1) indicate that "revolution in information and communication technologies has led to several changes in the daily lives of citizens as well as in the ways in which governments provide their services to the public". Verkijika and Wet (2018) also emphasise that eGovernment can offer potential benefits for enhancing the efficiency of government institutions, building trust among citizens and governments, and fostering democratic governance.

Today's transformation of the sectors can thus be regarded as the outcome of the current widespread Internet technology which, in turn, is motivating the public sector to use ICT for service delivery, enabling capacity for accessing a variety of timely information, creating new ways of interaction, and supporting knowledge sharing among various sectors (Gasovaa & Stofkovaa, 2017).

To this end, it can be argued that the evolution of Web technology — in accordance with the capability of enhancing and facilitating public services, creating informed citizens, ensuring accountability and transparency, improving internal workflow, and ensuring electronic workflow — has initiated the growing requirement for the application and use of eGovernment services. This recognition of eGovernment as one of the motivating factors for governments around the world can thus be due to eGovernment's capability to provide services in a better way to citizens (Kenenissa & Cho, 2017). The capabilities of transforming relationships among internal and external stakeholders, together with its roles in improving citizen and public interaction with government, enhancing citizens' access to information, and fostering internal work processes (Prahonoa & Elidjena, 2015), have also motivated many government and non-government sectors to look for the application and use of eGovernment. Moreover, as illustrated by Kenenissa and Cho (2017), the positive influence of the role of ICT infrastructure within eGovernment service, and the usefulness and ease of use of eGovernment, can be recognised as the sector's motivating factor.

Literature sources also indicate that the motivation and requirements for the implementation and use of eGovernment has increased from time to time. For example, Cavalheiro and Joia (2014) mention governments' increased motivation for public service delivery over the past few decades, as well as increased demand of citizens and businesses to access public services and better information, which has become the motivation for eGovernment implementation.

Not only government and business sectors, but also academia, are attracted by eGovernment. The initiation of eGovernment development initiatives by many countries increased interest from academia, and the provision of theoretical frameworks and models of eGovernment implementation has become a focus of eGovernment research. Accordingly, a variety of conceptual aspects of eGovernment and the role of ICTs in government have been raised and discussed, and useful proposals and suggestions are provided.

Research in the field refers to the role of ICTs associated with eGovernment. For example, Ornager and Verma (2005) stated that governments are using ICT applications for enhancing transparency and accountability, increasing efficiency, and facilitating public sector reforms. Prahonoa and Elidjena (2015) also revealed the role of ICTs, both in our daily lives and in government sectors, where eGovernment is presented as the use of ICT that can serve to improve effectiveness and efficiency, enhance accountability, and improve transparency. Gasovaa and Stofkovaa (2017), recently suggested that the public sector should adapt ICT to transform traditional bureaucracy for better service delivery in an easily accessible and usable manner; eGovernment can enable easier communication with citizens and easier data access, as well as improved communication among businesses and public institutions.

In general, while the adoption, implementation, and use of eGovernment has been discussed in both the developed and developing countries, the theoretical approach of developing country studies focus more on technological issues and describe the use of ICT in the eGovernment. Good governance, accountability, and transparency seem to be the widely accepted feature of eGovernment systems, in both developed and developing countries.

Compared to developed countries, more eGovernment implementation challenges have been described in developing countries; this implies that more research is needed on eGovernment systems in developing countries.

4.3.2 Basic Concepts and Principles of Existing Models and Frameworks

Concepts raised by many researchers have provided a better understanding of the components of eGovernment and its application in both public and government sectors. The concepts have been discussed by referring to two different terms, either eGovernment or e-Governance. However, the current theoretical concepts seem incapable of offering a commonly agreed definition for the two terms, and literature does not clearly differentiates these terms. This may reflect a lack of common understanding.

This thesis thus prefers to use both terms, eGovernment and e-Governance. The literature and all valuable studies that include the relevant concepts, principles, models, and components of eGovernment are included, based on both the terms e-Governance and eGovernment.

Gartner Group offered a model of eGovernment that entails that the capabilities of the current ICT to enhance access to government information can be achieved via the application of eGovernment, as it can improve work processes of government, characterized as the complex nature of bureaucracy, and corruption. The model of eGovernment can also enable citizens and businesses to access government information without standing in long queues, with the advancement of government work processes tied with bureaucracy of complex nature, and corruption.

Based on further investigation into related literature, as the use of ICT has become of great interest to governments of both developed and developing economies, it has also been influencing the sectors to imagine the successful implementation of eGovernment (Verkijika & Wet, 2018; Zamani et al., 2017).

Examples of eGovernment successes in developing economies are not many, as most countries are still facing a number of challenges in public service delivery. The bureaucratic structures in their business and government sectors are still characterised by work inefficiency, long queues at areas of service provision, and unnecessary procedural complexities of internal work processes; this is in spite of evidence from related literature that proves the current capabilities of ICT for addressing such challenges. According to Rao and Krishna (2013), the use of ICT by government organisations as tools to enhance the efficiency of internal work processes, improve public service delivery to citizens, facilitate interactions among government and citizens, businesses, and other government sectors, and improve the efficiency of eGovernment service delivery could address the variety of problems raised above, including issues related to work inefficiency, long queues at areas of service provision, and unnecessary procedural complexities of internal work processes.

The role of ICT and its use in eGovernment have been widely raised. However, eGovernment may in principle not be considered as merely implementing new ICT artefacts; instead, it may rather focus on both the role of ICT and on the transformation of existing working processes. Choi, Park, Rho, and Zo (2016) indicated that change and transformation are required within eGovernment aspects, as the study presented "Information sharing and integration are associated with technological transformation and also require changes in process, function, and management mind-sets, which is an extremely complicated task". Sarrayrih and Sriram (2015) also emphasised the requirement for change and transformation within the eGovernment arena, by presenting eGovernment as the transformation of relationships between internal and external public sectors through use of Information and Communications Technology for the purpose of enhancing government service delivery and citizen participation.

Past experiences of many developed economies in eGovernment implementation also recognised the transformation of public service delivery as a vital component of eGovernment. This can be illustrated from the experience of a particular developed country such as the USA, as mentioned by Yadav and Singh (2013). They outlined that the 2001 expansion of eGovernment was focused on transformation of government service delivery; the task was to identify priority actions based on the needs of citizens.

The implication is that, apart from the application and use of ICT within eGovernment, the requirement of a process focus in the redesign of existing systems should not be overlooked, as it may greatly hinder the success of eGovernment implementation. Thus, redesigning existing systems and proper integration of information and communication technology into a well-coordinated computing environment with work processes can help to achieve new work processes that can ensure quality service delivery via eGovernment. The process can also include clearly defined goals and properly identified principles.

Clearly defined goals and properly identified principles can be extracted and adopted, as they can have vital roles for successful eGovernment projects. In this regard, Hashemi (2013) can be mentioned as one supportive source that suggested that the goals of eGovernment projects should focus on appropriate eGovernment principles. The principles offered are:

- Improving the efficiency of government services provision;
- Increasing the quality and number of services delivered by government;
- Empowering citizens via access to timely information;
- Enhancing government's capability to interact and collaborate with citizens;
- Enhancing transparency of government;
- Enhancing accountability of government; and
- Improving internal relationships between government agencies.

In summary, various conceptual aspects of eGovernment have been raised and discussed. The commonly discussed conceptual aspects in literature include: accountability, transparency, effectiveness, efficiency, quality, interactions, principles, integration, reforms, change, transformation, bureaucratic structure, electronic service, and public sector. These discussions in literature have provided a better understanding of the conceptual components of eGovernment.

However, the successful implementation and use of eGovernment may require an exploration and investigation of the sector from different perspectives, such as the prerequisite requirements for eGovernment. Understanding the prerequisites for eGovernment can help to identify the building blocks of relevant eGovernment components that can be used to address the challenges that eGovernment may face. The discussion about the prerequisite requirements of eGovernment is presented below.

4.3.3 Prerequisites of eGovernment and Technological Aspects

The application of eGovernment and the delivery of efficient government services can be linked to a number of technological aspects as minimum requirement for making electronic services available to citizens. A variety of prerequisites have been listed by many literature sources, including technological prerequisites such as: network infrastructures, hardware, and servers housed and hosted in data centres that are used to provide eGovernment services. The network infrastructures (for broadband availability) include: satellite communication, fibre connectivity, and backbone networks at national level (Rao & Krishna, 2013; Triyason, Tassanaviboon, &

Arpnikanondt, 2017). As revealed by the United Nations Department of Economic and Social Affairs (UNPAN) (2018), access to high speed broadband and greater bandwidth is required to fully realise the benefits of eGovernment.

The prerequisites of eGovernment may also include: Internet gateways; security infrastructure; interaction gateways; application services (Website and/or portals) of eGovernment; integration and interoperability of services and application software; interaction interfaces (PC penetration, smart phones; Internet access centres and kiosks), policy for communication, ISP, standards and framework, and technology readiness. These aspects are considered by many published literature sources as required for the proper implementation and use of eGovernment (Kenenissa & Cho, 2017; Liu et al., 2018; Thiel, 2016). Kenenissa and Cho (2017), for example, refer to the requirement of Internet for delivery and access to eGovernment services, while Liu et al. (2018) indicate that hardware, network infrastructures, servers, applications, and system software are technical elements of eGovernment systems that can be considered as the prerequisite requirements of eGovernment. Thiel (2016) also identified issues related to privacy and security, legal and regulatory aspects, skilled manpower, and financial costs that can be considered as prerequisites of eGovernment.

Given the discussion above, data centres, servers, and storage have been widely accepted as prerequisite requirements of eGovernment systems. However, studies on eGovernment are limited in terms of the technology at hand, such as data centres, hardware, and the network infrastructure that has already been implemented by many developing countries. This remains as a research gap; more research is still needed on the technological aspects of eGovernment systems that refer to developing countries, including Ethiopia.

To aid in generalizing the prerequisite requirements of eGovernment, the various prerequisite requirements are summarised as follows from the existing literature:

- Underlying communication infrastructure;
- Technological aspects;
- Institutional frameworks;
- Human resources;
- Budgetary resources;
- Policy related issues;
- Identification of stakeholders; and
- Selected services.

4.3.4 Characteristics of eGovernment

An investigation into a number of aspects may be required in exploring and understanding the vital components of eGovernment that are relevant to this study. These include characteristics, challenges/risks, concepts, models, and frameworks upon which eGovernment can be better defined.

This thesis seeks to gain a better understanding of particular aspects of eGovernment, such as its characteristics. In recent years, many literature studies raised and discussed various eGovernment characteristics, including: technical characteristics (technology); ease of use of electronic services; quality (of information and system); digitization; system integration; perceived risk of eGovernment services; usefulness, security, and timeliness of information (Al-Hujran, Al-Debei, Chatfield, & Migdadi, 2015; Helao, 2015; Katebire, 2015; Kumar, Sachan, & Mukherjee, 2017; Liu et al., 2018). Katebire (2015), for example, discussed the status of usefulness, such as reduced costs, quality of services, and accuracy of information and integrated information management and dissemination in accordance with local governments, while Al-Hujran et al. (2015) pointed out that transparency and accountability can also represent the characteristics of good governance. Kumar et al. (2017) explained the relationships that convenience, security, ease of use, and customer support may have with behaviours of citizens and their attitude towards using eGovernment services, where the concepts raised can be regarded as characteristics of eGovernment services. Helao (2015) further included strategies, transparency, accountability, corruption, and rule of law as the eGovernment characteristics that can be discussed.

In order to generalize, a summary of eGovernment characteristics, as discussed by various published literature studies, is presented in Table 4-3.

Table 4-3 Characteristics of eGovernment

Study	Title	Characteristics	Discussion
(Liu et al., 2018, p. 4)	A socio-technical analysis of China's cyber security policy: towards delivering trusted eGovernment services	Technical characteristics, Safety Trust Perception of government	Zhang, et al. (2018a) discussed capabilities of hardware, network infrastructures, servers, applications, and user interaction interfaces as characteristics of eGovernment that are related to technological aspects, as well as information quality, systems quality, and ease of use as other technical characteristics that are discussed as usefulness of eGovernment services. Privacy, Security, Risk as a characteristic

Study	Title	Characteristics	Discussion
			termed as Safety. It is also discussed that Trust in Internet and in eGovernment as well as Perception of government as some other characteristics of eGovernment. [p.4]
(Janita & Miranda, 2018, p. 460)	Quality in eGovernment services: a proposal of dimensions from the perspective of public sector employees	Reliability-Security Communication Quality of the information Technical Efficiency	Janita and Miranda (2018) listed out usefulness of information; security of information; relevance of information, up-to-datedness of information; aspects related to accessibility aspects such as design, ease of use, and system availability as characteristics of eGovernment services. [p.460]
(Helao, 2015; Hodijah, 2017; Katebire, 2015; Sangki, 2017; Zamani et al., 2017)	An evaluation of good governance and service delivery at sub-national level in Namibia: the case of the Oshana region	Participatory Democracy Responsive Effectiveness Efficiency Inclusiveness Accountability Minimized corruption Government responsibility	Commonly discussed participatory, democracy, responsive, effectiveness, efficiency, inclusiveness, accountability, minimized corruption, and government as some of the key characteristics good governance or e-Governance
The UNISCO (Ornager & Verma, 2005) (Ornager & Verma, 2005)	eGovernment Toolkit For Developing Countries	Electronic Service Delivery Electronic Workflow Electronic Voting Productivity	UNISCO (Ornager & Verma, 2005) offered electronic service delivery, electronic workflow, electronic voting, electronic productivity as generalized characteristics of eGovernment

4.3.5 Defining eGovernment and e-Governance

Multiple definitions of eGovernment have been provided by scholars, public officials, and other stakeholders in recent years. For example, the UN (Ornager & Verma, 2005, p. 8) offered a definition stated of “eGovernment as the use of Information and Communication Technologies to promote more efficient and effective government, and make it more accessible and accountable to the citizens”. The World Bank Group (2002) similarly defined eGovernment as the use of information and communications technologies (ICT) to improve effectiveness, efficiency, transparency, and accountability of government.

E-governance is considered as a system that is required to overcome the deep-rooted bureaucratic problems faced by many government and public sectors, such as the physical paper-based system. Prasad and Atukuri (2012, p. 3241) stated that "E-governance is the application of information & communication technologies to transform the efficiency, effectiveness, transparency and accountability of informational & transactional exchanges within government, between govt. & govt. agencies of National, State, Municipal & Local levels, citizen & businesses, and to empower citizens through access & use of information". Likewise, Yadav and Singh (2013) indicated that e-Governance is the government's use of the Internet to provide services at the doorstep of business, users, and other stakeholders, and defined it as a system where the opportunity for transparency, efficient service delivery, good governance, and citizen empowerment are obtained through access to information resources of government offices over the Internet by ensuring a smooth information flow to all members of the general public.

According to the United Nations Economic and Social Council (2003, pp. 2-4), the application of ICT has useful roles in e-Governance, as explained in their definition of "the application of ICT tools for: (1) the interaction between government and citizens and businesses, and (2) internal government operations to simplify and improve democratic governance". According to Rao (2019, p. 24), UNESCO and NIC also raised the use of ICT, as they define e-Governance as "the application of ICT to the system of governance to ensure a wider participation and deeper involvement of citizens, institutions, NGOs as well as private firms in decision-making process".

The definition offered by UNESCO further discusses the concept of good governance, and presents e-Governance as a system at different government levels that exercise power so as to become equitable, accountable and transparent, effective, and honest (Rao, 2019). This also reveals that e-Governance is not only limited to the public sector, but is also applicable to civil society, NGOs, private businesses, and other non-state actors. The definition has raised a number of useful aspects, and is recognised by this thesis as a more convenient approach for this study. This is because the definition is more comprehensive and specific, and focuses on scaling up citizen participation in government decision-making processes, increasing customer satisfaction with electronic means, and promoting the 24/7 interaction between citizens and the government.

E-governance can in general be considered as the use of ICT, and as a process of strengthening citizen participation in the decision-making process. eGovernment can also be considered as an open system and an opportunity for improving transparency, enhancing the efficiency of service delivery, developing good governance, and empowering citizens through access to Internet-based information resources. Yadav and Singh (2013) emphasised that e-Governance can ensure smooth information flow to all members of the general public, and enhance full participation of everyone by reaching a distant villager or remote residents and improving government service delivery to citizens at their doorstep or fingertips.

A variety of definitions have been provided by different literature studies for the terms eGovernment or e-Governance, and some common approaches are seen among literature studies in defining eGovernment or e-Governance. Many literature studies commonly mentioned the requirement and use of information and communication technology for various aspects related to transparency, accountability, government service delivery, good governance, citizen empowerment, and communication between government and citizens.

To generalize the variety of definitions offered by literature studies, a summary of the definitions of the eGovernment is presented in Table 4-4.

Table 4-4 Summary of the definitions of eGovernment

Study	**Title**	**Definitions**
(Veeramootooa et al., 2018, p. 1)	What determines success of an eGovernment service? Validation of an integrative model of e-filing continuance usage	Defines eGovernment “as part of the modernization process of the public administration, governments worldwide are upgrading their services by providing them online — what is commonly referred to as eGovernment”.
(Janita & Miranda, 2018, p. 458)	Quality in eGovernment services: A proposal of dimensions from the perspective of public sector employees	Offers the definition of eGovernment as “a system for the management of public services that, based on Information and Communication Technologies (ICTs), aims to improve the quality of the services provided by the government to its stakeholders (citizens, companies, employees, other governments, etc.), increase its transparency, make improvements to its operation and achieve more efficient management in the different environments in which it operates”.
(Lallmahomed et al., 2017, p. 57)	Factors influencing the adoption of eGovernment Services in Mauritius	Cites the United Nations (UN) eGovernment development report, and offers the definition as “the use of information and communication technologies and its application by the government for the provision of information and public services to the people”.
(Kenenissa & Cho, 2017, p. 2)	Evaluating eGovernment Implementation in Public Service Delivery	Quotes the “*World Public Sector Report 2003”* and offers the definition as “The use of existing online technology products for transforming internal and external relationships can be defined as eGovernment”.

Study	Title	Definitions
(Gasovaa & Stofkovaa, 2017, p. 226)	eGovernment as a quality improvement tool for citizens' services	Quotes the UN and provides the definition as "continuing duty of public administration to improve relationships between citizens and the public sector by providing cheap and efficient services, information and knowledge. Practical realisation of what can the public administration offer".
(Cortés-Cediel et al., 2017, p. 2)	Recommender systems for e-governance in smart cities: State of the art and research opportunities	Defines eGovernment as "the application of ICT in the interactions of government with citizens and businesses — e.g., delivery of services, exchange of information, communication, and transactions — and in internal government operations, aiming to simplify and improve democratic, business and governmental aspects of governance".
(Prahonoa & Elidjena, 2015, p. 28)	Evaluating the Role eGovernment on Public Administration Reform: Case of Official City Government Websites in Indonesia	Defines eGovernment as "the use of ICT especially Internet to achieve better communication between G2C, G2B, G2E G2G in order improving efficiency, effectively, transparency, and accountability of government implementation".
(Arendsen, Peters, Ter Hedde, & Van Dijk, 2014, p. 162)	Does eGovernment reduce the administrative burden of businesses? An assessment of business-to-government systems usage in the Netherlands	The definition is stated as "all data, communication and transaction processing activities related to governmental tasks and responsibilities in which ICT is being used".
The UNESCO and NIC (Ornager & Verma, 2005, p. 8; Rao, 2019) [p.8]		eGovernment is defined as "the application of ICT tools for: (1) the interaction between government and citizens and businesses, and (2) internal government operations to simplify and improve democratic governance".
The UN (Ornager & Verma, 2005, p. 8)	eGovernment toolkit for developing countries	The definition states that "eGovernment is the use of Information and Communication Technologies to promote more efficient and effective government, and make it more accessible and accountable to the citizens".
The World Bank (2002)		Defines eGovernment as: "the use of information and communications technologies (ICT) to improve the efficiency, effectiveness, transparency and accountability of government".
The Gartner group (Brodkin, 2008) (Athmay, Aldin, & Rahim, 2015)	eGovernment maturity models	Defines eGovernment as "the continuous optimisation of service delivery, constituency participation and governance by transforming internal

Study	Title	Definitions
		and external relationships through technology, the Internet and new media”.

Given the various definitions depicted in Table 4-4, it seems that there is no commonly agreed approach for defining a standard definition. This implies that more research is needed to achieve a commonly agreed definition for both eGovernment and e-Governance aspects.

However, based on the commonalities, eGovernment is considered for this thesis as the fulfilment of a customer-centric environment in which Information Technology is used to support government operations such as information sharing for improved public administration (basic services, facilitating coordination, integration, informed decision making), enhancing governance, education, business, and others. It is also considered as a reform to treat citizens as customers of electronic public services, and to pursue customer satisfaction through these means. It includes any interaction of local, state, and federal government outside their domain by using technology, and is intended for improving the efficiency and effectiveness of overall government operations — Gartner Group’s definition (Athmay et al., 2015).

This thesis agrees that eGovernment is a system that can serve as an interaction interface between the public and government to facilitate free movement of ideas, increased transparency, improved accountability, and capacity building, by allowing access to government information in a one-stop service that can be achieved through transformation of the public service delivery system. In addition, eGovernment is considered as a viable system that is useful to overcome deep-rooted bureaucratic problems such as delays of work activities.

This thesis therefore defines eGovernment as:

> *“A participatory platform and a confluence (convergence place) of government and citizens for the process of decision making, and a system of transformation of government work into an online system in order to establish an open, proactive, and efficient government operation by replacing the traditional system (bureaucratic and physically-bound systems). eGovernment is also treated by this study as a reform mechanism that can help to enhance two-way interaction and substitute the top-down approach with bottom-up participation with the general public and government”.*

In the Ethiopian context, e-Governance /eGovernment can be an all-embracing initiative that integrates ICTs with public service delivery, with the aim of transforming the way in which government does business at present. (Dzidonu, 2006, p. 10) states that "the public sector management is changing towards shifting organisational objectives and performance from organisational lethargy to outputs, outcomes and impacts". In order to achieve the goal of government transformation, the Ethiopian government has introduced and implemented various reforms such as Business Process Reengineering (BPR), Balanced Score Card (BSC), and National ICT4D projects.

The government has implemented various ICT initiatives over the last decade, including new information and communication technologies for the growth of e-Governance. These aim to improve the efficiency and effectiveness of service delivery by public sector institutions. As pointed out by Adam (2014), the Ethiopian Government has made significant investments in the development of e-applications and human capacity, and to enhance network communications. It is also stated that a national IT park was being built by the government, aiming at attracting IT service companies. Recent discussions, such as that offered by Kenenissa and Cho (2017), also confirm the efforts that have been made by government to minimize the gaps in access to information, as information and communication technology has been implemented over a large part of the country.

According to some literature sources (Adam, 2014; Dzidonu, 2006), different eGovernment initiatives have been undertaken by the government, with objectives that include:

- Reducing operational, administrative, and transactional costs of administrative activities of regional governments, redundant spending, service delivery functions, and operations by reducing operational inefficiencies and unnecessary excessive paperwork;
- Improving productivity, administrative efficiency, information provision, effectiveness and service delivery to all governmental levels; and
- Transform government to become citizen-centred to facilitate the process of bringing government closer to the people, and thus allowing for accessibility to services and interaction agencies of government at all levels.

However, despite such valuable efforts, there are still problems regarding eGovernment; for example, the quality of public services is characterized by a very poor status in many developing economies. Dzidonu (2006), who has produced the National ICT4D five-year action plan for Ethiopia, revealed that long delays characterize the delivery of public services in Ethiopia due to complicated procedures and rigid bureaucratic structures (bureaucratized methods of work), high costs, a 'take it or leave it' attitude by civil servants, and excessively centralized decision-making processes.

However, other evidences also show that Ethiopia can be presented as a good example, particularly regarding government service delivery; it is usually ranked as the least stage on the United Nations eGovernment development indexes. For a decade, the United Nations has been assessing global eGovernment development for a global authoritative measure of how public administrations provide electronic and mobile public services. For example, according to a survey report on the eGovernment development index for eGovernment rankings, UNPAN (2014) ranked Ethiopia 157th from 193 countries, with an index value of 0.4567 — a value given by UNPAN as an online service index. The report from UNPAN (2014) has further placed Ethiopia's performance amongst the Least Developing Countries (LDCs) as "at 72nd place globally, and Ethiopia is one of the best-performing LDCs in online service delivery, ahead of many more wealthy countries, including a number of European nations". Comparing Ethiopia's 2014 rank to that of 2018, as depicted in Table 4-5, the overall ranking is somewhat better in 2018 than in 2014.

Table 4-5: United Nations' eGovernment Index (2014 & 2008) as (UNPAN, 2014; UNPAN, 2018)

United Nations eGovernment survey	2018	2014
eGovernment Development Index EGDI	Middle EGDI (Between 0.25 to 0.50) Ethiopia	Middle EGDI (Between 0.25 and 0.50)
Rank	151	157
EGDI	0.3463	0.2589
Online Service	0.6319	0.4567
Telecomm Infrastructure Component	0.0976	0.0266
Human Capital Component	0.3094	0.2934

To summarise, the very poor status of many developing economies in the implementation and use of eGovernment may be in contrast with the current opportunities of e-Governance, which can involve a computerization process to enhance the bureaucratized methods of work, thus replacing traditional paper-based processes and procedures with new and better ways of doing things, new styles of leadership and management, changes in attitude and working relationships, efficient ways of accessing and delivering government services, and new ways of organizing and delivering information and knowledge to citizens. These can be considered as some of the uses and physiognomies (characteristics) of eGovernment and eGovernment services; an overview thereof is provided below.

4.3.6 Physiognomies and General use of eGovernment and eGovernment Services

Based on the discussion above, the use of ICT for eGovernment can be recognised by the vital facets of eGovernment. It points to various intertwined aspects of eGovernment, such as: improving efficiency of administrative aspects, enhancing interactivity among administrative sectors, improving effectiveness of service delivery, enhancing interconnectivity, reducing administrative burdens, and removing corruption (Sangki, 2017). These can be recognised as some of the facets of the eGovernment system.

A number of different aspects have been raised and discussed that can be regarded as the physiognomies (characteristics) and uses of eGovernment and eGovernment services. Table 4-6 provides a summary of issues mentioned by literature related to the topic of interest.

Table 4-6 Summary of some of the facets of eGovernment

Author	Title	Discussion: physiognomies and use
(Veeramootooa et al., 2018, p. 1)	What determines success of an eGovernment service? Validation of an integrative model of e-filing continuance usage	Ensures effectiveness and aptitude in various areas of public service, provides citizens with better access to information, promotes transparency, improves service delivery and increases public participation in government affairs.
(Janita & Miranda, 2018, p. 458)	Quality in eGovernment services: A proposal of dimensions from the perspective of public sector employees	Improves the quality of the services provided by government to its stakeholders (citizens, companies, employees, other governments, etc.), increases its transparency, makes improvements to its operations, and achieves more efficient management in the different environments in which it operates.
(Zamani et al., 2017, p. 646)	Implementing eGovernment in Lagos State: Understanding the impact of Cultural Perceptions and Working Practices	ICTs enable citizens and businesses to interact with government, disseminate information and support business relationships with private sector organisations.
(Sangki, 2017, pp. 5-6)	Vision of future eGovernment via new eGovernment maturity model: Based on Korea's eGovernment practices	The transparency and efficiency of the system could be increased, which could increase the efficiency of public administrative affairs, increase confidence in government and freedom in society through information management systems, increase efficiency and productivity.

This chapter extracted and categorized the various facets and uses of eGovernment services that are widely discussed, and identified a number of commonalities. These include the use of eGovernment and eGovernment services as tools to:

- Enhance transparency and accountability within government;

- Improve relationships between government and citizens, government and government, and government and business;
- Empower citizens;
- Ensure citizens' participation in decision-making processes;
- Enhance work activities; and
- Enhance effectiveness and efficiency of service delivery by government departments and agencies.

4.3.7 Rewards (Opportunities), Risks and Challenges (Shortcomings) of eGovernment

4.3.7.1 Rewards and Opportunities

Many issues related to eGovernment concepts have been widely discussed, thus putting forward a number of aspects — one of which is the benefits of eGovernment services. Yadav and Singh (2013) presented advantages of eGovernment services, such as enabling governments to become more effective, transparent, and responsive. Arendsen et al. (2014) similarly mentioned potential advantages, such as minimising costs and reducing administrative burdens. Zhao et al. (2014), added the enhancement of business processes, acquiring better transparency and accountability, improving information sharing, and ensuring social inclusion as some of the benefits of eGovernment implementation. Recently, Verkijika and Wet (2018) listed some of the potential advantages of eGovernment: improved trust among citizens, governments, and private sectors; improved public sector administrative efficiency; and enhanced democratic governance.

Based on the literature, the most widely accepted advantages of eGovernment systems seem to be cost minimization, increased work efficiency, timely and reliable information delivery to citizens, and instant citizen access to government services.

4.3.7.2 Risks and Challenges (Shortcomings)

Apart from its advantages and rewards, eGovernment, like any other technology-based system, can also face a variety of challenging factors. Choi et al. (2016) mention the following challenges of developing countries as constraining factors of the implementation of eGovernment: socio-cultural backgrounds, regulatory frameworks, and political situations. A country's basic national characteristics, such as its history, culture, economics, and politics, are additional constraining challenges (Komba, 2013).

Research in the field also claims a number of other challenging factors that may constrain the enhancement of eGovernment services. Savoldelli, Codagnone, and Misuraca (2014) list lack of telecommunication infrastructures, trust in data privacy, reluctance to share information among departments, lack of telecommunications bandwidth, and shortage of ICT skills, as some of the barriers to eGovernment success.

In addition, limited awareness on how to access and use eGovernment services, and lack of skills for system administration purposes, may clearly affect the success of eGovernment in various sectors. According to Komba (2013), knowledge-related barriers to eGovernment include shortage of knowledge, lack of awareness, and lack of confidence to use services. Users may also constitute challenges to eGovernment; for example, as Rao and Krishna (2013) pointed out, users' resistance to change can be a constraining challenge to eGovernment implementation.

Further exploration of the related literature highlighted challenging issues from different perspectives. Prasad and Atukuri (2012), for example, raised challenges in a different way by discussing lack of interoperability in many government organisations as a barrier to eGovernment implementation. The reason for such interoperability problems may be that different government departments and organisations in many developing economies usually build their systems individually, without communicating with each other; these systems are hence designed differently and built on different infrastructure. Evidence-based recommendations can be adopted and applied where such interoperability problems during eGovernment implementation occur. As Rao and Krishna (2013) highlighted, interoperability vitality can be achieved by enabling different systems to communicate with each other, and by enabling electronic information sharing between the various governmental sectors to facilitate interoperability of systems. Recently, Sangki (2017) identified lack of standards for service delivery, insufficient funds, and lack of interoperability as constraining factors.

In summary, the literature presented challenges to eGovernment implementations from different perspectives; these improved the understanding for the identification of vital eGovernment components. This thesis sourced closely related literature to extract the risks and challenges that eGovernment may face. The constraining factors include: divide, rigid bureaucratic structures, poor telecommunications broadband, significant financial investment, a general resistance to the use of technology, the divide, lack of interest in using services, lack of participation, and lack of ICT support (particularly in rural areas). Among these, the divide can be the most pressing issue, because developing countries usually suffer from inadequate levels of public education and significant gaps between urban and rural areas (Jadi & Jie, 2017).

The different advantages, risks, and challenges of eGovernment services, as extracted from literature, are summarised in Table 4-7.

Table 4-7: Advantages and challenges of eGovernment arena

Advantages	Risks and challenges
Improve and expand business and create better expanded markets	Geographical location
Improve living standards of citizens	Language that people do not understand
Improve access to educational opportunities	Unreliable electricity
Improve access to medical services	Unavailability of required information
Cost and time savings	Security and privacy; lack of trust to use eGovernment services
Improve the quality and speed of eGovernment services	Lack or unevenness of knowledge and awareness
Enhance effectiveness of work functions	Lack of ICT resources in government departments and agencies; lack of ICT infrastructure in rural or remote areas
Provide new business opportunities by increasing market presence and facilitating online purchasing	Lack of guidance to using the Internet and eGovernment services
	Lack of support from government officials
	Unequal access to the Internet
	Low quality of eGovernment services and system
	Corruption
	Age-related barriers
	Cultural barriers

4.4 SUMMARIZING FINDINGS OF PREVIOUS RESEARCH AND STRUCTURING THE COMPONENTS OF eGOVERNMENT

To identify and understand the relevant components of eGovernment services, the exploration of the broader aspects of the topic of interest may be vital to gaining a deeper understanding of the different components, such as: characteristics, advantages, challenges, and the eGovernment computing infrastructure. Many of these components were explored and presented in the previous sub-sections. To provide an improved, clear, and comprehensive understanding of the most vital components of eGovernment, the literature is organized and structured in this section. In order to frame these components for the development of the second version of the proposed theoretical framework, the major components of the eGovernment, based on the reviewed literature, are summarised and presented in Table 4-8, where each of the major components consists of a number of sub-elements.

Table 4-8: The most relevant components of eGovernment to this study

Key Component	Source & Description
Legal Framework & Information Security	
Legal Framework ICT policy eGovernment policy Legal recognition of signatures Security standards Information Security Data security Privacy of data and information Confidentiality and trust	(Moreno, Martínez, Muguerza, & Abascal, 2018; Ornager & Verma, 2005; Sangki, 2017) pointed out the rights of all citizens, namely government services availability and accessibility; policies of eGovernment and ICT as well as ICT standards should be adapted and formulated so that they can be followed by different eGovernment stakeholders during the implementation and use thereof. In addition, the validity of certificates and signatures should be ensured; privacy of data and information of government agencies, private businesses and citizens need to be ensured; confidentiality and trust of private and sensitive transactions should be assured. (Alessandro, Barbara, & Alberto, 2017; Alkhwaldi, Kamala, & Qahwaji, 2017; Kenenissa & Cho, 2017) also commonly regard security, privacy, and confidentiality as critical challenges and risks of eGovernment services that should be addressed to ensure that users are protected, and that data integration is confidential, secure, and available.
Application and Services	
Shared Application Software Information in an up-to date manner Selected eGovernment services available on demand	(Gao & Lee, 2017; Gasovaa & Stofkovaa, 2017; Komba, 2013; Thiel, 2016) raised and discussed many eGovernment services. They also discussed that a successful eGovernment implementation needs to focus on the financial cost and the requirement of preselected services for initial deployment, such as: driving licenses; voter registration; immigration & travel; education & training, birth, death, and marriage certificates; national examination information; land information; property & local environment; educational, research, migration &travelling documents; housing, property and local environment, permit; passport issuance; e-Parking
Technology	
Back-end automation of hardware and high-end computing infrastructure High bandwidth Telecommunication infrastructure Last mile/rural area connectivity Electricity Data centres at national and state level Information /Internet access centres and Internet gateways	Electricity, telecommunication infrastructure, back-end automation of hardware and high-end computing infrastructure, last mile/rural area connectivity, national and regional data centres, access centres and Internet gateways, backup and disaster recovery, as well as security infrastructure are listed and discussed in literature as some of the technological aspects of eGovernment.

Key Component	Source & Description
Security infrastructure Backup and disaster recovery	
Common Systems Architecture	
Integration Interoperability	It is discussed that system architecture should focus on fostering and integrating eGovernment services, by including current ICT artefacts as tools of transforming work activities. Redesigning working process of government and its agencies, modernization and integration of existing technology resources, placing easier mechanisms of contact with citizens facilitating mechanisms of eGovernment services, common systems such as financial management information systems, and human resource management systems need to be integrated UNSCO: (Ornager & Verma, 2005).
Interaction Communication	
G2G G2C G2B G2E	(Choi et al., 2016; Cortés-Cediel et al., 2017; Jadi & Jie, 2017; Janita & Miranda, 2018) discussed, from a common perspective, a two-way communication relationship between citizens and government, and provided four communication types: G2C, where the communication is between private organisations and the government; G2B, where the communication is between government organisations, departments and authorities; G2G, where the communication is between governments; and G2E, where communication is between government and its employees.
Stakeholders	
Public sector Employees (including middle and top-level managers) Citizens Private sector Consultants NGOs	(Das, Singh, & Joseph, 2017; Janita & Miranda, 2018), in a similar approach, discussed that electronic services are provided by government to various stakeholders who interact and may impact one another for the development, implementation, delivery, and use of eGovernment and eGovernment services, with responsibility for setting rules and policies, regulating, and providing electronic services.
Interaction Interfaces and Portals	
A National portal: one-stop centre for delivery of all government services Smart phones, tablets, notebooks & personal computers	(Janita & Miranda, 2018; Moreno et al., 2018; Ornager & Verma, 2005) commonly discussed that a national portal and/or Website is required for government to interact with employees, citizens, government offices, and businesses. Citizens require broadband access with a variety of access instruments, including laptops, desktops, PDAs, or smart phones.
Principles and Guidance	

Key Component	**Source & Description**
Guidance to use eGovernment services Principles of eGovernment	Various authors (Moreno et al., 2018; Verkijika & Wet, 2018) pointed out that guidance (which includes principles and guidelines) may be required to use eGovernment services. Success criteria, as well as help features that can provide the user with guidance on how to easily use a government Website or portal, are also discussed Ornager and Verma (2005) also suggested basic requirements and regulations that need to be fulfilled during the implementation and use of eGovernment services, and that guidance need be used for the development of the Interoperability Framework, and Integration of Government services. Democracy, responsiveness, effectiveness, efficiency, inclusiveness, accountability, reliability of services, security, quality of the information, and participation may be some of the principles of eGovernment.
Challenging Factors	
Knowledge or skill Management support Financial cost Interoperability Lack of standardization Trust insecurity and privacy Delivery of services Lack of infrastructure, User interest	(Katebire, 2015; Kenenissa & Cho, 2017; Liu et al., 2018; Zamani et al., 2017) show some commonality in discussing challenging factors such as the lack of expertise and skilled human resources for the operation and usability of eGovernment. They suggested that it is required to train IT staff who work on eGovernment and use eGovernment systems and provide knowledge and skills. The literature pointed out that the lack of interoperability may be caused by silo-based deployment of information systems by different government agencies, which may challenge eGovernment. It is also pointed out that lack of standards can be a major factors challenging the adoption of eGovernment.

4.4.1 Component: Stakeholders

The stakeholders are discussed here in order to provide a better understanding of key stakeholders as components, and to assist with answering the second sub-research question.

As already discussed in the previous sections, electronic services are provided by government to various stakeholders, who interact and may also impact the development, implementation, delivery, and use of eGovernment services. In addition, in the use of eGovernment services, the stakeholders can be responsible for setting rules and policies, and regulating and providing electronic services. (Cortés-Cediel et al., 2017, p. 1), for instance, mention that "Governance refers to a new form of governing where a network of public and private actors share the responsibility of defining polices, and regulating and providing public services. Examples of these actors — commonly referred as stakeholders — are government agencies, citizens, markets, and organisations".

For this thesis, the stakeholder component of eGovernment can be classified as:

- Public sector;
- Employees (including middle and top-level managers);
- Citizens;
- Private sectors;
- Consultants; and
- NGOs.

The stakeholder components of eGovernment that are most relevant to this thesis are depicted in Table 4-9.

Table 4-9: The stakeholder components of eGovernment

Stakeholder	Description
Public sector (Government Bodies)	Develop and make available government services on Websites and portals Disseminate information Manage Websites and portals and their content
Employees (including middle and top-level managers)	Manage and administer electronic services Set policies, rules, regulations, and frameworks
Citizens	Access government electronic services Provide feedback to government agencies Participate in government activities
Private sector	Government to private partnership Participate in ICT-related aspects such as implementation

Stakeholder	Description
	Participate in setting policies and frameworks
Consultants	Consult in setting policies and frameworks Consult on ICT aspects
NGOs	Help with ICT implementation research and budget

4.4.2 Component: Legal Framework and Information security

The legal framework of eGovernment is discussed here in order to provide a better understanding of the legal framework components, and to assist in answering the second sub-research question.

The most relevant legal framework aspects of eGovernment that are widely discussed, as identified by this thesis, include:

- ICT and eGovernment policy;
- Legal recognition of signatures; and
- ICT Standards.

The most relevant information security aspects of eGovernment that are discussed, as identified by this thesis, include:

- Data security;
- Privacy of data and information; and
- Confidentiality and trust.

The institutional legal issues refer to the ICT and eGovernment policy, laws, regulations, ICT standards, data protection, and legal recognition of electronic signatures with which eGovernment must comply (Helao, 2015). In developing economies such as Ethiopia, legal considerations are a key concern, as there is a lack of regulations and policies to enhance the enforcement of eGovernment and the use of eGovernment services. Many government agencies also mostly lack the regulations, standardization, integration, and interoperability as discussed by (Belachew, 2010, p. 2), “Implementing eGovernment principles and functions require a range of standards, guidelines, rules, policies and legislative changes which do not exist in most developing countries".

While rules and regulations may offer a guide for interoperability and for integrating the silo deployment of systems, the standards and regulatory framework can help to ensure eGovernment accessibility. Legal frameworks, the standards that must be developed, and the rules and regulations of eGovernment that must be set can support users through the use of eGovernment services and the Internet, so as to meet the standards to create trust in cybercrimes, data privacy, and security of information. For example, in order to create confidentiality and trust in terms of rights of all citizens, and to ensure the availability and accessibility of services, appropriate eGovernment and ICT policies and standards need to be adapted and formulated so that they can be followed by different eGovernment stakeholders during the implementation and use of eGovernment services, within which the validity of certificates and signatures as suggested by UNESCO (Ornager & Verma, 2005), should be ensured.

Literature reflects security issues related to eGovernment. For example, some literature suggest that trust should be ensured, and that risks (including data security, privacy of data and information, and security of private and sensitive transactions of government agencies, businesses, and citizens) should be carefully addressed (Alessandro et al., 2017; Alkhwaldi et al., 2017).

Alessandro et al. (2017), highlighted that, in implementing eGovernment, trust and security can be the main challenges for organisations that adopt Cloud Computing; security issues are also regarded by Alkhwaldi et al. (2017), as major aspects that require attention during eGovernment adoption.

Data integration should be confidential, and data and information should be secure. This follows because risks can be the potential challenges of eGovernment implementation, and security issues (particularly privacy and confidentiality) can be critical risks of eGovernment services. It may thus become necessary to address such issues in advance and ensure that users are protected.

4.4.3 Component: Principles and Guidance

The principles and guidance that need to be focused on during adoption and use of eGovernment are discussed here, in order to provide a better understanding of the vital principles and guidance as components of eGovernment and to assist with answering the second sub-research question.

The principles and guidance component of eGovernment can be classified as:

- Guidance to use eGovernment services; and
- Principles of eGovernment that can ensure:
    - Democracy;
    - Responsiveness;
    - Effectiveness;
    - Efficiency;
    - Inclusiveness;
    - Accountability;
    - Reliability of services;
    - Quality of the information; and
    - Participation.

The implementation and use of eGovernment and eGovernment services may require the fulfilment of at least the basic or minimum requirements and regulations of eGovernment. This can be achieved by providing guidance, such as that offered by UNESCO (Ornager & Verma, 2005), on best practices of eGovernment services to users and principles of eGovernment to all concerned stakeholders. The guidance and principles of eGovernment need be used for the development of an interoperability framework, during the process of integration of government services.

As suggested by Moreno et al. (2018), such guidance can include principles, guidelines, and success criteria that may be required for the use of eGovernment services. Verkijika and Wet (2018) also mentioned the requirement for help features on how to easily use services via a government Website.

4.4.4 Component: Common Systems Architecture

As eGovernment can be a system that encompasses ICT implementation for fostering eGovernment services and enhancing service delivery to citizens, a framework for facilitating eGovernment services can be vital for the analysis of its related aspects (Jadi & Jie, 2017). This can be possible through a lens of a conceptual framework with which the architecture of eGovernment can be developed and used for the analysis and deployment of eGovernment and its roles; it can be done in terms of various concepts such as public service delivery, transparency, accountability, and good governance in a country.

The eGovernment conceptual framework and architecture may comprise different vital components. According to UNESCO (Ornager & Verma, 2005), three components (known as Services Architecture, Process Architecture, and Data Architecture) can be included in the eGovernment Architecture. It can be clear that the architecture should focus significantly on fostering eGovernment services by including current ICT artefacts as tools of transforming work activities. It thus needs to include various related and vital aspects of the eGovernment arena for the success of eGovernment service delivery.

Redesigning the work processes of government and its agencies in a manner of modernization, the integration and interoperability of existing technology resources, and silos of information systems may help to develop easier mechanisms of contact with citizens, and to facilitate mechanisms of eGovernment services. Many researchers of the field (Khare, 2012; Prasad & Atukuri, 2012) discussed that system architecture should focus extensively on integrating eGovernment services that leads to a government transformation by including current ICT artefacts as tools of transforming work activities.

Khare (2012), for example, points to the requirement of incorporating Web technology into e-Governance to integrate government's diverse information and services with e-democracy and e-participation. Prasad and Atukuri (2012, p. 3242) similarly stated that “A major design issue for integrated service delivery sites is how to capture data in a Web-based form and transfer it to an agency’s systems for processing and sharing that information in a common format”.

Integration may be required, because the deployment of silo systems may challenge the successful implementation and use of eGovernment services, where the challenges may be related to lack of interoperability, less efficiency in resource sharing, and inconsistency of information.

To address interoperability issues, the current state of the art of Cloud Computing has made available models that describe Cloud Computing resources, and that can enable interoperability between them with standards of Cloud Computing resource management. According to Yongsiriwit et al. (2016), among the most known standards are TOSCA (Topology and Orchestration Specification for Cloud Computing Applications), OCCI (Open Cloud Computing Interface), and CIMI (Cloud Computing Infrastructure Management Interface).

The most relevant and widely discussed eGovernment architecture, as identified by this thesis, includes:

- Integration; and
- Interoperability.

4.4.5 Component: Technology

The eGovernment technology architecture is discussed here in order to provide a better understanding of the technology requirements of eGovernment, and to assist with answering the second sub-research question.

It is repeatedly discussed that modern ICT artefacts have been implemented as enhancing tools of public service delivery in many developing countries, including Ethiopia, over the last decade. Further, it is discussed that the public sector in developing countries is still characterised by non-efficient provision of service; the deployment and use of eGovernment in this regard can present a useful opportunity to address such challenges (Gasovaa & Stofkovaa, 2017).

Regarding the deployment and use of eGovernment, the most fundamental consideration may not be limited to acquiring and implementing modern ICT artefacts. eGovernment should also focus on how to effectively, efficiently, and optimally utilise modern ICT artefacts and information systems for human and economic development, in accordance with selecting appropriate and cost effective modern ICT artefacts, such as Cloud Computing, for the advantages that it can provide for eGovernment (Alameri et al., 2017).

It might be logical to mention that Cloud Computing, as one form of modern ICT, can present a useful opportunity as a vital tool to enhance eGovernment service, with its vital role of fostering service delivery. Various authors (Alameri et al., 2017; Elbadawi, 2011; Park, 2009) commonly raised some useful and related ideas about ICT and Cloud Computing for eGovernment and eGovernment services, and discuss the Cloud Computing capability of minimising administrative cost, enhancing government transparency and accountability, and encouraging citizen-centric decision making.

Rana (2011) proposed a Cloud Computing architecture of distributed data centres to reduce the consumption of large amounts of electricity and to minimize carbon emissions from data centres, with computing resources such as storage and network resources (including cooling systems) to create a green computing environment. Further, there is evidence that technologies, including software, hardware and network components, can be designed as a collective and shared environment to create a government Cloud Computing (Khare, 2012; Prasad & Atukuri, 2012).

The most relevant technology aspects of eGovernment that are widely discussed, as identified by this thesis, include:

- Back-end automation of hardware and high end computing infrastructure;
- High bandwidth;
- Telecommunication infrastructure;
- Last Mile connectivity;
- Electricity availability;
- Data centres at national and state level;
- Information /Internet Access Centres and Internet Gateways;
- Security infrastructure; and
- Backup and disaster recovery sites.

4.4.6 Component: Application and Services

The applications and services that need to be focused on during the adoption and use of eGovernment are discussed here in order to provide a better understanding of the vital government services as components of eGovernment, and to assist with answering the second sub-research question.

Data and information need to be up-to date and services should be available and accessible, based on demand from properly designed and implemented applications and services. Various authors reached common agreement (Alameri et al., 2017; Kumar et al., 2017; Triyason et al., 2017) that provision of effective services to citizens and facilitation of reliable information sharing between government organisations, citizens, and private sectors, as well as accessing current information about government, need to be ensured by implementing eGovernment with appropriately selected eGovernment services.

Many eGovernment services exist where the deployment of all these electronic services can require a huge amount of financial, infrastructural, and human investment cost. Accordingly, it may be vital to select the most relevant electronic services carefully for initial deployment. Komba (2013) listed some of the major known eGovernment services, such as: driving licenses, voter registration, immigration and travel, education and training, birth, death, and marriage certificates, national examination information, land information, property and local environment, migration and travelling documents, housing, and passport issuance.

The most relevant aspects of eGovernment applications and services that are widely discussed, as identified by this thesis, include:

- Selected shared application software;
- Up-to date Information; and
- Selected eGovernment services available on demand.

4.4.7 Component: Interaction Communication

The different types of eGovernment interactions that could be focused on during the adoption and use of eGovernment are discussed here, in order to provide a better understanding of the vital interactions as components of eGovernment and to assist in answering the second sub-research question.

For improving effectiveness and efficiency, and strengthening the relationship between stakeholders and government as well as the transparency and accountability of the government, the implementation of a two-way interaction communication, via which a variety of online government services and information can be made available to the stakeholders, may be helpful. The two-way interaction communication agreed to in some published literature (Choi et al., 2016; Cortés-Cediel et al., 2017; Jadi & Jie, 2017) include: Government-to-Citizens (G2C), where the users are citizens and the communication is between the citizens and the government; Government-to-Businesses (G2B), where the users are private companies and non-government sectors and the communication is characterized as that among government organisations, departments, and agencies, and private business sectors; Government-to-Government (G2G), where the users are government agencies and offices, and the communication can be characterized as communication among government agencies and their government officers; and Government-to-Employee (G2E), where the users are government officers and the communication can be characterized as communication between government and its employees.

The most relevant communication aspects of eGovernment that are widely discussed and identified by this thesis, include relationships between:

- Government and Government (G2G);

- Government and Businesses (G2B);
- Government and Employees (G2E); and
- Government and Citizens (G2C).

4.4.8 Component: Interaction Interfaces and Portals

The interaction interfaces that might be used to access government's electronic services are discussed here in order to provide a better understanding of the available interaction interfaces as components of eGovernment, and to assist in answering the second sub-research question.

Well-designed and easily accessible government Websites and portals may be required for citizens to have access to reliable information and data. Janita and Miranda (2018) discuss that eGovernment requires portals and Websites via which government can interact with citizens, employees, other government offices, and businesses. These interaction interfaces can serve as a gateway to a variety of services and information that are delivered by different government departments; such a gateway can be a National Portal to Cloud Computing. Users can use laptops and PCs to access eGovernment applications and services. Das et al. (2017) state that the current widely available mobile phones and smart phones can serve as alternative to laptops and PCs for accessing eGovernment applications and services.

This thesis identified the following most relevant and widely discussed interaction aspects of eGovernment:

- Smart phones;
- Tablets;
- Notebooks;
- Personal computers; and
- Websites and government portals.

4.4.9 Component: Challenging Factors

The challenging factors that might be faced by eGovernment services are discussed here to provide a better understanding of the possible challenges of eGovernment services as components of eGovernment, and to assist in answering the second sub-research question.

Some of the challenging factors, according to Almutairi and Khan (2016), include: infrastructure problems; issues related to fraud; security; and lack of maintenance budgets. Alkhwaldi et al. (2017) also list a lack of expertise and skilled human resources on the operation and usability of eGovernment as challenges. It is also suggested that the requirement to train IT staff who work on eGovernment systems, and appropriate knowledge and skills, are focused on. Choi et al. (2016) on the other hand state that interoperability considerations that result from the deployment of information systems in silos may be another challenge that can be faced by different government agencies in the eGovernment arena.

The most relevant challenging aspects of eGovernment, as identified by this thesis, include:

- Knowledge or skill;
- Management support;
- Financial cost;
- Lack of interoperability;
- Lack of standardization;
- Trust on security and privacy;
- Delivery of services;
- Lack of infrastructure; and
- User interest.

4.5 EVALUATING THE COMPONENTS OF eGOVERNMENT SERVICES

The development of the interim theoretical conceptual framework is carried out in three stages. For the second version, the components are sourced from this chapter (Chapter 4). The evaluation of the identified components from literature were evaluated, and the success factors selected by this thesis include:

- Efficiency of delivery of eGovernment service;
- Reliability of eGovernment service;
- Availability of eGovernment service;
- Security, privacy, and trust;
- Quality of service and information;
- Performance of the back-end technology of the eGovernment service;
- Usability of interaction interfaces such as portals; and
- Availability of principles and guidance.

In order to validate the second version of the draft framework and get feedback, some questionnaires were generated based on a number of success factors of eGovernment services, to be used for assessing the components of eGovernment services that could be considered by various stakeholders of the WoredaNet while adopting and using Cloud Computing for efficient eGovernment services.

The second version of the working draft of the conceptual framework was supplemented with the feedback obtained from evaluators. The evaluators were requested to rate the stated factors according to their opinion, in terms of the following rating scale:

- Very important;
- Important;
- Less-important;
- Not-important; and
- Neutral.

Ten out of 30 experts were selected by means of a purposive sampling technique to evaluate the components of eGovernment: four directors from top-level management; four managers of different ICT sectors and PSOs, from mid-level management; and two low-level managers, namely, ICT personnel or technical staff from local Woreda centres, as depicted in Table 4-10. The questionnaires for eGovernment are depicted in Appendix B and C.

Table 4-10: Experts selected for eGovernment components

Participants	Occupation	Age (years)	Gender	Level	Education	Workplace	Experience
Part 1	Consultant	> 50	Male	Top level Mgt.	Doctorate degree	Federal Govt ICT sector	8-10 years
Part 2	Director	40-50	Male	Top level Mgt.	Doctorate degree	Federal Govt Ministry office	8-10 years
Part 3	Director	40-50	Female	Top level Mgt.	Doctorate Degree	Federal Govt PSO	8-10 years
Part 4	Director	40-50	Male	Top level Mgt.	Master's Degree	Regional Govt ICT	8-10 years
Part 5	Manger	40-50	Male	Middle level Mgt.	Master's Degree	Federal Govt ICT	6-8 years

Participants	Occupation	Age (years)	Gender	Level	Education	Workplace	Experience
Part 6	Manger	30-40	Female	Middle level Mgt.	Doctorate degree	Federal Govt ICT sector	6-8 years
Part 7	Consultant	30-40	Male	Middle level Mgt.	Master’s Degree	Federal Govt Ministry office	8-10 years
Part 8	Director	30-40	Male	Top level Mgt	Master’s Degree	Federal Govt PSO	6-8 years
Part 9	ICT personnel	25-30	Male	Low level Mgt.	BSc Degree	Federal Govt ICT Sector	4-6 years
Part 10	ICT personnel	25-30	Female	Low level Mgt.	BSc Degree	Local Woreda ICT centre	4-6 years

4.5.1.1 Gender

Three (30%) females and seven (70%) males participated in the study to evaluate the components of both eGovernment and RCE.

4.5.1.2 Age Range of experts in eGovernment and RCEs

One (10%) expert who participated in evaluating the components of both eGovernment and RCE was above the age of 50, four (40%) were in the age range 40 to 50, three (30%) were in the age range 30 to 40, and two (20%) were in the age range 25 to 30. This indicates that experts of different ages participated in evaluating the components of both eGovernment and RCE.

4.5.1.3 Occupation of experts in eGovernment and RCEs

Two (20%) consultants, four (40%) directors, two (20%) managers, and two (20%) ICT personnel participated in evaluating the components of both eGovernment and RCE.

4.5.1.4 Years of Experience of experts in eGovernment and RCEs

Five (50%) experts who participated in ranking the components of both eGovernment and RCE had 8 to 10 years’ experience in ICT sector, three (30%) had 6 to 8 years’ experience in the ICT sector, and two (20%) had 4 to 6 years’ experience in in ICT sector. This shows that the experts who participated in evaluating the components of both eGovernment and RCE in the study possessed various levels of experience.

4.5.1.5 Education of experts in eGovernment and RCEs

Four (40%) experts with PhD degrees, four (40%) experts with masters' degrees, and two (20%) experts with BSc degrees evaluated the components of both eGovernment and RCE. This reveals that experts with different qualifications participated in evaluating the components of both eGovernment and RCE.

4.5.1.6 Work Context of experts in eGovernment and RCEs

All 10 (100%) experts who ranked the components of both eGovernment and RCE work at WoredaNet and in the government ICT sector.

4.5.1.7 Findings from the Questionnaires of eGovernment Services

This section provides findings that the evaluators provided based on the different components of eGovernment services.

Six experts ranked *ICT policy* as a very important legal framework component of eGovernment relevant to the Ethiopian context in general and to the WoredaNet context in particular, while three experts ranked it as an important legal framework component; one expert was neutral. Eight experts ranked *eGovernment policy* as a very important legal framework component of eGovernment relevant to the Ethiopian context in general and to the WoredaNet context in particular, while one expert ranked it as an important component; one expert was neutral. Five experts ranked *legal recognition of signatures* as a very important legal framework component of eGovernment relevant to the Ethiopian context in general and to the WoredaNet context in particular, while three experts ranked it as an important component and two experts ranked it as a less important component.

The findings validate *ICT policy, eGovernment policy,* and *legal recognition of signatures* as relevant legal framework components of eGovernment relevant to the Ethiopian context in general and to the WoredaNet context in particular, as most of the experts believe and agreed that these components are either very important or important within the Ethiopian context. The concepts are thus retained.

Eight experts similarly ranked each of *data security, privacy of data and information, and confidentiality and trust*, as very important security components of eGovernment relevant to the Ethiopian context in general and to the WoredaNet context in particular, while two experts commonly ranked each of *data security, privacy of data and information, and confidentiality and trust*, as important security components.

The findings validate *security standards, data security, privacy of data and information, and confidentiality and trust* as relevant consideration components of the security component of eGovernment relevant to the Ethiopian context in general and to the WoredaNet context in particular, as the majority of the experts believe and approved that *security standards, data security, privacy of data and information, and confidentiality and trust* are very important within the Ethiopian context. The concepts are thus retained.

Table 4-11: Experts' rating of the factors of eGovernment

	eGovernment service components		**Feedback: Number of experts responded to:**									
#	**Major Component**	**Sub-component**	**Very important**		**Important**		**Less important**		**Not important**		**Neutral**	
			Fq	**%**	**Fq**	**%**	**Fq**	**%**	**Fq**	**%**	**Fq**	**%**
1	… as legal Framework component of eGovernment relevant to the Ethiopian context in general and the WoredaNet context in particular	'ICT policy'	6	60	3	30					1	10
2		'eGovernment policy'	8	80	1	10					1	10
3		'Legal recognition of signatures'	5	50	3	30	2	20				
4	…as security component of eGovernment relevant to the Ethiopian context in general and the WoredaNet context in particular	'Security standards'	8	80	2	20						
5		'Data security'	8	80	2	20						
6		'Privacy of data and information'	8	80	2	20						
7		'Confidentiality and trust'	8	80	2	20						

#	eGovernment service components		Feedback: Number of experts responded to:									
	Major Component	Sub-component	Very important		Important		Less important		Not important		Neutral	
			Fq	%	Fq	%	Fq	%	Fq	%	Fq	%
8	….as application and service component of eGovernment relevant to the Ethiopian context in general and the WoredaNet context in particular	'Shared application software'	6	60	2	20					2	20
9		'Information in an up-to date manner'	6	60	3	30					1	10
10		'Selected eGovernment services available on demand'	7	70	3	30						
11		'Back-end automation of hardware and high-end computing infrastructure'	9	90			1	10				
12	… as technology component of eGovernment relevant to the Ethiopian context in general and the WoredaNet context in particular	'High bandwidth'	7	70	3	30						
13		'Telecommu-nication infrastructure'	10	100								
14		'Last mile/Rural area connectivity'	9	90			1	10				
15		'Electricity'	9	90	1	10						
16		'Data centres at national and state level'	7	70	1	10	2	20				
17		'Information /Internet access centres and Internet gateways'	5	50	4	40					1	10
18		'Security infrastructure'	10	100								
19		'Backup and disaster recovery'	7	70			2	20			1	10

#	eGovernment service components		Feedback: Number of experts responded to:									
	Major Component	**Sub-component**	**Very important**		**Important**		**Less important**		**Not important**		**Neutral**	
			Fq	**%**	**Fq**	**%**	**Fq**	**%**	**Fq**	**%**	**Fq**	**%**
20	…as Common Systems Architecture component of eGovernment relevant to the Ethiopian context in general and the WoredaNet context in particular	'Integration'	6	60	4	40						
21		'Interoperability'	7	70	3	30						
22	…as Interaction Communication component of eGovernment relevant to the Ethiopian context in general and the WoredaNet context in particular	'Government-to-Government (G2G) communication'	8	80	1	10	1	10				
23		'Government-to-Citizen (G2C) communication'	7	70	2	20	1	10				
24		'Government-to-Business (G2B) communication'	5	50	3	30	1	10			1	10
25		'Government-to-Employee (G2E) communication'	7	70	3	30						
26	…as Stakeholders component of eGovernment relevant to the Ethiopian	'Public sector'	7	70	3	30						
27		'employees (including middle and top level managers)'	9	90	1	10						

#	eGovernment service components		Feedback: Number of experts responded to:									
	Major Component	Sub-component	Very important		Important		Less important		Not important		Neutral	
			Fq	%	Fq	%	Fq	%	Fq	%	Fq	%
28	context in general and the WoredaNet context in particular	'Citizens'	9	90	1	10						
29		'Private sectors'	9	90	1	10						
30		'Consultants'	5	50	5	50						
31		'Non-Government Organisations'	7	70	3	30						
32	…as component of eGovernment relevant to the Ethiopian context in general and the WoredaNet context in particular	'A national portal'			10	100						
33		'Notebooks, personal computers, smart phones, and tablets'			10	100						
34		'Guidance to use eGovernment services'	9	90	1	10						
35		'Principles of eGovernment services'	8	80	1	10	1	10				
36	Any relevant components of eGovernment that have not been mentioned here in the above questions?		None of the experts provided any relevant components of Cloud Computing which have not been mentioned in the above questions									

The percentages in the previous table are summarised below:

Table 4-12: Responses of experts expressed as percentages

#	Major Component	Sub-component	Very important	Important	Less important	Not important	Neutral
			%	%	%	%	%
1	… as legal Framework component of eGovernment relevant to the context of Ethiopian in general and to the WoredaNet context in particular	'ICT policy'	60	30			10
2		' eGovernment policy'	80	10			10
3		'Legal recognition of Signatures'	50	30	20		
4	…as security component of eGovernment relevant to the context of Ethiopian in general and to the WoredaNet context in particular	'Security Standards'	80	20			
5		'Data security'	80	20			
6		'Privacy of data and information'	80	20			
7		'Confidentiality and trust'	80	20			
8	….as Application and Service component of eGovernment relevant to the context of Ethiopian in general and to the WoredaNet context in particular	'Shared Application Software'	60	20			20
9		'Information in an up-to date manner'	60	30			10
10		'Selected eGovernment services available on demand'	70	30			
11		'Back-end Automation of Hardware and High End Computing Infrastructure'	90		10		
12	… as technology component of eGovernment relevant to the context of Ethiopian in general and to the WoredaNet context in particular	'High bandwidth'	70	30			
13		'Telecommunication infrastructure'	100				
14		'Last Mile/Rural Area Connectivity'	90		10		
15		'Electricity'	90	10			
16		'Data Centres at National and State Level'	70	10	20		

#	Major Component	Sub-component	Very important	Important	Less important	Not important	Neutral
			%	%	%	%	%
17		'Information /Internet Access Centres and Internet Gateway'	50	40			10
18		'Security Infrastructure'	100				
19		'Backup and disaster recovery'	70		20		10
20	…as Common Systems Architecture component of eGovernment relevant to the context of Ethiopian in general and to the WoredaNet context in particular	'Integration'	60	40			
21		'Interoperability'	70	30			
22	…as Interaction Communication component of eGovernment relevant to the context of Ethiopian in general and to the WoredaNet context in particular	'Government-to-Government (G2G) communication'	80	10	10		
23		'Government-to-Citizen (G2C) communication'	70	20	10		
24		'Government-to-Business (G2B) communication'	50	30	10		10
25		'Government-to-Employee (G2E) communication'	70	30			
26	…as Stakeholders component of eGovernment relevant to the context of Ethiopian in general and to the WoredaNet context in particular	'Public sector'	70	30			
27		'employees (including middle and top level managers)'	90	10			
28		'citizens'	90	10			
29		'Private sectors'	90	10			
30		'Consultants'	50	50			
31		'Non-Government Organisations'	70	30			
32		'A national portal'		100			

#	Major Component	Sub-component	Very important	Important	Less important	Not important	Neutral
			%	%	%	%	%
33	…as component of eGovernment relevant to the context of Ethiopian in general and to the WoredaNet context in particular	'Notebooks, personal computers, smart phones, and tablets'		100			
34		'Guidance to use eGovernment services'	90	10			
35		'Principles of eGovernment services'	80	10	10		

Six experts ranked *shared application software*, as a very important Application and Service component of eGovernment relevant to the Ethiopian context in general and the WoredaNet context in particular, while two experts commonly ranked it as an important component, and two experts were neutral. Six experts ranked *information in an up-to date manner* as a very important Application and Service component of eGovernment relevant to the Ethiopian context in general and the WoredaNet context in particular, while three experts commonly ranked it as an important component and one expert was neutral. Seven experts ranked selected government services available on demand as a very important Application and Service component of eGovernment relevant to the Ethiopian context in general and the WoredaNet context in particular, while three experts commonly ranked it as an important component. Nine experts ranked *back-end automation of hardware and high-end computing infrastructure* as a very important Application and Service component of eGovernment relevant to the Ethiopian context in general and the WoredaNet context in particular, while one expert ranked it as a less important component.

The findings validate *shared application software*, *information in an up-to date manner*, *selected eGovernment services available on demand*, *and back-end automation of hardware and high-end computing infrastructure* as relevant Application and Service components of eGovernment relevant to the Ethiopian context in general and the WoredaNet context in particular, as the majority of the experts believe and accepted that these components are relatively important within the Ethiopian context. The concept is thus retained.

Seven experts ranked *high bandwidth* as a very important technology component of eGovernment relevant to the Ethiopian context in general and the WoredaNet context in particular, while three experts ranked it as an important component. All 10 experts commonly ranked *telecommunication infrastructure* as a very important technology component of eGovernment relevant to the Ethiopian context in general and the WoredaNet context in particular. Nine experts ranked *last mile/rural area connectivity* as a very important technology component of eGovernment relevant to the Ethiopian context in general and the WoredaNet context in particular, while one expert ranked it as less important component. Nine experts ranked *electricity* as a very important technology component of eGovernment relevant to the Ethiopian context in general and the WoredaNet context in particular, while one expert ranked Electricity as an important component. Seven experts ranked *data centres at national and state level* as a very important technology component of eGovernment relevant to the Ethiopian context in general and the WoredaNet context in particular, while one expert ranked it as an important component, and two experts ranked it as a less important technology component of eGovernment relevant to the Ethiopian context in general and the WoredaNet context in particular. Five experts ranked *information /internet access centres and Internet gateway* as very important technology components of eGovernment relevant to the Ethiopian context in general and the WoredaNet context in particular, while four experts ranked it as an important component, and one expert was neutral. All 10 experts ranked *security infrastructure* as a very important technology component of eGovernment relevant to the Ethiopian context in general and the WoredaNet context in particular. Seven experts ranked *backup and disaster recovery* as very an important technology component of eGovernment relevant to the Ethiopian context in general and the WoredaNet context in particular, while two experts ranked it as a less important component, and one expert was neutral.

The findings validate *high bandwidth*, *telecommunication infrastructure*, *last mile/rural area connectivity*, *electricity*, *data centres at national and state level*, *information /Internet access centres and Internet gateway*, *security infrastructure*, *backup and disaster recovery* as relevant technology components of eGovernment relevant to the Ethiopian context in general and the WoredaNet context in particular, as the majority of the experts believe and decided that these components are relatively important within the Ethiopian context. The concepts are thus retained.

Six experts ranked *integration* as a very important Common Systems Architecture component of eGovernment relevant to the Ethiopian context in general and the WoredaNet context in particular, while four experts ranked it as an important component of eGovernment. Seven experts ranked *interoperability* as a very important Common Systems Architecture component of eGovernment relevant to the Ethiopian context in general and the WoredaNet context in particular, while three experts ranked it as an important component of eGovernment.

The findings validate both *integration* and *interoperability* as relevant Common Systems Architecture component of eGovernment relevant to the Ethiopian context in general and the WoredaNet context in particular, as the majority of the experts commended and accepted that these components are relatively important within the Ethiopian context. The concepts are thus retained.

Eight experts ranked *G2G* as a very important Interaction Communication component of eGovernment relevant to the Ethiopian context in general and the WoredaNet context in particular, while one expert ranked it as an important component of eGovernment and one expert ranked it as a less important component. Seven experts ranked *G2C* as a very important Interaction Communication component of eGovernment relevant to the Ethiopian context in general and the WoredaNet context in particular, while two experts ranked it as an important component of eGovernment and one expert ranked it as less important component. Five experts ranked *G2B* as a very important Interaction Communication component of eGovernment relevant to the Ethiopian context in general and the WoredaNet context in particular, while three experts ranked it as an important component of eGovernment; one expert ranked it as a less important component and one expert was neutral. Seven experts ranked *G2E*, as a very important Interaction Communication component of eGovernment relevant to the Ethiopian context in general and the WoredaNet context in particular, while three experts ranked it as an important component of eGovernment.

The findings validate *G2G, G2C, G2B,* and *G2E* as relevant Interaction Communication components of eGovernment relevant to the Ethiopian context in general and the WoredaNet context in particular, as all of the experts acknowledged and agreed that these components are highly important within the Ethiopian context. The concepts are thus retained.

Seven experts ranked *public sector* as a very important Stakeholders component of eGovernment relevant to the Ethiopian context in general and the WoredaNet context in particular, while three experts ranked it as an important component of eGovernment. Nine experts ranked *employees including middle and top level managers* as a very important Stakeholders component of eGovernment relevant to the Ethiopian context in general and the

WoredaNet context in particular, while one expert ranked it as an important component of eGovernment. Nine experts ranked *citizens* as a very important Stakeholders component of eGovernment relevant to the Ethiopian context in general and the WoredaNet context in particular, while one expert ranked it as an important component of eGovernment. Nine experts ranked *private sectors* as a very important Stakeholders component of eGovernment relevant to the Ethiopian context in general and the WoredaNet context in particular, while one expert ranked it as an important component of eGovernment. Five experts ranked *consultants* as a very important Stakeholders component of eGovernment relevant to the Ethiopian context in general and the WoredaNet context in particular while five experts ranked it as an important component of eGovernment. Seven experts ranked *non-government organisations* as a very important Stakeholders component of eGovernment relevant to the Ethiopian context in general and the WoredaNet context in particular, while three experts ranked it as an important component of eGovernment.

The findings validate *public sector, employees (including middle and top level managers), citizens, private sectors, consultants, and non-government organisations* as relevant Stakeholders components of eGovernment relevant to the Ethiopian context in general and the WoredaNet context in particular, as the majority of the experts recognised and believe that the Stakeholders component of eGovernment relevant to the Ethiopian context in general and the WoredaNet context in particular are very important within the Ethiopian context. The concepts are thus retained.

All 10 experts commonly ranked *a national portal, notebooks, personal computers, smart phones, and tablets*, as an important Interaction Interfaces and Portal component of eGovernment relevant to the Ethiopian context in general and the WoredaNet context in particular.

The findings validate *a national portal, notebooks, personal computers, smart phones, and tablets* as relevant Interaction Interfaces and Portal components of eGovernment relevant to the Ethiopian context in general and the WoredaNet context in particular, as all of the experts believe and decided that these components are relevant to the Ethiopian context in general and the WoredaNet context in particular, and are very important within the Ethiopian context. The concepts are thus retained.

Nine experts ranked *guidance to use eGovernment services* as a very important Principles and Guidance component of eGovernment relevant to the Ethiopian context in general and the WoredaNet context in particular, while one expert ranked it as an important component of eGovernment.

Eight experts ranked *principles of eGovernment services* as a very important Principles and Guidance component of eGovernment relevant to the Ethiopian context in general and the WoredaNet context in particular, while one expert ranked it as an important component of eGovernment and one expert ranked it as a less important component of eGovernment.

The findings validate *guidance to use eGovernment services* and *principles of eGovernment services* as relevant Principles and Guidance components of eGovernment relevant to the Ethiopian context in general and the WoredaNet context in particular, as all of the experts believe and accept that these components are relatively important within the Ethiopian context. These concepts are thus retained.

In general, the questionnaires on eGovernment service requested participants to rank 35 components of eGovernment service and to indicate any relevant component not listed. A total number of 10 responses were received in evaluating each of the components of eGovernment services.

Figure 4-4 provides a diagrammatic representation of the most relevant components of eGovernment that were identified and evaluated in this chapter. This is to be used to frame the second version of the proposed framework for Cloud Computing for facilitating eGovernment services.

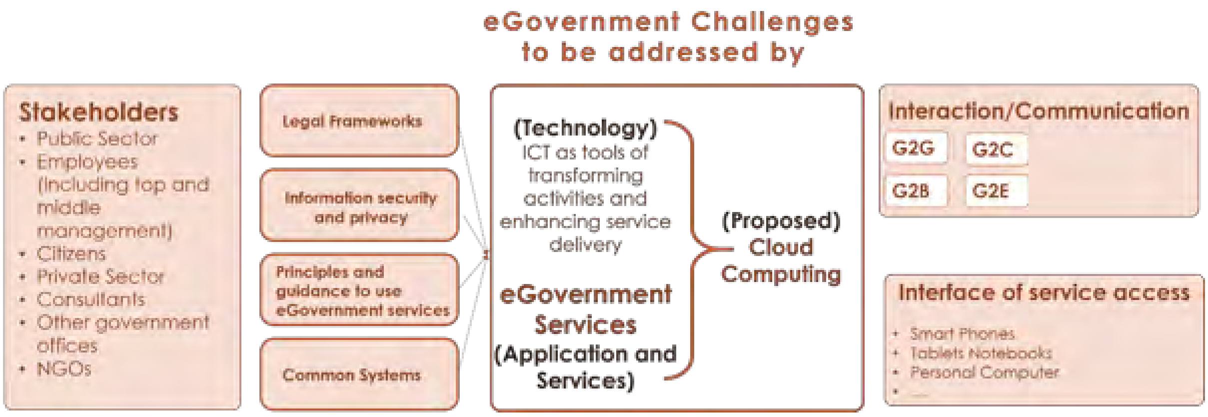

Figure 4-4: The diagrammatic representation of the components of eGovernment

The evolution of Web technology, together with Cloud Computing technology, has become tools of eGovernment services that contribute to the facilitation thereof, create equally informed citizens, ensure accountability and transparency, facilitate effective service delivery, and transform internal workflow into electronic-based workflow (Alameri et al., 2017; Prasad & Atukuri, 2012). Cloud Computing can thus be considered as an innovative technology that can extend government services in an economical manner, providing considerable opportunities for offering user-centred services. It can serve as one useful solution for addressing many eGovernment challenges, and can provide a good basis from which to address some of the aforementioned challenges faced by governments, as depicted in Figure 4-4 (see the central element). Accordingly, among the various technological aspects, Cloud Computing technology is proposed by this thesis as a means of addressing eGovernment challenges.

The components from eGovernment services identified in Chapter 4, as guided by an approach adopted from UNESCO, included the following environmental aspects to which the application of eGovernment may initially contribute:

- Status of underlying communication infrastructure;
- Availability of institutional framework;
- Availability of human resources;
- Existing budgetary resources;
- Policy related issues;
- Industry and social sector issues; and
- Investment issues.

Based on those conducive environments to which eGovernment services are applied, as well as the findings from other relevant literature sources, Chapter 4 summarised 10 basic components of eGovernment services, namely:

- Legal framework;
- Information security;
- Application and services;
- Technology;
- Common systems;

- Methodologies;
- Interaction (G2G, G2C, G2B, G2E);
- Stakeholders;
- Portals; and
- Guidance to use eGovernment services.

Each of the major components from eGovernment services presented above is comprised of a number of particular descriptions; the description in each category is depicted in Table 4-13.

Table 4-13 Summary of the relevant components of the eGovernment arena

Main Components	
Legal framework	ICT Policy; eGov.; policy; legal recognition of signatures, security standards; privacy policy
Information security and privacy	Data security, privacy of data and information, government agencies, private businesses and citizens comfortable private and sensitive transactions
Application and Services	Application software interoperability framework, up-to date information and service on demand eGovernment services include: licenses; voter registration; immigration and travel; education and training; birth, death, and marriage certificates; employment; health & safety information; national examination information; customs; land information; property and local environment; educational and research; migration and travelling documents; housing, property, and local environment; permits; passport issuance; e-Parking
Technology /physical infrastructure	Back-end automation; hardware, fully reliable to ensure 24*7 fast access; high-end computing infrastructure; electricity; national and state-level data centres; community information/Internet access centres; network operation centres; Internet gateway; security infrastructure; high bandwidth; telecommunication infrastructure in rural parts and remote areas, including fixed line and/or wireless; service gateways/payment gateways; last mile/rural area connectivity; backup and disaster recovery
Common Systems	Financial management information systems; human resource management systems,
Interaction /communication/ relationship among various stakeholders	Information exchange between G2G, G2C, G2B, G2E
Stakeholders	Citizens, political leaders, legislative bodies, private sectors, government departments, agencies, NGOs
interfaces of service delivery and access or gateway	A national portal: one-stop centre for delivery of all government services Smart phones, tablets, notebooks and personal computers

Guidance to use eGovernment services	Documents

These components are depicted in Figure 4-4.

4.6 VERSION 2 OF THE INTERIM THEORETICAL FRAMEWORK

To frame the second version of the proposed theoretical framework for Cloud Computing for facilitating eGovernment services, the relationships between the proposed vital Cloud Computing components and the vital eGovernment components are designed and presented as a theoretical framework (see Table 4-14)

Table 4-14: The components of Cloud Computing and eGovernment and their relationships

<table>
<tr><th>Cloud Computing</th><th></th><th>eGovernment</th></tr>
<tr><td>Key components of Cloud Computing</td><td>Principle factors that will influence eGovernment services with the adoption and use of Cloud Computing</td><td>Key components of eGovernment</td></tr>
<tr><td>Models</td><td>Principle factors</td><td>Application and services</td></tr>
<tr><td>SaaS and IaaS</td><td>Efficiency
Availability
Reliability</td><td>Shared application software
information in an up-to date manner
Selected eGovernment services available on demand</td></tr>
<tr><td>Models</td><td>Principle factors</td><td>Legal framework and information security</td></tr>
<tr><td>Public and community</td><td>Availability
Security
Privacy and trust
Management support</td><td rowspan="2">Legal framework
ICT policy
eGovernment policy
Legal recognition of signatures
Security standards
Information security
Data security
Privacy of data and information
Confidentiality and trust</td></tr>
<tr><td>IaaS and SaaS</td><td>Security
Privacy and trust
SLAs</td></tr>
<tr><td>Technology
Architecture</td><td>Principle factors</td><td>Technology</td></tr>
<tr><td>Data centres
Virtualised hardware and network infrastructure
Application software</td><td>Availability
Cost
Management support
Performance
Security</td><td>Back-end automation of hardware and high-end computing infrastructure
High bandwidth
Telecommunications infrastructure
Last mile/rural area connectivity,
Electricity
Data centres at national and state level</td></tr>
</table>

Cloud Computing		eGovernment
		Information /Internet access centres and Internet gateways Security infrastructure Backup and disaster recovery
Models	Principle factors	Common Systems Architecture
Public and community	Availability of Cloud Computing standards	Integration Interoperability
	Principle factors	Interaction Communication
	Availability Reliability	G2G G2C G2B G2E
Considerations	Principle factors	Stakeholders
Risks and challenges Service level agreements (SLAs)	Availability of SLAs Privacy and trust Quality of service	Public sector Employees (including middle and top-level managers) Citizens Private sectors Consultants NGOs
Models	Principle factors	
SaaS and IaaS	Quality of service	
Interaction interfaces	Principle factors	Interaction Interfaces and Portals
Smart phones, tablets, notebooks personal computers	Availability Quality Reliability	a National portal: one-stop centre for delivery of all government services Smart phones, tablets, notebooks and personal computers
Characteristics	Principle factors	Challenging factors
Rapid elasticity On-demand self service Measured service Broad network access Resource pooling	Cost Management support	Knowledge or skill Management support Financial cost Interoperability Lack of standardization Trust on security and privacy Delivery of services Lack of infrastructure User interest
Technology Architecture	Principle factors	
Data centres Virtualised hardware and network infrastructure Application software	Availability Cost Access to resource SLAs	
Principles	Principle factors	Principles and Guidance
Availability Performance Security	Availability Reliability	Guidance to use eGovernment services Principles of eGovernment

The preference for Cloud Computing technology is due to the advantages that Cloud Computing offer to eGovernments. These advantages are outlined in Section 4.7.

4.7 ADVANTAGES OF CLOUD COMPUTING IN eGOVERNMENT SERVICES

Some studies offer useful opportunities, based on the technical and practical aspects of Cloud Computing and its benefits for eGovernment services. According to Alameri et al. (2017) and Gongolidis et al. (2016), some of the benefits can include: availability of virtualised resources; an integrated management and minimised budget or cost savings; effective use of resources; decreased repetitive work activities; policy management; scaling up or down of resources; and addressing the shortage of ICT capabilities. Yadav and Singh (2013) also discussed that Cloud Computing within eGovernment can provide technical and economic benefits to an organisation, with advantages such as improving the scope of communication, as it encompasses government-to-citizens, government-to-government, government-to-employees, and government-to-business communications.

Studies also reproduced the contributions of Cloud Computing to eGovernment in terms of economic growth and human development. Hashemi (2013) in this regard pointed out that the economic roles and benefits of Cloud Computing as a vital tool in bridging economic and social divides include a shift in both technology and the economy within organisational and social contexts. In addition, Rao and Krishna (2013) indicated that Cloud Computing electronic services can also be regarded as an advantage for eGovernment by reducing the overall cost of government departments and enabling efficient utilisation of money. Further, Khare (2012) added decreased cost, improved agility, easier scalability, easier maintenance, and realization of Green ICT as a key contribution of Cloud Computing, which is viewed in terms of the implementation of the national eGovernment plan.

Cloud Computing has recently created a revolution in how organisations and individuals use ICT to fulfil the unanticipated requests for resources; strong performance has been established concerning the state sector's utilization of cloud-based services. Aligning these drivers with common eGovernment implementation challenges (ICT infrastructure, human resources, and financial resources) shows that Cloud Computing may fit with eGovernment implementation requirements in developing countries such as Ethiopia (Alameri et al., 2017).

Cloud Computing can thus be a useful solution that may address the various eGovernment challenges (Section 4.4.9). Cloud Computing can serve as tools of transforming work activities, facilitating eGovernment services, and improving the underlying practices, including: the practices of public accountability and transparency that directly relates to performance of work processes; and the practices of delivering public service, as well as the practices of interaction with particular technology such as the eGovernment services.

This aided the development of the second version of the interim theoretical framework, as the first version of the interim theoretical framework for Cloud Computing can be incorporated into the middle part of the interim theoretical framework presented in Figure 4-5. This resulted in the intended and fully developed second version of the interim theoretical framework for Cloud Computing for facilitating eGovernment services, as presented in Figure 4-5.

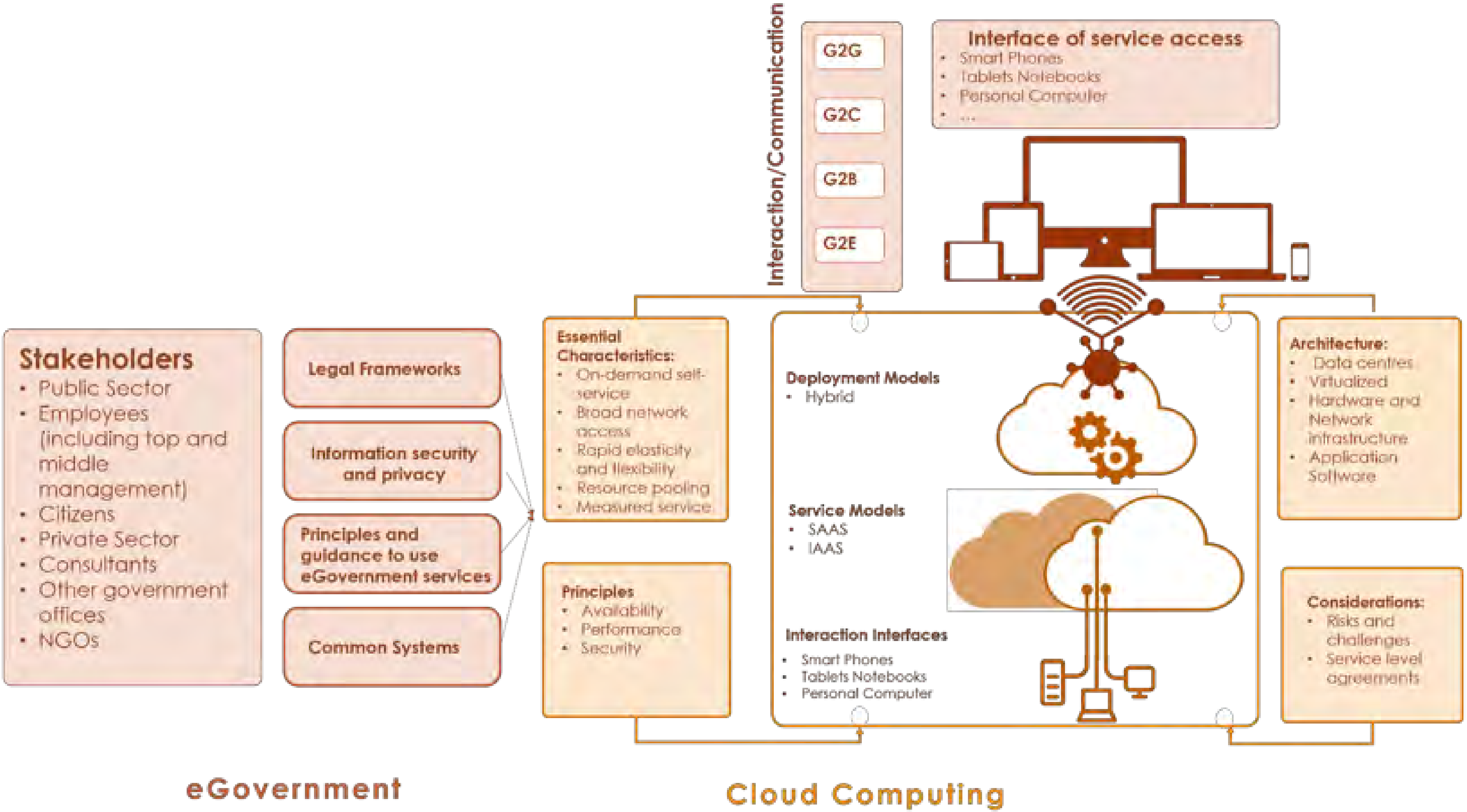

Figure 4-5: The Second Version of the theoretical framework for Cloud Computing for facilitating eGovernment services

As is illustrated in Figure 4-5, laws and guidelines for how to deliver and access the services, and the relevant documents should be included for each of eGovernment services to be delivered by Cloud Computing, as is proposed by the second version of the theoretical framework; this framework for facilitating eGovernment services can guide the various activities around the Cloud Computing architecture and communications among various sectors.

The architecture element of the Cloud Computing framework includes technologies such as integrated, distributed data centres, virtualised hardware, and network components, and application software; these can be designed or re-designed (if the infrastructure already exists, it can be utilized to minimize the cost of new deployment) as a collective and shared environment within which to create eGovernment Cloud Computing.

Based on this interim theoretical framework version 2 (Figure 4-5), the advantages of Cloud Computing in fostering eGovernment services are illustrated based on the integrated Cloud Computing technology within the framework. It provides opportunities for gaining advantages to improve economic growth and human development through effective and efficient public service delivery to citizens by improving public services quality and enhancing transparency, accountability, and good governance in government, businesses, and PSOs.

The inclusion of Cloud Computing in the proposed framework can promote and facilitate the effectiveness of government operations as work processes of institutions; costs can be reduced in order to meet the needs of citizens.

Government to government (G2G), government to citizens (G2C), government to employees (G2E) and government to business (G2B) relationships can be facilitated via effectively delivered services and accessed through the gateway (the national portal). Because of the included Cloud Computing technology, the enhancement of work activities can facilitate service delivery and, as a result, the general scope of G2G, G2C, G2E, and G2B communication can also be improved and enhanced. This can be motivated by efficient and effective service delivery to various stakeholders that may exist within the framework.

Enhanced access to government information and eGovernment services for citizens, employees, and other stakeholders can be facilitated through the availability of timely and reliable information; easier and simpler access can be ensured through interaction interfaces such as the national portal, as well as the broad media access that is enabled by smart phones, tablets, notebooks, and personal computers.

While this theoretical framework is assumed to address a variety of challenges in the general electronic service delivery processes and can play vital roles in the improvement of work efficiencies, the framework still requires further development — particularly in environments that my pose challenges during application and use of Cloud Computing technology, where the resolution of these challenges have not yet been determined. This requires further development, in particular through an exploration and investigation of the framework for RCEs that can be directly related to the outcomes of Chapter 5; the overall discussion thereof is produced next.

4.8 CHAPTER SUMMARY

This chapter outlined a scoping review, based on a rigorous methodology as adopted from a systematic review of the concepts of eGovernment services. It proposed a definition of eGovernment relevant to this study, and identified the proposed basic components of the eGovernment services.

The following Chapter will provide an overview of the components and concepts of RCEs, as these are applied and used in the Ethiopian context and in other developing countries. A literature review (scoping review) of the existing concepts of RCEs and the challenges that they can pose to Cloud Computing are provided, and answers are developed to the third sub-research question of this study

CHAPTER 5 SCOPING REVIEW: RCES

5.1 CHAPTER OVERVIEW

Chapter 5 is divided into seven sub-sections, following this chapter overview (Section 5.1 Section 5.2 introduces RCEs. Section 5.3 presents how the scoping literature review was conducted for this study, and Section 5.4 discusses the components of RCEs in general. Section 5.5 outlines the RCEs in a particular research context known as the WoredaNet in Ethiopia, and provides a detailed discussion of WoredaNet. Section 5.6 presents existing opportunities for addressing the challenges of the RCE in facilitating Cloud Computing-based eGovernment services. Section 5.7 summarises the research findings and findings from discussions about WoredaNet. Section 5.8 provides a concept map for the third version of the theoretical framework for Cloud Computing for facilitating eGovernment services in RCEs. Section 5.9 concludes the chapter.

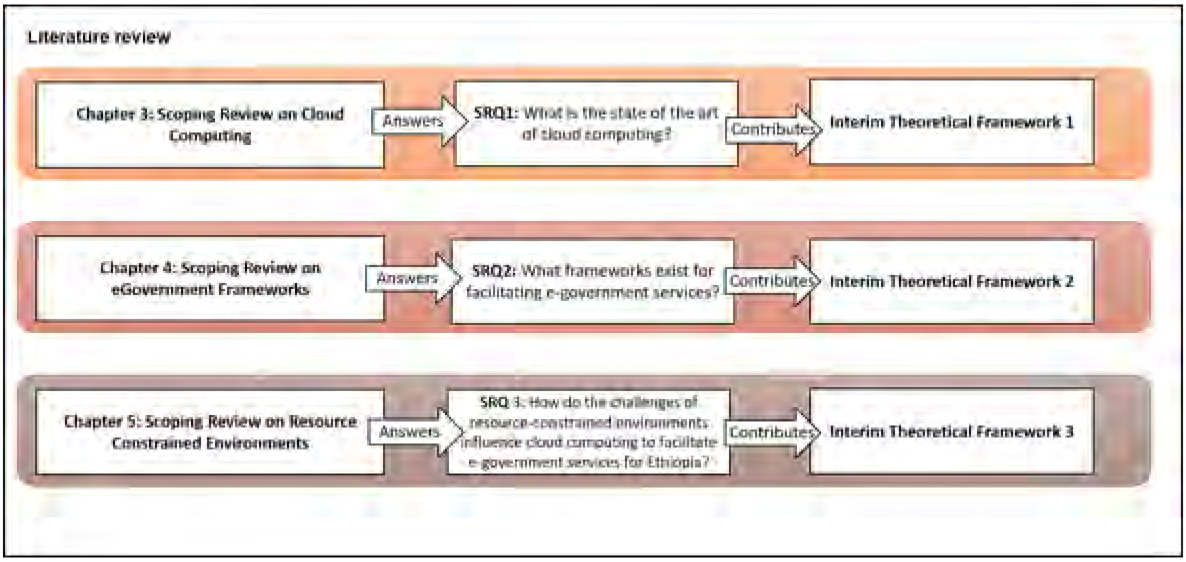

Figure 5-1: The phases of Chapters 5 as Circled.

5.2 INTRODUCING RCEs

Pholotho (2017), citing (Anderson *et al*. 2012), defines RCEs as places with inadequate network bandwidth and areas with less income. In developing economies, an RCE may show a clear distinction in particular areas, such as a remote area or rural location, as these areas are usually categorized by limited ICTs, limited access to service, and limited service delivery.

This chapter focuses on exploring the vital components of the RCEs that are relevant to this study. These may include environments with insufficient ICT resources, limited human expertise, and other challenges posed by RCEs. This chapter seeks to explore constraints related to Cloud Computing, as an element of the ICT sector, in fostering eGovernment service delivery.

The exploration and discussion of the topic is conducted by means of a scoping review of closely related literature of RCEs. The steps of the review are depicted in Figure 5-2.

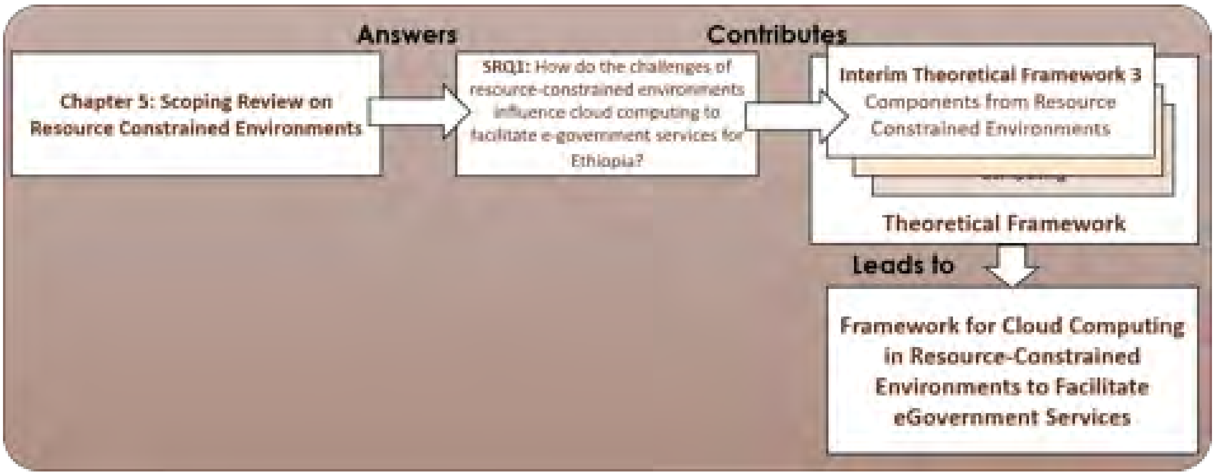

Figure 5-2: The different phases of Chapter 5.

The following sub-sections present the scoping review of RCEs, and outlines the components and approaches for implementing Cloud Computing to facilitate eGovernment services in RCEs; these are used to develop the third version of the proposed framework.

The findings of the components of RCEs in general, and RCEs in relation to a particular research context (the WoredaNet in Ethiopia), are discussed to identify all components of RCEs that are relevant to the Ethiopian context.

5.3 SCOPING LITERATURE REVIEW: RCEs

This chapter aims to:

1. Answer the third sub-research question; and
2. Address the third objective of the study: to explore and identify challenges that an RCE can pose for Cloud Computing in facilitating eGovernment services.

The aim of this chapter guided the selection of an appropriate review type and, accordingly, a scoping review method was adopted and applied to search for the literature on RCEs. The relevance of the scoping review to this thesis was presented in Chapter 3 (Section 3.3).

The scoping review method was applied in this chapter to:

- Identify the nature and extent of research evidence on RCEs;
- Identify what has been done and what has remained unexplored in existing literature regarding RCEs; and
- Summarise and disseminate research findings.

5.3.1 Identifying the Research Question

The process of exploration and investigation in this chapter is guided by the third sub-research question (SRQ3): *How do the challenges of RCEs influence Cloud Computing in facilitating eGovernment services for Ethiopia?*

The findings from the scoping review are disseminated mainly in tabular form, followed by some narrative commentary. Table 3-2 (Chapter 3) provides more details about the academic databases, keywords and date ranges that were used to search for relevant articles (2000-2018). The inclusion and exclusion criteria are also summarised in this table.

137 results were retrieved using keyword searches. After removing 73 duplicate studies, screening for eligibility and relevance was conducted on the titles and abstracts of 64 studies.

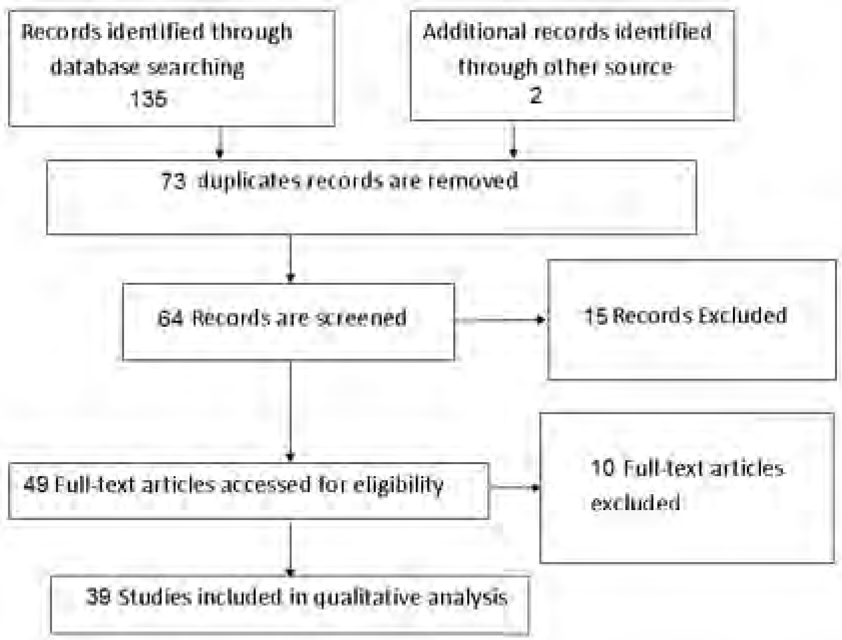

Figure 5-3: Different phases of the scoping review search for studies on RCEs

5.3.2 Data Chart

The data chart for included publications is presented with information about the:

- Publication/title;
- Name of the author and publication date; and
- Basic concepts and findings of the study (components of RCEs and challenges that may be posed by RCEs in general, Cloud Computing in particular, in facilitating eGovernment services).

A summary of the identified relevant 39 papers can be found in Appendix H

5.4 CONCEPTUALIZING RCEs

An RCE can be characterized as places that may provide challenges such as low availability of, or expensive, electric power, low availability of network connectivity, poor ICT infrastructure, lack of ICT infrastructure, or high cost of implementation of ICT, and lack of experts to help. Chetlur, Tamhane, Reddy et al. (2014), illuminated the difficulty of getting help from an expert, and mentioned how costly it is to download bulky content using mobile devices in a resource-constrained context; Salerno, Ouma, and Botha (2015) similarly raised low literacy, and included lack of Internet access, low ICT proficiency, limited electricity, and a lack of ICT-confident populations within RCEs.

Different authors discussed RCEs, based on particular research contexts and/or particular technology artefacts. Regarding research of particular technology artefacts, Kong, Ang, and Seng (2014), for example, pointed out battery-life, memory, latency of computation, and communication bandwidth as constraints to device performance, where an investigation was made mainly focusing on selecting a suitable cryptographic algorithm for solutions of security-related issues in hardware-constrained environments. However, the discussion is focused on specific systems known as data communication systems; the issues raised above — such as battery-life, memory, latency of computation and communication, as well as bandwidth — are regarded as characteristic of RCEs. Pholotho (2017) likewise focused on particular technology artefacts, such as broadband services and infrastructure, but in particular in rural areas, and identified the following characteristics of RCEs: lack of broadband, lack of ICT infrastructure, fear of security, high deployment cost of fixed lines, high maintenance cost, and lack of technical skills.

In developing countries, the digital divide, political issues, lack of regulatory aspects, high mobile transaction costs, security concerns, and poverty can become significant challenges and barriers to transition, with the non-availability of government policies and regulations representing additional challenges in these areas (Africa, including Ethiopia). For example, Desta (2018) refers to the divide as one of the main challenges, particularly in places such as countries in the Horn of African, including Kenya and Ethiopia. This, according to Desta (2018), may be due to regulations and policies of government that allow only a slow and highly controlled development of media. However, Desta (2018) also stated that increasing affordability and access to computers, laptops, mobile phones, tablets, and smart phones in Africa could be regarded as a promising aspect of such an RCE regarding the digitization of countries.

It can, in general, be argued that the widely and commonly mentioned challenges that the RCE may pose, including shortage of access to resources such as computers, low access to the Internet, fear of change, high technology implementation and maintenance costs, and language used may negatively impact on the delivery of government electronic services in rural areas (Anderson & Kolko, 2011; Kulkarni & Rajamanickam, 2016; Pholotho, 2017; Salerno et al., 2015).

It may thus be worth understanding the root concepts of the subject to explore, investigate, and understand the real challenges that RCEs may pose, particularly to the success of Cloud Computing in fostering eGovernment services. This can enable conceptualization of the vital components of RCEs that may pose limitations to Cloud Computing in facilitating eGovernment services. However, what is an RCE?

The next section provides an overview of the concepts from the literature study related to RCEs.

5.4.1 Concepts of RCEs

Anderson and Kolko (2011, p. 3) defined RCEs as “a range of conditions, including material issues such as limited electricity as well as societal conditions such as low literate populations. RCEs provide unique infrastructure, technical, and social constraints that demand innovative design approaches”.

RCEs are mainly discussed by referring to terms such as ‘lack’, ‘shortage’, or ‘limitedness’ in accordance with resources, in a sense that ‘lack’, ‘shortage’, or ‘limitedness’ can be from a technical (technology) perspective (shortage of technology artefacts), an organisational perspective (lack of structure), social considerations (shortage of technical skills or limited acceptance to technology change), security concerns (fear of security), or financial constraints (limitedness of budget). For example, Kulkarni and Rajamanickam (2016) use terms such as ‘lack and shortage of resources’ and describe a lack of the availability of computing devices, Internet and literate manpower as challenges that may be posed by RCEs.

The varieties of concepts raised in relation to RCEs are explored from different discussions offered by existing published literature studies. According to Salerno et al. (2015), a number of challenges and constraints in a variety of place-specific contexts can be used to define an RCE. Pholotho (2017), citing (Herselman & Botha, 2014:1), defined an RCE by considering it as an area in which the community is characterized by low income and in which the availability of network bandwidth is low. This thesis agrees that the approach offered by Salerno et al. (2015) is a more generic approach to defining an RCE.

Botha and Herselman (2017), citing the definition offered by Anderson, Anderson, Borriello, and Kolko (2012), regard an RCE as a low bandwidth environment with low-income communities; they considered an area known as the Nciba Circuit of the Cofimvaba School District in the Eastern Cape Province of South Africa, with 35500 people, schools scattered over mountainous areas, and a gravel road network as an RCE. According to Botha and Herselman (2017, p. 4), “RCEs provide unique constraints (cultures) where people are unfamiliar with, or afraid of, technology and/or environments where power and network connectivity are scarce and expensive”.

Given the definitions offered by different researchers as baseline, and considering a particular research context such as the WoredaNet, this thesis defines an RCE as:

“An environment with lack or limited resources related to various aspects such as technology, organisation, finance, security, trained human resources, and social issues of a particular context (such as the WoredaNet), which may pose various challenges to the adoption, deployment, and use of technology in general, and Cloud Computing in particular, for facilitating eGovernment services”.

The exploration of the various components of RCEs relevant to this study and their illustration is outlined below.

5.5 RELEVANT COMPONENTS FROM RCEs

Different authors agree that the applications delivered as services, the Internet over which the applications are delivered, the hardware and systems software, and the data centres that host and provide those applications and services represent resources in the ICT paradigm (Bwalya & Mutula, 2016; Odusote & Adigun, 2014; Pandey, Pompili, & Yi, 2015). The various concepts related to lack or limitedness can be discussed in terms of these resources within the ICT paradigm, as the component of an ICT artefact in particular.

In discussing an RCE, some published studies are more generic instead of being specific on particular issues; for example, Salerno et al. (2015) offered issues related to the general infrastructure, such as poor or limited data coverage and limited electricity, and included issues related to social aspects, such as low literacy an lack of ICT-confident populations. In contrast, other studies are rather more specific to a particular technology artefact; Kong et al. (2014) focused in this regard very specifically on design space, and discussed the limited availability of design space within a hardware development platform. The article discussed RCEs by pointing out challenges such as battery life, memory limitations, computation latency, and bandwidth limitations. Kaguma, Karumba, Walcott-Bryant, and Weldemariam (2016), similarly focused on specific artefacts, such as mobile devices, and included challenging issues such as battery power, connectivity limitations, bandwidth shortages that could be posed by the RCEs within which mobile devices are usually operating. These discussions further pointed out that a user, who has limited resources, is constrained in downloading a large multimedia file.

As discussed above, published literature addressed many challenging issues that are considered characteristic of RCEs. In order to frame the relevant components of RCEs, this thesis extracted relevant challenges from different published literature sources, presented as follows:

- Resistance to change and limited support from management;
- Lack of cooperation and collaboration;
- Lack of integration and interoperability;
- Limited ICT awareness and disparity of ICT skills;
- Lack of an ICT strategy and security plan;
- Lack of enterprise architecture;
- Silos of applications and data centre (DC) deployment;

- Internet of Things (IoT);
- Limited broadband and interruption of network connectivity;
- Interruption of electric power;
- Limited ICT artefacts, spare parts, and limited access to ICT equipment;
- Lack of scale-up or scale-down infrastructure;
- A limited number of electronic services and limited access to Internet services;
- Lack of trust, fear of cyber security, and fear of confidentiality and control of personal data;
- Divide;
- Rigid bureaucratic workplace culture;
- High investment and maintenance cost; and
- High telecoms data network services costs.

This has helped to provide insights into the various constraining challenges that RCEs may impose on the development and use of ICTs, such as Cloud Computing for facilitating eGovernment services; it is further illustrated below.

5.5.1 RCE challenges for Cloud Computing facilitating eGovernment Services

Many publications in the field discussed that RCEs could pose several challenges related to particular ICT infrastructure devices, such as mobile devices (Kaguma et al., 2016; Yang, Wang, Wang et al., 2011), or related to particular institutions such as schools (Kulkarni & Rajamanickam, 2016; Pholotho, 2017).

According to different authors, the limitations that may constrain the application and use of ICT resources in general and the application of Cloud Computing, in particular, may range from lack of Internet availability to lack of ownership of data, fear for information security in Cloud Computing, repeated interruptions of electric power supply, lack of policy, lack of data ownership legislation for Cloud Computing, and lack of interoperability within or across organisations (Kattepur, Dohare, Mushunuri et al., 2016; Kulkarni & Rajamanickam, 2016; Lewis, Echeverría, Simanta et al., 2014; Pholotho, 2017). These can be considered constraining challenges to the successful achievement of ICT-related issues such as Cloud Computing for facilitating eGovernment services, which may be sourced for RCEs to adopt, implement, and use the system.

The thesis categorized the various constraints into five major categories, as depicted in Table 5-1.

Table 5-1: Categories of challenges that may be posed by RCEs

Technical constraints	Organisational constraints	Security and privacy constraints	Social constraints	Financial constraints
Internet of Things (IoT)	Lack of, or limited support from management	Lack of trust	Divide	High investment and maintenance costs
Bandwidth limitation	Negligence and resistance to change, modernization and optimisation of technology	Fear of: cyber security, privacy, confidentiality, and personal data handling	Rigid bureaucratic workplace Culture and attitude	High costs for telecoms network services
Interruption of network connectivity, and electric power	Limited understanding of management of ICTs, particularly Cloud Computing technology	Fear of loss of control over personal data	Limited capacity building	
Limited technical support	Lack of, or immature, integration and interoperability		Fear of job losses	
Lack of maintenance centre	Limited number of employees and ICT expertise			
Limited WiFi broadband	Lack of cooperation and collaboration			
Limited number and diversity of electronic services available	Lack of, or immature, ICT strategy and security plan			
Obsolescence of ICT Infrastructure	Lack of, or immature, enterprise architecture			
	Silos of application and DCs deployment			

These are depicted in Figure 5-4:

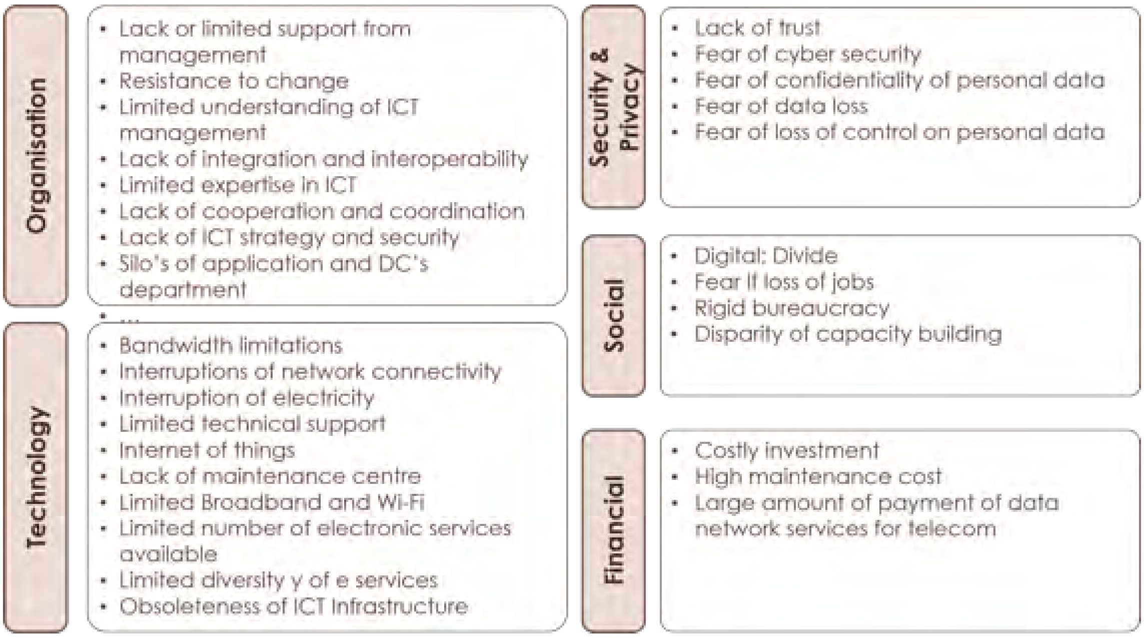

Figure 5-4: Categories of Studies challenges that may be posed by RCEs

The sub-sections below describe the Ethiopian government network (WoredaNet), including its objectives and organisational structure. The WoredaNet services and the Ethiopian National Data Centre (NDC) are also discussed in accordance with their organisational structures.

5.6 SUMMARIZING THE CHALLENGES BY RCEs WITHIN WOREDANET

This thesis identified a number of challenges related to infrastructural/technological, organisational, financial, security, and social considerations that are closely related to the WoredaNet (see case description Appendix E: WoredaNet as the Case) context, and recognised them as constraints posed by RCEs in a particular context such as that of WoredaNet. It generalized the challenges as follows:

- Limited or lack of acceptance to change, and ICT adoption and use;
- Limited or lack of rules and regulations for ICT-related issues;
- Limited or lack of integration among government agencies and departments;
- Limited or lack of a data release strategy and format;
- Limited or lack of common standards for eGovernment service delivery and usage;
- Limited or lack of centralized data storage for reference for decision making;
- Limited or lack of a central authentication and verification service;
- Silos of application and deployment of DCs by government agencies and departments;

- The traditional nature of the distributed chimney-type data centres that have already been built by government;
- Low commuting efficiency;
- Non-reliable electric power sources for processor cooling;
- Non-reliable disaster recovery; and
- Minimum utilization of the existing ICT infrastructure at hand.

This thesis categorized the various challenges within WoredaNet, and categorized these into infrastructural/technological, organisational, financial, security, and social groups, as depicted in Table 5-2.

Table 5-2: Challenges that may be posed by RCEs

Category of components of RCEs	Challenges that could be posed by RCEs	Description
Organisation	Strategies	Lack of rules, regulations, and strategies
	Structure	Lack of standardization of organisational structure
	Work culture	Rigid bureaucratic work culture
	Processes	Lack of processes
Technology	Infrastructure	Limited Infrastructure
	Network and communications	Limited network and communications
	Applications	Limited applications
	Communication	Legacy data communication
Financial	Cost of deployment	High deployment cost
	Maintenance and administration costs	High maintenance cost
	Cost of management	High management costs
Security and privacy	Security of data and information	Fear of security of data and information
	Privacy of personal data and information	Fear of privacy of personal data and information
Social	Technology acceptance	Limited technology acceptance
	Capabilities and skills	Limited capabilities and skills
Human agency	Human skill/trained people	Limitedness of skill; Limited human resources

Table 5-2 summarises the components of RCEs and the challenges that may be posed by them to Cloud Computing for facilitating eGovernment services.

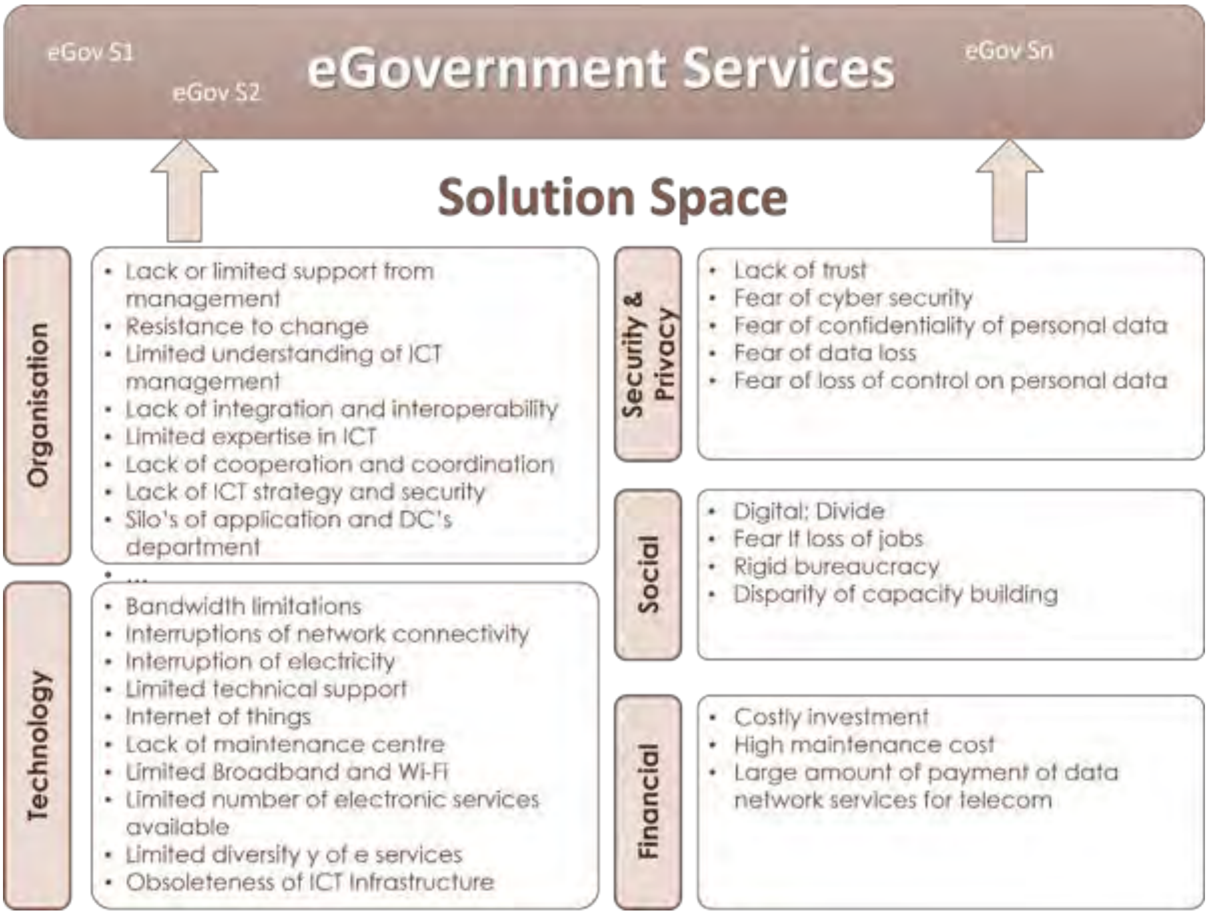

Figure 5-5: Components of RCEs combined with the challenges

5.7 POSSIBLE OPPORTUNITIES TO ADDRESS CHALLENGES POSED BY RCEs

The widely available ICTs have created a variety of opportunities for addressing a number of challenges that may constrain eGovernment services. Cloud Computing can be one example for the potential advantages that it can offer, such as Cloud Computing storage services, which can enable users to save on infrastructure investment costs (storage and application servers) and on deployment and maintenance costs (Yang et al., 2011). It is found in the literature that high operational costs no longer need to be a burden, since it can be minimized by applying the various Utility Computing platforms such as pay-as-you-use, Utility Computing, or utility on-demand that can reduce operational costs related to ICT, as well as Total Cost of Ownership (TCO) (Odusote & Adigun, 2014). The features of Cloud Computing, including pay-as-you-go, Utility Computing, and on-demand service delivery (as discussed in Chapter 3) imply that Cloud Computing can offer vital opportunities for addressing challenges that can be posed by RCEs to facilitation of eGovernment services.

Given the discussions of Cloud Computing presented in this thesis (see Chapter 3), various challenging aspects related to ICTs can be raised, such as the requirement for high bandwidth, the availability of non-interruptible Internet connectivity and electrical power sources, and reliable back-end ICT infrastructure, including modern data centres; all of these can be addressed by implementing and adopting Cloud Computing for eGovernment. It was discussed how these various aspects could become applicable within eGovernment services, as enablers of efficiency and effectiveness of internal work activities and facilitating service delivery tools to citizens. It was also pointed out how ICT artefacts can be used as tools to transform work activities for facilitating eGovernment services.

In different environments, the adoption and implementation of the ICT artefacts, such as Cloud Computing for eGovernment services, can enable the facilitation of eGovernment service delivery in environments that may pose challenges. In this regard, the exploration and identification of the vital components of RCEs may enable a proper understanding of the constraining factors and possible challenges and may facilitate these constraining factors to be addressed.

In attempting to address the challenges that RCEs may pose, this thesis sought to explore the advantages of Cloud Computing as a solution by exploring and identifying a particular characteristic and advantage of Cloud Computing that may closely fit with each of the five categories of constraints offered by this thesis in the previous sub-sections.

5.8 COMBINING THE COMPONENTS AND CHALLENGES FOR RCE AND WOREDANET

In order to frame the relevant components of RCEs, the variety of challenges identified from these environments (Section 5.7) include:

- Resistance to change and limited support from management;
- Lack of cooperation and collaboration;
- Lack of integration and interoperability;
- Limited ICT awareness and disparity of ICT skills;
- Lack of an ICT strategy and security plan;
- Lack of enterprise architecture;
- Silos of applications and DC deployment;
- Internet of Things (IoT);

- Limited broadband and interruption of network connectivity;
- Interruption of electric power;
- Limited ICT artefacts, spare parts, and limited access to ICT equipment;
- Lack of scale-up or scale-down infrastructure;
- Limited number of electronic services and limited access to Internet services;
- Lack of trust, fear of cyber security, and fear of confidentiality and control of personal data;
- Digital divide;
- Rigid bureaucratic workplace culture;
- High investment and maintenance costs; and
- High costs of data network service for telecommunications.

In order to gain useful insights into the various constraining challenges of Cloud Computing for facilitating eGovernment services that may be posed by RCEs, the challenges offered above are categorized into five major groups; these are summarised in Table 5-3 and Figure 5-6.

Table 5-3: Groups of categories of challenges that may be posed by RCEs

Technical constraints	Organisational constraints	Security and privacy constraints	Social constraints	Financial constraints
Internet of Things (IoT)	Lack of, or limited support from management	Lack of trust	Digital divide	High investment and maintenance costs
Bandwidth limitation	Negligence and resistance to change, modernization and optimisation of technology	Fear of: cyber security, privacy, confidentiality, personal data handling	Rigid bureaucratic workplace culture and attitude	High costs of data network service for telecommunications
Interruption of network connectivity and electric power	Limited understanding of management of ICTs, particularly Cloud Computing technology	Fear of loss of control over personal data	Limited capacity building	
Limited technical support	Lack of, or immature integration and interoperability		Fear of job losses	

Technical constraints	**Organisational constraints**	**Security and privacy constraints**	**Social constraints**	**Financial constraints**
Lack of maintenance centres	Limited number of ICT employees and ICT expertise			
Limited WiFi broadband	Lack of cooperation and collaboration			
Limited number and diversity of electronic services available	Lack of, or immature, ICT strategy and security plan			
Obsolescence of ICT Infrastructure	Lack of, or immature, enterprise architecture			
	Silos of application and DC deployment			

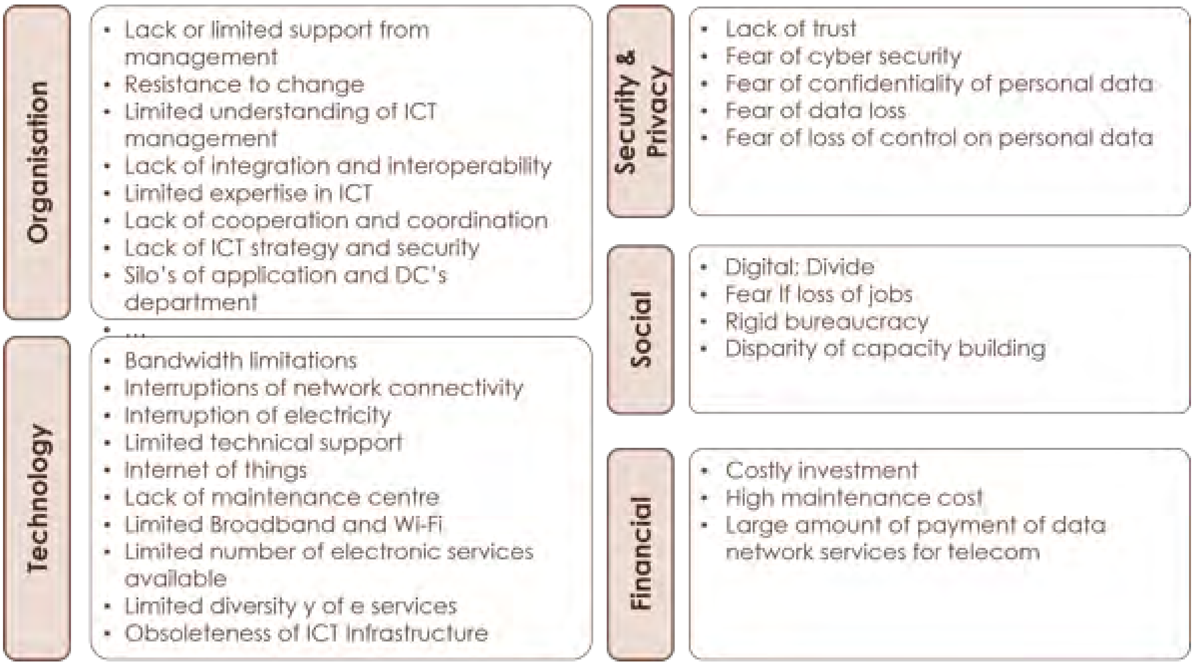

Figure 5-6: Categories of challenges that may be posed by RCEs

5.9 EVALUATING THE COMPONENTS OF RCEs

In order to assess the components of RCEs, validate the final version of the draft framework, and get feedback, questionnaires were generated based on a number of RCE success factors. The final version of the working draft of the conceptual framework was thus supplemented by the evaluator feedback depicted in the feedback columns of Table 5-5. The evaluators were requested to rate the stated factors according to the following rating scale:

- Very important;
- Important;
- Less-important;
- Not-important; and
- Neutral.

Ranking the components of RCEs (the same experts who participated in eGovernment were also selected for RCEs) are outlined in Table 5-4 below.

Table 5-4: Experts' rating of the factors of RCEs

Participants	Occupation	Age	Gender	Level	Education	Workplace	Experience
Part 1	Consultant	> 50 Years	Male	Top level Mgt.	Doctorate degree	Federal Govt ICT sector	8-10 years
Part 2	Director	40-50	Male	Top level Mgt.	Doctorate degree	Federal Govt Ministry office	8-10 years
Part 3	Director	40-50	Female	Top level Mgt.	Doctorate Degree	Federal Govt PSO	8-10 years
Part 4	Director	40-50	Male	Top level Mgt.	Master's Degree	Regional Govt ICT	8-10 years
Part 5	Manger	40-50	Male	Middle level Mgt.	Master's Degree	Federal Govt ICT	6-8 years
Part 6	Manger	30-40	Female	Middle level Mgt.	Doctorate degree	Federal Govt ICT sector	6-8 years

Part 7	Consultant	30-40	Male	Middle level Mgt.	Master's Degree	Federal Govt Ministry office	8-10 years
Part 8	Director	30-40	Male	Top level Mgt.	Master's Degree	Federal Govt PSO	6-8 years
Part 9	ICT personnel	25-30	Male	Low level Mgt.	BSc Degree	Federal Govt ICT Sector	4-6 years
Part 10	ICT personnel	25-30	Female	Low level Mgt.	BSc Degree	Local Woreda ICT centre	4-6 years

5.9.1.1 Findings from the questionnaires of RCEs

This section outlines the findings that the experts provided, based on the different components of the RCEs. The participants of the eGovernment service (10 experts) were also requested to respond to questionnaires of the RCE.

Six experts ranked *lack of rules and regulations and strategies* as a very important Organisation component of RCE relevant to the Ethiopian context in general and the WoredaNet context in particular, while two experts ranked it as an important component of RCEs; two experts were neutral. Seven experts ranked *lack of standardization of organisational structure* as a very important Organisation component of RCE relevant to the Ethiopian context in general and the WoredaNet context in particular, while three experts ranked it as an important component of RCE. Five experts ranked *rigid bureaucratic work culture* as a very important Organisation component of RCE relevant to the Ethiopian context in general and the WoredaNet context in particular, three experts ranked it as an important component, while one expert ranked it as a less important component of RCE; one expert was neutral. One expert ranked *lack of processes* as a very important Organisation component of RCE relevant to the Ethiopian context in general and the WoredaNet context in particular, while seven experts ranked it as an important component; two experts ranked it as less important component of RCE.

The findings validate *lack of rules and regulations and strategies, lack of standardization of organisational structure, rigid bureaucratic work culture*, as well as *lack of processes as relevant components of RCE* relevant to the Ethiopian context in general and the WoredaNet context in particular, as all of the experts declared and accepted that these components are relatively important within the Ethiopian context. These concepts are thus retained.

Seven experts ranked *limited Infrastructure* as a very important technology component of RCE relevant to the Ethiopian context in general and the WoredaNet context in particular, while three experts ranked it as an important component. Six experts ranked *limited network and communications* as a very important technology component of RCE relevant to the Ethiopian context in general and the WoredaNet context in particular, while one expert ranked it as an important component of RCE and three experts were neutral. Seven experts ranked *limited applications* as a very important technology component of RCE relevant to the Ethiopian context in general and the WoredaNet context in particular, while one expert ranked it as an important component and two experts ranked it as a less important component of RCE.

The findings validate *limited infrastructure, limited network and communications*, as well as *limited applications* relevant to the Ethiopian context in general and the WoredaNet context in particular, as all of the experts affirmed and decided that these components are relatively important within the Ethiopian context. These concepts are thus retained.

Table 5-5: Experts rating of the factors of RCEs

#	Major Component	Sub-components	Very important		Important		Less important		Not important		Neutral	
			Fq	%	Fq	%	Fq	%	Fq	%	Fq	%
1	…Organisation component of RCE relevant to the Ethiopian context in general and the WoredaNet context in particular	'Lack of rules and regulations and strategies'	6	60	2	20					2	20
2		'Lack of standardization of organisational structure'	7	70	3	30						
3		'Rigid bureaucratic work culture'	5	50	3	30	1	10			1	10
4		'Lack of processes'	1	10	7	70	2	20				
5	…as technology component of RCE	'Limited Infrastructure'	7	70	3	30						
6	relevant to		6	60	1	10					3	30

	the Ethiopian context in general and the WoredaNet context in particular	‘Limited network and communications’										
7		‘Limited applications’	7	70	1	10	2	20				
8	…as financial component of RCE relevant to the Ethiopian context in general and the WoredaNet context in particular.	‘Large amount of cost of deployment’	9	90			1	10				
9		‘Large amount of maintenance cost’	7	70	2	20					1	10
10		‘Large amount of Cost of management’	7	70			3	30				
11	…as security and privacy component of RCE relevant to the Ethiopian context in general and the WoredaNet context in particular.	‘ear of security of data and information’	10	100								
12		‘Fear of Privacy of personal data and information’	10	100								
13	…as social related component of RCE relevant to the Ethiopian context in general and the WoredaNet	‘Limited technology acceptance’	6	60	2	20	2	20				
14		‘Limited capabilities and skills’	6	60	3	30					1	10

	context in particular.										
15	Any relevant components of RCE which have not been mentioned here in the above questions?		None of the experts provided any relevant components of RCE which have not been mentioned here in the above questions								

The following table presents a summary of the percentages in Table 5-5.

Table 5-6: Responses of experts expressed as percentages

#	Major Component	Questionnaires	Very Important	Important	Less Important	Not Important	Neutral
			%	%	%	%	%
1	… Organisation component of RCE relevant to the Ethiopian context in general and the WoredaNet context in particular	'Lack of rules and regulations and strategies'	60	20			20
2		'Lack of standardization of organisational structure'	70	30			
3		'Rigid bureaucratic work culture'	50	30	10		10
4		'Lack of processes'	10	70	20		
5	…as technology component of RCE relevant to the Ethiopian context in general and the WoredaNet context in particular	'Limited Infrastructure'	70	30			
6		'Limited network and communications'	60	10			30
7		'Limited applications'	70	10	20		
8	…as financial component of RCE relevant to the Ethiopian context in general and the WoredaNet context in particular.	'Large amount of cost of deployment'	90		10		
9		'Large amount of maintenance cost'	70	20			10
10		'Large amount of Cost of management'	70		30		
11	…as security and privacy component of RCE relevant to the Ethiopian context in general	'Fear of security of data and information'	100				

#	Major Component	Questionnaires	Very Important	Important	Less Important	Not Important	Neutral
			%	%	%	%	%
12	and the WoredaNet context in particular.	'Fear of Privacy of personal data and information'	100				
13	…as social related component of RCE relevant to the Ethiopian context in general and the WoredaNet context in particular.	'Limited technology acceptance'	60	20	20		
14		'Limited capabilities and skills'	60	30			10

Nine experts ranked *large amount of cost of deployment* as a very important financial component of RCE relevant to the Ethiopian context in general and the WoredaNet context in particular, while one expert ranked it as a less important financial component of RCE. Seven experts ranked *large amount of maintenance cost* as a very important financial component of RCE relevant to the Ethiopian context in general and the WoredaNet context in particular, while two experts ranked it as less important, and one expert was neutral. Seven experts ranked *large amount of Cost of management* as a very important financial component of RCE relevant to the Ethiopian context in general and the WoredaNet context in particular, while three experts ranked it as less important financial component of an RCE.

The findings validate *large amount of cost of deployment, large amount of maintenance cost,* and *large amount of Cost of management* as relevant financial components of RCEs relevant to the Ethiopian context in general and the WoredaNet context in particular, as all of the experts confirmed and believe that these components are highly important within the Ethiopian context. These concepts are thus retained.

All 10 experts commonly ranked each of *fear of security of data and information* and *fear of privacy of personal data and information* as a very important security and privacy component of RCEs relevant to the Ethiopian context in general and the WoredaNet context in particular.

The findings validate both *fear of security of data and information* and *fear of Privacy of personal data and information* relevant to the Ethiopian context in general and the WoredaNet context in particular, as all of the experts approved and accepted that these components are highly important within the Ethiopian context. These concepts are thus retained.

Six experts ranked *limited technology acceptance* as a very important social-related component of RCEs relevant to the Ethiopian context in general and the WoredaNet context in particular, and two experts ranked it as an important component, whereas two experts ranked it as a less important component of RCEs. Six experts ranked *limited capabilities and skills* as a very important social-related component of RCEs relevant to the Ethiopian context in general and the WoredaNet context in particular, and three experts ranked it as an important component while one expert was neutral.

The findings validate both *limited technology acceptance* and *limited capabilities and skills* relevant to the Ethiopian context in general and the WoredaNet context in particular, as most of the experts recognised and admitted that these components are relatively important within the Ethiopian context. These concepts are thus retained.

In general, the questionnaires for RCEs indicated in Appendix C requested participants to rank 14 components of RCEs, and to indicate any relevant component not listed. As can be seen from the percentages of their responses (See Table 5-6), the components of the RCE are considered relevant and important to the Ethiopian context.

5.10 CATEGORIZING WOREDANET CHALLENGES AS RCEs

To better describe the current challenges of the Ethiopian government network (WoredaNet), Chapter 5 sourced its information from the grey literature and the challenges restricting the effectiveness and efficiency of service delivery as required by citizens within the WoredaNet context. These include:

- Minimum utilization of existing ICT resources, including the various data centres from where electronic services are delivered;
- Lack of continuous upgrade and modernization of existing stationary data centres/lack of integration with existing stationary data centres;
- Lack of improvement of computing hardware within the data centres;
- Lack of continuous maintenance and upgrades of artefacts related to electric power systems;

- Limited, or lack of, acceptance to change, and ICT adoption and use;
- Limited, or lack of, rules and regulations for ICT-related issues;
- Limited, or lack of, integration among government agencies and departments;
- Limited, or lack of, data release strategy and format;
- Limited, or lack of, common standards for eGovernment service delivery and use;
- Limited, or lack of, centralized data storage as reference for decision making;
- Limited, or lack of, central authentication and verification service;
- Silos of application and deployment of DCs by government agencies and departments;
- The traditional nature of the distributed chimney type data centres that are already built by government;
- Low commuting efficiency;
- Non-reliable electric power source for processing cooling;
- Non-reliable disaster recovery; and
- Minimum utilization of the existing ICT infrastructure at hand.

The majority, if not all, challenges that constrain eGovernment services within WoredaNet are similar to the challenges that RCEs may pose; this similarity has reduced the complexity of the design process of the proposed third version of the theoretical framework. This thesis considers the challenging constraints as construing factors that may challenge eGovernment services and hinder work efficiency within the WoredaNet context that may be posed by RCEs.

5.11 STRATEGY FOR DEVELOPING THE THIRD VERSION OF THEORETICAL FRAMEWORK

The variety of challenges sourced from formal and grey literature (as in the WoredaNet research context) are categorized into five major groups: organisational, technological/infrastructural, financial, security and privacy, and social aspects, as depicted in Table 5-7.

Table 5-7: Categories of Possible Challenges and descriptions

Category of components of RCEs	Possible challenges that could be posed by RCEs	Description
Organisation	Strategies	Lack of rules, regulations, and strategies
	Structure	Lack of standardisation of organisational structure
	Work culture	Rigid bureaucratic work culture

	Processes	Lack of processes
Technology	Infrastructure	Limited infrastructure
	Network and communications	Limited network access and communications
	Applications	Limited applications
Financial	Cost of deployment	High deployment cost
	Maintenance and Administration cost	High maintenance cost
	Cost of management	High management cost
Security and Privacy	Security of data and information	Fear of security of data and information
	Privacy of personal data and information	Fear of privacy of personal data and information
Social	Technology acceptance	Limited technology acceptance
	Capabilities and skills	Limited capabilities and skills

For the exploration of useful solutions in accordance with each of the categories of challenges, this thesis followed a strategy that first presented the categorized challenges and then explored and identified the possible opportunities.

As illustrated by Table 5-8, several relationships that were identified helped to frame the third version of the proposed theoretical framework as presented in Section 5.12.

Table 5-8: Relationships among various components

Challenges of eGovernment services	Particular challenges that may be posed by RCEs	Existing opportunities of Cloud Computing and eGovernment applications	Source framework for existing opportunities
Lack of policies, rules, and regulations Lack of partnership; Rigid bureaucratic structure and work culture Inefficient internal work processes Corruption	Strategies	Rules, regulations, and strategies that can be attached to the framework	The proposed eGovernment framework (V2)
	Structure	Standardization of structure	
	Work Culture	Change and transformation of rigid bureaucratic work culture, based on concepts such as transparency, efficient service delivery, good governance, and empowerment of citizens. The application of ICT tools for the enhancement of internal government operations to simplify and improve internal work efficiency.	

Challenges of eGovernment services	**Particular challenges that may be posed by RCEs**	**Existing opportunities of Cloud Computing and eGovernment applications**	**Source framework for existing opportunities**
Unevenness of knowledge among organisations and across different regions	Processes	Reforming the way in which governments are doing businesses with their citizens by using electronic and digitized tools to enhance work activities and internal and external communications; supporting internal processes; and ensuring change and transformation of processes	
Lack or shortage of ICT resources in government departments and agencies Lack of ICT infrastructure in rural or remote areas	Infrastructure	High-speed and high-bandwidth G-Network within G-Cloud Modern DC (NDC) and integrating existing DCs within the Cloud Computing framework Applying virtualisation technology Applying resource pooling and a shared pool of resources, including storage, processing, memory, and network bandwidth to be shared among multiple users; resources availability in a location-independent manner	The proposed Cloud Computing framework (V1)
Unavailability of services as required by users; Unavailability of timely and reliable information; Low quality of eGovernment services; Lack of SLAs;	Applications	Software as a Service (SaaS), enabling users to use Cloud applications and software running on Cloud infrastructure, or to use Cloud infrastructure Selected eGovernment services, with a wide range of SaaS services ERP and CRM High availability of computing resources, applications, and services; availability of infinite computing resources, applications, and services.	The proposed Cloud Computing framework (V1)

Challenges of eGovernment services	**Particular challenges that may be posed by RCEs**	**Existing opportunities of Cloud Computing and eGovernment applications**	**Source framework for existing opportunities**
		Computing resources, applications, and services available on demand and pay-for-use only manner	
		Improve the quality of eGovernment services and deliver citizen-centric services; improve the speed of eGovernment services, as services can be measured via reliable service level agreements (SLAs)	
Frequent interruption of network connectivity; and Slow network bandwidth	Network and communications	High speed G-Network with high bandwidth within the G-Cloud; Scalable and elastic communications resource infrastructure and services	The proposed Cloud Computing framework (V1)
Low utilization of existing ICT; Unreliable electricity supply; High costs of telecoms service provision	ICT Deployment Cost	Pay-as-you-go, on-demand, ICT as a service; access to shared pool of computing resources. The elimination of an up-front cost, decrease in cost of operations, network bandwidth, electricity, software, and hardware available. Increased utilization in Cloud Computing compared to traditional data centres. Computing resources and Cloud services available on demand and in a pay-for-use only manner. Minimize consumption of electric power and ensure Green ICT	The proposed Cloud Computing framework (V1)
Frequent interruption of hardware and systems software from which services are delivered	High ICT maintenance and management costs	Access to shared pool of computing resources with minimized administrative and maintenance costs	The proposed Cloud Computing framework (V1)

Challenges of eGovernment services	Particular challenges that may be posed by RCEs	Existing opportunities of Cloud Computing and eGovernment applications	Source framework for existing opportunities
Fear of security and privacy; Lack of trust to use eGovernment services	Security of data and information, and privacy of personal data and information	Minimize risks and challenges such as security and privacy, with reliable disaster recovery. Keep data stored safely in the cloud infrastructure, with a set of procedures, processes, and standards in the Cloud to provide information security assurance — benefiting the capability of Cloud Computing to deploy firewalls, encryption, and VLANs. Ensure confidentiality through measured service to control resource availability and use by applying metering and providing transparency of the utilized service where resource usage can be monitored, controlled, and reported. Broad network access offering opportunities through diverse client platforms, including smart phones, tablets, notebooks, and personal computers to access eGovernment services.	The proposed Cloud Computing framework (V1)
Unevenness of knowledge; Unequal access to the Internet;	Limited technology acceptance Limited capabilities and skills	Improve access to educational opportunities such as e-libraries and distance education. Ensure a wider participation and involvement of citizens and stakeholders in decision-making process. Ensure delivery of timely information and job opportunities Ensure easy access to eGovernment services at any time and from anywhere	The proposed Cloud Computing framework (V1) and the proposed eGovernment framework (V2)

5.12 THE THIRD VERSION OF THE THEORETICAL FRAMEWORK FOR CLOUD COMPUTING FOR FACILITATING EGOVERNMENT SERVICES IN RCEs

Based on the opportunities to use Cloud Computing as tools to address the challenges of eGovernment services that RCEs may pose, as presented in Table 5-9, the proposed theoretical framework for Cloud Computing for facilitating eGovernment services in RCEs is designed and presented (see Figure 5-7). Following this, and aiming to address the challenges depicted in Table 5-5, the thesis extracted useful opportunities from the proposed two theoretical frameworks: the first version of the theoretical framework (V1) and the second theoretical framework (V2).

Figure 5-7 indicates how the literature reviews added to the development of the various versions of the theoretical framework:

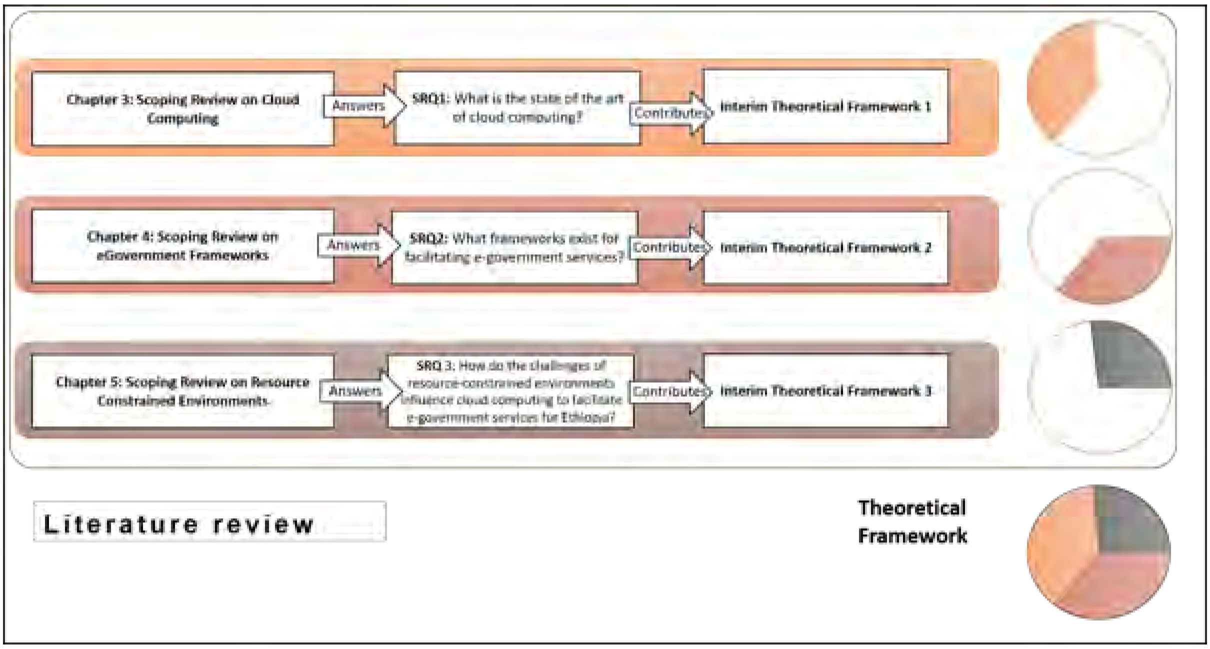

Figure 5-7: Literature review contributions to develop the theoretical framework

These theoretical frameworks provided a number of closely related components to solutions to the challenges that RCEs may pose to Cloud Computing for facilitating eGovernment services.

The opportunities extracted by this thesis for the development of this third version of the theoretical framework are as outlined below.

5.12.1 Existing possible opportunities of sharing ICT resources

Resource pooling and a shared pool of resources, including shared storage, processing, memory, and network bandwidth among multiple users; resources availability in a manner that is location-independent to reduce the cost of administration and maintenance of ICT infrastructure.

5.12.2 High availability of computing resources with non-human interaction

High availability of computing resources; availability of infinite computing resources; computing resources available on demand and in a pay-for-use only manner, as well as elasticity based on load variation, and addition or removal of resources (automatically scale up or down in response to load increases and decreases); and automatic resource allocation and management, requiring non-human intervention.

5.12.3 Confidentiality and reliability of service

Measured service to control resource availability and use, by applying a metering that provides transparency where access to resources can be monitored, controlled, and reported.

5.12.4 The opportunities of minimizing up-front cost

Elimination of an up-front cost and decreased cost of operations, network bandwidth, electricity, software, and hardware availability, and increased utilization in Cloud Computing compared to traditional data centres.

5.12.5 The opportunities of ensuring security in Cloud Computing

In a Cloud Computing environment, security mechanisms include a set of procedures, processes, and standards to provide information security assurance; the capability of Cloud Computing to deploy firewalls, encryption, and VLANs to address confidentiality and security challenges and risks; and management and handling of security risks that are divided among many stakeholders, including the Cloud Computing user, the Cloud Computing vendor, and any third-party vendors that users rely on for security-sensitive software or configurations. A Service Level Agreement (SLA) is included in Cloud Computing as a legal binding agreement for mutual understanding and acceptance about service between a user and a service provider.

5.12.6 The opportunities of using diverse client platforms

These include the broad network access offering opportunities of diverse client platforms, namely, smartphones, tablets, notebooks, and personal computers. Software as a Service (SaaS) enables users to use Cloud Computing applications and software on Cloud Computing infrastructure or use Cloud Computing infrastructure. A thin client interface, such as a Web browser (e.g., Web-based email), or a program interface, is used to access the applications. The consumer does not manage or control the underlying Cloud Computing infrastructure, including networks, servers, etc., with the possible exception of limited user-specific application configuration settings. The user need not manage or control the underlying Cloud Computing infrastructure.

All can be done with virtualisation that can simplify operations and increase utilization, in which multiple virtual machines can share resources such as CPUs and memory in Cloud Computing.

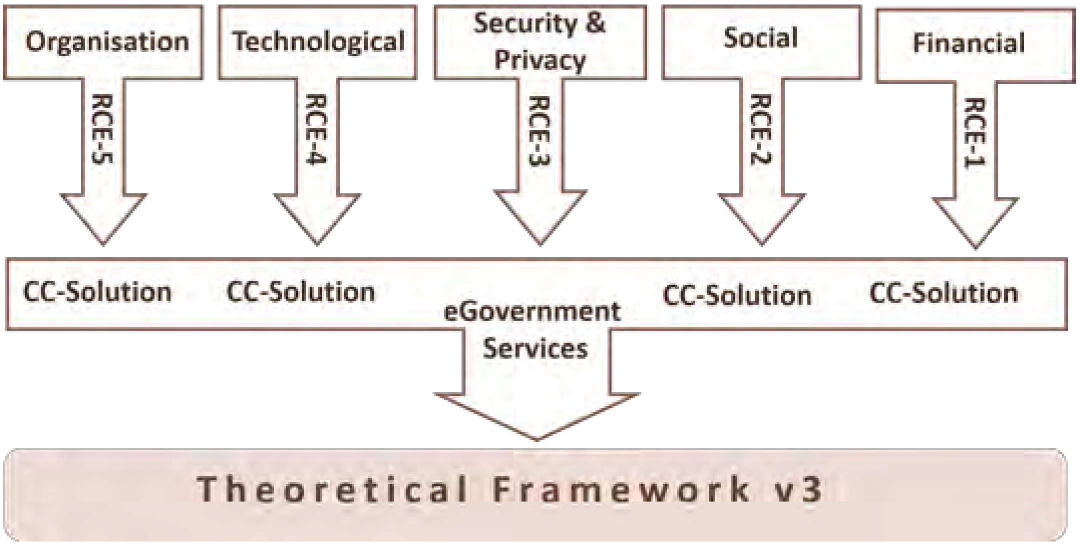

Figure 5-8: The third version of the theoretical framework for Cloud Computing for facilitating eGovernment services in RCEs

Using the above theoretical framework, the process of adoption and use of Cloud Computing for facilitating eGovernment services may follow a number of steps, as depicted in Figure 5-9.

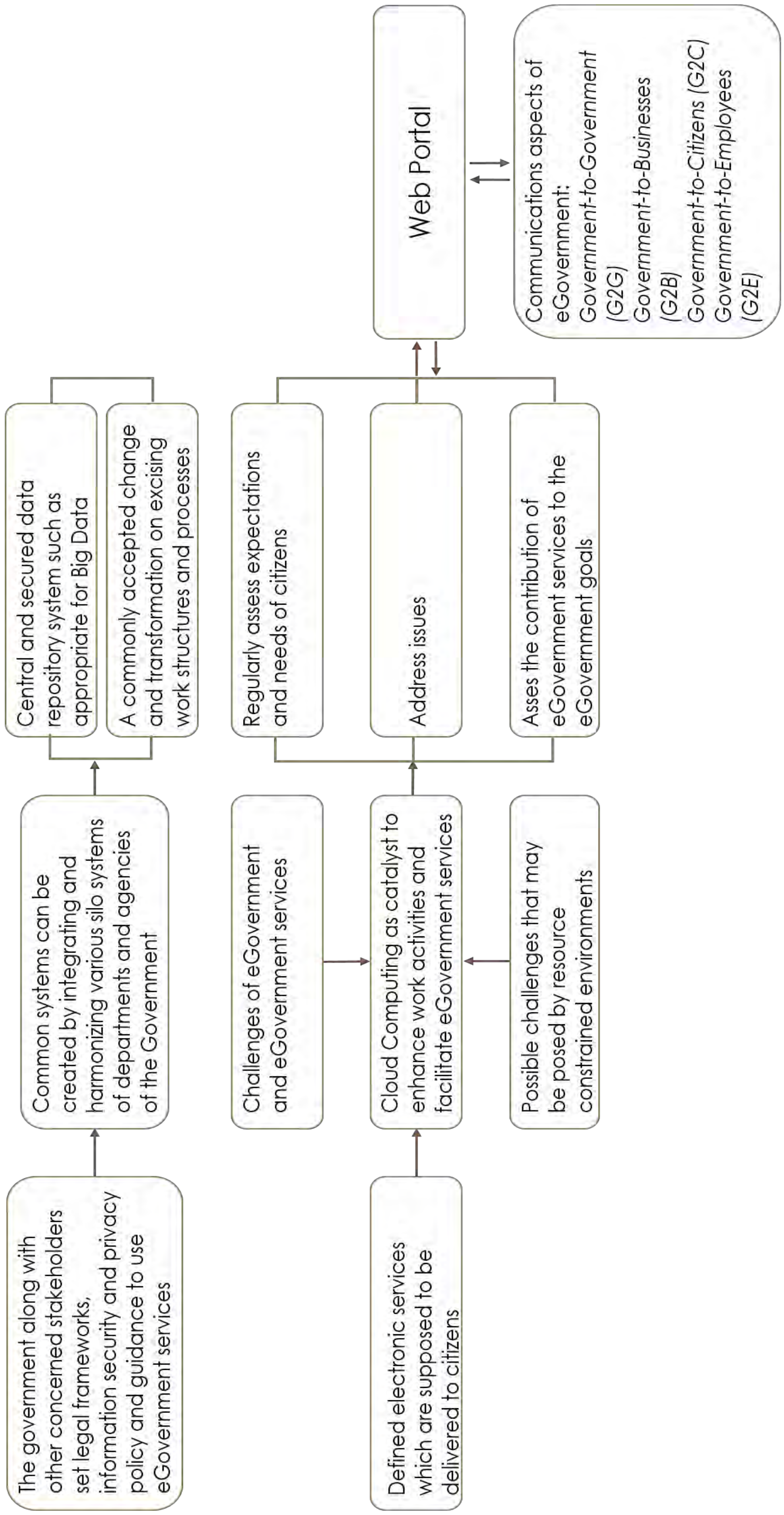

Figure 5-9: Process of adoption and use of Cloud Computing for facilitating eGovernment services in RCEs

5.13 CHAPTER SUMMARY

This chapter provided a scoping review, based on the rigorous methodology adopted from a systematic review, of the concepts of RCEs, including the possible challenges that they can pose to Cloud Computing. The ICT-related challenges faced by WoredaNet were also discussed, as well as the importance of Cloud Computing in eGovernment service delivery in addressing these challenges, were provided. The chapter also provided a scoping review of RCEs in developed and developing countries, and examined the scope of studies that have been conducted within Ethiopia. A concept map for RCEs was proposed and, finally, the conceptualising of the third version of Cloud Computing for facilitating eGovernment services in RCE was provided. The preferred research content, namely, the WoredaNet, and its composition as well as its organisational structure were presented. The success factors and its promising opportunities were also presented.

The following chapter discusses and provides the various version of framework development.

CHAPTER 6 FRAMEWORK DEVELOPMENT

6.1 INTRODUCTION

The aim of this thesis, as presented in Chapter 1, was to explore and develop a framework for Cloud Computing in RCEs to facilitate eGovernment services in Ethiopia. The main goal of this chapter is to describe how the different versions of the interim theoretical frameworks were developed towards the final framework for Cloud Computing for facilitating eGovernment services in resource-constrained environments. The vital components of Cloud Computing, eGovernment services, and RCEs were explored in Chapters 3, 4, and 5, respectively. These components are used to construct the first, second, and third versions of the interim theoretical framework. The framework addresses the unique aspects of the adoption and use of Cloud Computing to facilitate the eGovernment services offered via the WoredaNet; adoption of such a framework can also be useful for supporting internal work activities and for enhancing service delivery (depicted in Figure 5-9).

Figure 6-1 illustrates how the framework was developed:

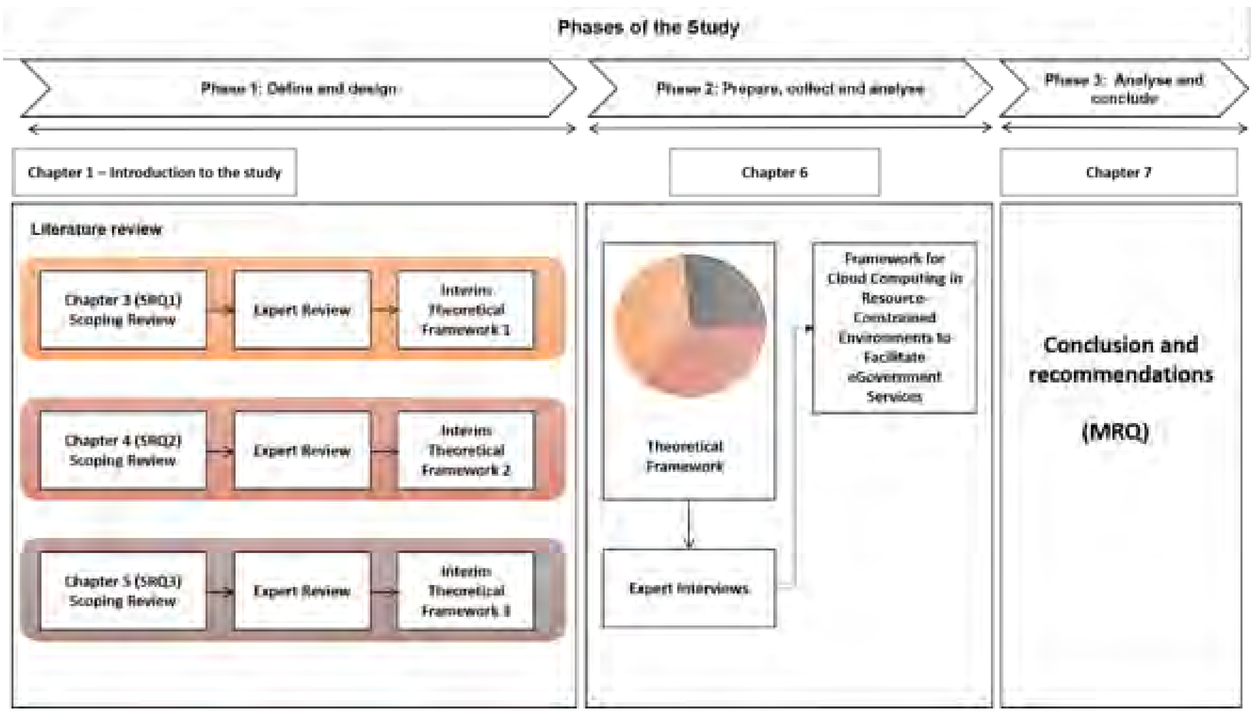

Figure 6-1: Phases of framework development

The different versions of the theoretical frameworks were developed in three different phases. Figure 6-1 illustrates the phases and the steps followed in this chapter for the development of the different versions of the proposed theoretical frameworks.

At every stage of the development, each of the different versions of the proposed theoretical frameworks were evaluated through expert reviews, as depicted in Figure 6-1.

6.2 DEFINING A THEORETICAL FRAMEWORK

As was indicated in Chapter 2 (Section 2.10) of this study, the definition of Hassan (2014) will be applied (a framework acts as the map for the researcher to indicate the important concepts and constructs, and how these relate to one another).

In recent years, research studies have provided various definitions of the term theoretical framework (e.g., Neale, 2005). Petty (2015) defined a theoretical framework as the scaffolding, the frame, or the structure of a research study, while Walsham (1995) and Orlikowski and Baroudi (1991), defined it as the lens of viewing the world.

This thesis provided its own working definition of a theoretical framework as:

> *An evaluated and validated frame and/or structure build with components (such as interrelated concepts, characteristics, models, etc.) relevant to the topic of interest to account for the gaps in knowledge ascertained in similar existing literature, answer research questions, and address research purposes, and also to be used as an instrument that can guide the researcher through the development of the research methods, analysis, and the way in which the researcher interprets the findings.*

Given the above definition, a theoretical framework can help a researcher to answer research questions posed by a given research study, and to address the purpose of the research. The development of a theoretical framework may require the exploration and identification of vital components closely related to the topic of interest, based on which the proposed theoretical framework can be developed as the components can become the building blocks of thereof.

6.3 THE FIRST TO THIRD VERSIONS OF THE PROPOSED INTERIM THEORETICAL FRAMEWORK

Version 1 of the framework was discussed in Chapter 3 (Section 3.8); Figure 6-2 represents the outcome:

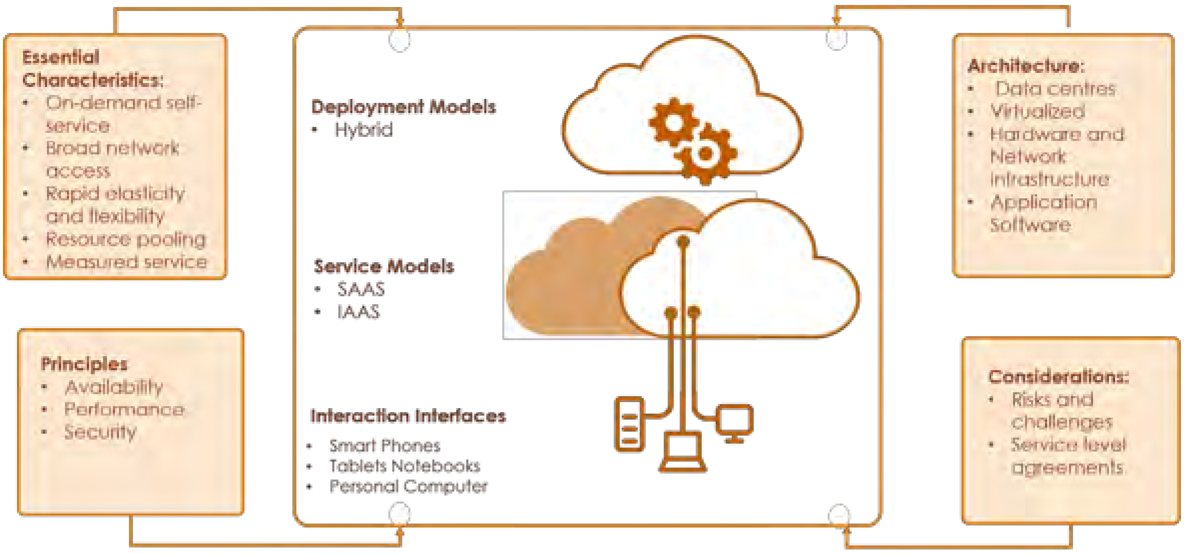

Figure 6-2: Diagrammatic representation of the proposed theoretical framework for Cloud Computing (V1)

Using these building blocks, the second version of the theoretical framework was developed in two different phases (Phase 1: Figure 6-3 and Phase 2: Figure 6-4).

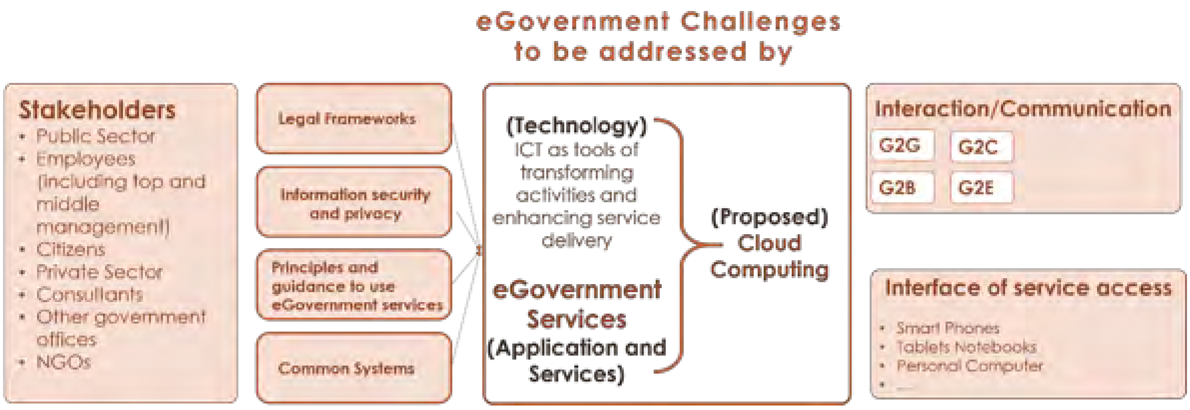

Figure 6-3: The first phase of V2 of the interim theoretical framework

The first phase identified the components of eGovernment services, while the second phase incorporated the challenges of eGovernment to realise how Cloud Computing can be applied to support these. This enabled the development of V2 of the interim theoretical framework, as V1 could be incorporated into the middle part of the theoretical framework presented in Figure

6-3. This resulted in the intended and fully developed V2 framework, as depicted in Figure 6-4.

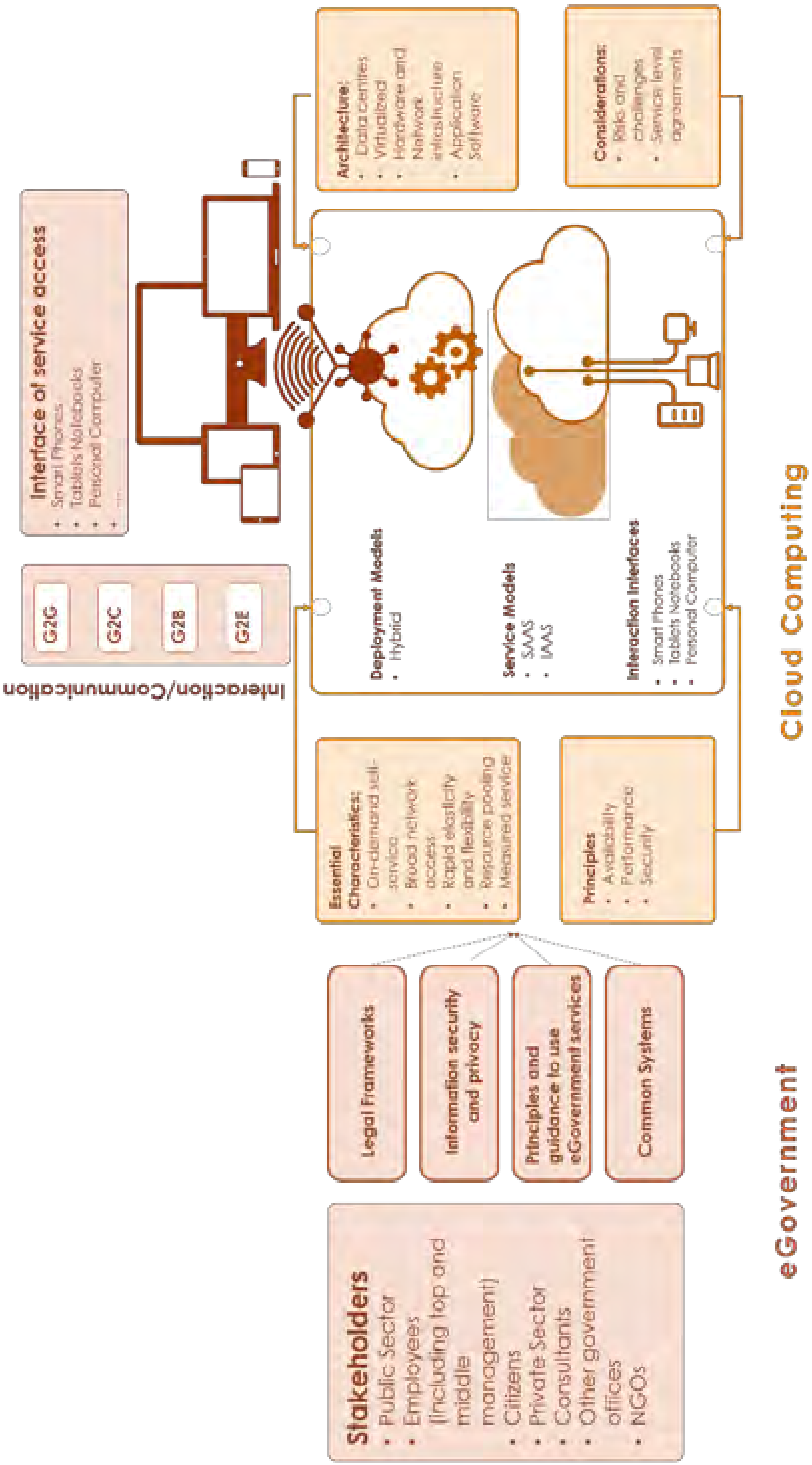

Figure 6-4: Version 2 of the interim theoretical framework for Cloud Computing for facilitating eGovernment services

These V1 and V2 interim theoretical frameworks provided a number of components that are closely related to solutions, in order to address the challenges posed by RCEs to Cloud Computing for facilitating eGovernment services. This resulted in V3 of the interim theoretical framework, as depicted in Figure 6-5:

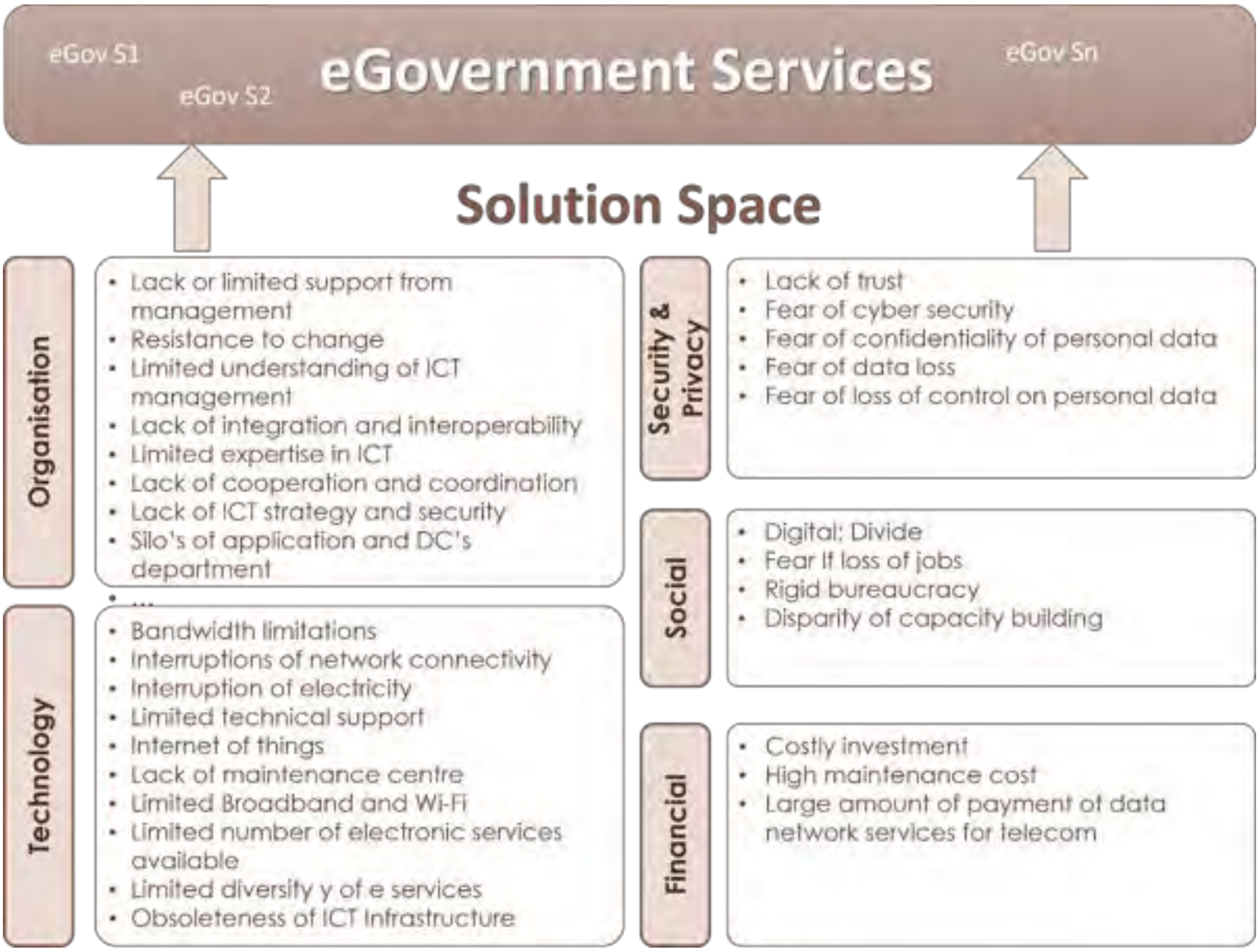

Figure 6-5: V3 of the interim theoretical framework for Cloud Computing for facilitating eGovernment services in RCEs

The V3 framework components, which included all components from Cloud Computing, eGovernment services, and RCEs, were then validated by experts to produce the final vital components of each of the concepts.

6.4 VALIDATING THE COMPONENTS OF THE THEORETICAL FRAMEWORK

After completion of the analysis of the questionnaires for Cloud Computing, eGovernment services, and resource-constrained digital environments, 10 participants were selected to participate in the expert interviews; the interview questions are depicted in Appendix D. The 10 participants included:

- Top Management (3):

One director was selected from the regional government administration sectors that possess regional data centres, and two directors were selected from capital government offices that possess organisational data centres in the capital Addis Ababa.

- Middle Level Management (7):

Two middle level managers were selected from the regional government administration sectors, two were selected from local districts with Woreda Centres (selected from 11 regions), and three were selected from the capital city ministries, agencies, and government offices possessing organisational data centres in the capital Addis Ababa.

The 10 participants were grouped into two groups:

- The first group consists of five participants for \Cloud Computing interviews; and
- The second group also consists of five participants, for both eGovernment and RCE interviews

Table 6-1: Expert Interview participants

Main Data Source					
Location	**Sites**	**Category**			**Respondents**
		Top-level management	**Middle management**	**Lower level Mgt. (technical staff)**	
Regional data centres	11	1 director	2 mid-level managers	-	3
Local Woreda Centres selected from 11 regions	11		2 mid-level managers	-	2
Ministries, agencies and other government offices	8	2 directors	3 mid-level managers	-	5
Total	30 Sites	3 higher level management	7 mid-level management	-	10

Five experts were asked to describe the WoredaNet's organisational structure in general, and their workplace's organisational structure in particular. Expert 1 stated:

> *"…the WoredaNet is designed as centralized administration technically with a three-tier hierarchical structure (federal, regional and Woreda level), it is also characterized by a decentralisation structure as the Information and Communication Technology (ICT) is disseminated into different levels of regional administrative sectors of the country…".*

Four experts similarly indicated that the WoredaNet's organisational structure is both centralized and hierarchical. Expert 4 included:

> *"…the centralized administrational WoredaNet organisational structure has helped secured information access and effective management of government ICT infrastructure … "*

The WoredaNet, with such organisational structure, has enabled the Capital and Regional administration sectors to acquire network connectivity for accessing different government services such as video conferencing, e-mail, messaging, and the Internet with computerized systems. It has attempted to ensure the process of information gathering and dissemination in a decentralised structure, of managing the ICT infrastructure in a centralized administration, and of ensuring up-to-date information access by civic, economic, and administrative sectors — even at Woreda or district level.

However, it cannot be denied that many PSOs are still relying on paper-based work activities, with slow network connectivity and inefficient service delivery. In order to address such challenging issues, the first step will be to modernize the existing system with minimal cost, so as to provide technical and economic benefits to organisations within WoredaNet via effective use of resources, minimizing repetitive work activities, and ensuring availability of ICT resources that can easily be scaled up or down to improve the scope of communication in eGovernment, such as government-to-citizens, government-to-government, government-to-employees, and government-to-business communication. Upgrading such a huge government network connectivity and ICT infrastructure can be a preferable approach to implementing completely new ICT infrastructure. In this regard, an options is to use the Cloud Computing-based electronic services and realize resource sharing, so as to foster and facilitate eGovernment service delivery in Ethiopia.

Expert 3 explained that

> *"there is a lot that needs to be done for the existing WoredaNet ICT infrastructure from which the government electronic service delivery be effective and efficient, but the most important is to make the different stakeholders become aware of the benefits of eGovernment service including the back end government ICT infrastructure…".*

Expert 6 added that:

"*upgrading and properly utilizing existing WoredaNet technology such as the data centres and network connectivity is one key point that needs to be established. The people involved in WoredaNet should be trained on how to deliver eGovernment services and use this WoredaNet ICT infrastructure. Not just the WoredaNet service providers, the civil servants should have an idea of what to do with this WoredaNet ICT infrastructure and eGovernment delivered and how it affects them".*

Expert 5 included:

> *"In my opinion, the first step for improving the WoredaNet ICT infrastructure and the eGovernment service delivery to work is infrastructure readiness and to include modern technology such as the Cloud Computing in the process. If the WoredaNet infrastructure is optimized and fully utilized it can play a vital role to deploy the Cloud Computing technology and then the Cloud Computing can facilitate the eGovernment service delivery and improve work efficiency in Ethiopia".*

On the other hand, Expert 2 described:

> *"In order to facilitate the eGovernment service using modern technology like the Cloud Computing, we need to first prepare a policy and legal framework and develop guidance to use eGovernment services. This can be followed by improving WoredaNet technology and fully utilizing it in workplaces for enhancing eGovernment service delivery"*

The WoredaNet VPN connectivity and the ICT infrastructure at hand has contributed in various aspects, such as cost minimizing and sharing the experiences of electronic service delivery, as well as sharing experiences of IT security protection that have been gained through the process of electronic service delivery following implementation of the WoredaNet and initiation of delivery of selected services. However, as time passed, the requirement of infrastructure-intensive eGovernment services has increased significantly, while the back-end ICT infrastructure has not been upgraded as per eGovernment service requirements.

Expert 8 described:

> *"… the NDC, which is the command centre of the WoredaNet, initially started to deliver only few services such as video conferencing, messaging, IP Telephony, and the Internet. These days, the number of hosted services in NDC has been increased and it is delivering quite a number of additional electronic services with the same ICT infrastructure, though the services are requiring modern and improved infrastructure. The services currently delivered by the NDC via the old WoredaNet technology include: Web Hosting, Government Mobile Apps, SMS Service (accessed by dialling 8181), Government e-mail service, Electronic data storage, Support centre such as network operation centre (NOC), IT Security service, and reliable environment and collocation service".*

Expert 8 also described:

> *" … the Web hosting service is the process of deploying Websites and portals in the NDC and making them available to users via the Internet and WoredaNet ICT infrastructure; the service is guided by some governing guidelines and data integrity mechanisms. Any government sector can obtain the service for free, where majority of the Websites and Web portals of the government sectors are now hosted on WoredaNet ICT infrastructure within the NDC. Currently (in the year 2019) there are more than 160 Websites and portals which are getting technical and security support for free from the NDC; information about the Websites and portals is gathered every month using Web analytic tools. But the problem is majority of the back-end WoredaNet ICT infrastructure on which they reside is obsolete…"*

Expert 8 also discussed:

> *"… Out of the 160 Websites and portals delivered via the WoredaNet technology, the Ethiopia's official government portal (the* http://www.ethiopia.gov.et*) and is the main portal which feeds the other Web portals of different government sectors such as ministry offices, agencies, and bureaus. Each ministry and government sector has the*

privilege of administering its own Web portal or Website and in order to support these trainings are delivered by the WoredaNet professionals. In addition to the informational Web sites and the portals hosted in NDC that the researcher mentioned earlier, other transactional Web based services are also hosted in the NDC and delivered to various stakeholders including citizens. For example, one of the Web-based transactional electronic service is accessible by a URL http://www.eservices.gov.et *that has been developed by the ministry and hosted in NDC for 29 government sectors making more than 169 services accessible via the WoredaNet ICT infrastructure…"*

It is clear that, regardless of the other services, only such a large number of electronic services (the 169 services mentioned above by Expert 8) require a sufficient amount of broadband connectivity as well as improved performance of ICT infrastructure. The current of service delivery via WoredaNet ICT infrastructure is worsened by the increased number of eGovernment services hosted in the NDC, as not only the electronic services accessed by the URL http://www.eservices.gov.et are included into the existing infrastructure of the NDC. Expert 8 further discussed:

"… Another electronic-based service hosted in NDC is known as open data, accessed by a URL http://www.data.gov.et, *which is a new idea and open related to technical and law perspectives. It is raw data (not interpreted) which is collected during the day-to-day work activities of various government sectors. It is deployed to help citizens capable of making decisions based on truth made available from this service; it can also help developers to develop new services which were not available previously…"*

Performance and ongoing service availability or continuity is also a challenging issue, as the number of eGovernment services increased to be hosted on ICT infrastructure once deployed for selected services only. Expert 8 continued to discuss more electronic services hosted in NDC, and described:

"…Furthermore, I know that a Web-based portal for Government Mobile App Stores accessible by a URL http://www.apps.gov.et *consisting of mobile based applications easily accessible and usable by citizens has been developed by the ministry and hosted on the existing ICT infrastructure of the NDC. As an initial start-up, 20 apps have been developed and made accessible in this electronic service. The SMS Service is also another service accessed by dialling 8181, where the major user of this electronic*

service is the Ethiopian exam agency to deliver text messaging service to students about their exam results and their university placement".

In terms of the requirement for the increased number of eGovernment services, the challenge is not only performance-related for the back-end ICT infrastructure on which the services are going to be hosted; management and administration of the infrastructure and power consumption can also be a challenging factor that can be addressed with the application of the Cloud Computing framework for facilitating eGovernment service delivery. However, with such problems, another resource-intensive service known as the government e-mail is still included in the existing ICT infrastructure of the WoredaNet and NDC. It was developed by the ministry and deployed in the NDC.

Expert 8 included:

"… Using the Microsoft Exchange Email Service, the ministry has developed an e-mail system to deliver e-mail service for 37 government agencies, bureaus, and 6 ministry offices, and all these government sectors are using the service…"

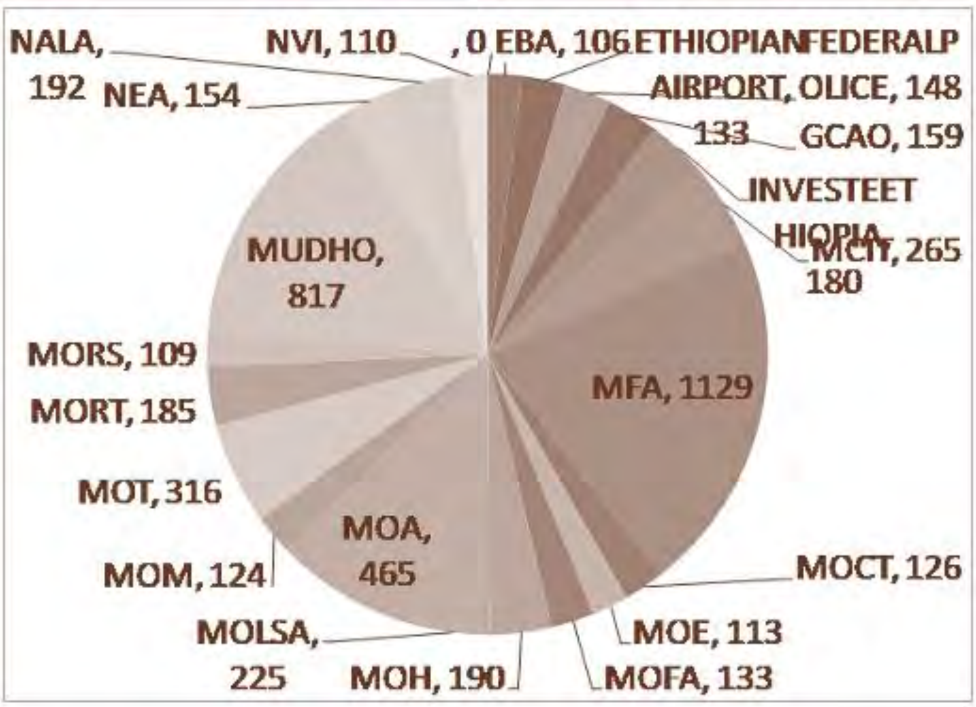

Figure 6-6: Number of users of the Ethiopian Government e-mail facility in different sectors

Depending on the purpose of the service, some eGovernment services are more frequently accessed by users than others; in situations like this, dynamic demand-based resource allocation has to be prioritised as one vital component of Cloud Computing, so as to ensure efficient service delivery and availability. Identifying the eGovernment services that are more often accessed by users is useful for optimal resource allocation and utilization. When experts were asked which electronic-based government service is most accessed through WoredaNet technology in their workplace, the majority indicated that the most highly and repeatedly used WoredaNet services is the video conferencing, which is the most applicable contribution of WoredaNet. When they were asked for what purpose the staff in their organisation are using the WoredaNet services such as the video conferencing technology, the majority indicated video conferencing is used for facilitating meetings of Woredas and regions, for delivering short term trainings, for distance education, and for court legal services. Expert 8 indicated:

> *"…only in 11 months of the year 2019 the video conference service is delivered for 610 hours for 71,289 participants and has contributed its role in reducing time and cost…".*

Expert 3 commented:

> *"I would like to be able to connect with other ministry offices and regional administration sectors or even Woredas/districts so that I can share ideas with other public servants and vice versa via the video conferencing and Internet service. I would also use the video conferencing technology to provide workshops and trainings to public servants".*

Different WoredaNet service usage behaviour can be observed among the different groups of WoredaNet service users. The outcomes of the analysis indicate the existence of diverse service usage behaviour of various groups of WoredaNet service users. This has helped to provide a deeper understanding on how these shifting intentions of users may result in negative or positive influences of human-technology interactions within WoredaNet social practices. Experts 1 and 6 similarly mentioned that WoredaNet service users show different characteristics of service usage. For example, according to them some very small user groups were initially active in terms of WoredaNet service usage; over time, they began to show reluctant behaviour to use the new technology artefacts of the WoredaNet system. This study engaged ideal groupings of service users within the WoredaNet system, so as to provide a clear understanding of the WoredaNet social norms and the practices of users of WoredaNet services and their different service usage characteristics. Accordingly, the group of service users such as those mentioned by Expert 1 and Expert 6 were given named the "Lame User Group". Both

Expert 1 and Expert 6 mentioned that the use of services by other WoredaNet service users with a moderate number of members fluctuate during the year. The thesis recognised a cyclical/periodic nature of service usage in the WoredaNet system, and grouped service users characterized by cyclic behaviour and named them the "Monsoon User Group".

There are also other characteristics of WoredaNet service usage, for example, after discussing behaviours of service usage similar to those discussed above, Expert 8 included that a group of service users with a large number of members, whose degree of frequency of communication and level of service usage is not dependent on any particular time, rather continuously and regularly use the WoredaNet services. The thesis identified a group of WoredaNet service users characterised by a regular behaviour of service usage and a very stable level of need and usage of WoredaNet services, as an ideal "Orthodox User Group".

Expert 8 further mentioned massive WoredaNet service usage behaviour by discussing that many users frequently and massively use the WoredaNet services, regardless of the time of the year. The thesis categorised such users as a mega or super user type, with a massive and huge interest in continual service usage in their working activities within the WoredaNet context; it named these users as the "Harambee User Group".

Many Websites, Web portals, and electronic services are hosted at WoredaNet's central administration point (NDC). This indicates that quite a lot of digital social sectors, who are owners and users of Web services, are included in the "Harambee User Group". Due to the significant increase in the hosting need of Web-based services from time to time, additional service users could be included to this group.

The ‘Harambee User Group’ is mainly differentiated from the ‘Orthodox User Group’ and the ‘Monsoon User Group’ by an intensive behaviour of service usage and bigger need for all types of WoredaNet service. Thus, members of the ‘Harambee User Group’ are considered as the super users of the WoredaNet service; they also show some similarities with members of the ‘Orthodox User Group’, as both are regular users of WoredaNet services. However, this also differentiates them from members of the ‘Monsoon User Group’, who are usually seasonal in terms of service usage.

Service users in this group often have many frequent interactions (Government to Government) with the WoredaNet central administration point to obtain Web hosting services; these are sourced from private ICT companies (e.g., developers of Websites and portals) (Government to Business) and non-government sectors (e.g., flower exporters, coffee exporters).

To conclude, their intensive usage of WoredaNet services and frequent and continuous communication, regardless of time and space, differentiates member of the ‘Harambee User Group’ as the mega users of the WoredaNet service.

All these implied that the degree of frequency of access to eGovernment services vary depending on various factors. There are different reasons why some eGovernment services are accessed more frequently than others.

In such variations, allocating the static nature of resources may worsen the situation, as such it requires dynamic resource allocation based on demand; for example, information sharing was considered as an area in which administrators, ICT staff, and public servants would like to use WoredaNet's technology. Expert 1 stated:

> *“I use the WoredaNet technology for sharing relevant information with other administrators, ICT staff and public servants, within my organisation, as well as other organisations. I have been assisted by WoredaNet technologies such as the video conferencing and e-mail”.*

Another reason is that some eGovernment services enable citizens to save time and resources. Expert 3 discussed:

> *“People are using the e-Court service via the Video conferencing more frequently than other eGovernment services of the WoredaNet. I can easily see how the society can save money, time, and manpower, and gain advantages of using this WoredaNet technology. I also believe that the e-Court is contributing in creating confidence of society in the justice system. But these days there are also many discouraging situations in delivering the service, there are frequent service interruptions. In my opinion, the reasons are related to the ICT infrastructure, which became old, and the slow network connectivity and even the frequent interrupted network connectivity…”*

However, it cannot be denied that government has made efforts to improve technology use within WoredaNet; for example, implementation and support of the network master plan was a WoredaNet service that was developed as a roadmap for the design of LAN and WAN network connectivity for ministry offices and government agencies. Expert 8 described:

"The network master plan was a project implemented in two phases: the first phase is known as Network master plan 1 and was implemented for 13 ministry offices and 32 government agencies, and the second phase called Network master plan 2 included 6 ministry offices and 7 different government sectors, some of which include: Ministry of Transport, Ministry of Foreign Affairs, Ministry of Culture and Tourism, Federal Supreme Court, Ministry of Mines, Ministry of Water, Irrigation and Energy, Government Communication Affairs Office, Federal Small and Medium Enterprises Development Agency, Ministry of Agriculture, Federal Transport Authority, and Private Sector Social Security Agency. I think it has addressed infrastructure problems of various government sectors. I also know that the NDC is currently (2019) delivering technical support to address technical challenges in using the network master plan".

Regarding the services delivered via the WoredaNet, Expert 8 included:

"…the NDC also delivers reliable environment and collocation services for various government sectors …"

This is also another WoredaNet's service for delivering reliable environment.

In terms of stable eGovernment service delivery, the current status of the WoredaNet technology cannot fully accommodate the growing requirement for services, since much of the existing infrastructure through which obsolete services cannot be delivered effectively are affecting the service user in different ways. Expert 7 described:

"… there are still long queues at the counters of many government sectors, long turnaround time for all government service needs of citizens and business because of the old and outdated technology use…"

Expert 6 included:

"…the process for registration and issuance of applications by citizens takes a long time due to slow network connectivity or obsolete ICT devices; there is also inadequate transparency and simplicity of process in managing the relationship between the government entities and citizens and businesses".

Expert 6 added:

"…the service delivery system in many organisations is still rigid and monolithic with less value of improving economic viability as expected…"

Based on the outcomes of the interview analysis, the challenges faced by the WoredaNet during the design and use, and the constraints of the socio-technical structure of the WoredaNet system (the Ethiopia government network) in the initial stages and even after implementation, can provide useful insights when we are looking at modernizing the existing WoredaNet ICT infrastructure. Cloud Computing can play a vital role for facilitating the delivery of eGovernment services in resource-constrained digital environments within the Ethiopian context.

There are some challenges to implementing the Cloud Computing technology for facilitating the eGovernment services. Expert 9 described:

> *"…Cloud Computing can solve a number of challenges currently existing within the WoredaNet and constraining the effective delivery of eGovernment service in our country, but there are also challenges that may constrain the implementation, and the main challenges of implementing the Cloud Computing technology in my opinion are lack of policies, lack of system integration and migration to new technologies that can be the barriers of the Ethiopian ICT constraining the use of Cloud Computing technology for e-governance which may also limit activities of policy makers that should have been addressed by successful implementation of e-governance".*

This implies that, although Cloud Computing is accepted as a useful approach, it will still face problems such as those mentioned above. A lack of human expertise is another challenging factor. Expert 10 said:

> *"...Excuse me I do not understand what the Cloud Computing exactly is, can you please explain this to me?"*

However, such challenges can be addressed, and Cloud Computing can be a useful solution that may address the various constraints of the eGovernment service delivery. Expert 2 discussed:

> *"...providing electronic services from the Cloud Computing infrastructure within the WoredaNet will be necessary; I think it can contribute for improving service delivery and making ICT resource administration easier…"*

Expert 6 indicated that:

"I see a number of advantages in the implementation of Cloud Computing for benefit of the e-Governance, especially for delivering valuable information and improving efficiency of day-to-day work activities. I can also see that the eGovernment service is improved, transparency and accountability can also be improved"

The transcribed data of the interview was manually coded, categorised, and compared to adhere to patterns that were assigned to different statements.

The interview data analysis revealed the following organisational structure of WoredaNet, based on the questions where experts were asked to describe WoredaNet's organisational structure in general, and their workplace's organisational structure in particular:

- Administratively hierarchical structure; and
- Technically Centralized administration.

The following codes were generated from the interview findings; they revealed the following technical challenges of WoredaNet, where experts were asked to describe the type of work relationships among middle and top management of regional representatives within WoredaNet or in their organisation:

- Participation;
- Collaboration; and
- Collegial (team-sprit work relationship).

The following codes were generated from the findings of the interviews, revealing the technical challenges of the WoredaNet implementation; experts were asked to describe the challenging constraints that they faced during implementation of the WoredaNet system:

- Geographic location (implementation of network connectivity and device delivery was affected);
- Lack of a proper place for implementation;
- Delay of implementation of network connectivity by the telecommunication provider (Ethio-telecom);
- Delay of electric power authority to implement commercial power; and
- Lack of skilled manpower in the ICT sector.

The following codes were generated from the interview findings, revealing the WoredaNet services that were experienced as useful; experts were asked to describe the most utilized WoredaNet service within day-to-day operations and activities.

- Video Conferencing; and
- Messaging.

The following codes were generated from the interview findings, revealing the technical challenges of WoredaNet service delivery; experts were asked to specify the service name, describe in detail any WoredaNet Cloud Computing service accessed in their workplace, and indicate the level and manner of access (slow, medium, fast, very fast, or other).

- Video Conferencing is medium;
- Messaging is medium; and
- Internet is slow.

The following codes were generated from the interview findings, revealing the technical challenges of the WoredaNet; experts were asked to describe the challenging constraints following WoredaNet implementation and commencement of delivery of selected services:

- Bandwidth limitations;
- Frequent interruption of network connectivity;
- Frequent interruption of electric power;
- Lack of technical support;
- Lack of spare parts and maintenance centres;
- Lack of integration and interoperability caused by deployment of silo systems;
- Unavailability of Wi-Fi broadband within WoredaNet;
- Increased requirement for electronic services; and
- Obsolete ICT Infrastructure.

The following codes were generated from the interview findings, revealing the security and privacy challenges as organisational barriers of WoredaNet service delivery, following implementation:

- Lack of trust in the technology itself (e.g., there were people who did not believe that they were really attending their cases or communicating with the judge via VC); and
- Fear of cyber security, privacy, and confidentiality of personal data.

The following codes were generated from the interview findings, revealing social barriers as challenges following implementation of WoredaNet:

- Digital divide (between various government sectors), as well as unevenness in skilled manpower among various government sectors;
- Misinterpretation of the outcome of technology use, such as believing that technology use can cause job losses; and
- Workplace culture and attitude (e.g. corruption).

The following codes were generated from the interview findings, revealing the following social barriers as organisational challenges to WoredaNet service delivery:

- High investment cost of implementation and maintenance (all regions and many ministry offices); and
- High payments to Ethio-telecom for data network services (many regions are in debt as a result).

In identifying threats that may constrain the deployment and use of e-Governance and public service delivery, the following codes were generated from the interview findings, revealing the challenges of WoredaNet eGovernment service delivery that may also constrain the successful implementation of CC and its contribution to e-governance; experts were asked to describe the drawbacks associated with WoredaNet technology in terms of technology use and service delivery:

- Inefficient governance in the existing systems of many business and PSOs;
- Lack of extensive broadband connectivity;
- Uneven distribution of skills among various government sectors;
- Lack of standards for delivery of electronic services; and
- Lack of interoperability.

The following codes were generated from the interview findings, revealing the roles of Cloud Computing; experts were asked to describe the advantages that can be offered by Cloud Computing technology to their organisation in terms of public service delivery and internal work activities:

- Access to virtualised infrastructure;
- Ability to use existing modular data centres;

- Easy access to shared resources;
- Flexibility of resources;
- Minimize consumption of electricity power;
- Safe data storage; and
- Ability to use smart phones and computers to access Cloud Computing services such as SaaS.

The following codes were generated from the interview findings, revealing the service requirements of citizens from the WoredaNet; experts were asked to describe the public services needed and most useful to their workplace, that can be delivered as WoredaNet Cloud Computing Service in advance:

- Licenses;
- Immigration and travel;
- Employment, health, and safety information;
- Customs;
- Land information, property, and local environment;
- Housing, property, and local environment; and
- Passport issuance.

In response to the interview findings, the following codes were developed to showcase the advantages of the Cloud Computing technology and software as a service (SaaS):

- The Cloud Computing applications and software run on a Cloud Computing infrastructure;
- Shared Cloud Computing infrastructure;
- A service user need not manage the underlying Cloud Computing infrastructure; and
- A service that can minimize cost.

6.5 IMPLICATIONS OF THE FINDINGS

Administratively, WoredaNet is organized into three-tier administration sectors, namely, Woreda, regional, and federal administrative sectors. There is centralization of administration within WoredaNet's organisational structure and, regarding technical aspects, it is distributed for technology management and administration. For example, regional ICT development agencies administer and manage their DCs and Woreda level ICT centres. All these are also under the centralised administration of the government network. The WoredaNet organisational structure comprises one National Data centre governed by MCIT, and 11 Regional Data Centres in which the technology is governed by the regional agencies. WoredaNet interconnects nearly 2000 sites.

A number of promising aspects indicate that WoredaNet can play its role in implementing Cloud Computing for facilitating eGovernment service delivery in Ethiopia. All of the regional ICT agencies and bureaus, many of the ministry offices and agencies, and almost all of the local Woreda centres are connected to the Internet via the WoredaNet, and have VPN connectivity to access various applications and services. Many are currently making efforts to improve their service delivery using ICTs such as the WoredaNet VPN connectivity as tools to enhance work activities; they are making efforts to develop different applications and electronic services to be accessed via WoredaNet's ICT infrastructure.

The day-to-day work practices for supporting large-scale planning and policy development in Ethiopia can contribute much to elucidating institutional culture and technology artefacts — particularly integrated DCs, including their infrastructure and hardware/software, as well as services such as video conferencing, messaging, and Web and database technology. This implies readiness and acceptance of various sectors of technology use for fostering eGovernment service delivery within the country.

6.6 OUTCOMES OF THE ANALYSIS

6.6.1 WoredaNet Contributions

The analysis of the findings of the interviews revealed current experience and a culture of knowledge sharing, information access, collaborative discussions for common decision-making processes, sharing of administrative and/or technical tasks and work experiences, file transfer and sharing, e-learning, system and application access, information delivery and access; these could be useful contributions to the implementation of Cloud Computing and ensuring its contribution to e-Governance.

The use of WoredaNet technology infrastructure and services (such as VC, Internet, and messaging as collective problem solving tools) was taken for granted in the utilisation of WoredaNet technology artefacts; these can play a vital role in minimizing the neglect of technology use during the implementation and use of Cloud Computing for facilitating eGovernment service, for example, Expert 7 described:

"...in using WoredaNet technology infrastructure, professionals in my organisation are able to gain supportive technical knowledge that helped for carrying out the implementation of virtualisation technology into the DC of our organisation found in the WoredaNet system. The process of virtualisation technology has thus become familiarized in the WoredaNet system".

As Cloud Computing technology is increasingly using virtualisation to build cloud-based systems, such experience of using technology can be one of the major contributing roles of the WoredaNet for Cloud Computing for facilitating eGovernment services.

Given the literature review of this thesis, it is known that virtualisation is one of the technological aspects of Cloud Computing technology. Expert 8 in this regard described:

> *"...Virtualisation has become a new technology of the NDC and can be used for the development and use of Cloud Computing technology in improving the WoredaNet service delivery".*

Implementing Cloud Computing technology requires a standardized framework that includes its basic components such as models, technology, and other important aspects; these are to be included as vital components of Cloud Computing technology. Based on the findings from experts' evaluation of the components of Cloud Computing, the very basic model components of Cloud Computing infrastructure are SaaS and IaaS. One of the model components known as SaaS resides within the other basic model component of Cloud Computing infrastructure known as IaaS, where IaaS provides a set of virtualised computing resources (e.g., virtualised machines, network bandwidth, storage capacity, memory, and processing power) in a resource pool. Expert 8 also included:

> *"...as I mentioned earlier, the virtualisation technology is already implemented in the NDC starting from 2016 and has been delivering virtualised machines, storage capacity, memory, and processing power to various regional and federal level government sectors. However, the back-end servers and storage system in the NDC, on top of which virtualisation is implemented, were obsolete and were in the process of modernization, due to some restructuring of the WoredaNet administration, the service has unfortunately been stopped".*

This implies that the WoredaNet can play vital roles such as providing a place for secured data storage and cost minimization in the implementation and use of Cloud Computing technology. Expert 6 described:

"The WoredaNet has created central access and management of ICT resources, and ensured secure electronic data storage".

Such capability can be a useful contribution for minimizing the investment in implementation of Cloud Computing for facilitating eGovernment services.

On the other hand, there are also some challenging factors that must be considered. Findings from the evaluation of the challenge components of Cloud Computing by the experts revealed the existence of acceptance for technology adoption and use within WoredaNet. The WoredaNet past experience in this regard can contribute toward enhancing acceptance for technology adoption and use, as well as readiness for consistent and well-organized information access to policy makers and decision-making bodies of the federal and regional administrative sectors in a way that can be useful for decision making. For example, Expert 3 described:

"We are able to access WoredaNet infrastructure and services, even in situations where there is no reliable Internet. This has made the WoredaNet's technology more acceptable in our organisation thus improvement of technology acceptance in day-to-day work activities has been increased".

Expert 4 similarly described that they are able to access WoredaNet infrastructure and services in situations where there is interruption of Internet, and indicated that this WoredaNet capability makes its technology more acceptable in their organisation, indicating the increasing improvement of technology acceptance in day-to-day work activities.

Expert 6 also pointed out:

"the efforts made within the WoredaNet for achieving fast and consistent information access to bring change and improve productivity, the strong desire for improvement of service delivery, and the strong desire for using technology as tools of enhancing work activities, as well as the motivation to increase the number of electronic services that can be delivered to citizens are also additional factors that has improved technology acceptance in my work place".

The WoredaNet can further contribute towards ensuring readiness of government sectors to adopt and implement Cloud Computing and its SaaS model from which electronic services can be delivered. Expert 6 described: "in our agency (AA city administration), services like birth, death, and cast certificates management are delivered to citizens from the vital events registration system"; Expert 8 described "water, electric, telephone billing, and payment services are simultaneously delivered in a single centre from the existing integrated billing system which was known as 'lehulu', implemented in NDC and now terminated due to the restructure process made in the ICT sector of the country".

Expert 5 described:

> *"the e-procurement management system has been hosted in NDC and is providing procurement services electronically; and road transport management has also been deployed in our DC and is providing traffic related services electronically. However, the backend infrastructure is not completely based on the Cloud Computing framework".*

The existence and provision of such electronic services via the existing government ICT infrastructure can be considered as a contributing factor to WoredaNet for ensuring the readiness of government sectors for Cloud Computing technology. Some government sectors have already included Cloud Computing services in their initiatives. Expert 8 described:

> *"I know that the ICT agency in Tigray region and the ICT agency in Addis Ababa City Administration have planned to implement Cloud Computing technology so as to deliver Cloud Computing services".*

This is also considered as another contribution of the WoredaNet, as many government sectors are using WoredaNet infrastructure that can enhance implementation of future Cloud Computing services such as e-police, e-court, job portal, municipal management, Woreda (district) management, service and help desk, population management, and immigration management in an integrated way that can be made available from one single government portal deployed in one central location, such as the existing government portal hosted in the NDC mentioned by Expert 6.

Moreover, the promising initiatives of many ongoing government projects, such as the National Payment Gateway, Enterprise Architecture Framework, Public Key Infrastructure, National Data Set, National Enterprise Service Bus, and National integrated Authentication Framework, as well as applications that can be used as common services and shared resources, such as financial management and information System, E-Procurement, and E-Office, can be useful contributions of the WoredaNet to the CC technology for facilitating eGovernment services.

Given such conducive aspects of the existing environment, some promising aspects of the ICT sector in the Ethiopian context can be extracted for Cloud Computing for facilitating eGovernment services. The conducive aspects include: the growing number of stations of WoredaNet, SchoolNet, and AgriNet with their current reach of 1,364; the widespread Telecom's core network, with a capacity of 2.4 Million fixed NGN; the widespread fibre connectivity network created in 14 towns that has a capacity of more than one million —its installation of a metropolitan transmission fibre optics cable network has been fully implemented and represents a promising initiative.

The broadband requirement of the Cloud Computing service can be supported by the already installed fibre optic network connectivity mentioned above, as it has a high capacity of communication transmission and covered a large distance of 14,000 km, which is used to connect the main communication nodes of the country and towns, situated on the main roads. Further, the broadband requirement of the Cloud Computing service can combine the advantages of the existing broadband connectivity (with 3.2 GB/Sec bandwidth in each of five terminals), with another existing broadband network with a capacity of 2 GB/Sec that was implemented in 75 towns to provide a wide range broadband data service. Moreover, 600 district towns that possessed a network that provides ADSL service can also play their role for the requirement of Cloud Computing for facilitating eGovernment services in RCEs.

The development of a framework for Cloud Computing for fostering eGovernment service delivery in the Ethiopian context can also be supported by a number of promising aspects that have been already made by the government. For example, some government programs can contribute toward Cloud Computing within organisations and civil service reform programs in a manner that can bring about institutional change, which include that: higher managerial reform system sub-program activities are implemented; human resource management reform sub-program goals are implemented, and service delivery reform sub-program activities are implemented.

Other promising factors that can be considered for the development of a Cloud Computing framework can be the already finalized policy and strategy of Information and Communication Technology developed by government to assist in accelerating the development of Information and Communication Technology, the success of poverty elimination, and attainment of the development goals. This can include a policy and legal framework, and an encouragement system for the Information and Communication Technology industry. The latter should be developed and implemented by government to attract and encourage private investors; it includes a directive by government for hardware and software levels and procurement. The directive and competency levels of the qualifications of professionals, trainers, and service providers of ICTs are also additional promising factors of the implementation of government Cloud Computing for facilitating eGovernment service delivery in RCEs.

Moreover, regarding the security of the national information system to oversee and protect citizens' rights and national security due to the technology, an information security policy and strategy is already prepared and implemented by government, comprising a directive of ICT security enforcement, together with an ICT security standard. These can serve as a vital component of the framework for Cloud Computing for facilitating eGovernment services in RCEs

From an infrastructure perspective, the extended and utilized WoredaNet infrastructure development extension to the existing and new Woredas, based on regional state and federal government needs, can minimize the cost of ICT infrastructure that may be required for Cloud Computing for facilitating eGovernment services in RCEs. For example, the 100 community radio centres that are already established and administered by the community, as well as centres of information service providers that were established to connect government and the public and to increase public participation, can also play a vital role as an input into the interaction component of service delivery in establishing the components of the framework for Cloud Computing for facilitating eGovernment services in RCEs.

Practically, WoredaNet and the country’s NDC can be restructured, optimized, modernized, and fully utilized to provide reliable access to common Cloud Computing services such as IaaS, and shared Cloud Computing resources such as customer relationship management and Web content management, which can be made available as SaaS offerings on G-cloud. This can also serve as a central location for managing the interaction between NDC and other related stakeholders, and handling the day-to-day operational aspects of Cloud Computing and its use for facilitating eGovernment service delivery. This can also play a vital role as a centre of knowledge management and dissemination — to ensure participation in working groups, and help to define guidelines and necessary tools such as applications, standards, technical implementation, request for proposal, Service Level Agreements (SLAs), and contract management. In this regard, the WoredaNet can be restructured with its own network in NDC.

From the findings of the study, it is apparent that many bureaucratic government structures are is still traditional in Ethiopia, with reluctance and mistrust of technology use. eGovernment service delivery is challenged by a lack of quality of services, obsolescence of ICT artefacts, and inconvenience of service delivery mechanisms. Currently, service delivery is still facing a number of challenges. For example, the WoredaNet is constrained by several challenges related to supporting workflow with technology, service accessibility, and the quality of government services. Other forms of technology use, such as Cloud Computing, should be implemented to facilitate eGovernment services within the Ethiopian context to improve service delivery.

On the other hand, it was learned that the WoredaNet is also vitally important in the sense that its technology would have a direct impact on the development and use of new technology. This is due to the fact that long-term experiences of technology use and service delivery can have far-reaching implications on fostering the efficiency and effectiveness of public services delivery. This is a promising initiative to use the technology at hand, together with the development of Cloud Computing technology, to enhance service delivery by supporting the convergence of developments in data availability, software, and hardware.

6.7 THE FINAL FRAMEWORK

Change is required to enable the application of new technology, such as Cloud Computing technology, within the existing system. Thus, an initial framework for Cloud Computing in resource-constrained digital environments to facilitate eGovernment services was developed. It was re-developed by including components from eGovernment services, and further developed by including components from RCEs, components of Cloud Computing, eGovernment services, and resource-constrained digital environments.

The final version of the framework (See Figures 6-7 and 6-8) was developed after each of the different versions of the working draft of the conceptual framework was supplemented with evaluators' feedback.

The evaluators were requested to rate the stated factors according to their opinion, on the following rating scale:

- Very important;
- Important;
- Less-important;
- Not-important; and

- Neutral.

The final framework was developed by adding the last layer (in green in Figure 6-7), which is a combination of the provided WoredaNet and RCE challenges and the feedback on all the components by the 10 expert interviews. The implications of the findings were discussed in Section 6.5, with the outcomes of the analysis in Section 6.6. These contributed to the refinement and final framework, as depicted in Figure 6-7.

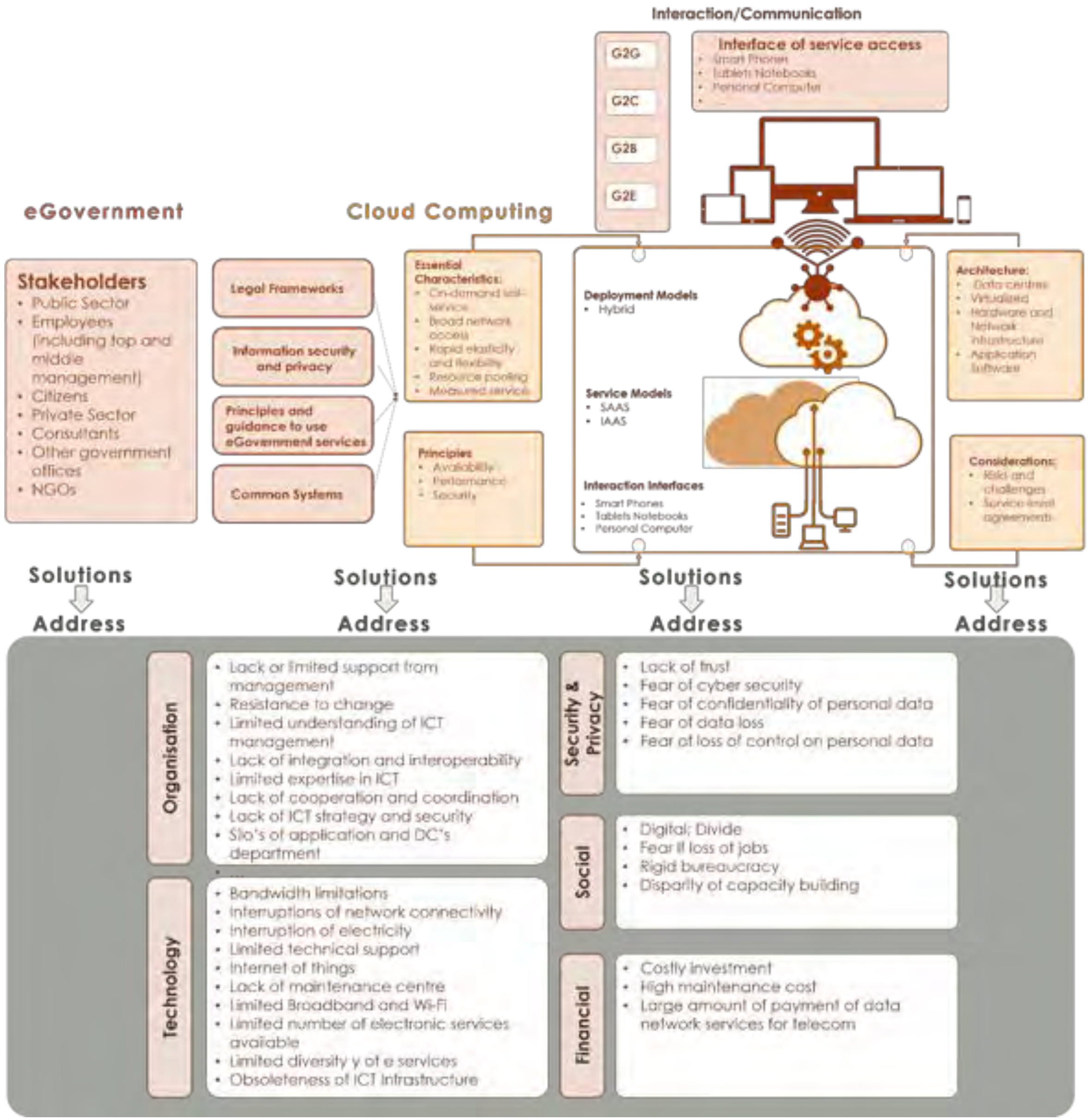

Figure 6-7: The final version of the theoretical framework for Cloud Computing for facilitating eGovernment services in RCEs.

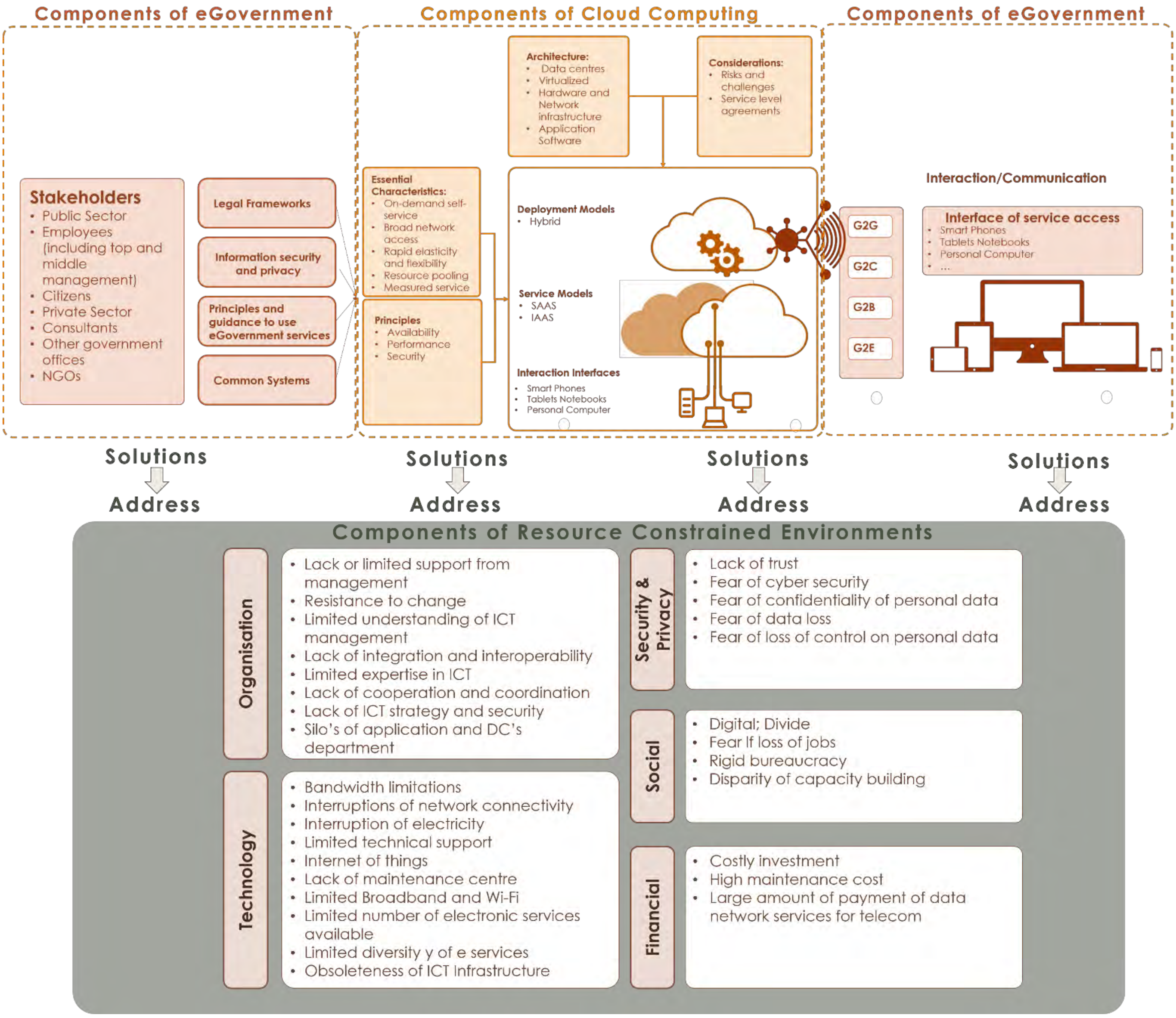

Figure 6 8: The theoretical framework for Cloud Computing for facilitating e-Government services in RCEs.

6.8 DISCUSSION

The first version of the framework provided the most relevant components of Cloud Computing. The conceptualisation of the first version of the framework represented only a unit part of the framework for Cloud Computing in resource-constrained digital environments facilitating eGovernment services. The second version of the framework, presented in Chapter 4, provided the most relevant components of the eGovernment services (Figure 6-8). The conceptualisation of the second version of the framework was an additional unit part of the framework for Cloud Computing in resource-constrained digital environment facilitating eGovernment services.

The third phase of the literature study, presented in Chapter 5, provided the most relevant components of the resource-constrained digital environment, presented in the yellow rectangle at the at the bottom of Figure 6-8 above; these are termed as the most relevant components in a resource-constrained digital environment. The conceptualisation of the third version of the framework consisted of V1 and V2 theoretical frameworks, with vital components presented as solutions to address the challenges posed by RCEs as depicted in Figure 6-8.

It is important to describe the Ethiopian eGovernment ICT sector (WoredaNet) and examine the current status and future requirement of the WoredaNet from which eGovernment service delivery has been applied in Ethiopia. Hence, it was important to comprehend which components of the Cloud Computing, eGovernment services, and resource-constrained digital environment relates to the Ethiopian context. KPs from Ethiopia ranked the components of each of the three concepts so that they can be used to finalise the framework for Cloud Computing in resource-constrained digital environment facilitating eGovernment services, particularly for the Ethiopian context such as the Ethiopian eGovernment ICT sector (WoredaNet).

The entire contextualisation comprised the following:

Chapter 3 (Table 3-12) provided a summary of the components of the relevant concepts of Cloud Computing, which were constituted through a systematic literature review. The concepts, from Chapter 3 (Figure 3-4), and their interrelationships, constituted the first version of the framework for Cloud Computing.

Chapter 4 (Table 4-9) provided a summary of the components of the concept eGovernment services, which was also constituted through systematic literature review of the challenging factors of eGovernment service delivery, as depicted in Chapter 4 (Figure 4-4).

For the purpose of exploring and identifying appropriate solutions, Table 6-2 below provided the relationships that sub-components of the concept of Cloud Computing has with the related sub-components of the concept of eGovernment services, which was later used to fill the gap and provide solutions for e-Government challenges in Chapter 4, as indicated in Figure 4-5.

Through the third cluster of the systematic literature review, Chapter 5 (Figure 5-4) provided a summary of the components of the concept resource-constrained digital environment as challenging factors that can be posed by resource-constrained digital environments for the adoption and use of Cloud Computing and eGovernment service delivery, which later became additional components of the concept resource-constrained digital environment.

The three major concepts, from Chapter 3 (Figure 3-4), Chapter 4 (Figure 4-5), and Chapter 5 (Figure 5-4), were then combined and interrelated to constitute the last version of the framework for Cloud Computing facilitating eGovernment services in resource-constrained digital environments, as illustrated in Figure 6-8. The downward arrows from the components of Cloud Computing and eGovernment services towards the components of the resource-constrained digital environment indicated how solutions are generated to address the categorized challenges presented and regarded as challenges posed by RCEs.

The following table summarises the variety of components of Cloud Computing, eGovernment services, and resource-constrained digital environments.

Table 6-2: Expert Interview participants

#	Vital components of Cloud Computing	Vital components of eGovernment services	Vital components of resource-constrained environments
1	**Essential characteristics**	**Common systems architecture**	**Organisational constraints**
	• On-demand service • Broad network access • Rapid elasticity • Resource pooling • Measured service	• Integration • Interoperability	• Lack or limited support from management • Negligence and resistance to change, modernization and optimisation of technology • Limited understanding of management on ICT particularly the cloud computing technology • Lack or un-matured integration and interoperability • Limited number of employee and expertise on ICT

#	Vital components of Cloud Computing	Vital components of eGovernment services	Vital components of resource-constrained environments
1	**Essential characteristics**	**Common systems architecture**	**Organisational constraints**
			• Lack of cooperation and collaboration • Lack or un-matured ICT strategy and security plan • Lack or un-matured enterprise architecture • Silos of application and DCs deployment
2	**Models**	**Application and Services**	**Financial Constraints**
	• SaaS and IaaS: Service models • Hybrid: Deployment models	• Shared Application Software • Information in an up-to date manner • Selected eGovernment services available on demand	• High investment cost • High maintenance cost • Large amount of payment of data network service for telecom
3	**Technology Architecture**	**Technology**	**Technical Constraints**
	• Data centres • Virtualised hardware and network infrastructure • Application software	• Back-end automation of hardware and high-end computing infrastructure • High bandwidth • Telecommunication infrastructure • Last mile/rural area connectivity • Electricity • Data centres at national and state level • Information /Internet access centres and Internet gateways • Security infrastructure • Backup and disaster recovery	• Internet of Things (IoT) • Bandwidth limitation • Interruption of network connectivity, and electric power • Limited technical support • Lack of maintenance centre • Limited WiFi broadband within • Limited number and diversity of electronic service available • Obsolescence of ICT infrastructure
4	**Interaction interfaces**	**Interaction Interfaces and Portals**	**Social Constraints**
	• Laptops, desktops, PDAs, and smart phones	• a National portal: one-stop centre for delivery of all government services • Laptops, desktops, smart phones, PDAs	Digital divide Rigid bureaucratic workplace culture and attitude Limited capacity building Fear of job losses

#	Vital components of Cloud Computing	Vital components of eGovernment services	Vital components of resource-constrained environments
5	**Considerations**	**Legal framework & information security**	**Security and privacy constraints**
	● Risks and challenges ● Service Level Agreements (SLAs)	**Legal Framework** ● ICT policy ● eGovernment policy ● Legal recognition of digital signatures ● Security standards **Information Security** ● Data security ● Privacy of data and information ● Confidentiality and trust	● Lack of trust ● Fear of cyber security fear of privacy fear of confidentiality ● Fear of personal data handling ● Fear of loss of control on personal data
6	**Principles**	**Principles and Guidance**	
	● Availability ● Performance ● Security	● Guidance in using eGovernment services ● Principles of eGovernment	
7		**Interaction Communication**	
		● G2G ● G2C ● G2B ● G2E	
8		**Stakeholders**	
		● Public sector ● Employees (including middle and top- level managers) ● Citizens ● Private sector ● Consultants ● NGOs	
9		**Challenging Factors**	
		● Knowledge or skill ● Management support ● Financial cost ● Interoperability ● Lack of standardization ● Trust in security and privacy ● Delivery of services ● Lack of infrastructure ● User interest	

6.9 SUMMARY

As per Figure 6-8, the sub-components of Cloud Computing portion in the top-middle portion of the figure (inside the blue rectangle) include data centres, virtualised hardware and network infrastructure, and application software; these are regarded as the technology architecture of Cloud Computing (Ali et al., 2016; Mell & Grance, 2011). It represents the current requirement of Cloud Computing technology, and is one of the most relevant components particular to the Ethiopian context and the Ethiopian eGovernment ICT sector (WoredaNet research context). In order to access such Cloud Computing services, a variety of interaction interfaces should be made available, such as laptops, tablets, and smart phones (Bassett, 2015). As per Figure 6-8, these sub-components of Cloud Computing are considered as the interaction interface component of Cloud Computing.

However, during service delivery and data and information flow within the Cloud Computing, the system can be challenged due to users' fear for privacy of personal data and information security. The adoption and use of Cloud Computing should consider such risks and challenges, and should ensure security and create thrust by setting up appropriate Service Level Agreements (SLAs). As per Figure 6-8, a particular sub-component constitutes the security considerations of the Cloud Computing, and is considered as the Consideration component of Cloud Computing relevant to the Ethiopian context.

Availability and performance of the ICT often present challenges in many developing countries such as Ethiopia. Principles should be set up, implemented, and strictly followed — not only for security of data and information flow, but also to ensure the availability of services and the performance of the backend infrastructure (Sabri, 2015). These represent the current requirement of properly set-up principles of accessing eGovernment services delivered via Cloud Computing that is most relevant to the Ethiopian context. The Cloud service provided through Cloud technology should ensure availability, performance, and security, and a framework is required to include such considerations, as presented as the sub-component in Figure 6-8 that constitutes the principle component of Cloud Computing.

EGovernment services in many PSOs and Government sectors are also challenged by unavailability of standards and policies (Veeramootooa et al., 2018). Such aspects can in general be considered as the Legal Component of a framework, where the framework should constitute ICT policy, EGovernment policy, legal recognition of digital signatures, and security standards, as well as an information security component. The framework should further constitute data security, and privacy of data and information, to create confidentiality and trust (Moreno et al., 2018). These represent the current requirements of a legal framework and information security in accessing eGovernment services that is most relevant to the Ethiopian context and other developing economies, as sub-component of eGovernment services (inside the red rectangle at the left top of Figure 6-8).

In addition to addressing legal and security issues, a theoretical framework should point out how to minimize financial investment cost to ensure a successful implementation of eGovernment. One mechanism can be to initiate eGovernment service delivery by focussing on selected applications and services for initial deployment (Gao & Lee, 2017). The application and services component of eGovernment should thus provide opportunities to delivering shared application software, information in an up-to date manner, and selected eGovernment services available on demand as common system sub-component of eGovernment services (see the red rectangle at the left top of Figure 6-8 and the characteristics sub-component of Cloud Computing inside the blue rectangle, top-middle of Figure 6-8). This study proposes selection of the most relevant applications and software, rather than to deploy a large number of services at the outset.

On the other hand, once Cloud Computing was adopted for facilitating eGovernment services, and delivery of selected services have been initiated, this cannot be a complete success; sustainability of service delivery should be ensured so that various stakeholders can acquire trust on service availability. For sustainability of service delivery, technology such as Cloud Computing can play a vital role in providing sustainable back-end automation of hardware and high-end computing infrastructure, bigger bandwidth, and uninterrupted telecommunication infrastructure, even with last mile/rural area connectivity. Cloud Computing can also minimize electricity consumption for data centres at national and state level, which will deliver services that are backed up and protected in disaster recovery to be accessed from information /internet access centres via internet gateways. Thus, Cloud Computing is regarded as an appropriate technology for providing reliable, effective, and efficient eGovernment services and for creating users' trust in the most relevant government services, as presented inside the red rectangle at the top left of Figure 6-8.

Further consideration with respect to eGovernment services is the unavailability of integration and interoperability between different silos systems that are usually deployed by different government sectors. In this regard, a Common Systems Architecture for central deployment of data and information of different government sectors with common structures can be facilitated, and repetition of services can be removed. This is one of the most relevant aspects of eGovernment services in the Ethiopian context, presented in Figure 6-8 as the Common Systems Architecture sub-component of the eGovernment services.

The advantages of the eGovernment service are not limited to providing effective and efficient electronic services or creating integration and interoperability via Cloud Computing. It can also enhance a two-way relationship between citizens and government and other stakeholders, via different communication types such as G2C between private organisations and government; G2B between government organisations, departments, and authorities; G2G between governments; and G2E between government and its employees (Choi et al., 2016; Cortés-Cediel et al., 2017). The enhancement of G2C, G2B, G2G, and G2E is most relevant to the Ethiopian context, as presented inside the red rectangle at the top right of Figure 6-8; it constitutes the interaction /communication sub-component of eGovernment services.

This implies that the eGovernment services are delivered to various stakeholders, including government organisations, departments and authorities, private organisations, citizens, and government employees. These stakeholders represent a vital component, as their participation can play an important role in defining rules and policies, in regulating, and in providing electronic services (Janita & Miranda, 2018). Figure 6-8 presents stakeholders inside the red rectangle at the top right , constituting concept sub-components such as the public sector, employees, citizens, private sector, consultants, and NGOs, which are regarded as the Stakeholders component of eGovernment services. A national portal can be a one-stop centre for the delivery of those government services to be accessed via laptops, desktops, and smart phones. The availability of a national portal for government, and laptops and smart phones for citizens, are most relevant to the Ethiopian context; it is presented in Figure 6-8 as the interaction Interfaces and Portals sub-component of the eGovernment services.

Success criteria and help features should be incorporated into eGovernment services to provide the user with guidance on how to easily use a government website or portal (Moreno, 2018, 146-157; Verkijika, 2018, 20-29). The implementation of eGovernment services should thus incorporate principles and guidance to use eGovernment services, presented in Figure 6-8, as the Principles and Guidance sub-component of eGovernment services.

However, the adoption and use of eGovernment services may not always be successful, due to challenging factors such as scarcity of knowledge or skill, lack of management support, big financial cost, lack of standardization, and lack of user interest (Katebire, 2015; Kenenissa, 2017). Such challenges should be taken into consideration and should be addressed during the adoption and implementation of eGovernment service, as presented in Figure 6-8 inside the yellow rectangle at the bottom of the framework; it constitutes the Challenges that a resource-constrained digital environment can pose.

The challenges can constrain the application and use of ICT resources such as Cloud Computing, including a lack of or limited support from management; negligence and resistance to change; modernization and optimisation of technology; limited understanding of management of ICT, particularly Cloud Computing technology; lack of cooperation and collaboration; lack of or immature ICT strategy and security plan; lack of or immature enterprise architecture; and silos DCs deployment (Kattepur et al., 2016; Kulkarni & Rajamanickam, 2016; Lewis et al., 2014; Pholotho, 2017). In this research, the theoretical framework constitutes Technical Constraints, Organisational Constraints, Security and Privacy Constraints, Social Constraints, and Financial Constraints components of resource-constrained digital environments, as presented in the bottom yellow section of Figure 6-8. These represent the current challenging factors of the PSOs service delivery in the Ethiopian context.

The RCE concepts are categorized into the different components of RCEs, including organisation, technology, financial, security and privacy, and a social component of Resource-Constrained Digital Environments. Lack or limited support from management; resistance to change; limited understanding of management on ICT; lack of integration and interoperability; limited number of ICT experts; lack of cooperation and collaboration; lack of ICT strategy and security plan; lack of enterprise architecture; and silos of application and DC implementation are presented in the in bottom portion of Figure 6-8, as sub-component that constitutes the organisation component of the resource-constrained digital environment. Further, the barriers of limited acceptance of technology and the limited capabilities and skills component of the resource-constrained digital environment relevant to the context of Ethiopian in general and to the WoredaNet context in particular are discussed. While technology acceptance is focused on addressing the barriers of limited technology acceptance, the capabilities and skills portion is focused on addressing the barriers of the limited capabilities and skills that exist in many government organisations, as presented in the bottom portion of Figure 6-8. As these can constrain the success of eGovernment services, such organisational challenges have to be addressed; this can be achieved through the introduction of Cloud Computing.

Public service organisations and departments of the government in many developing countries, including Ethiopia, are characterized by limited resources and ICT Infrastructure (Frehywot, 2013). Bandwidth limitations; interruption of network connectivity and electric power; limited technical support; lack of maintenance centre; limited WiFi broadband within; a limited availability of diverse electronic services; and obsolescence of ICT Infrastructure, presented as the technology sub-component of the resource-constrained digital environment in Figure 6-8. These technological challenges can constrain the effectiveness and efficiency of eGovernment services, and have to be addressed; this can be achieved through the introduction of Cloud Computing.

Infrastructure in this conceptual framework is concerned with the availability of reliable sources of electric power and back-end ICT infrastructure, including modern data centres, as well as hardware infrastructure (application and database servers, storage and backup devices). Lack of such infrastructure is explored to be addressed by adopting and implementing Cloud Computing for eGovernment. The conceptual framework for Cloud Computing discussed how these various aspects can become applicable within eGovernment service delivery, as enablers of efficiency and effectiveness of internal work activities, and to facilitate tools of service delivery to citizens.

The identification of challenges that may constrain the efficiency and effectiveness of eGovernment service delivery within RCEs and the WoredaNet context has reduced the complexity of designing the theoretical framework. These challenging constraints can be posed by resource-constrained digital environments, and are considered as constraining factors of eGovernment services and work efficiency within the WoredaNet context. In delivering eGovernment service via Cloud Computing, security and privacy constraints can be another challenging factor for users in using public services. As per Figure 6-8, the Security and Privacy components in the bottom constitute the sub-components of the resource-constrained digital environments, and include lack of trust; fear of cyber security; fear for privacy and confidentiality; fear of personal data handling; and fear for loss of control on personal data. These are considered as factors of the Security and Privacy components that can affect eGovernment services and work efficiently within the WoredaNet context.

For the success of eGovernment and Cloud Computing, social constraints should be addressed. In this research the Digital Divide; rigid bureaucratic workplace culture and attitude; limited capacity building; and fear for job losses are presented in Figure 6-8 as the sub-component that constitutes the Social Constraint component of a resource-constrained digital environment. Financial constraints such as high investment costs, high maintenance costs, and high costs of network service provision, as presented in Figure 6-8, are also challenging factors that have to be addressed for successful implementation of Cloud Computing for facilitating eGovernment services. These are considered as constructing factors of the financial components that can affect eGovernment services and work efficiency within the WoredaNet context. Public service organisations in many developing countries, including Ethiopia, are challenged by the large deployment costs, which represent one of the barriers to success of eGovernment deployment and the delivery of eGovernments services. In this conceptual framework, the manner in which this constraint should be addressed is discussed in adopting the Cloud Computing framework for facilitating eGovernment services in RCEs. The conceptual framework also discussed how deployment cost can become applicable within eGovernment service delivery, as enabler of efficiency and effectiveness of service delivery to citizens, as the adoption of Cloud Computing in eGovernment can play a vital role in cost reduction (Goncalves, 2015)

How to address the requirement of large maintenance, administration, and management costs is discussed via the Cloud Computing framework for facilitating eGovernment services in RCEs. The conceptual framework discussed how the challenges can become applicable within eGovernment service delivery, as enablers of efficiency and effectiveness of service delivery to citizens; the adoption of Cloud Computing in eGovernment can play a vital role in cost reduction. The framework sought to address these challenges via the adoption and implementation of Cloud Computing to improve the efficiency and effectiveness of eGovernment service delivery.

The Consideration component of Cloud Computing identified in Chapter 3, when considered in the Ethiopian context, constitutes lack of trust; fear of cyber security; fear for privacy and confidentiality transgressions; fear of personal data handling; and fear of loss of control over personal data. Both the fear for security of data and information and the fear for transgression of privacy of personal data and information comprise the Security and Privacy component of the RCE relevant to the Ethiopian context in general and the WoredaNet context in particular. While security of data and information as one component is presented to address the fear for loss of security of data and information that exists in many government organisations, the privacy of personal data and information portion is focused on addressing the fear for transgression of privacy of personal data and information. The proposed conceptual framework for Cloud Computing for facilitating eGovernment services in resource-constrained digital environments recognised the organisational challenges of government organisations as lack of rules and regulations and strategies; lack of standardization of organisational structure; rigid bureaucratic work culture; and lack of processes, and framed them as vital organisational components of resource-constrained digital environments. The framework sought for a mechanism to address these challenges and proposed the adoption and implementation of Cloud Computing for improving the efficiency and effectiveness of eGovernment service delivery.

The following table summarises the interrelationships of the variety of concepts of the components of Cloud Computing, eGovernment services, and resource-constrained digital environments and how these relationships indicated the solutions that can be explored from the components of the Cloud Computing for the challenges that can be posed by RCEs.

Table 6-3: Summary of vital component to depict solutions

No	Cloud Computing components	Detail components of CC relevant to this thesis (addressing eGovernment requirement and challenges that can be posed by RCEs)	eGovernment components	Resource-Constrained digital environment components
1	Concepts	Pay-as-you-go, access on-demand, access shared pool of resources, ICT as a service that can ensure interoperability, standardization, and administered with non-complicated knowledge skill	**Challenging Factors** ● Knowledge or skill ● Management support ● Financial cost ● Interoperability ● Lack of standardization ● Trust on security and privacy	**Organisational Constraints** ● Lack or limited support from management ● Negligence and resistance to change, modernization and optimisation of technology

No	Cloud Computing components	Detail components of CC relevant to this thesis (addressing eGovernment requirement and challenges that can be posed by RCEs)	eGovernment components	Resource-Constrained digital environment components
			• Delivery of services • Lack of infrastructure • User interest	• Limited understanding of management on ICT particularly the cloud computing technology • Lack or un-matured integration and interoperability • Limited number of employee and expertise on ICT • Lack of cooperation and collaboration • Lack or un-matured ICT strategy and security plan • Lack or un-matured enterprise architecture • Silos of application and DCs deployment
2	Characteristics	No up-front cost, pay only for use, scalability of resources, for minimizing financial cost computing resources as a service, easy for management support Rapidly availability of on-demand and on-demand self-service; easier delivery of services according to user interest Broad network access, resource pooling for lack of infrastructure Measured service for trust of security and privacy		

No	Cloud Computing components	Detail components of CC relevant to this thesis (addressing eGovernment requirement and challenges that can be posed by RCEs)	eGovernment components	Resource-Constrained digital environment components
3	Model	SaaS and IaaS service models + Hybrid deployment model -> • To deliver Shared Application Software, • To provide information in an up-to date manner, • To deploy Selected eGovernment services available on demand • To ensure Availability • To ensure Security Privacy and trust • To minimize Management support • To use SLAs • The availability of cloud computing standards for integration and interoperability • To ensure availability and reliability of services	**Application and Services** ● Shared Application Software ● Information in an up-to date manner ● Selected eGovernment services available on demand **Legal Framework** ● ICT policy ● EGovernment policy ● Legal recognition of digital Signatures ● Security Standards **Information Security** ● Data security ● Privacy of data and information ● Confidentiality and trust **Common Systems Architecture** ● Integration ● Interoperability	**Financial Constraints** ● High investment cost high maintenance cost ● Large amount of payment of data network service for telecom
4	Architecture /Technologies	With principle factors Availability Cost Management support Performance Security Virtualisation, data centres and their infrastructure/Hardware (including data centres), Software and Applications,	**Technology** ● Back-end automation of hardware and high-end computing infrastructure ● High bandwidth ● Telecommunications infrastructure ● Last mile/rural area connectivity, ● Electricity ● Data centres at national and state Level	**Technical Constraints** ● Internet of Things (IoT) ● Bandwidth limitation ● Interruption of network connectivity, and electric power ● Limited technical support ● Lack of maintenance centre ● Limited WiFi broadband within ● Limited number and diversity of electronic service available

No	Cloud Computing components	Detail components of CC relevant to this thesis (addressing eGovernment requirement and challenges that can be posed by RCEs)	eGovernment components	Resource-Constrained digital environment components
		Easy accessibility of Cloud services via interaction interfaces (laptops, desktops, mobiles, PDAs) Easy availability of Cloud services via Web portals for interaction communication	● Information /Internet Access Centres and Internet Gateways ● Security infrastructure ● Backup and disaster recovery **Interaction Communication** ● G2G ● G2C ● G2B ● G2E **Interaction Interfaces and Portals** ● A national portal: one-stop centre for delivery of all government services ● Laptops, desktops, smart phones, PDAs	● Obsolescence of ICT Infrastructure **Social Constraints** ● Digital divide ● Rigid bureaucratic workplace culture and attitude ● Limited capacity building ● Fear of loss of jobs
5	Considerations and principles	Availability of SLAs Privacy and trust Quality of service For risks and challenges such as security and privacy; implementing service level agreements (SLAs); To apply Rules and Regulations for how to deliver and access services such as Guidance to use eGovernment services, Principles of eGovernment Help stakeholders participate in different activities	**Stakeholders** ● Public sector ● Employees (including middle and top-level managers) ● Citizens ● Private sectors ● Consultants ● NGOs **Principles and Guidance** ● Guidance to use eGovernment services ● Principles of eGovernment	**Security and Privacy Constraints** ● Lack of trust ● Fear of cyber security fear of privacy fear of confidentiality ● Fear of personal data handling ● Fear of loss of control on personal data

6.10 RECOMMENDATIONS

This research proposed the final framework for Cloud Computing in a resource-constrained digital environment facilitating eGovernment services; it consists of the components Cloud Computing, eGovernment services, and a resource-constrained digital environment, which have been evaluated by Ethiopian KPs and validated by global experts in Cloud Computing, eGovernment services, and resource-constrained digital environments. The framework not only contains components of Cloud Computing, eGovernment services, and resource-constrained digital environments for the Ethiopian context, but it also provides useful insights to be taken into consideration for the implementation of Cloud Computing for facilitating eGovernment services in Ethiopia. The vital components of the theoretical frameworks provided a number of sub-components, which illuminate the challenges that may be posed by resource-constrained digital environments to Cloud Computing for facilitating eGovernment services; solutions that are closely related to the challenges are also included.

The research recommended the adoption and implementation of Cloud Computing for facilitating eGovernment services in RCEs to address such challenges. The hybrid deployment model is proposed for managing IT infrastructure, including all of the information technology, hardware, software, and networks to satisfy the requirements of the Government Cloud, to preserve the requirements of privacy, and to make available Cloud applications using integrated Cloud technologies. The Cloud services (SaaS) and infrastructure (IaaS) can become applicable for reliable, efficient, and effective eGovernment service delivery to citizens, as enablers of internal work activities. Cloud Computing will be used as the tools to transform work activities during the delivery of eGovernment services. The advantages of Cloud Computing in fostering eGovernment services via integrated Cloud Computing technology is presented within the framework, so as to provide opportunities to gain advantages to improve economic growth and human development for making public service delivery effective and efficient, and to improve the quality of public services, and enhance transparency, accountability, and good governance in government, business, and PSOs.

The research also recommended Cloud Computing to address the various challenges of the preferred research context, the WoredaNet. It recommended that these challenges are addressed through the building blocks sourced from the first version of the framework, which is termed a theoretical framework for Cloud Computing.

In addition, the framework includes the vital components of the first version of the theoretical framework for Cloud Computing, aimed at improving the underlying work practices, enhancing accountability and transparency, fostering public service delivery, and promoting user interaction with particular technology such as eGovernment services. Cloud Computing services, as cost reducing solution to minimize the investment cost of infrastructure, and deployment and maintenance costs (Yang et al., 2011), through the various Utility Computing platforms such as pay-as-you-use or utility computing or utility on-demand, that can reduce ICT-related operational costs and Total Cost of Ownership (TCO) (Odusote & Adigun, 2014). The components of Cloud Computing included in the model offer vital opportunities for addressing the challenges of eGovernment services. The sharing ICT resources through resource pooling — including storage, processing, memory, and network bandwidth, shared among multiple users as location-independent resources — should be protected for its potential to reduce the administration and maintenance costs of ICT infrastructure.

Due to a lack of relevant policies, as indicated by KPs in Ethiopia, the implementation of Cloud Computing in a developing country such as Ethiopia will be challenging. However, the current effort made by the government in implementing relevant policies can be a promising initiative in the sector. The Cloud Computing environment includes security mechanisms with a set of procedures, processes, and standards to provide information security assurance; the capability to deploy firewalls, encryption, and VLANs; it can therefore address confidentiality and security challenges by including Service Level Agreement (SLA) as a legal binding agreement in the mutual understanding and acceptance of a service between a uses and service provider.

Confidentiality and service reliability can be ensured via the implementation of a measured service to control resource availability and use, and by applying metering that provides transparency where resource access can be monitored, controlled, and reported. Security law is a component that Namibian KPs in Ethiopia deem important to Ethiopian Cloud Computing and eGovernment service delivery. Security laws have to be implemented to address security threats, and guidelines should be provided to users of services so as to guide them on how to access services, and to guide the government on service delivery. The various activities around Cloud Computing architecture and communications among various sectors should also be guided through the framework for facilitating eGovernment services, as presented by the vital components in the left portion of the framework. Policies should be put into place and made applicable regarding the enforcement of security measures within eGovernment service delivery.

Cost minimization should be considered; KPs in Ethiopia deem this important to Ethiopian eGovernment service delivery. The cost minimization component of Cloud Computing can provide opportunities to minimize or eliminate the up-front cost and decrease the cost of operations, network bandwidth, electricity, software, and hardware, and increase the utilization of Cloud Computing.

Given the categorized constraints (presented in the bottom portion of the framework), the advantages of Cloud Computing — such as Utility Computing platforms (termed pay-as-you-use, Utility Computing, utility on-demand) — can reduce ICT-related operational costs and Total Cost of Ownership (TCO) (Odusote & Adigun, 2014). These were explored as vital Components of Cloud Computing (see Figure 6-8), based on the components of the framework, which serve as the source of solutions to the challenges posed by RCEs. Technologies such as virtualised hardware, integrated data centres, network components, and application software are presented as vital components of Cloud Computing; these should be designed and/or re-designed as a collective and shared environment to create government Cloud Computing (if the infrastructure already exists, they can be utilized to minimize the cost of new deployment).

The relationships among the components of Cloud Computing, eGovernment services, the risks and challenges of eGovernment services, and the components of Cloud Computing for addressing eGovernment risks and challenges are included in the theoretical framework.

One of the initiatives for the growing acceptance of eGovernment services is the current information age that has opened the opportunity for the ultimate revolution in bringing together all stakeholders around eGovernment services. Communication between government, citizens, and stakeholders in eGovernment service delivery should thus be facilitated with the deployment of an appropriate communication gateway such as the national portal. In the Ethiopian context, this should comprise the upgrading of the existing national portal to a single window access point of different eGovernment services, rather than offering a limited number of services. It should include services such as issuance of driving licenses; voter registration services; immigration and travel services; birth, death, & marriage certificates services; land information; housing, property, & local environment services; permits; issuance of passports; e-Parking; bill request services; and municipal services. As indicated by KPs in Ethiopia, a communication gateway development is relevant to Ethiopian eGovernment service delivery, as it can facilitate PSO service delivery. Via Cloud Computing technology, the enhancement of work activities should facilitate service delivery; as a result, the general scope of these communication gateways can be improved and enhanced.

As indicated by KPs in Ethiopia, many private and public organisations currently have their own systems. Many government organisations developed new applications of similar nature. The lack of interoperability can be caused by silo deployment of services, applications, and systems by different government agencies that can challenge the success of eGovernment service delivery. As the different services, applications, and systems of government departments should communicate with each other, the proposed framework can be applied to ensure Integration and Interoperability of these eGovernment services, applications, and systems via the implementation of a Common Systems Architecture. In addition, a lack of standards as indicated by KPs in Ethiopia, presented within the framework in Figure 5-8, can also challenge the adoption of eGovernment. Some principles, guidance, and standards should be set up and implemented to be strictly followed for ensuring availability, performance, and security of eGovernment services; the performance of the back-end infrastructure, and the security of data and information flow.

For understanding the feedback of various stakeholders of the eGovernment system in Ethiopia, and to transform relationships among internal and external stakeholders, the research recommends that different stakeholders should be considered during the adoption and use of Cloud Computing, as indicated by the theoretical framework. Stakeholders will include the public sector, employees (including middle and top- level managers), citizens, private sector, consultants, and NGOs. As indicated by KPs in Ethiopia, and presented within the framework in Figure 5-8, citizens, employees, and other stakeholders' accessibility to government information and eGovernment services in the Ethiopian context should be enhanced by ensuring timely and reliable information through interaction interfaces such as the broad network access media, such as smart phones, tablets, notebooks, and personal computers.

Limited ICT training centres can challenge the empowerment of officers and officials in managing and using ICT resources. As indicated by KPs in Ethiopia, training is vital to the Ethiopian ICT sector for enhancing technology acceptance and improving a rigid bureaucratic structure and work culture. This research recommended regular training, knowledge provision, and skills development for IT staff who operate eGovernment systems, so as to enable the officers and officials to provide maintenance and support. It is also recommended to provide basic IT training to those who use eGovernment services, on the safety of electronic services.

Despite its limited performance, as complained by many KPs, due to limited bandwidth and frequent interruptions, the WoredaNet and ICTs — together with a current ongoing project for the implementation of a government-wide broadband network — should become a vital initiative for the adoption and use of Cloud Computing to contribute towards improved user-driven eGovernment service delivery in the Ethiopian context. The Ethiopian government should finalize the ongoing transaction act and policies to ensure the monitoring and securing of financial activities that will take place within eGovernment service delivery.

As indicated by KPs in Ethiopia, existing data centres across the WoredaNet should be assessed for technological optimisation and integration, and should adopt a Cloud architecture so that they can contribute towards cost minimization. As indicated by KPs in Ethiopia, when presented within the framework in Figure 5-8, virtualisation can play a vital role in using the existing data centres for cost minimization, space reduction, easier administration and maintenance and green computing with reduced carbon emissions.

6.11 CHAPTER SUMMARY

Ethiopian and global experts reviewed and validated the various components of the framework in this chapter. Additionally, the chapter presented the first, second, and final Cloud Computing frameworks to facilitate e-learning in Ethiopia.

The following chapter outlines the conclusion and recommendations of the study.

CHAPTER 7 CONCLUSIONS AND RECOMMENDATIONS

7.1 INTRODUCTION

Chapter 6 completed the development and validation of the initial, intermediate, and final frameworks for Cloud Computing for facilitating eGovernments services in RCEs. The findings from expert interviews discussed in Chapter 6 provided relevant information towards refining the different versions of the framework.

This chapter summarises and concludes the research project. The contribution of this thesis is evaluated in addressing the research questions; this is followed by a discussion of the limitations of the research and opportunities for future research.

7.2 CHAPTER OVERVIEW

Section 7.3 presents the overview of the research study, while Section 7.4 presents how the main and sub-research questions are answered and how the research objectives are addressed. A summary of the research methodology applied by this research study is presented in Section 7.5. Section 7.6 summarises the validation and evaluation of the research study. The study's contribution is outlined in Section 7.7, and an assessment of the contribution is made in Section 7.8. Section 7.9 presents the research limitations, and recommendations for future research is elaborated on in Section 7.10. The researcher's reflections are presented in Section 7.11. Section 7.12 presents the lessons learned, and the conclusions and recommendations of the research are presented in Section 7.13.

7.3 OVERVIEW OF THE RESEARCH STUDY

This thesis is organized into seven chapters. The research overview, which highlighted the research problem, research questions and research objectives, was provided in Chapter 1. Chapter 2 discussed the research processes, including the methodology and design employed by this thesis.

Chapters 3, 4, and 5 presented the scoping literature reviews on Cloud Computing, eGovernment services, and RCEs, respectively.

Chapter 6 presented the validations of the different versions of the framework development, so as to arrive at the final version of the framework for Cloud Computing in RCEs facilitating eGovernment services.

The summary and conclusion of the research is presented in Chapter 7.

7.4 ADDRESSING THE RESEARCH QUESTIONS AND RESEARCH OBJECTIVE

This study aimed to explore and develop a framework for Cloud Computing in RCEs to facilitate eGovernment services in Ethiopia, which led to the formulation of the main research question:

How can a Cloud Computing framework support resource-constrained environments to facilitate eGovernment services in Ethiopia?

The main research question was addressed through sub-research questions and objectives, which were listed in Chapter 1 (Sections 1.2.1 and 1.2.2).

The main research questions guided this research study and addressed the following research objective:

To explore and develop a framework for Cloud Computing in RCEs to facilitate eGovernment services in Ethiopia.

The first sub-research question is presented below:

- SRQ1: What is the State-of-the-Art of Cloud Computing?

The first sub-research question addressed the following research objective:

- To explore and investigate the components of the State-of-the-Art of Cloud Computing

The first phase of framework development was outlined in Chapter 3, and answered the first research question by identifying the vital components of the state of the art of the Cloud Computing; these were used for the development of the first version of a Cloud Computing framework in RCEs for facilitating eGovernment services. The development of this first version of the framework was presented in Chapter 6. The scoping review, adopted from a systematic review with the rigor methodology, on Cloud Computing contributed towards answering the first sub-research question by providing the Cloud Computing components that are used for the development of the first version of the proposed theoretical framework.

The second sub-research question is:

- SRQ2: What frameworks exist for facilitating eGovernment services?

The second sub-research question addressed the following research objective:

- To explore and investigate existing frameworks for facilitating eGovernment services

In the second phase of the framework development as outlined in Chapter 4, a scoping review, that was adopted from a systematic review with methodological rigor, was applied to examine existing frameworks to facilitate eGovernment services. It answered the second sub-research question, and also addressed its related objective by identifying the components from eGovernment services that were used for the development of the second version of the proposed theoretical framework towards the framework for Cloud Computing in RCEs facilitating eGovernment services, presented in Chapter 5.

The third sub-research question is:

- SRQ3: How do the challenges of resource-constrained environments influence Cloud Computing to facilitate eGovernment services for Ethiopia?

The third sub-research question addressed the following research objective:

- To explore and identify the challenges that an RCE can pose for Cloud Computing facilitating eGovernment services for Ethiopia.

The third phase of the development of the framework, outlined in Chapter 5, answered the third research question by providing the vital components from RCEs that are used for the development of the third version of the proposed theoretical framework towards the framework for Cloud Computing in RCEs Facilitating eGovernment services. The scoping review adopted from a systematic review with the rigor methodology on RCEs helped for answering the third sub-research question by providing the components from RCEs.

7.4.1 Main research question answered

The literature reviews (in three Chapters) supported the answers to the three sub-research questions and components from these chapters were used as building blocks in the development and explanation of the framework. The final framework is provided in Chapter 6 (see Section 6.7 and Figure 6-7). Feedback from the expert interviews was incorporated to refine and improve the final framework.

Table 7-1: Main research question answered

Topic	Description
Main question, addressed in main findings (outputs):	How can a Cloud Computing framework support resource-constrained environments to facilitate eGovernment services in Ethiopia?
	Chapters 3 to 6
	The components indicated in the final framework (Figure 6-7) were supported by literature findings, and ranked and validated by experts from WoredaNet and globally. It became apparent that such a framework can support RCEs to facilitate eGovernment services in Ethiopia, because the framework can act as a guide that can be used by government. It has both theoretical and practical value, as is indicated in Section 7-7. This framework, with its unique components, can also be applied in other developing contexts as the results can be generalizable to assist any government with similar RCE challenges. The next step will be to implement this framework and refine and improve it even further.

The following section provides information on the methodology that was applied in conducting the research.

7.5 RESEARCH METHODOLOGY

An interpretivism philosophy, together with the fundamental methodological aspect of hermeneutics known as the ‘hermeneutic circle’ followed by this research study, facilitated an understanding of the views and perceptions of people and their actions in social and organisational contexts. This hermeneutics principle considers the principle of human understanding as a fundamental principle to all the other principles (Klein and Myers, 1999a). This also enabled deep insights into the phenomenon of information systems within WoredaNet, and an understanding of the complex whole of the WoredaNet from preconceptions about the meanings of its parts and their interrelationships; these were guided by, and are consistent with, the research questions of this study.

The **inductive** research approach allowed this research study to start from observations and data collection, and the qualitative research method enabled observation and interviews of people to learn about their social and cultural contexts. Hence, a **qualitative exploratory research method** was applied to address the objectives of the thesis through the preferred research strategy for IS research, to capture the knowledge of practitioners and document the views and perceptions of participants and experiences of practices, namely, the case study strategy (Klein and Myers, 1999a).

By choosing the mono-method approach, this study was able to develop a holistic interpretation of the problem to generate possible solutions (Tashakkori & Creswell, 2007). A **cross-sectional time horizon** that relies on existing differences rather than change when following interventions, and that does not recognise a time dimension, facilitated selection of groups for the purpose of data collection from WoredaNet, based on existing differences rather than random allocations (Trochim & Donnelly, 2001). A qualitative data technique was adopted for **data collection**, data storage, and data reduction. In this research study, for obtaining qualitative data as well as published and unpublished documentary evidence, qualitative data sources were explored via semi-structured interviews, questionnaires, observation, expert reviews, and document analysis, as they were regarded as qualitative data sources (Myers, 1997). Thus, the primary data collection method used Web-based questionnaires, expert interviews, and expert reviews, while document analysis was used as secondary data collection method. Data recorders were used for data storage, while a qualitative data reduction technique was used to transform the data from semi-structured interviews into a form that can be analysed.

A qualitative **data analysis** technique was adopted, and used an analytical framework with an open-coding (Nvivo 10) approach that underpinned triangulation to develop themes. Within-case and holistic case analyses were also conducted. The qualitative data analysis assisted to interpret WoredaNet peoples' responses in different contexts, based on their different experiences, and helped to define the phenomenon within the WoredaNet to be investigated and the case to be examined. The coding process (see Figure 2-5) enabled interpretation of human views and identification of themes.

The theories that supported the development and exploration of the framework were the affordances and socio-technical systems theories. These theories were applied throughout the chapters as lenses to understand how goal-oriented individuals interpret properties within information systems to create changes in organisational practices. Affordances theory in this study played a role when experts from WoredaNet applied their experiences and skills to improve the framework through its various iterations of development. Their goals were to improve WoredaNet so that Ethiopia could improve the country's delivery of eGovernment services. The affordances theory also supported the socio-technical systems theory. The socio-technical systems theory influence the way in which participants perceive WoredaNet in Ethiopia as an ICT system. It also highlighted the way in which this system has influenced their daily working activities to support the society of Ethiopia better when they want to access eGovernment services. The interplay between humans and systems allowed the researcher to address the main research question.

7.6 RESEARCH STUDY EVALUATION

To maintain the reliability and validity of the results for each concept of cloud computing, eGovernment, and RCEs, results from each phase of the interim theoretical framework development were examined by supervisors and experts (from 30 WoredaNet sites) who were invited to rank each and every component of the concepts, based on their level of management and experience in daily use of WoredaNet. To ensure the trustworthiness of the research findings, this interpretive research study with its a hermeneutic nature followed the principles of Klein and Myers — offered for interpretive field research and used to ensure reality and credibility of the findings (Klein & Myers, 1999).

The principles include seven classifications of elements, namely, the fundamental principles of the Hermeneutic Circle, as depicted in Table 7-2:

Table 7-2 Principles used for evaluation of Interpretive Field Research

#	Major Principle	Description and application to this study
1	The Fundamental principle of the Hermeneutic circle	Considering that they all form a whole by examining their interdependent meaning, this principle contributed to viewing human understanding as a fundamental principle.

#	Major Principle	Description and application to this study
2	The principle of contextualization	In addition, this principle was used to allow the intended audience to understand the context of the research (the WoredaNet) and provide a means for critical reflection upon the social and historical background.
3	The Principle of interaction between the researchers and the subjects.	The preferred research study context was the WoredaNet, within which the various activities of decision makers, team leaders, ICT technical professionals, and IT administrators of PSOs (actors), as well as the WoredaNet system as a whole, operated. In relation to the social construction of the research materials, this was the critical reflection of the researcher and the participants. The investigations were instantiated by placing the subject within the social and historical context of WoredaNet, into the diverse views and perceptions of participants about WoredaNet ICT artefacts as well as the Cloud Computing in RCEs to facilitate eGovernment services (Klein & Myers, 1999). This principle of interaction helped to place the subject and the researcher in the historical perspective of the WoredaNet system, where data were socially constructed through interactions between the researcher and the participants.
4	The Principle of abstraction and generalization	Based on principles one and two, the data interpretation derived idiographic details that are related to the theory of understanding and social action based on general, theoretical concepts.
5	The Principle of Dialogical Reasoning	This principle, by finding out and documenting multiple sense perceptions and responses of people together with the reasons, helped to address possible contradictions between theoretical preconceptions and the research's actual findings; the research examined influences that the WoredaNet social context had upon actions of the study under investigation. It helped to place the participants and the researcher in a mental relationship of interpretation; analysis of theoretical abstractions and generalizations were consequently related to the field study details as they were experienced and collected. By applying this principle, the researcher was able to apply the theoretical preconceptions to guide the design of the research, as well as to synthesize the information that emerged during the research process, making the historical context of the study as transparent as possible.

#	Major Principle	Description and application to this study
6	The principle of multiple interpretations	Due to this principle, it was possible to be sensitive to differences in interpretation among participants, as stories were typically related to the same sequence of events under study.
7	The principle of suspicion	Assisted participants in detecting biases and distortions in their narratives when the data was collected through WoredaNet.

Table 7-3: Reliability, Validity, and Trustworthiness of the Research

Measures	Description
Reliability of data	Multiple data sources, including observation, document analysis, questionnaires, and interviews, were used to ensure credibility. Interviews were recorded and transcribed (analysed using Nvivo 10). Reliability of the research is recognised by the researcher as important; inevitably. Qualitative research is by nature a "subjective" analysis.
Validity of Research	The validity of the research findings and conclusions are based on a reasonable account of the recorded interview transcripts/coding schemes and themes that emerged. Triangulation was used for validity to assess bias and other potential problems. The use of pattern matching and explanation building aimed to address the issue of internal validity.
Trustworthiness	Experts from the fields of Cloud Computing, eGovernment, and WoredaNet networking were selected to evaluate the components of Cloud Computing, eGovernment, and RCE within the Ethiopian context to ensure trustworthiness of the findings. Researchers in the fields of cloud computing, e-government, and RCEs participated in interviews to validate the findings presented by Ethiopian experts (see Section 6.4 for an overview of the interviews conducted with global experts). Consequently, it can be said that the findings of this study are of solid quality, given the comparison of qualitative data with literature and the support of theory and empirical evidence.

In general, measures for achieving trustworthiness, the concepts' credibility, dependability, and transferability, have been used in qualitative research (Lincoln and Guba, 1985). The following measures were adopted by this research study to achieve trustworthiness:

- Credibility: multiple data sources such as observation, questionnaires, interviews and multiple data collection methods were used to ensure credibility

- Dependability: the degree to which data changed over time was mitigated by employing multiple data sources.
- Trustworthiness: to evaluate the components of Cloud Computing, eGovernment services, and RCEs, experts in the field of interest within the Ethiopian context were selected.
- Conformability: interviews and questionnaires were used to address various aspects of the findings. The feedback from experts in Ethiopia provided useful information that led to the development of the final Cloud Computing framework for facilitating eGovernment services in RCEs.
- Transferability: the findings of this study can be transferred to other environments of a similar context and nature, or to groups that want to improve their eGovernment services (developing context especially).

7.7 RESEARCH CONTRIBUTION

Each of the three phases of the interim theoretical framework development (see Figure 5-7) in this research study contributed towards answering the research questions and addressing the objectives of the research study. The findings provided practical and theoretical contributions, as presented below.

7.7.1 Practical Contributions

A lack of academic study still limits the Cloud Computing, eGovernment services, and RCE sector in Ethiopia; there is no such framework specifically developed for the Ethiopian context. This study aims to explore components and develop *a Framework for Cloud Computing for RCEs to facilitate eGovernment services in Ethiopia*. The framework consists of components of Cloud Computing, eGovernment services, and RCEs.

The final framework provides relevant information regarding the components that constitute a Cloud Computing framework for the Ethiopian context for Cloud Computing for facilitating eGovernment services in RCEs. This framework has particular importance for the Ethiopian government and for governments of other developing countries in the context of their own contexts. Findings can allow executives of federal and state agencies in Ethiopia to better examine the framework for Cloud Computing during its adoption and implementation to facilitate eGovernment services in RCEs within their organisations. The findings can also enable decision makers in improving planning, goal setting, and resource allocation.

The other practical contribution of this study includes the finding that, in this particular eGovernment services context, Cloud Computing technology is most appropriately placed as a tool to enhance service delivery and improve work activities. The study showed that the system (in Ethiopia) was resistant to change; it illuminated current routine work practices and how these routines could remain resistant to change. In this way, the study contributed by providing a clear understanding of how Cloud Computing functionalities can improve existing systems for the delivery of eGovernment services and for improving work activities in PSOs.

It provided an analysis and explanations for those outcomes. For instance, from an international perspective, the development of the framework for Cloud Computing highlighted the differences and similarities that are apparent between the local and international contexts. In the case of online government service delivery, the government and PSOs had to modify and adapt the tool to accommodate another set of efficient work practices. It also illuminated how Cloud Computing can play a useful role in addressing the lack of proper infrastructure and shortage of computer-aware citizens in rural areas and provided a suggestion for the implementation of eGovernment services using Cloud Computing service models.

It also presented a discussion on how Cloud Computing can enable users to access computing resources from anywhere based on their demand; here, broad network access is also available and can be accessed through different platforms, including mobile phones, notebooks, and tablets. Location-independent Cloud Computing services can be made available and accessed via the Internet.

7.7.2 Theoretical Contributions

From the theoretical perspective, this research contributes to the theory and knowledge where eGovernment services are deployed. New knowledge also emerged about Cloud Computing in RCEs. It added value within the study of Cloud Computing by enhancing the development of e-governance that fosters service delivery and improves efficiency, effectiveness, and productivity of administrative tasks and improved the delivery of information and improved services to the public. Thus, the establishment of a conceptual base around WoredaNet Cloud Computing data centres will allow for responsive understandings of the research field.

The results of the study thus laid the foundation for further studies and contributed to individuals, organisations, institutions, and governments in providing concepts, frameworks, theoretical models, and data for their research of the Cloud Computing field.

7.8 LIMITATIONS OF THE STUDY

Although a framework for Cloud Computing in RCEs to facilitate eGovernment services in the Ethiopian context was provided, this thesis recognises that there were limitations to the study, which require further research on the topic of interest. The limitations of the study in identifying all the components of a Cloud Computing framework in RCEs to facilitate eGovernment services in the Ethiopian context are acknowledged. The suggestions made by this thesis are for the provision of possible future research to reach a fully developed and worldwide-accepted theoretical framework that was not achieved; this requires further research. The main limitations, therefore, resided in the number of sites (n=30) in Woreda in Ethiopia, as well as the number of participants (n=30) to evaluate, rank, and validate the framework.

7.9 FUTURE RESEARCH

The suggestions made by this thesis were that other developing countries could also apply the developed framework to adapt or refine it based on their specific needs.

Therefore, further research on the topic of interest is recommended. As the current transformation may not depend only on the adoption and use of technologies, but may also require a comprehensive approach that delivers fast, reliable, and accessible services, appropriate procedures and strategies should be established within the Ethiopian context; in other developing the circumstance should further be researched in accordance with the topic of interest.

7.10 RESEARCHER'S REFLECTION

As a researcher, I realised the importance of having a well-formulated research design coupled with a focused research problem and a research process of how the research will unfold that can be used as a guide throughout the study. I have learnt a lot about the relevance and rigour of research, and how theory supports statements and assumptions, even when using grey literature (document analysis of Woreda and WoredaNet). My location in Ethiopia caused challenges related to Internet access for downloading articles from all the different databases.

Regular communication with my supervisors was also difficult at times, based on the poor Internet connectivity in my country. We did manage to use WhatsApp, and this worked better than email. Balancing work and studies were also not easy at times, but I feel that I have grown tremendously through this journey as a researcher and as a contributor through this study to improve the eGovernment services of my country.

7.11 WHAT HAS BEEN LEARNED?

From the findings of the study, it is apparent that many government institutions in Ethiopia are still using standalone computers as a replacement for typewriters and paperwork; networking is only used for printing and information sharing; automation was without preparation; and less focus was on the application of modern technologies for eGovernment services.

Other forms of application of *information technology* should be implemented, such as Cloud Computing, to enhance eGovernment services. The application of Cloud Computing was examined by focusing on both its conceptual and practical aspects and was investigated in terms of two realms: on the one hand, an investigation into the advantages of Cloud Computing revealed its vital role for various aspects of public service delivery, citizen involvement, and government internal work activities while, on the other hand, the investigation revealed effective utilization of existing technologies such as data centres and ICT infrastructure, network infrastructure at hand, and skills of human agents in fostering service delivery within the Ethiopian context and to improve the work activities in PSOs.

Government offices and PSOs should be willing to adopt the use of Cloud Computing for facilitating eGovernment services in resource-constrained environments, and hence participate in Cloud Computing and the delivery of eGovernment services.

7.12 SUMMARY AND RECOMMENDATIONS

It is essential to address eGovernment service delivery in RCEs within Ethiopia. This indicates that an appropriate framework should be developed to conceptualise citizens' constraints of access to reliable and timely information, significant investment cost, scarce access to transactional applications from the Web and Internet, limited bandwidth, frequent interruption of network connectivity and electric power, lack of integration and interoperability among existing silo systems, unevenness on skills, and inefficient governance in existing systems. It is thus essential to address such challenges by ensuring the proper utilization of existing IT and new technologies such as the Cloud Computing to foster service delivery in PSOs and increase the performance of work activities. Static sources of information should not be the only information source to citizens; they must have access to reliable and timely information about government and gain trust about the availability of online applications; further, they must be guaranteed safety and gain confidence that they feel safe when accessing such a system. In addressing the challenge that constrains effective and efficient eGovernment service delivery, Cloud Computing should be a major technological focus point. Cloud Computing as a tool to enhance service delivery should significantly impact the work activities of government organisations and PSOs. In order to improve data quality and procedural quality, it should be designed and implemented, so employees learn new analytical skills, improve their thinking, and improve data collection behaviour. Thus, experts will have more time to devote to their important tasks, in addition to gaining access to accurate and timely data that will help them make better decisions and monitor progress. This study revealed that information technology had become an indispensable tool for poverty alleviation in Ethiopia, as it is no longer a luxury for the poor. Measurement and assessment are important aspects of assessing the effectiveness of different poverty eradication programs. It has been difficult to alleviate poverty due to a lack of knowledge about the effects of different programs.

For eGovernment services, there should be a common systems architecture that ensures integration and interoperability, while Cloud Computing should handle everything as an accessible service, with components such as notebook computers, personal computers, smartphones, and tablets serving as interaction interfaces. Web portals should serve as one-stop centres for the delivery of all government services to citizens. Cloud Computing must ensure the availability of on-demand service, broad network access, rapid elasticity and resource pooling, performance of infrastructure, and security. A shared pool of resources across groups, where there are enhanced management and governance, good participation, and better capacity building, should be created. Citizens must abide by principles and guidance to use eGovernment services, and principles of eGovernment should govern the PSO and government. The eGovernment services should enhance interaction communication such as G2G, G2C, G2B, and G2E.

The specific challenges involved in implementing eGovernment solutions in Ethiopia need to be addressed in order for Cloud Computing to be effective in fostering eGovernment service delivery. In order to provide eGovernment services to populations in urban and rural areas, we need to develop carefully designed measurement mechanisms, such as Service Level Agreements (SLAs), that can help create a relationship of trust between governments and their citizens. Based on the local situations of organisational, cultural, social, and economic factors, Cloud Computing can be developed locally and can bring the required success if adapted with respect to exercising and improving the broader capabilities of Ethiopians in fostering eGovernment service delivery.

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APPENDICES

APPENDIX A: QUESTIONNAIRE ON CLOUD COMPUTING

Subject: To collect data that can be used to validate the components of the Cloud Computing that can be used for the building blocks of the draft framework and to get feedback on the contributions of Cloud Computing in Public Service Organizations (PSOs) of Ethiopia.

Dear Participant,

These questionnaires are designed to obtain data and facts on utilization of WoredaNet technology and components of Cloud Computing in PSOs. You are therefore kindly requested to assist us by providing all facts and opinions that you may think are helpful to evaluate and improve the vital components of Cloud Computing and utilization of WoredaNet technology as well as contributions of Cloud Computing in your office. All the information provided by you or data gathered from this questionnaire is used only for the mentioned purpose and will be handled confidentially to be used for the academic purpose only, thus please feel free in this regard. The aim of these questionnaires is thus to determine the components that constitute Cloud Computing there by contributing towards the development of a framework for Cloud Computing in resource-constrained environments to facilitate e-Government services.

A scoping review and systematic literature review was conducted to explore the concepts, Cloud Computing to identify the components that constitute Cloud Computing.

As a result, an initial framework for Cloud Computing in resource-constrained environments to facilitate e-Government services was developed, However, the components of the Cloud Computing, e-Government services and resource-constrained environments can only be useful within the Ethiopian context once they have been evaluated by knowledgeable professionals like you.

Please rank the questions from 1 being very important to 5 being neutral

1. Please rank "on-demand service" as characteristic component of Cloud Computing relevant to the context of Ethiopian in general and to the WoredaNet setting in particular

    Very Important: ☐

    Important: ☐

    Less Important: ☐

    Not Important: ☐

    Neutral: ☐

2. Please rank "broad network access" as characteristic component of Cloud Computing relevant to the context of Ethiopian in general and to the WoredaNet setting in particular

    Very Important: ☐

    Important: ☐

    Less Important: ☐

    Not Important: ☐

    Neutral: ☐

3. Please rank "Rapid elasticity" as characteristic component of Cloud Computing relevant to the context of Ethiopian in general and to the WoredaNet setting in particular

    Very Important: ☐

    Important: ☐

    Less Important: ☐

    Not Important: ☐

    Neutral: ☐

4. Please rank "Resource pooling" as characteristic component of Cloud Computing relevant to the context of Ethiopian in general and to the WoredaNet setting in particular

Very Important: ☐

Important: ☐

Less Important: ☐

Not Important: ☐

Neutral: ☐

5. Please rank "Measured service" as characteristic component of Cloud Computing relevant to the context of Ethiopian in general and to the WoredaNet setting in particular

Very Important: ☐

Important: ☐

Less Important: ☐

Not Important: ☐

Neutral: ☐

6. Please rank "infinite computing resources" as characteristic component of Cloud Computing relevant to the context of Ethiopian in general and to the WoredaNet setting in particular

Very Important: ☐

Important: ☐

Less Important: ☐

Not Important: ☐

Neutral: ☐

7. Please rank "SaaS" as model component of Cloud Computing relevant to the context of Ethiopian in general and to the WoredaNet setting in particular

Very Important: ☐

Important: ☐

Less Important: ☐

Not Important: ☐

Neutral: ☐

8. Please rank "IaaS" as model component of Cloud Computing relevant to the context of Ethiopian in general and to the WoredaNet setting in particular

Very Important: ☐

Important: ☐

Less Important: ☐

Not Important: ☐

Neutral: ☐

9. Please rank "PaaS" as model component of Cloud Computing relevant to the context of Ethiopian in general and to the WoredaNet setting in particular

Very Important: ☐

Important: ☐

Less Important: ☐

Not Important: ☐

Neutral: ☐

10. Please rank "Public cloud computing " as model component of Cloud Computing relevant to the context of Ethiopian in general and to the WoredaNet setting in particular

Very Important: ☐

Important: ☐

Less Important: ☐

Not Important: ☐

Neutral: ☐

11. Please rank "Private cloud computing " as model component of Cloud Computing relevant to the context of Ethiopian in general and to the WoredaNet setting in particular

    Very Important: ☐

    Important: ☐

    Less Important: ☐

    Not Important: ☐

    Neutral: ☐

12. Please rank "Community cloud computing " as model component of Cloud Computing relevant to the context of Ethiopian in general and to the WoredaNet setting in particular

    Very Important: ☐

    Important: ☐

    Less Important: ☐

    Not Important: ☐

    Neutral: ☐

13. Please rank "Hybrid cloud computing " as model component of Cloud Computing relevant to the context of Ethiopian in general and to the WoredaNet setting in particular

    Very Important: ☐

    Important: ☐

    Less Important: ☐

    Not Important: ☐

    Neutral: ☐

14. Please rank "Data centres" as technology component of Cloud Computing relevant to the context of Ethiopian in general and to the WoredaNet setting in particular

Very Important: ☐

Important: ☐

Less Important: ☐

Not Important: ☐

Neutral: ☐

15. Please rank "Virtualized hardware and network infrastructure" as technology component of Cloud Computing relevant to the context of Ethiopian in general and to the WoredaNet setting in particular

Very Important: ☐

Important: ☐

Less Important: ☐

Not Important: ☐

Neutral: ☐

16. Please rank "Application software" as technology component of Cloud Computing relevant to the context of Ethiopian in general and to the WoredaNet setting in particular

Very Important: ☐

Important: ☐

Less Important: ☐

Not Important: ☐

Neutral: ☐

17. Please rank "Notebooks" as interaction interface component of Cloud Computing relevant to the context of Ethiopian in general and to the WoredaNet setting in particular

    Very Important: ☐
    Important: ☐
    Less Important: ☐
    Not Important: ☐
    Neutral: ☐

18. Please rank "Personal computers" as Interaction interface component of Cloud Computing relevant to the context of Ethiopian in general and to the WoredaNet setting in particular

    Very Important: ☐
    Important: ☐
    Less Important: ☐
    Not Important: ☐
    Neutral: ☐

19. Please rank "Tablets" as Interaction interface component of Cloud Computing relevant to the context of Ethiopian in general and to the WoredaNet setting in particular

    Very Important: ☐
    Important: ☐
    Less Important: ☐
    Not Important: ☐
    Neutral: ☐

20. Please rank "Smart phones" as Interaction interface component of Cloud Computing relevant to the context of Ethiopian in general and to the WoredaNet setting in particular

Very Important: ☐

Important: ☐

Less Important: ☐

Not Important: ☐

Neutral: ☐

21. Please rank "Risks and challenges" as consideration component of Cloud Computing relevant to the context of Ethiopian in general and to the WoredaNet setting in particular

Very Important: ☐

Important: ☐

Less Important: ☐

Not Important: ☐

Neutral: ☐

22. Please rank "Service Level Agreements (SLAs)" as consideration component of Cloud Computing relevant to the context of Ethiopian in general and to the WoredaNet setting in particular

Very Important: ☐

Important: ☐

Less Important: ☐

Not Important: ☐

Neutral: ☐

23. Please rank "availability of services" as principle component of Cloud Computing relevant to the context of Ethiopian in general and to the WoredaNet setting in particular

Very Important: ☐

Important: ☐

Less Important: ☐

Not Important: ☐

Neutral: ☐

24. Please rank "performance of infrastructure" as principle component of Cloud Computing relevant to the context of Ethiopian in general and to the WoredaNet setting in particular

Very Important: ☐

Important: ☐

Less Important: ☐

Not Important: ☐

Neutral: ☐

Please rank "Security" as principle component of Cloud computing relevant to the context of Ethiopian in general and to the WoredaNet setting in particular

Very Important: ☐

Important: ☐

Less Important: ☐

Not Important: ☐

Neutral: ☐

25. Are there any relevant components of Cloud Computing which have not been mentioned here in the above questions?

Yes: ☐

No: ☐

26. If your answer to the previous question is yes, what are those components? Please explain the reason that they should be added.

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27. What best describes your title?

Information Technology (IT) Director: ☐

Information Technology (IT) Manager: ☐

IT Administrators

Network Administrator: ☐

System Administrator: ☐

Security Administrator: ☐

Others specify ______________

Thank you very much for your precious time that you spend in answering these questions

APPENDIX B: QUESTIONNAIRE ON EGOVERNMENT SERVICES

Subject: To collect data that can be used to validate the components of e-Government that is used as the building blocks of the second version of the draft framework and to get feedback on the contributions of e-Government in Public Service Organizations' (PSOs) of Ethiopia.

Dear Participant,

These questionnaires are designed to obtain data and facts on the vital components of the e-Government and utilization of WoredaNet technology. You are therefore kindly requested to assist us by providing all facts and opinions that you may think are helpful to evaluate and improve the vital components of e-Government and its contributions in your office. All the information provided by you or data gathered from these questionnaires is used only for the mentioned purpose and will be handled confidentially to be used for the academic purpose only, thus please feel free in this regard. The aim of these questionnaires is for you to identify and rank relevant components of e-Government services within the Ethiopian context that constitute e-Government there by contributing towards the development of a second version of a framework for Cloud Computing in resource-constrained environments to facilitate e-Government services.

A scoping review and systematic literature review was conducted to explore the concepts, e-Government to identify the components that constitute Cloud Computing.

As a result, a second version of framework for Cloud Computing in resource-constrained environments to facilitate e-Government services was developed. However, the components of the e-Government can only be useful within the Ethiopian context once it has been evaluated by knowledgeable professionals like you.

Please rank the questions from 1 being very important to 5 being neutral

1. Please rank "ICT policy" as legal Framework component of e-Government relevant to the context of Ethiopian in general and to the WoredaNet setting in particular

   Very Important: ☐

   Important: ☐

   Less Important: ☐

   Not Important: ☐

   Neutral: ☐

2. Please rank "E-Government policy" as legal Framework component of e-Government relevant to the context of Ethiopian in general and to the WoredaNet setting in particular

   Very Important: ☐

   Important: ☐

   Less Important: ☐

   Not Important: ☐

   Neutral: ☐

3. Please rank "Legal recognition of Signatures" as legal Framework component of e-Government relevant to the context of Ethiopian in general and to the WoredaNet setting in particular

   Very Important: ☐

   Important: ☐

   Less Important: ☐

   Not Important: ☐

   Neutral: ☐

4. Please rank "Security Standards" as legal Framework component of e-Government relevant to the context of Ethiopian in general and to the WoredaNet setting in particular

   Very Important: ☐

   Important: ☐

   Less Important: ☐

   Not Important: ☐

   Neutral: ☐

5. Please rank "Data security" as Information Security component of e-Government relevant to the context of Ethiopian in general and to the WoredaNet setting in particular

   Very Important: ☐

Important: ☐

Less Important: ☐

Not Important: ☐

Neutral: ☐

6. Please rank "Privacy of data and information" as Information Security component of e-Government relevant to the context of Ethiopian in general and to the WoredaNet setting in particular

   Very Important: ☐

   Important: ☐

   Less Important: ☐

   Not Important: ☐

   Neutral: ☐

7. Please rank "Confidentiality and trust" as Information Security component of e-Government relevant to the context of Ethiopian in general and to the WoredaNet setting in particular

   Very Important: ☐

   Important: ☐

   Less Important: ☐

   Not Important: ☐

   Neutral: ☐

8. Please rank "Shared Application Software" as Application and Service component of e-Government relevant to the context of Ethiopian in general and to the WoredaNet setting in particular

   Very Important: ☐

   Important: ☐

Less Important: ☐

Not Important: ☐

Neutral: ☐

9. Please rank "Information in an up-to date manner" as Application and Service component of e-Government relevant to the context of Ethiopian in general and to the WoredaNet setting in particular

Very Important: ☐

Important: ☐

Less Important: ☐

Not Important: ☐

Neutral: ☐

10. Please rank "Selected e-Government services available on demand" as Application and Service component of e-Government relevant to the context of Ethiopian in general and to the WoredaNet setting in particular

Very Important: ☐

Important: ☐

Less Important: ☐

Not Important: ☐

Neutral: ☐

11. Please rank "Back-end Automation of Hardware and High End Computing Infrastructure" as technology component of e-Government relevant to the context of Ethiopian in general and to the WoredaNet setting in particular

Very Important: ☐

Important: ☐

Less Important: ☐

Not Important: ☐

Neutral: ☐

12. Please rank "High bandwidth" as technology component of e-Government relevant to the context of Ethiopian in general and to the WoredaNet setting in particular

    Very Important: ☐

    Important: ☐

    Less Important: ☐

    Not Important: ☐

    Neutral: ☐

13. Please rank "Telecommunication infrastructure" as technology component of e-Government relevant to the context of Ethiopian in general and to the WoredaNet setting in particular

    Very Important: ☐

    Important: ☐

    Less Important: ☐

    Not Important: ☐

    Neutral: ☐

14. Please rank "Last Mile/Rural Area Connectivity" as technology component of e-Government relevant to the context of Ethiopian in general and to the WoredaNet setting in particular

    Very Important: ☐

    Important: ☐

    Less Important: ☐

    Not Important: ☐

    Neutral: ☐

15. Please rank "Electricity" as technology component of e-Government relevant to the context of Ethiopian in general and to the WoredaNet setting in particular

    Very Important: ☐

    Important: ☐

Not Important: ☐

Neutral: ☐

19. Please rank "Backup and disaster recovery" as technology component of e-Government relevant to the context of Ethiopian in general and to the WoredaNet setting in particular

Very Important: ☐

Important: ☐

Less Important: ☐

Not Important: ☐

Neutral: ☐

20. Please rank "Integration" as Common Systems Architecture component of e-Government relevant to the context of Ethiopian in general and to the WoredaNet setting in particular

Very Important: ☐

Important: ☐

Less Important: ☐

Not Important: ☐

Neutral: ☐

21. Please rank "interoperability" as Common Systems Architecture component of e-Government relevant to the context of Ethiopian in general and to the WoredaNet setting in particular

Very Important: ☐

Important: ☐

Less Important: ☐

Not Important: ☐

Neutral: ☐

22. Please rank "Government-to-Government (G2G) communication" as Interaction Communication component of e-Government relevant to the context of Ethiopian in general and to the WoredaNet setting in particular

    Very Important: ☐

    Important: ☐

    Less Important: ☐

    Not Important: ☐

    Neutral: ☐

23. Please rank "Government-to-Citizens (G2C) communication" as Interaction Communication component of e-Government relevant to the context of Ethiopian in general and to the WoredaNet setting in particular

    Very Important: ☐

    Important: ☐

    Less Important: ☐

    Not Important: ☐

    Neutral: ☐

24. Please rank "Government-to-Business (G2B) communication" as Interaction Communication component of e-Government relevant to the context of Ethiopian in general and to the WoredaNet setting in particular

    Very Important: ☐

    Important: ☐

    Less Important: ☐

    Not Important: ☐

    Neutral: ☐

25. Please rank "Government-to-Employee (G2E) communication" as Interaction Communication component of e-Government relevant to the context of Ethiopian in general and to the WoredaNet setting in particular

    Very Important: ☐

Important: ☐

Less Important: ☐

Not Important: ☐

Neutral: ☐

26. Please rank "Public sector" as Stakeholders component of e-Government relevant to the context of Ethiopian in general and to the WoredaNet setting in particular

Very Important: ☐

Important: ☐

Less Important: ☐

Not Important: ☐

Neutral: ☐

27. Please rank "employees (including middle and top level managers)" as stakeholder component of e-Government relevant to the context of Ethiopian in general and to the WoredaNet setting in particular

Very Important: ☐

Important: ☐

Less Important: ☐

Not Important: ☐

Neutral: ☐

28. Please rank "citizens" as stakeholder component of e-Government relevant to the context of Ethiopian in general and to the WoredaNet setting in particular

Very Important: ☐

Important: ☐

Less Important: ☐

Not Important: ☐

Neutral: ☐

29. Please rank "private sectors" as stakeholder component of e-Government relevant to the context of Ethiopian in general and to the WoredaNet setting in particular

    Very Important: ☐

    Important: ☐

    Less Important: ☐

    Not Important: ☐

    Neutral: ☐

30. Please rank "consultants" as stakeholder component of e-Government relevant to the context of Ethiopian in general and to the WoredaNet setting in particular

    Very Important: ☐

    Important: ☐

    Less Important: ☐

    Not Important: ☐

    Neutral: ☐

31. Please rank "Non-Government Organizations (NGOs)" as stakeholder component of e-Government relevant to the context of Ethiopian in general and to the WoredaNet setting in particular

    Very Important: ☐

    Important: ☐

    Less Important: ☐

    Not Important: ☐

    Neutral: ☐

32. Please rank “a national portal" as component of e-Government relevant to the context of Ethiopian in general and to the WoredaNet setting in particular

Very Important: ☐

Important: ☐

Less Important: ☐

Not Important: ☐

Neutral: ☐

33. Please rank "notebooks, Personal computers, smart phones, and Tablets" as component of e-Government relevant to the context of Ethiopian in general and to the WoredaNet setting in particular

Very Important: ☐

Important: ☐

Less Important: ☐

Not Important: ☐

Neutral: ☐

34. Please rank "guidance to use e-Government services" as component of e-Government relevant to the context of Ethiopian in general and to the WoredaNet setting in particular

Very Important: ☐

Important: ☐

Less Important: ☐

Not Important: ☐

Neutral: ☐

35. Please rank "principles of e-Government services" as component of e-Government relevant to the context of Ethiopian in general and to the WoredaNet setting in particular

Very Important: ☐

Important: ☐

Less Important: ☐

Not Important: ☐

Neutral: ☐

36. Are there any relevant components of e-Government which have not been mentioned here in the above questions?

Yes: ☐

No: ☐

Neutral: ☐

37. If your answer to the previous question is yes, what are those components? Please explain the reason that they should be added.

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38. What best describes your title?

Information Technology (IT) Director: ☐

Information Technology (IT) Manager: ☐

IT Administrators

Network Administrator: ☐

System Administrator: ☐

Security Administrator: ☐

Others specify ______________

APPENDIX C:

Subject: To collect data that can be used to validate the components of Resource-Constrained Environment that can be used for the building blocks of the final version of the framework and to get feedback on the contributions of Cloud Computing in Public Service Organizations (PSOs) of Ethiopia in Resource-Constrained Environment.

Dear Participant,

The questionnaires are designed to obtain data and facts on challenges that may be posed by Resource-Constrained Environment within WoredaNet and data and facts regarding Resource-Constrained Environment. You are therefore kindly requested to assist us by providing all facts and opinions that you may think are helpful to evaluate and improve the vital components of Resource-Constrained Environment within WoredaNet technology that may challenge the contributions of Cloud Computing. All the information provided by you or data gathered from these questionnaires are used only for the mentioned purpose and will be handled confidentially to be used for the academic purpose only, and hence please feel free in this regard. The aim of the questionnaires is thus to determine the components that constitute Resource-Constrained Environment there by contributing towards the development of a framework for Cloud Computing in resource-constrained environments to facilitate e-Government services

A scoping review and systematic literature review was conducted to explore the concepts, Resource-Constrained Environment to identify the components that constitute Resource-Constrained Environment.

As a result, the final version of the framework for Cloud Computing in resource-constrained environments to facilitate e-Government services was developed. However, the components of the Resource-Constrained Environment can only be useful within the Ethiopian context once it has been evaluated by knowledgeable professionals like you.

Please rank the questions from 1 being very important to 5 being neutral

1. Please rank "lack of rules and regulations and strategies" as organization component of Resource-Constrained Environment relevant to the context of Ethiopian in general and to the WoredaNet setting in particular.

    Very Important: ☐

    Important: ☐

    Less Important: ☐

    Not Important: ☐

    Neutral: ☐

2. Please rank "lack of standardization of organizational structure" as organization component of Resource-Constrained Environment relevant to the context of Ethiopian in general and to the WoredaNet setting in particular.

   Very Important: ☐

   Important: ☐

   Less Important: ☐

   Not Important: ☐

   Neutral: ☐

3. Please rank "rigid bureaucratic work culture" as organization component of Resource-Constrained Environment relevant to the context of Ethiopian in general and to the WoredaNet setting in particular.

   Very Important: ☐

   Important: ☐

   Less Important: ☐

   Not Important: ☐

   Neutral: ☐

4. Please rank "lack of processes" as organization component of Resource-Constrained Environment relevant to the context of Ethiopian in general and to the WoredaNet setting in particular.

   Very Important: ☐

   Important: ☐

   Less Important: ☐

   Not Important: ☐

   Neutral: ☐

5. Please rank "limited Infrastructure" as technology component of Resource-Constrained Environment relevant to the context of Ethiopian in general and to the WoredaNet setting in particular.

   Very Important: ☐

Important: ☐

Less Important: ☐

Not Important: ☐

Neutral: ☐

6. Please rank "limited network and communications" as technology component of Resource-Constrained Environment relevant to the context of Ethiopian in general and to the WoredaNet setting in particular.

   Very Important: ☐

   Important: ☐

   Less Important: ☐

   Not Important: ☐

   Neutral: ☐

7. Please rank "limited applications" as technology component of Resource-Constrained Environment relevant to the context of Ethiopian in general and to the WoredaNet setting in particular.

   Very Important: ☐

   Important: ☐

   Less Important: ☐

   Not Important: ☐

   Neutral: ☐

8. Please rank "large amount of cost of deployment" as financial component of Resource-Constrained Environment relevant to the context of Ethiopian in general and to the WoredaNet setting in particular.

   Very Important: ☐

   Important: ☐

   Less Important: ☐

Not Important: ☐

Neutral: ☐

9. Please rank "large amount of maintenance cost" as financial component of Resource-Constrained Environment relevant to the context of Ethiopian in general and to the WoredaNet setting in particular.

Very Important: ☐

Important: ☐

Less Important: ☐

Not Important: ☐

Neutral: ☐

10. Please rank "large amount of Cost of management" as financial component of Resource-Constrained Environment relevant to the context of Ethiopian in general and to the WoredaNet setting in particular.

Very Important: ☐

Important: ☐

Less Important: ☐

Not Important: ☐

Neutral: ☐

11. Please rank "fear of security of data and information" as security and privacy component of Resource-Constrained Environment relevant to the context of Ethiopian in general and to the WoredaNet setting in particular.

Very Important: ☐

Important: ☐

Less Important: ☐

Not Important: ☐

Neutral: ☐

12. Please rank "fear of Privacy of personal data and information" as security and privacy component of Resource-Constrained Environment relevant to the context of Ethiopian in general and to the WoredaNet setting in particular.

Very Important: ☐

Important: ☐

Less Important: ☐

Not Important: ☐

Neutral: ☐

13. Please rank "limited technology acceptance" as social related component of Resource-Constrained Environment relevant to the context of Ethiopian in general and to the WoredaNet setting in particular.

Very Important: ☐

Important: ☐

Less Important: ☐

Not Important: ☐

Neutral: ☐

14. Please rank "limited capabilities and skills" as social related component of Resource-Constrained Environment relevant to the context of Ethiopian in general and to the WoredaNet setting in particular.

Very Important: ☐

Important: ☐

Less Important: ☐

Not Important: ☐

Neutral: ☐

15. Are there any relevant components of Resource-Constrained Environment which have not been mentioned here in the above questions?

Yes: ☐

No: ☐

16. If your answer to the previous question is yes, what are those components? Please explain the reason that they should be added.

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17. What best describes your title?

Information Technology (IT) Director: ☐

Information Technology (IT) Manager: ☐

IT Administrators

Network Administrator: ☐

System Administrator: ☐

Security Administrator: ☐

Others specify _______________

Thank you very much for your precious time that you spend in answering these questions.

APPENDIX D: EXPERT INTERVIEW QUESTIONS

Subject: To collect data and feedback on the contributions of Cloud Computing for facilitating e-Government in Public Service Organization s (PSOs) of Ethiopia.

Dear Participant,

This interview question is designed to obtain data and facts on the contributions of Cloud Computing for facilitating e-Government and utilization of WoredaNet technology. You are therefore kindly requested to closely observe the questions as it may assist you during the face-to-face interview in providing all facts and opinions that you may think are helpful to evaluate and improve the vital aspects of Cloud Computing for facilitating e-Government and its contributions in your office. All the information provided by you or data gathered from this interview is used only for the mentioned purpose and will be handled confidentially to be used for the academic purpose only, thus please feel free in this regard.

As a result, a framework for Cloud Computing in resource-constrained environments to facilitate e-Government services was developed.

1. What in your opinion can best describe WoredaNet's organizational structure in general and your work place's organizational structure in particular?

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2. What kind of work relationships exist among middle and top management of regional representatives within WoredaNet? Please also specify the relationship with ordinary staff in WoredaNet. (Or in your organization)

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3. What can you tell us about your work place culture and day to day work practice of your organization in accordance with WoredaNet's technology use?
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4. What challenging constraints did you face at the time of implementation of WoredaNet system as well as constraints after implementation was completed?
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5. For what purposes are people using WoredaNet technology in your work place?
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6. What do you think is the role of WoredaNet technology regarding relationships within your organization or between your organization and other WoredaNet offices?
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7. What do you think is the role of WoredaNet technology in your organization? Please specify its role in accordance with technical and/or administrative work activities of your organization?

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8. For what purpose do the staffs in your organization use WoredaNet video conferencing technology?

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9. For what purpose do administrators, ICT staff and public servants use WoredaNet's computerized integrated document management technology in your organization? If there is no such a system, please specify.

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10. For what purpose do administrators, ICT staff and public servants use WoredaNet's technology and shared services in your organization? If there are no such services, please specify

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11. What can you tell us about the current status of WoredaNet technology particularly in your place? Please specify your answer relating the technology to service delivery.

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12. What do you think are the limiting factors constraining the effective utilisation of WoredaNet technology?

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13. What kind of public services are delivered to/from your organization? And also please specify those public services supported with WoredaNet technology and those delivered manually.

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14. What contributions do you think are offered from WoredaNet technology to public service delivery in general? Please specify also its contribution to Cloud Computing and e-governance.

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15. What drawbacks do you think are associated with WoredaNet technology in terms of technology use and service delivery?

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16. What is the status of utilization of WoredaNet technology in your place?

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17. What can you tell us about the level of acceptance of WoredaNet technology use in your work place?

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18. After WoredaNet has been implemented, what kinds of changes have been made in existing ways of service delivery? If any change has been made please specify the reason and the result of the outcome of the change

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19. What positive or negative influences do you think are exerted by existing social practices as well as existing working culture on using WoredaNet technology?

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20. What do you think are the roles of WoredaNet technology related to implementation policies between policy makers, implementers and policy? And please also specify contributions of WoredaNet technology to e-governance.

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21. In your organization, which are the most utilized WoredaNet service within day to day operations and activities?

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22. What do you think is the level of satisfaction of WoredaNet technology and service delivery?

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23. In your opinion what advantages can be offered by Cloud computing technology to your organization? Please specify the advantages in terms of public service delivery and internal work activities?

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24. What do you think are the contributions of Cloud computing to e-governance?

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25. If any WoredaNet Cloud computing service is accessed in your place, please specify its name and tell us the level and way of way of access (slow, medium, fast, very fast or other), please describe in detail.

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26. In your opinion, which public services can be needed and be most useful to your location, if can be delivered as WoredaNet Cloud computing Service in advance

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27. What can you tell us about Cloud computing technology and delivering software as a service?

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28. What best describes your title?

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Thank you very much for your precious time that you spend in answering these questions.

APPENDIX E: WOREDANET AS THE CASE

RESOURCE-CONSTRAINED ENVIRONMENTS IN ETHIOPIA

This thesis sourced information from the grey literature[1] to substantiate and analyse government policies, strategies and project documents written both in English and Amharic[2] language. Policy documents and technical documentations of projects of the Ethiopian government network (WoredaNet) starting from the initial inception to the implementation process are also assessed.

Ethiopia is one of the developing economies that has undergone extensive reform programs in public service organizations (PSOs), in order to cope with the current technology revolution aiming at accelerating the growth of its socio-economic development and improving the country's public service delivery (Adam, 2014); (Kenenissa & Cho, 2017). To effectively materialize the envisioned accelerated development, one of the strategies that the country has adopted was the empowerment of local governments at Woreda (district) levels through a process known as decentralization development (Woldemariam & Lessa, 2011). This decentralization development strategy has included: a high demand for skill, effective information management, and creation of a seamless flow of information that drives exploitation of ICTs for public service delivery and development and ICTs capacity building via the establishment of the Ethiopian Government Network (Lessa, Klischewski, Belachew & Anteneh, 2015).

Background on the Ethiopian Government Network

The rapid advancement of communication technologies, such as the Internet, has enabled the Ethiopian government, reach its remote sectors to improve the lives of underprivileged citizens (Belachew, 2010); (Adam, 2014). An information centre known as NCIC (National Computers

[1] Grey literature refers to documents of government policies, strategies, project documents and internal documents (memoranda, newsletters) as well as reports (technical reports or statistical reports) primarily government reports, working papers written in Amharic language including WoredaNet's policy documents and technical documentation starting from the initial inception and implementation launched in 2003. It includes technical specifications and standards in print and electronic formats. I have translated all the Amharic language documentation used as source for this particular research, in to English.

[2] The official working language of the Federal Democratic Republic of Ethiopia, Amharic is also the official or working language of several of the regions and states within the federal system. It has been the working language of government, throughout medieval and modern times. According to the 2007 census nearly 22 million are native speakers in Ethiopia.English language is also used in various government sectors.

and Information Centre), under the then Science and Technology commission (the present Ministry of Science and Technology) has led the advancement of communication technologies and all ICT initiatives in Ethiopia, since 2002. It has been at the forefront of an active promotion and implementation of Information and Communication Technology (ICT) solutions to the government. NCIC spearheaded e-governance drives in the country such as developing the first Amharic software, ICT training centres, ICT policy, and various e-government initiatives including the Ethiopian government network known as WoredaNet.

What is WoredaNet?

The WoredaNet is comprised of a National Data Centre which was established in 2008 based on data centre standard of TIA-942. Based on evidences from the literature studies, the WoredaNet can be recognized as the Ethiopian government VPN[3] which is a terrestrial and satellite-based network of technology and people whose primary objective is to provide ICT services to different government offices (PSOs) (Atnafu, 2015; Lessa *et al.*, 2015; Miruts & Asfaw, 2014). Based on evidences from the policy documents of EICTDA (2009), The implementation was launched in 2003 and it comprises of one National Data centre and 11 Regional Data Centres, interconnecting 1000 sites where the sites currently grows to 2000. The implementation of WoredaNet project was part of the broader ICT initiative of the Ethiopian government that aimed at promoting sustainable development through a massive program of ICT applications, to empowering citizens and this nationwide network has also aimed at playing vital roles in success of economic growth, political stability, and good governance of the nation (Kenenissa & Cho, 2017).

The WoredaNet came into existence with existence of a decentralization program launched in 2003. The program was an outcome of reforms in which the smallest government administration sectors known as Woredas or districts were recognized as key players of government activities such as good governance, productivity and development. This was in responsive to the view that it is important to use time and resource effectively and deliver timely and reliable information for fast and efficient decision-making at district level; in contrast to the initial, lack of proper information that degraded the enhancement of democracy, productivity and development of the country where the effect had also reflected badly on various government sectors, and created a divide in the whole society (Lessa *et al.*, 2015;

[3] VPN stands for Virtual Private Network; in the WoredaNet system, it is implemented in making the WoredaNet network as private property of the WoredaNet system, in this case the word private does not mean or represent a single person.

Belachew, 2010). With such targeted aims, the WoredaNet is designed as a three-tier structure (federal, regional and district level), and implemented by the Ministry of Communication and Information Technology (MCIT) in collaboration with a telecommunication company called Ethio-Telecom and regional local governments. Initially the WoredaNet has used broadband terrestrial and VSAT infrastructure for the delivery of services to government bodies and the public in which most of the infrastructure are now upgraded into a broadband connectivity with fibre cable technology (Lessa *et al.*, 2015).

As the initial implementation of network infrastructure and ICT artefacts was based on regional administration sectors, it might be logical to present how these administration sectors are structured and provide clearer insights. In Ethiopia, the structure of the government administration consists of 9 regions and 2 federal/states, where each of the regional and federal sectors further comprises a number of districts. Every region has a local data centre known as a Regional Data Centre (Nieuwenhuisa, Ehrenhardc & Prausec), implemented inside the capital of that particular region and is composed of five personal computers and wide area network connectivity. Every district situated in a given region has a local *Woreda Centre* with an average of two personal computers and network connectivity infrastructure. Each of the country's two federal states has a local data centre of its own. There are also other data centres known as organizational data centres (back office data centres), implemented for various government organizations which are situated within the two federal states (Addis Ababa and DireDawa).

In addition to these main data centres, according to documents of a project known as "Backup and Disaster recovery project", every region has also a backup Regional Data Centre (BRDC) for the purpose of disaster recovery (EICTDA, 2009).

Moreover, according to documents of another WoredaNet project known as the "Master Plan Project", there are also organizational data centres (a back office DC), designed and implemented by the WoredaNet for various ministry offices, agencies and other government sectors found within the two federal administrative sectors (Addis Ababa and DireDawa). Through the first phase of this particular project, 21 government organizations have become the owners' organizational data centres; and through the second phase of the project another 13 government organizations are included. Each and every data centre is deployed by the WoredaNet with the purpose of empowering PSOs by supporting the public services with modern ICT artefacts. As a result, the public servants of the PSOs within regional, federal and district administration offices and their sub-sectors have become the users of these ICT infrastructures (EICTDA, 2009).

Furthermore, in order to bridge the divide, the government has also made various efforts at district level and it has started these efforts for the purpose of realizing information and communication technology at district level which has aimed at achieving the following objectives:

- Enabling ICT professionals at district levels, access information easily.
- Ascertaining fast and two-way information flow.
- Ensuring the process of information gathering in a decentralised structure and also ensuring information regarding civic, economic and administrative sectors is always up-to-date at district level.
- Ensuring ICT professionals at district level use information technology for planning, implementation, and follow-ups and to improving the collection, retrieval, and manipulation of information.
- Creating fast, easy and reliable collection and manipulation of information.
- Ensuring information about change and productivity issues at district level is provided in a consistent and well organised way to policy makers and decision making bodies found at federal and regional sectors in a way that can be useful for decision making.

Objectives of WoredaNet

According to a written document obtained from the previously called MCIT (http://www.mcit.gov.et) and now changed into MINT (Ministry of Innovation and Technology), the major objectives of the WoredaNet are to:

- Bridge the divide between urban and rural communities;
- Provide knowledge and information to citizens;
- Build organisational capacity at all levels of government offices; and
- Provide accurate and timely information to the sectors at the lowest government levels.

Organizational structures of the WoredaNet

The WoredaNet is under the direct management of the Ethiopian Ministry of Communication and Information Technology (MCIT[4]), and this Ministry is responsible for devising rules and

[4] The Ethiopian government established Ministry of Communication and Information Technology in 2010 recognizing the critical role of information and communication technology (ICT) in the national development strategy. The ministry is an apex institution

regulations, useful to guiding the use of WoredaNet ICT infrastructure. As discussed above, the WoredaNet is organized in such a way that it consists of: one National Data Centre (NDC) (the coordinating centre) located at Addis Ababa, nine data centres at regional levels (RDCs) located at their respective local capitals, and two federal level data centres (RDCs) located at Addis Ababa and Dire Dawa federal administration cities, as well as other organizational data centres (back office DCs) of government agencies and organizations also located at the tow federal states.

The Regional Data Centres (RDCs) are designed and implemented for regional government sectors at the capital of each region. Based on needs and requirements of regions, a local storage capacity of 2-300 Terra-Bytes (Stavros & Westberg)disk arrays at every Regional Data Centre and a tapes library of 10-240 TB at the National Data Centre are implemented.

All the data centres of regional and federal states, except three regional data centres (known by the names: Afar, Benihshangul Gumuz and Gambella) are in a network environment, connected to NDC via terrestrial fibre connectivity technology. All local Woreda (district) Centres including data centres of the three regions mentioned earlier, are connected to NDC using a satellite communication technology known as VSAT[5].

WoredaNet and Information and Communication Technology in Ethiopia

Based on the discussions presented in the previous sub-sections and sources of additional documents, Ethiopia has attempted to support various sectors such as the agricultural, health and education sectors with the application of e-government and modern ICTs, this is to create opportunities for transparency, accountability and good governance as well as to enable the delivery of e-services reach to remote residents. In order to achieve this, the Ethiopian government network serves as a fulfilment of customer-centric environment in which ICT is used to support government operations such as information sharing, for improving public service administration, transformation of governance, education, businesses and other operation. The government has also made various reforms so as to involve citizens as customers of electronic public services and to provide satisfactory service.

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which spearheads the ICT development of the nation by way of developing policy instruments, designing various programs, mobilising resources, guiding and monitoring ICT implementation. Consequently, the ministry's achievement will be measured primarily by the depth and breadth of ICT assisted life, it brings to Ethiopian citizens.

[5] VSAT (Very Small Aperture Terminal) is a satellite communications system that serves the WoredaNet sites which do not have fibre connectivity. A VSAT end user (sites) needs a box that interfaces between the site and an outside antenna with a transceiver. The transceiver receives or sends a signal to a satellite transponder in the sky. The satellite sends and receives signals from an earth station computer that acts as a hub for the system. It provide high speed, broadband satellite communications for Internet or private network communications on a global basis

Accordingly, the WoredaNet was implemented and it includes any interaction of local, state and federal government outside their domain using the Internet technology, and is intended to improve efficiency and effectiveness of all government operations. The WoredaNet and its ICT artefacts consists of: a controlling centre known as the National Data Centre (NDC), from which electronic services such as video conferencing, Internet, VOIP, messaging and cloud computing services are provided.

The Ethiopian National Data Centre (NDC) and its Structure

It is known that a data centre is typically used as a central hub of government network (or a data warehouse for the government's data and information), which is connected to all government ICT systems (PSO) that usually contain very sensitive information such as internal government correspondences, citizens' records, ownership data, and data of government budgets. This thesis defines the National Data Centre (NDC[6]), as a central location where modern information technology systems within WoredaNet are monitored, controlled and administered.

The National Data Centre (NDC) is the 'command post' and 'heart' of WoredaNet, where all electronic services are hosted and delivered to various sectors. In relation to WoredaNet, NDC is responsible for:

1 Centrally managing all WoredaNet sites;
2 Coordinating various activities of data centres of regional and federal administration sectors as well as activities of local Woreda Centres (ICT centres deployed in Districts/Woredas);
3 Optimising network traffic;
4 Securely storing data and objects to logical structures; and
5 Providing maintenance and training support.

NDC Structure: the National Data Centre (NDC) is the central controlling and administration point of WoredaNet system that is used to centrally manage, monitor and support the entire

[6] MCIT is structured with various departments and in Ethiopia such departments are known as 'directorates'. The e-government directorate is one of the directorates that coordinates all the government information systems development and has two major sectors organised for specific assignments: the National Data Centre (NDC) and the E-Service sector. The e-government administers the National Data Centre (NDC). The NDC is responsible for, hosting web applications to be shared to different organisations and branches of same organisations; domain name operation and administration; network administrations and operations including securing the government networks and applications. The video conferencing, network operations, security of the networks, directory services, internet services and hosting of applications are just some of the operations and services rendered from NDC.

WoredaNet infrastructure. It also coordinates all activities of data centres of the regional and district level administration sectors

The NDC is structured comprising of the following teams:

- Network Administration Team;
- System and Portal Administration Team;
- Information Technology Security Team;
- Video Conferencing Administration Team;
- Data centre Facility and Maintenance Team (Support Technician); and
- Business Continuity and Strategy Team.

The National Data Centre (NDC) and its ICT artefacts consist of: a controlling centre known as a Network Operation Centre (Prasad et al.) with a security management centre known as Security Operation Centres (SOC).

Network Operation Centre (NOC) & Security operation centre (SOC)

The National Data Centre (NDC) consists of a Network Operation Centre (NOC) and a Security Operation Centres (SOC). An Integrated Network Operations Centre (I-NOC) was established in 2009 for the purpose of round the clock monitoring of all WAN links between WoredaNet sites. The NOC is used for monitoring and management of ICT hardware equipment and software. The large plasma screen dynamically (real time monitoring) displays the status of network connectivity as well as the status of various ICT equipment, so that the staff can see out any failure of a system immediately. As an IT infrastructure solution, the NOC provides a central network management environment to deploy business-critical solutions, and supports various security solutions. The NOCs and SOCs are critical ICT nerve centres of public and private enterprises throughout the world. Historically, NOCs and SOCs functioned as separate entities with different missions (EICTDA, 2008).

While, the purpose of a NOC has always been to ensure "power, ping, and pipe" to computing resources and is critically measured on uptime Service Level Agreements (SLAs), conversely, the purpose of a SOC has been to "protect, detect, react, and recover" and is critically measured in response time SLAs. Combining, operations of the NOC and SOC, serves as an immune and central nervous system, to ensuring availability and integrity of ICT assets.

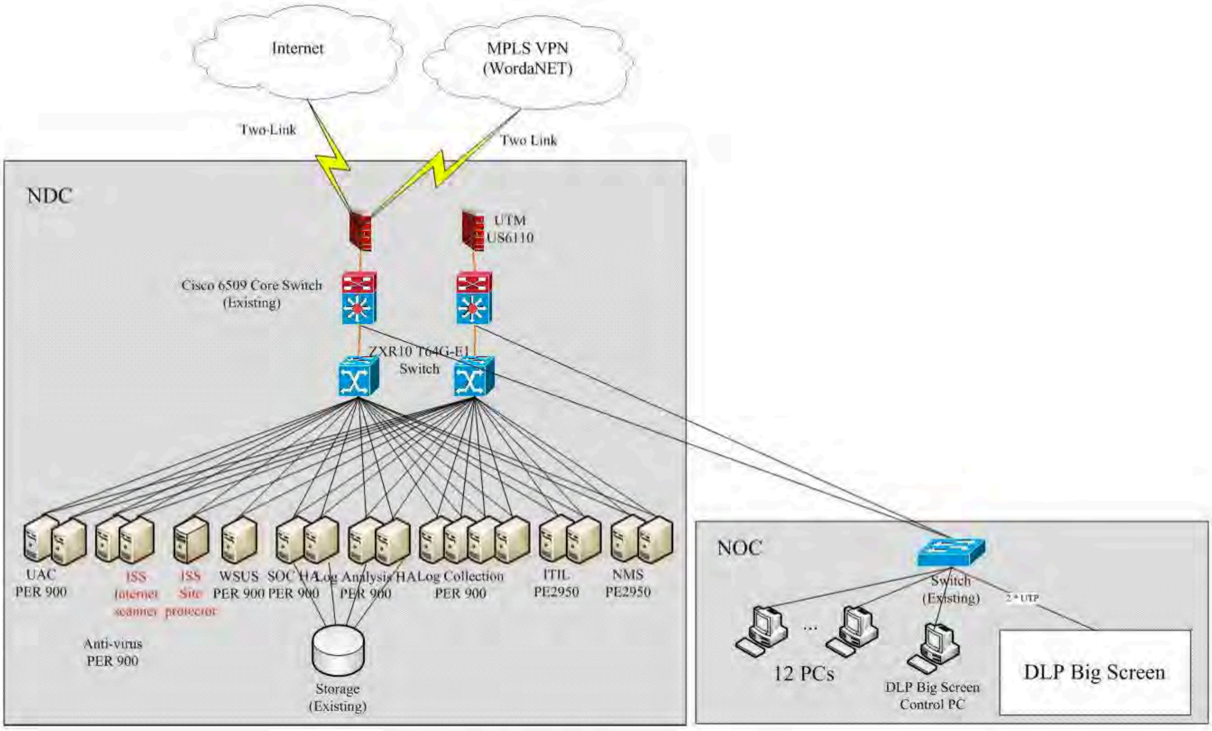

Figure 0-1: NOC and SOC in NDC

The NOCs and SOCs share similar operational structures in the NDC, with staff who are assigned roles at three-tiers (Tier 1 staff, Tier 2 staff and Tier 3 staff). The backbone of Tier 1[7] is composed of employees that include service desk team; monitoring and incident management team; and response team. Here, junior analysts are responsible for work orders using service support of Information Technology Infrastructure Library (ITIL). Other activities of analysts at Tier 1 include: real time monitoring of security devices by using a system known as Network Management System (NMS), call handling, and initial identification and triage of detected and reported events. Events which cannot be addressed by staff members of Tier 1 are escalated into senior analysts appointed as Tier 2 staff, for more detailed review and resolution (Tier 2 includes: problem management, change management and configuration management teams). Tier 3 is composed of subject matter experts who serve as the final escalation point of most complex issues that could not be resolved by Tier 2 members.

[7] The NDC has an ICT controlling centre known as NOC with IT staff organised as three tiers. Tier 1: Refers to first level IT Junior analysts who are responsible to initially respond to customer requests; Tier 2: Refers to second level IT analysts who are responsible to respond to customer requests that are beyond the capabilities of the first level IT Junior analysts; Tier 3: Refers to the highest level subject matter experts in NDC who are responsible to respond to customer requests that are beyond the capabilities of the second level IT analysts.

Backup Data Centre Project

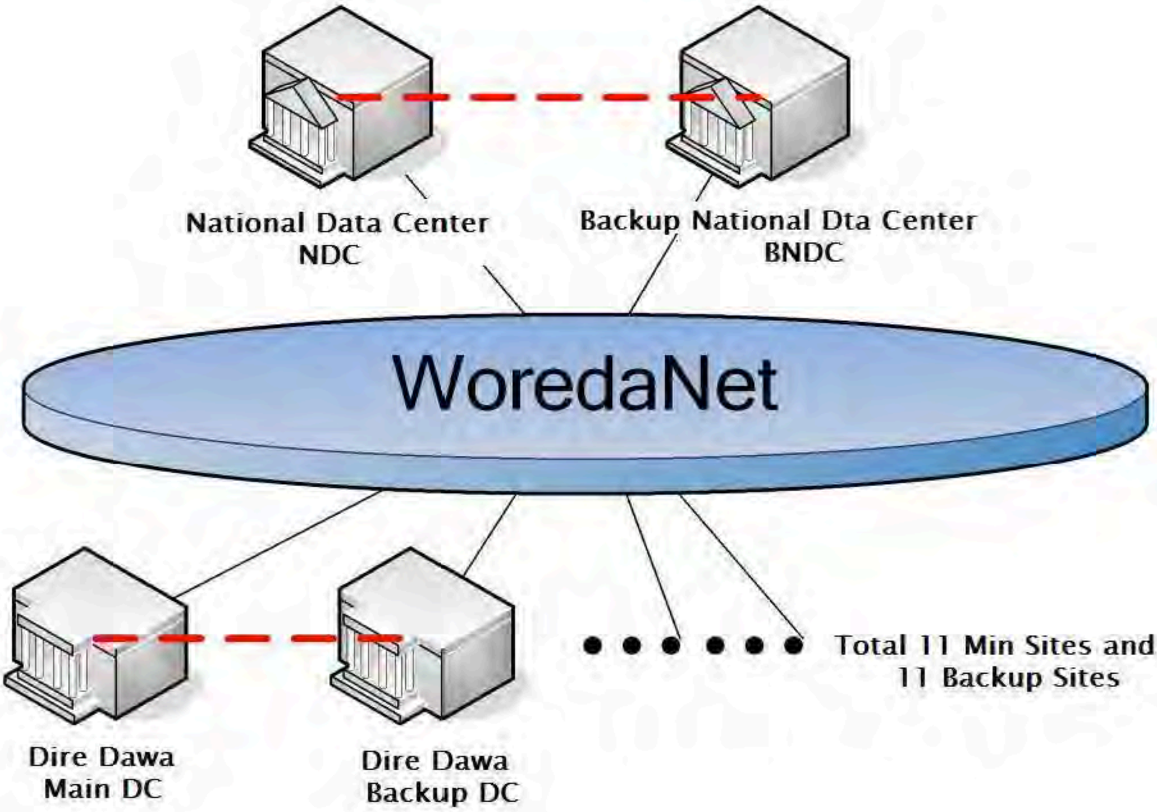

Figure 0-2: WoredaNet Main DCs and Backup DCs

For the purpose of disaster recovery, the WoredaNet is implementing backup data centres for all regional data centres as well as the national data centre. A project known as WoredaNet Backup data centre project is a current project for the purpose of implementing a Backup Data Centre (BDC) at a distance of five kilometres away from the location of each of the main regional data centre (Nieuwenhuisa *et al.*). Currently, disaster recovery sites for twelve data centres are already built and nine of them started delivering their intended services. The twelve recovery sites include one Back up National Data centre (1 BNDC), and eleven back up Regional Data centres (11 BRDCs) (MOIT, 2010).

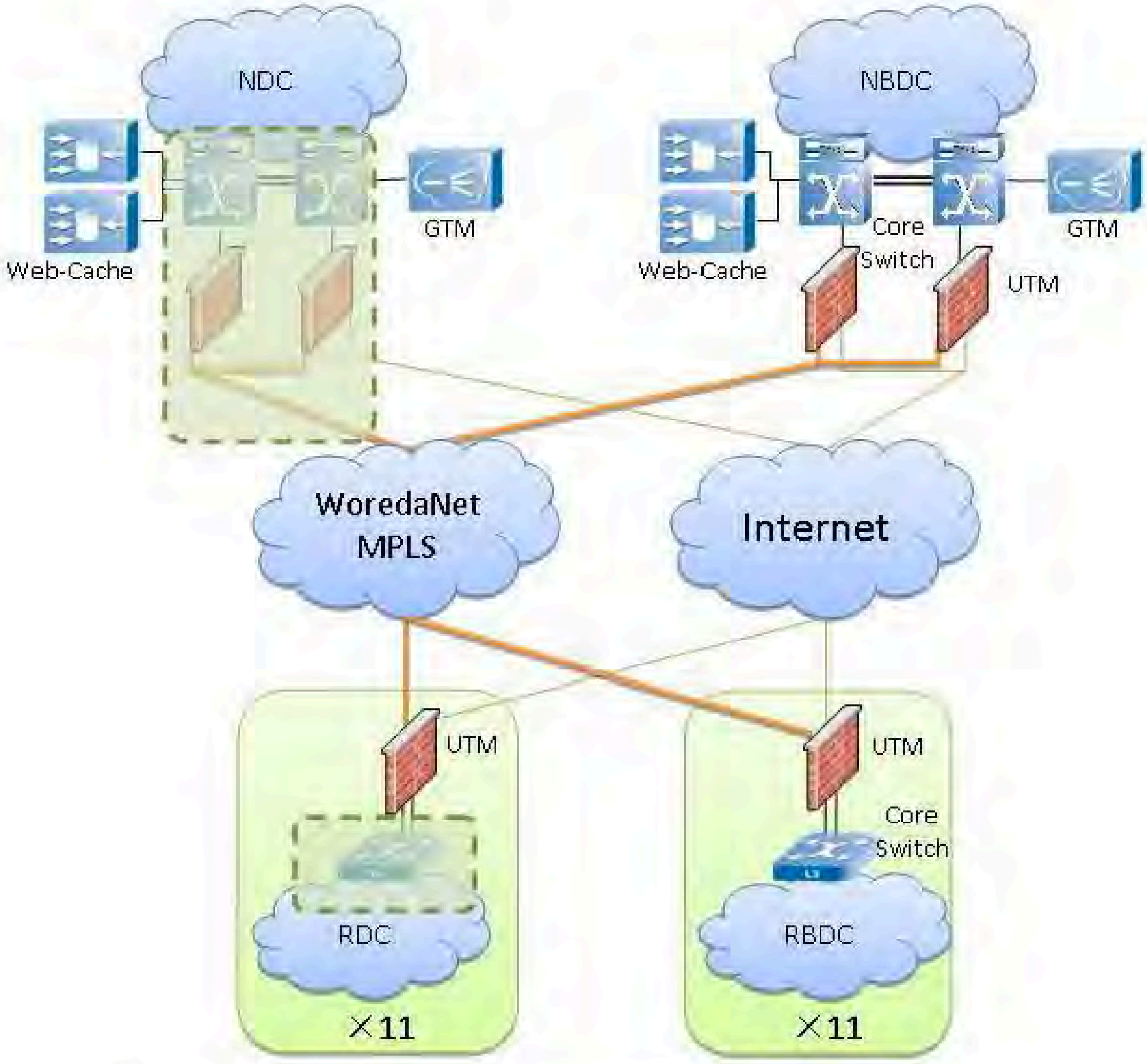

Figure 0-3: WAN Connectivity of Main DCs and Backup DCs

Applications and data found in every data centre are replicated to a repository of a respective backup data centre. Each disaster recovery centre is located in a different seismic zone and serves as a disaster recovery solution to databases residing at the respective primary data centre of that particular region. In events of any disaster, the primary data centre can be re-established in a short period by recovering data from its disaster recovery site. This minimizes loss of critical data with reduced time required to recover the data.

Milestones of the WoredaNet

WoredaNet with its National Data Centre hosts over 120 websites and web portals of different government agencies and ministries. It provides citizens access to a single-window service

Woreda/district sector situated all over the country and also by implementing a new Data Centre at the National level. Until this plan is accomplished, the local Woreda Centres, RDCs, organizational data centres (for back office purpose) including the NDC stay operational in providing the above mentioned shared services (see Section 4.7.7) including the Internet and E-mail services.

The Internet/ web browsing and E-mail services have been delivered for the past decade and continue to be delivered by the NDC via the local Woreda Centres, RDCs, and Organizational DCs and accessed by government officials and citizens. Through these services exchanges of document and information has become an important advantage of information flow for information transactions which requires faster transmission speed, this is because document and information exchange is faster through e-mail, as e-mail attachments can be transmitted as different types of documents.

Various Government offices which lack such facilities may easily implement the document exchange systems within the DCs of ICT agencies and bureaus of federal and regional government administrative sectors using WoredaNet e-mail system. To enable various civil service administrative bureaus and sector organizations to implement document exchange system, majority of the preliminary conditions are already set up. Few preliminary conditions are also in progress including policy making, preparation of standards, rules and regulations for ICT related activities including issues related to hardware and application software that can be used for basic and regular jobs such as accounting, finance and budget, personnel and administration jobs, archives, and statistical information.

In addition, the existing technology offers possible opportunities that various types of software which are currently in use can be used with little customization in the future. One more advantage can be mentioned here is knowledge and skill development, for example the ICT and other professionals found in federal, regional, zone and Woreda/district sectors, can develop their skills by using the Internet/Web browsing service of WoredaNet systems.

Video Conference (VC) Service and its Uses

The video conferencing service first commenced in 2004 connecting around 500 sites located all around the country and these days the connectivity includes more than 2000 sites from different locations. This WoredaNet video conferencing service is used to reduce distance, time, and travel cost and to enhance the value of face-to-face meetings using Internet Protocol

(IP) and Video Conferencing (VC) technology, as tools of conducting work activities such as meetings, distance education, and judicial services (e-justice).

Meetings: ly one of the main purposes of the video conferencing WoredaNet service is to improve understandings of various issues that can be raised between policy makers and policy which usually requires meetings and discussions among concerned participants. For the purpose of such discussions and meetings, the conventional way of gathering participants (people including WoredaNet's employees) from different regional, zone (county) or Woreda (district) locations, to Addis Ababa[8] or any other main regional city, entails a great waste of time and resources. In this regard the Video conferencing significantly reduces time and labour intensive activities.

The NDC mainly organizes meetings, workshops, trainings which are required to be conducted by various government sectors. It makes sure that the technology is ready and organizes perquisites for the sites in which participants become available. The connectivity and communication among the sites which host the participants for a particular session of the video conferencing service can be:

- One Government office to another Government office in the capital;
- Addis Ababa to regional government office;
- The Capital to Woreda/district government office;
- Regional to regional government office (Inter-region Video conferencing);
- Regional government office to Woreda/district government office; and
- The country to the outside world (International Video conferencing). The purposes include: meetings, workshops, short term trainings and knowledge sharing, technical purposes such as technical support and general information sharing.

Distance Education: by coordinating two ministries known as the Ministry of Education and the ministry of communication and information technology (MCIT), the Ethiopian government has made quite a lot of efforts to improve the country's educational policy and practices. The efforts are made to support educational practices such as support for distance education with technology particularly the video conferencing technology as enhancing tool of teaching and

[8] Addis Ababa literally, meaning "new flower", officially is the capital and largest city of Ethiopia. It is the country's commercial and cultural hub, populated with more than 3 million people (according to the 2007 population census of Ethiopia) from different regions of Ethiopia.

learning activities as well as implementing supportive libraries for educational practices. The government has thus focused on the application of the video conferencing technology for educational practices (distance education) which helps to deliver lessons to different institutions found in remote regions without the requirement of the lecturer's physical presence. One way of conducting distance education can be via the application of a video conferencing system. It is known that, the Internet service these days enables connections from any parts of the world; this has also provided Ethiopia the opportunity of creating connection from any parts of the country. With such opportunity on the ground the country applied the video conferencing technology to be used as one of the enhancing ways of teaching students. This has become one way of supporting and enhancing the education system within the country via the application of the video conferencing system for distance education.

In order to materialize this, a project with two phases, was initiated (between the years 2009 and 2010) by the Government of Ethiopia; and nine universities, become users of the video conferencing technology as well as the library technologies in the first phase of this project. The second phase aims to include all other universities that were not included in the first phase of the project. In addition to the enhancement of distance education in the country as supported with video conferencing technology, some efforts are also made to widen the communications which initially included only internal institutions, to further include universities and learning institutions from other countries, the ministry of education for example has made some useful agreements with universities of other countries including: India, South Africa, UK, and other countries.

Moreover, the Ethiopian government provides distance education programs also for judicial court services with the aim to deliver education to the level of diploma in law fields. Seven distance education centres (constituting of law institutes) are open to enhance distance learning of the field of law with video conferencing infrastructure. Challenges such as classroom inaccessibility and travel constraints, could limit the reach of learning; in response with video conferencing solutions, for law education, the government has extended learning, live or on demand, to homebound students and remote campuses.

On the other hand, it does not to mean that all programs of distance education in Ethiopia are supported with video conferencing technology. Rather, distance education is also carried out without the involvement of the video conferencing technology. For example, two different types of locations (residents of participants) can be referred to discuss the process of distance education in which the programs are conducted without the involvement of the video conferencing technology. One refers to places which have privileges of access to the Internet service and the other refers to places which do not have access to the Internet service.

While in the places where the participants of the distance education have access to the Internet service and knowledge of using the technology, the delivery of the education materials is using FTP or E-mail service via the Internet; on the other hand in the places where participants do not have the Internet access, the delivery of education materials regarding distance education is via post offices and the distributed materials are in formats of printed hard copies of lessons.

'E-trial'/ E-Justice: another e-Government sector within the Ethiopia context which is supported by the video conferencing technology is the judicial court services where the system is known as 'E-trial' or 'E-Justice'. The 'E-trial' is an electronic system for legal services conducted through video conferencing and applied to avoid problems of hazardous travel in reaching judicial court centres that could be faced by people living in very remote areas. Economically weaker parts of the society including very poor farmers and their family members, particularly live very far away from places where court centres are situated. These people face transportation and other problems of reaching court centres in order to obtain legal services; for example, poor families spend their money for transportation and other costs; they also lose their valuable time and power to reach court centres, this is because the court centres are usually located in cities of regional or zone level administration sectors.

Even though, the cost of using 'e-trial' system is also very high, in addition to the capability of 'e-trial' system in creating very high confidence (confidence of society on justice system) on existing justice system, it is important to see how part of the society could save money, time and manpower that could be spent for obtaining various legal services. The video conferencing can allow any person who has a case or an interest in court proceedings to be involved in a hearing from a remote location.

Due to these circumstances, there has been an increasing effort to improve access to legal services with the help of a video conferencing technology. In order to perform a wide range of judicial activities and to settle legal disputes, video conferencing equipment is made widely available in courtrooms of several court centres. By now, a system known as e-justice is already implemented and becomes functional in federal and regional states of the country.

The e-justice electronic system can be recognized as one of the useful advantages of technology artefacts within the sector, for example using one of the e-justice system known as e-filing, a person at a remote location can give his/her evidence via a video link to the court with the help of a plasma screen (a kind of TV screen) and camera found in the courtroom. One can also dial 992 and connect to a system known as an interactive voice response (IVR[9]) to access any legal service including his own legal cases and know the status of his judicial cases. Through the WoredaNet and under the control of the Supreme Court, the service is now available in 13 case stations located in Addis Ababa (EICTDA, 2009).

Achievements of the WoredaNet

The WoredaNet leverages ICT almost all over the country with the aim to provide a robust communication backbone and effective support for various e-government aspects to federal, regional, district and other government sectors. As already discussed in the previous sections, the WoredaNet has some useful achievements in offering a wide range of electronic services including the video conferencing service, web-hosting service, and a nationwide communication network with gateway nodes of more than 2000 sites.

In addition, the WoredaNet has also recorded a number of useful achievements regarding various aspects related to government and citizens of the country, just to mention some:

- It plays a pivotal role in the decentralized planning;
- It plays a pivotal role in improvement of government services;
- It plays a pivotal role in realization of wider transparency among the national and local governments;
- It plays a pivotal role in improvement of accountability among the national and local governments to the people; and
- It assists the local governments endeavour to reach people in remote areas.

WoredaNet Challenges as Possible Challenges from Resource-Constrained Environments

In order to better describe the previous and current challenges within the Ethiopian government network (WoredaNet), this thesis sourced its information from the grey literature as discussed earlier (See Section 5.7).

[9]Ethiopia's IVR legal services is an automated telephony system that interacts with callers, gathers information and routes calls to the court recipient system. It is a technology in which someone uses his mobile phone to interact with the court database to acquire information from or enter data into the database. The court centers can receive up-to-date account information instantly and easily without having to speak directly to a person.

During the past few decades, the rapid advancement of communication technologies, such as the Internet has created various opportunities all around the world including Ethiopia, with such opportunities of technologies, the Ethiopian government like any other developing economies; made efforts to reach its remote sectors to improve the lives of underprivileged citizens (Atnafu, 2015; Belachew, 2010). Unfortunately, the current communication technologies have also brought various challenges to the government as citizens are now become more aware of situations around the world.

It is undeniable that these circumstances have become one of the initiating factors for the current growing citizens' need for access to effective and efficient service. The current growing citizens need also includes the requirement for a wide range of services that can be accessed in a secured manner. The need for more secured mechanism of storage and access for their personal data and information is growing much; they also want an easier and simpler access to a variety of government services as well as access to timely and reliable information.

As a result, this situation has led to the requirement of a variety of e-Government services in which the need for some variety systems such as a centralized citizen authentication system, shared document accessible by government institutions and private companies (banks, insurances, mobile operators, and healthcare) is increasing from time to time. This has continued to be some of the major challenging factors of the developing economies including Ethiopia in terms of delivery of government services and information delivery to citizens.

Apparently, apart from some useful achievements discussed in the previous sub-section, as the deployment and use of ICTs within the WoredaNet and application of e-Governance in Ethiopia could not be different from any other IS settings, it could certainly not be without any limitation. Like any other technological aspects, the implementation and use of ICT in e-Government, application of e-Governance as well as service delivery within the WoredaNet could have faced challenges and constraining barriers.

For example, due to a number of challenges within the existing WoredaNet setting, there has been a considerable concern about the nature of service delivery of PSOs, in terms of efficiency and effectiveness. Though the WoredaNet has registered some useful achievements in delivering some selected services (Video conferencing, Internet, Web hosting, e-mail), in terms of the growing needs of citizens, it cannot be said that tangible changes have been made on existing service delivery of PSOs that can improve efficiency and effectiveness of the sector and to achieve good governance, productivity, development and realize transparency, accountability and good governance as well as ensuring improved citizen participation with the government in the country.

Moreover, addressing the fast growing requirements of citizens certainly requires continuous optimization and upgrading of existing ICT infrastructure as well as the application of better and more modernized information and communication technology artefacts whereas the process of upgrading, modernization of existing systems or adoption and implementation of new systems could face challenges as discussed previously.

Hence, according to this thesis the challenges that WoredaNet is facing and restricting the effectiveness and efficiency of delivery of services as required by citizens include:

- Minimum utilization of existing ICT resources including the various data centres from where electronic service are delivered;
- Lack of continuous upgrade and modernization of existing stationary data centres, lack of integration on existing stationary data centres;
- Lack of improvement of computing hardware within the data centres; and
- Lack of continuous maintenance and upgrade of artefacts related to electric power systems.

When we talk about traditional/stationary nature of data centres like the ones existing within the WoredaNet, the process of purchasing ICT infrastructure and cost of data centres setup, including cost of maintenance and administration purposes, requires the process of a substantial amount of financial and manpower resources because of their stationary nature.

On the other hand, being aware of these challenges various government PSOs, departments and agencies are currently dreaming to deliver effective and efficient e-Government services through the benefits and opportunities of current technologies such as the cloud computing technology. This has also to individualism in adoption and deployment and use of technology artefacts including silos of application software and service deployment.

As a result, the traditional nature of the distributed chimney type data centres that are already built by the government which has become incapable of carrying the burden and the current deployment of silos of applications and DCs implemented by different agencies individually, is becoming fragmented with a considerable loss of unnecessary cost which can be considered as resource-constrained environments (low commuting efficiency, non-reliable electric power source for processing cooling, non-reliable disaster recovery, lack of interoperability and integration and limited capacity of central storage).

This is because the government and its PSOs, departments and agencies cannot use the existing DCs directly due to that, delivering effective and efficient e-Government services may include transactions of large files and central repository of big-data which may not be tolerable in such types of DCs and ICT infrastructure.

Hence, though the government of Ethiopia is continuously making efforts of centralizing its computing assets with the aim to lowering the current challenging cost of financial and manpower constraints, the problem still remained as one challenging factor forcing the government to still make huge amount of un-necessary cost due to the fragment deployment of applications and ICT infrastructure including by various departments and agencies.

Another reason for such an un-necessary cost for the ICT artefacts may also be due to lack of rules and regulations which could have enforce and guide the strategies to be followed by all government sectors. While the government attempts to enhance effectiveness and efficiency of service delivery and to increase the number and variety of electronic services delivered to citizens, due to lack of such enforcing laws some evidences show that a trend of buying additional hardware infrastructure is experienced widely by different agencies and departments whenever new services are supposed to be included as the infrastructure definitely requires huge investment cost from the government budget, including the cost of administration and maintenance of newly included artefacts.

The challenges may also include other constraints that can be related to peoples' capabilities both economically and knowledge base. According to Salerno, Ouma and Botha (2015), in resource-constrained environments people usually cannot afford to buy ICT devices of their own, such as mobile, desktop or laptop devices, resource-constrained environments usually lack data network coverage infrastructure such as broadband ADSL or fibre and cellular data, resource-constrained environments people usually lack the ICT skill required to operate these technologies, people living within resource-constrained environments have a lower level of maintenance skill (social challenge).

All the challenges discussed above are considered by this thesis as constraints that could be posed by a RCE.

APPENDIX F: APPLICABLE ARTICLES AFTER SCOPING REVIEW ON CLOUD COMPUTING COMPONENTS (CHAPTER 3)

The table below: presents study focus, objective of the research, research question and/or problem, and basic concepts discussed by the literature, as well as frameworks and models applied within the 63 full-text articles that are included, based on the eligibility criteria set of this study.

The 63 full-text studies included in qualitative analysis

#	Study	Focus	Purpose/ Aims / Objective	Research question/problem	Basic concepts	Frameworks / Models
1	(Al-Ruithe *et al.*, 2018:2-5)	Data governance Data management within cloud computing	To provide a holistic view of data governance for both cloud and non-cloud computing, using a taxonomy approach	What is the main factor that requires the development of data governance for non-cloud and cloud computing?	Data governance, ubiquitous, convenient, on-demand network access; shared pool of configurable computing resources	Data governance model of roles and responsibilities Deployment models: public, private, community, hybrid Service models: SaaS, IaaS, PaaS A strategic framework for data governance; cloud governance considered as the intersection of IT governance and data governance
2	(Harmon, 2018:29-45)	Cloud security strategies	To explore strategies used by cloud security managers to implement secure access methods to protect data on cloud infrastructure	Hackers have created security concerns for users that incorporate cloud computing in their everyday functions	Cloud Strategies, Cloud Security Secure Access	Deployment models: public, private, Three service layers: IaaS, PaaS, and SaaS Technology acceptance model
3	(Campeanu, 2018)	On the challenge that comes with IoT and the CC as a solution	Regarding the usage of micro service providers, and overview of the current state-of-the-art and state-of-practice architectures by IoT and cloud computing	RQ1: How many publications per year are found in the research area? RQ2: What are the main venues for the publications of the research area? RQ3: Which are the main publication types in the research area?	Concepts such as storage, processing power, analytics instruments, and monitoring are mentioned as solutions for IoT challenges	Platform-as-a-Service Software-as-a-Service
4	(Younas *et al.*, 2018)	Agile software development and cloud	Identifies the techniques employed in the cloud computing environment that are useful for agile development	What is the impact of cloud computing on agile software development?	Data sharing, distributed application, prioritizing	Five essential components, three service and four deployment models: PaaS, SaaS and IaaS private, public, hybrid, and community

5	(Senyo *et al.*, 2018)	Meta-analysis of cloud computing research in information systems	Taking stock of literature and their associated research frameworks, research methodology, geographical distribution, and level of analysis, as well as trends of these studies over a period of seven years	-	Grid, parallel, and distributed systems, virtualization, multi-core chips, and Internet technologies on-demand self-service, broad network access, resource pooling, rapid elasticity, and measured service	PaaS, SaaS and IaaS Public, private, hybrid and community clouds
6	(Nieuwenhuisa *et al.*, 2018)	The value network of enterprise software solutions changes as a consequence of shifting from on-premise to Cloud-based technology	To analyse the changing value network of the enterprise software industry through Cloud computing.		The National Institute of Standards and Technology (Bannister and Connolly) defines ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources	PaaS, SaaS, and IaaS Public, private, hybrid, and on premise
7	(Abdel-Basset *et al.*, 2018)	Evaluating cloud services providers	To solve the performance estimation problem and improve the quality of services by creating a strong competition between cloud providers		On-demand, scalability, computing services, pay-as-you-go	Three delivery models: PaaS, SaaS, and IaaS Deployment models: Public, private, community, hybrid, and virtual private
8	(Liu *et al.*, 2018)	On reliable resource supply scheme for cloud service			Virtual technology, QoS and performance, dynamic composite services	None
9	(Mouradian *et al.*, 2017)	Cover both the architectures and the algorithms that make fog systems	To present a comprehensive survey on fog computing	-	Scalability, on-demand resource allocation, reduced management efforts, pay-as-you-go, easy applications and services provisioning [p.416]	Three service models: SaaS, PaaS, IaaS The fundamental limitation of the CC as the connectivity between the cloud and end-devices. P.416] Computing, storage, and networking services are mentioned as building blocks of the cloud and the fog. [p.416]

10	(Alruwaili & Gulliver, 2018)	On evaluating migration readiness and selecting an appropriate vendor with a case study involving the Saudi Arabian central bank	-	-	Based on NIST, offered five essential characteristics: on-demand, scalability, computing services, pay-as-you-go; Virtual Machine (VM)	Service models: PaaS, SaaS, and IaaS Deployment models: public, private, community, and hybrid:
11	(Hudic *et al.*, 2017:723-724)	Security assessments of cloud computing	To evaluate the security of services that are deployed in the cloud	Difficulty in evaluating security of services that are deployed in cloud computing Security as the most widely-considered areas of cloud computing study	Security in hybrid clouds, Policy-driven security assessments, Security metrics	Cloud model public, private, hybrid Cloud services: IaaS, PaaS, and SaaS services Proposed: security assessment methodology in the cloud
12	(Deb, 2017a) ISSN: 22311963	Cloud computing concept Enterprise state-of-the-art of IT infrastructure	Purpose: to identify and establish the capabilities of cloud computing as an enterprise IT infrastructure. One of the path-breaking shifts that we saw in the recent past was instigated by cloud computing	Problem: the difficulty in an enterprise to manage huge IT infrastructure, as it requires a big investment as well as support roles such as database administrators, network administrators, security staff, teams for deployment	Capacity to scale up and down, Pay based on usage, Secure environment	Service models: IaaS, SaaS, PaaS; Deployment models: "all-in cloud based deployment" Hybrid Cloud solution for managing IT infrastructure: all of the information technology, hardware, software, networks, facilities
13	(Khan & Alam, 2017:416)	Cloud computing universities and other institutions	Review the growth of cloud computing, its benefits and problems, features of common cloud computing services	-	Virtualization; Five essential characteristics: on-demand self-service; broad network access; resource pooling; rapid elasticity; measured service	Three service models: SaaS, PaaS, IaaS; Four deployment models: public, private, hybrid cloud
14	(Bazi *et al.*, 2017)	Migration of the cloud	To use a meta-synthesis method for the first time for analysis and synthesis of previous published studies and suggests a	-	Based on NIST, offered: agility, flexibility, scalability, simple and secure accessibility from anywhere, increasing reliability, enhancing fault	Three delivery models: PaaS, SaaS, and IaaS Deployment models: Public, private, community, and hybrid

			comprehensive cloud migration framework.		tolerance and economic efficiency Main characteristics of cloud computing: on-demand self-service, broad network access, resource pooling, rapid elasticity, measured services and multi-tenancy	
15	(Alessandro *et al.*, 2017:997)	on critical security factors that influence the decision to adopt cloud computing by Saudi government agencies	Help KSA government organisations to identify the security factors which could potentially influence their adoption of cloud computing	What is an appropriate framework for security factors on the adoption of cloud computing in the Saudi government Context?	referring to NIST: ubiquitous, convenient, on-demand network access, shared pool of configurable computing resources	A framework was proposed for three categories, Social Factors category, Cloud Security Risks Category, and Perceived Cloud Security Benefits Three delivery models: PaaS, SaaS and IaaS Deployment models: Public, private, community, and hybrid
16	(Singh & Chatterjee, 2017)	the basic features of the cloud computing, security issues, threats and their solutions	To address security issues at different area in the cloud		Broad network access, rapid elasticity, measured services, on demand self-service and resource pooling	Three delivery models: PaaS, SaaS, and IaaS Deployment models: Public, private, community, and hybrid
17	(Shojaiemehr *et al.*, 2017)	Cloud computing service negotiation (CCSN)	Propose efficient CCSN models in future.	What are the negotiation issues for each type of cloud service? For example, which issues are important for SaaS provisioning?	Negotiation, interconnected computers, public or private networks	IaaS, PaaS, and SaaS
18	(Priyadarshinee *et al.*, 2017:341)	Motivators affecting cloud computing adoption services in the Indian private organizations	To develop a hybrid two-stage, structural equation model (SEM)		Referring to the NIST: on-demand self-service, broad network access, location independence, rapid elasticity, measured service, massive scaling, similarity, virtualization, robust computing, low cost	Three delivery models: PaaS, SaaS, and IaaS Deployment models: Public, private, community, and hybrid

					software, geographical dissemination, facility orientation, and progressive security.	
19	(Majhia *et al.*, 2016:778)	Issues related to cyber enterprise cloud	To discuss challenges and research directions for enterprise cloud and smart grid utilities	Security threats, incidents, and related challenges on cyber physical systems	Cyber-physical systems (CPS) Cyber computing Technologies: Cloud computing and Internet-of-things	Cloud models: public, private, State-of-the-art Enterprise Cloud, Smart Grid
20	(Ali *et al.*, 2016:310)	On factors that the regional municipal governments should consider in adopting cloud computing	"To confirm the factors to be considered for cloud computing adoption in Australian regional municipal government" [p.310]	"What arethe actual factors to be considered by Australian regional municipal governments when planning to adopt Cloud computing?" [p.310]	Accessible of service from anywhere at any time, shared pool of services, rapidly provisioned and released service, minimal management effort or service provider interaction	Three service models: SaaS, PaaS, IaaS Four deployment models: public, private, hybrid cloud Five essential characteristics: on-demand self-service; broad network access; resource pooling; rapid elasticity; measured service [p.310]
21	(Yongsiriwit *et al.*, 2016)	On Semantic Web technologies to unify the representation of cloud resources described by different standards	To enable *interoperability* between cloud resource description standards	Challenges such as *interoperability problem* in order to efficiently provide, supervise, and manage cloud resources	*Interoperability, Linked Cloud Resource*	Semantic framework for cloud resources is proposed to unify the representation of cloud resources
22	(dos Santos *et al.*, 2016) [pp. 86-87]	Risk-based access control in the cloud	To use Risk-based access control models	No enforcing mechanism for risk-based policies in the cloud	Risk-based access control in the cloud;	Public deployments risk-based access control model
23	(Singh *et al.*, 2016:203)	On security of cloud and factors that affect cloud computing	The aim is to achieve an efficient, secure, good privacy, trustworthy and cost effective cloud system [p.203]	-	Pay as you go model, virtualization, manageability, scalability, availability, ubiquitous, multitenant, elasticity, stability	Service delivery models: SaaS, PaaS, and IaaS Four deployment models: Public, private, community, and hybrid

24	(Al-Ruithe *et al*., 2016)	On developing effective data governance programs for the cloud paradigm [p.160]	Supposed to support cloud consumers who need to design data governance for cloud computing in their organisations by covering general procedures in designing data governance for the cloud computing services [p.1]	-	Based on NIST: resource pooling, rapid elasticity, measured services, broad network access, on demand self-service; on-demand self-service, broad network access, resource pooling, rapid elasticity and measured service [p.161]	Four deployment models: Public, private, community, and hybrid, Three service models: IaaS, PaaS, and SaaS [p.161]
25	(Johnston *et al*., 2016:1-4)	On issues in South Africa related to cloud computing	To provide insight into the business value of cloud computing using qualitative evidence extracted from an exploratory study [p.1]	Four RQs, including: RQ1: what does cloud computing mean to South African organizations? RQ2: what are the perceived benefits of cloud computing in South Africa?	Cloud computing requirements: elasticity, scalability, multi-tenancy, economics, abstraction, and broad network access; multi-tenancy [p.4]	Software as a Service (SaaS) implementations residing on a public cloud or as Infrastructure as a Service in a private cloud.
26	(Sharma *et al*., 2016:61)	on readiness to adopt cloud computing	to develop a new model by extending the Technology Acceptance Model with three external constructs namely computer self-efficacy, trust, and job opportunity [p.61]	-	pay-for-use, on-demand, network-based access; CC discussed as metered usage of an easily accessible and secure collection of remotely available information technology(IT) enabled resources and capabilities including network, servers, storage, applications and services [p.61]	Service models: PaaS, SaaS and IaaS [p.61]
27	(Khana & Al-Yasirib, 2016:485-488)	Security and privacy issues related to the cloud computing	-	-	The scalability and extensibility of distributed software architectures have led to the concept called Cloud computing, [p.485] Pool of resources, distributed and virtualized, [p.486]	Service delivery models: SaaS, PaaS, and IaaS.; SaaS security, PaaS security, IaaS security, [p.488]
28	(Mijumbi *et al*., 2015)	The state-of-the-art in NFV, Software Defined	To examine the state-of-the-art of NFV, identify and explore the relationship	Qualitative analysis	NFV, Virtual Machines (VMs), virtual link; Broad network access,	Service models: SaaS, PaaS, IaaS

		Networking (SDN), and cloud computing	between NFV and two closely related fields, SDN and cloud computing		Resource pooling, Rapid elasticity, Measured service as Essential Characteristics;	
29	(Bassett, 2015:39-57) [pp. 39-45 & 56-57]	Benefits of cloud computing risks and challenges of cloud computing	To determine benefits, risks, and challenges, viability for records management of cloud computing	Multi-tenancy system; Virtualised resources (hard and soft); Resources with utility properties (pay-per-use); Pooled resources; Virtual computing service; Available with an internet connection	Rapid, pooled resources; virtual computing services, access from any location, pay for use	Three layers of cloud computing services: SaaS, PaaS, IaaS Deployment models: Private, Public, Hybrid Community
30	(Mwansa, 2015:14-16) [pp. 14-16] Student number: 34208704	Cloud computing concept Development of a framework Adoption and use of cloud computing services in South Africa	- To investigate factors influencing migration - To investigate factors for adoption of cloud computing services; - To deliver guidelines of cloud computing services	Lack of a framework to adopt and use cloud computing services by SMMEs in SA	Resources as type of service; user-demand based; dynamically scalable,	Service types: PaaS, IaaS, SaaS Deployment models: private, public, community, hybrid cloud
31	(Mustafa *et al.*, 2015)	Cloud computing concept Green Cloud	To judge definition and form a rational basis for advancement	What is to transcend cloud computing and current networking paradigms	Virtualization, abstraction, parallel computing, grid computing, High Performance Computing (HPC)	Service model: IaaS, PaaS, SaaS Deployment models: public, private, community, hybrid cloud; proposed an architecture/framework for systems of the future. "Green Symbiotic Cloud (GSC)"
32	(Sabri, 2015)	Measuring success factors of cloud computing	To measure the components of success of Cloud computing in enterprises	-	Sharing resources, on-demand	A framework for the success components of the CC
33	(Almudarra & Qureshi, 2015)	Issues in	To explore design and implementation of a hybrid	-	Pay-as you-go; scalability and elasticity	Sha-Mo-Cloud, a hybrid cloud framework

		developing mobile cloud applications using agile software development methodologies	cloud environment to satisfy the requirements of a mobile cloud content management and sharing framework, preserving the privacy requirements; to study the various aspects of developing a mobile cloud application using extreme programming as an agile development methodology. Integrate usage of cloud technologies in software team development, integration and testing.			Service model: IaaS, PaaS, SaaS Deployment models: public, private, community, hybrid cloud
34	(Patel *et al.*, 2015)	On authentication, confidentiality, integrity, and privacy features to Cloud Service Providers and Cloud Users	PGP and Kerberos in cloud computing	Issues of data security users' privacy and access control in Cloud computing	Large-scale, distributed computing, abstracted, virtualized, dynamically-scalable, managed computing pool, on demand service	Service delivery models: SaaS, PaaS, IaaS Deployment models: Public, Private, Community, Hybrid Cloud
35	(Puthal *et al.*, 2015)	On challenges of cloud computing	To precise the current open challenges and issues of Cloud computing		Based on NIST, five essential characteristics are discussed: On-demand service, Broad network access, Rapid elasticity, Resource pooling, Measured service	Three delivery models: SaaS. PaaS, and IaaS Four deployment models: public, private, community, and hybrid
36	(Garrisona *et al.*, 2015:377-378)	On the effect of relational, managerial, and technical IT-based capabilities on cloud com-putting success [p.377]	-	(1) What is the distinct influence of relational, technical, and managerial IT capabilities on cloud implementation success? (2) How do the relationships in the model differ according to the cloud delivery structure that is chosen? [p.378]	Shared pool, on-demand, computing resources, dynamically configured, optimized resource utilization, ubiquitous, convenient access, pay-per-use	Three models: IaaS, SaaS, PaaS Delivery models: public cloud, private cloud, hybrid cloud
37	(Mbuba & Wang, 2014:115-117)	IT department human resource management	To examine how the adoption of SaaS may	Lack of research that studies the implications of SaaS models	No investment cost,	Cloud computing models: public and private

			change roles and tasks of IT workers		elasticity of computing resources, agility, metered as utility, resource pooling	Cloud service levels: SaaS, PaaS, IaaS, HaaS
38	(Kruger, 2014:13-16) UMI Number: 1554505	Cloud computing concept	To identify issues of cloud computing technologies To identify issues to solve abuse of cyber crime and attacks	Investigators are not able to acquire the physical drives that store the data; makes more difficult to both acquire and verify the integrity of data	On-demand self-service, broad network access, resource pooling, rapid elasticity, measured service	Service models: IaaS, PaaS, SaaS Deployment models: public, private, community, hybrid Cloud
39	(Mohlameane & Ruxwana, 2014) Vol. 5, No. 1, February 2014	Focuses on the creation of awareness of cloud computing, SMEs in South Africa	To investigate the awareness of cloud computing within SMEs in South Africa and to identify SMEs perceptions on cloud computing as an alternative ICT solution	Lack of knowledge and perceptions on cloud computing potentials and value	Convenient, on-demand network access, shared pool of configurable computing resources, rapid provision and release, minimal management	Service models: SaaS, PaaS, IaaS; Deployment models: private, public, hybrid, community cloud
40	(Shahzad, 2014)	Security challenges of cloud computing State-of-the-art	To provide a better understanding of the security challenges of cloud computing and identify approaches and solutions that have been proposed and adopted by the cloud service industry	Unresolved issues such as data security and privacy of information stored and processed In the cloud service provider's systems	Elasticity, pay-per-use, transfer of risk	Service models: SaaS, PaaS, IaaS Deployment models: public, private, hybrid cloud models
41	(Sun *et al.*, 2014)	Addressing challenges related to Cloud services on the Internet	Evaluate and compare current Cloud service publication platforms; provide information to service users on service selection techniques and the factors that are critical when choosing Cloud services that are suitable for adaptation to their business strategies.	-	Virtualization as the core enabling technology, distributed computers; on demand; service-level agreement ;dynamically allocate Cloud resources, pay-per-use	Service models: IaaS, SaaS, PaaS
42	(Mbuba & Wang, 2014:115)	Implications of SaaS adoption on	To examine how SaaS adoption may change IT workers' roles and tasks, and functions of the IT department	A need for research that examines the implications of SaaS adoption on functions of IT departments and on the associated	"Model for enabling ever-present, convenient, on-demand network access to a shared pool of configurable computing resources (such as	Four types of cloud service levels, that is, hardware as a Service (HaaS), Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and SaaS

				human resource management.	networks, servers, storage, applications, and services) that can be rapidly accessed and released with minimal service provider interaction" Utility model (Deb)	[p.115]
43	(Twum-Darko & Sibanyoni, 2014)	Role of cloud computing in small and medium enterprises in South Africa	To determine the readiness of SMEs to innovate their businesses using technology solutions such as cloud computing	Readiness of SMEs to innovate their businesses using technology solutions such as cloud computing		Service models: SaaS, PaaS, IaaS Deployment models: private, public, hybrid, community cloud
44	(Yadav *et al.*, 2014:1)	Cloud computing based on Artificial Intelligence in higher education	How Artificial Intelligence-based cloud computing in higher education will improve quality and ease the process of getting e-resources (software/hardware platform, storage etc.) [p.1]	-	Storing, sharing, and controlling data online in an efficient manner	Service delivery models: SaaS, PaaS, IaaS Deployment models: Public, Private, Hybrid Cloud
45	(Jing *et al.*, 2013) J Super comput (2013) 65:445–468 DOI 10.1007/s11227-011-0722-1	State-of-the-art techniques cloud computing Power saving in the IaaS	To provide a better understanding of the design challenges of energy management in the IaaS of a cloud computing system	Issues such as security, software frameworks, quality of service, standardization, and power consumption are challenging cloud computing; "Efficient energy management is one of the most challenging research issues"	On-demand computing resources, elastic scaling, no up-front capital and operational cost, pay-as-you-go business model	Core service: SaaS, PaaS, IaaS Deployment Models: public, private, hybrid cloud solutions for building green cloud computing
46	(Gunka *et al.*, 2013:36)	The migration of an existing application to a cloud based environment	To support the migration of legacy systems to the cloud based on a Service-Oriented Architecture with a set of model-driven engineering tools and methods [p.36]	-	Multi-cloud based infrastructure, redundancy, scalability, elasticity	SaaS, PaaS, IaaS [p.36]

47	(Youssef, 2012)	Cloud computing e-government, e-learning, Enterprise Resource Planning (ERP) Services and applications of cloud computing	Objective: to provide understandings on how customized, reliable, and cost-effective services can be obtained from cloud computing in a variety of applications	-	Flexibility and availability of computing resources; abstraction levels, cost minimization, dynamically utilized resources, on-demand	Service models discussed as service-Oriented Architecture: PaaS, IaaS, SaaS Deployment models: public, private, community, hybrid cloud No framework, but planned to propose a framework and a security model that address the security threats
48	(Ahmed *et al.*, 2012:203-204) ISSN (Online): 1694-0814	Focuses on cloud computing concept Most advanced research issues	To provide a better understanding of cloud computing	Existence of challenges in cloud computing that requires to be carefully addressed	No centralized location or organization that controls application, a Web browser and Internet connection accessibility "virtualization is not a prerequisite for cloud computing"	Location-based cloud computing: public, private Services based cloud computing: IaaS, PaaS, SaaS.
49	(Prasad & Atukuri, 2012)	Utilize the Cloud computing (CC) applications	To discuss how to utilize the Cloud Computing (CC) applications for effective functioning of E-Governance activities in India	-	Shared infrastructure	Service delivery models: SaaS, PaaS, IaaS Type of cloud Public/private/ community/ hybrid cloud
50	(Hailu, 2012:8-10)	Factors that influence an organization in their decisions about cloud computing	To evaluate reasons for adopting cloud computing to satisfy some or all of the computing needs of an organization [p.8]	Is a CIO/IT or other manager's decision to recommend cloud computing technology independent of his/her perception of its cost-effectiveness? [p.10]	Computing as a utility, providing computing as a service, savings on space, utilities, and maintenance staff	SaaS, IaaS, PaaS
51	(Zhao *et al.*, 2012)	Designing and building a scientific computing Cloud platform	A structured architecture to implement a scientific computing Cloud platform		Computing resources and storage space, virtualization technology,	SaaS, IaaS

					virtual machine (VM)	
52	NIST (Mell & Grance, 2011:2-3) NIST Special Publication 800-145	Cloud computing concept Guideline	To provide a baseline for discussion, from what is cloud computing to how to best use cloud computing	Is a guideline	Ubiquitous, on-demand access, shared pooled configurable resources, rapidly provisioned and releasable	IaaS, PaaS, SaaS Private, public, community, hybrid cloud No framework but guideline for cloud computing concept
53	(Bollineni & Neupane, 2011:14-17) SE – 371 79 Karlskrona Sweden	Cloud computing	To explore the limitations and find the opportunities and barriers between cloud computing and e-Health	RQ1. What is the current state of the art of cloud computing and the issues involved in the deployment of cloud computing? RQ2. What are the associates' concerns and factors regarding adoption of cloud computing in e-Health? RQ3. What is the future of cloud computing in e-Health?	On-demand self –service, Broad network access, Resource pooling, Rapid elasticity, Measured service	Service models: SaaS, PaaS, IaaS Deployment models: public, private, hybrid cloud
54	(Kundra, 2011)	A Cloud policy	To achieve the significant cost, agility, and innovation benefits of cloud computing as quickly as possible	What will the impact of cloud computing be? How can cloud computing deliver on its promise if it cannot overcome the challenges discussed above?	Shared infrastructure and economies of scale; measure and pay for only the IT resources consumed	Citing Wyld: service models: SaaS, PaaS, IaaS Deployment models: private, public, hybrid, community cloud
55	Armbrust (JoSEP *et al.*, 2010:1-52) vol. 53 no. 4	Cloud computing concept	To reduce confusion by clarifying terms, providing simple figures to quantify comparisons between of cloud and conventional computing, and identifying the top technical and non-	There is confusion about what cloud computing is and when it is useful	Applications delivered over the Internet “Low-level” Infrastructure A higher level “platform” “Grid computing” Pay-as-you-go Utility computing Surge computing	One service type: SaaS Deployment models: private, public cloud

			technical obstacles and opportunities of cloud computing		Hybrid cloud computing Virtualization Abstraction	
56	(Zhang *et al.*, 2010)	Cloud computing, state-of-the-art implementation	To delivera better understanding of the challenges of cloud computing design To identify useful research directions	Cloud computing technology is not well developed thus still has many issues to be addressed	Grid computing, utility computing, virtualization, automatic computing, convenience, on-demand network access, shared pool of configurable computing resources	Business model: consisting of cloud services: SaaS, PaaS, IaaS Cloud model: public, private, hybrid Virtual private cloud
57	(Ghosh & Arce, 2010) Roll no:09305052	Cloud computing India	-	Challenges of technological and social issues in cloud computing	Virtualization, utility computing model; distributed programming; on-demand, utility	Business Model: pay-as-you-go model, application model, security model. Service models: SaaS, IaaS, PaaS
58	(Wang *et al.*, 2010:137)	Enterprise cloud services; State-of-the-art of Cloud computing technologies. Definitions for the Cloud computing	Survey to provide state-of-the art of enterprise cloud service architectures and to discuss architectural requirements	"the lack of a lack of standard method for architecture, which can meet the requirements of an enterprise cloud computing"	On-demand, scalability, computing services, pay-as-you-go	Service delivery models: SaaS, PaaS, IaaS Deployment models: public, private, community, hybrid cloud enterprise cloud service architectures with layers: resource, platform, and application
59	The World Economic Forum ((WEF)) (Gordon *et al.*, 2010:1)	The impact benefits, potential use, users of cloud computing, and major concerns when buying cloud services	To develop a set of collaborative actions and identify policy and industry recommendations thatcould steer the healthy development of cloud computing [p.1]	What are cloud computing most important current and potential future benefits for industry, governments, and society? What might derail cloud computing progress? Are the overall benefits worth the risks? [p.1]	Scalability, lower upfront investment	
60	(Ross, 2010:ii)	On the factors influencing an	To evaluate the factors that influence an organization in their decision of whether to	Is a CIO/IT or other manager's decision to recommend cloud	Parallel and distributed resources, massive scalability,	SaaS IaaS PaaS

		organization in adopting CC	adopt cloud computing as part of their strategic information technology planning [p.ii]	computing technology independent of his/her perception of its cost-effectiveness?	abstract entity Service-Oriented Architecture distributed computing, virtualization, and grid computing	 Private cloud
61	(Abadi, 2009)	Limitations and opportunities of deploying data management issues on cloud computing platforms	DBMS designed for large scale data analysis tasks running on an Amazon-style offering	-	Pay-as-you-go, elasticity,	Database-as-a-service (DaaS)
62	(Wyld, 2009)	Cloud computing in Government		What will be the impact of cloud computing? How can cloud computing deliver on its promise if it cannot overcome the challenges discussed above?	Citing NIST: offered the five essential characteristics on-demand, scalable form, as additional network bandwidth, storage, and computation capacity can be added as needed, much as people simply use—and pay for—more (or less) electricity as their energy needs change	Citing NIST: service models: SaaS, PaaS, IaaS Deployment models: private, public, hybrid, community cloud
63	https://tech.slashdot.org/story/08/07/17/2117221/multiple-experts-try-defining-cloud-computing	Different definitions are provided by different authors				

APPENDIX G: APPLICABLE ARTICLES AFTER SCOPING REVIEW ON EGOVERNMENT SERVICES (CHAPTER 4)

Chapter 4: The 69 Full-text articles included and findings of the papers

#	Study	Title	Focus	Purpose/ Aims / Objective	Basic concept	Frameworks / Models	Other relevant issues raised
1	(Liu *et al.*, 2018:1-4)	A socio-technical analysis of China's cyber security policy: Towards delivering trusted e-Government services	Factors that affect user responses to e-Government portals China's cyber security law	Identifying the critical issues that users name as the determining factors in their decision to utilize e-Government services [p.2]	An appropriate framework for analysing socio-technical systems (STS)to evaluate Information and Communication Technology (ICT) policies [p.1]	E-Government portal comprised of technical and social systems with external influences such as laws, social norms, and technologies	Technical elements of e-Government systems—the network infrastructures, hardware, content servers, database management systems, applications, user interfaces [p.4]
2	(Verkijika & Wet, 2018:20-21)	A usability assessment of e-Government websites in Sub-Saharan Africa	e-Government websites' usability	To evaluate the usability of e-Government websites in SSA countries, and compare the usability outcomes against the overall e-Government development in these countries [p.21]	e-Government websites as the major platform for interaction between citizens and government [p.20]	-	Improving the administrative efficiency of public institutions, encouraging Democratic governance, and building trust between citizens/private sector and governments [p.20]
3	(Veeramootooa, Nunkoob & Dwivedic, 2018:1-2)	What determines success of an e-Government service? Validation of an integrative model of e-filing continuance usage	Factors influencing continuance usage intention of e-filing	To validate an integrated model of e-filing continuance usage [p.1]	e-Government service: e-filing	Information quality; system quality; and service quality as constructs of IS and e-Government service success model [p.2]	-
4	(Moreno, Martínez, Muguerza & Abascal, 2018)	Support resource based on standards for accessible e-Government transactional services	Accessibility criteria to be followed while designing and evaluating government transactional e-Service websites	A support resource, which includes the accessibility criteria to be followed while designing and evaluating government transactional e-	e-Government standards	-	Digital society

				Service websites that incorporate online forms in the process flow			
5	(Janita & Miranda, 2018)	Quality in e-Government services: a proposal of dimensions from the perspective of public sector employees	Quality of electronic services	To make a proposal on the dimensions or characteristics that a Government website must have if it is to be considered by its employees as high quality	e-government is based on Information and Communication Technologies G2B, G2C, G2E, G2G, high quality services	-	Quality of information, technical efficiency, privacy, and communication with the employee Stakeholders of e-government (citizens, companies, employees, other governments, etc.),
6	(Zamani, Choudrie, Umeoji & Adebola, 2017:647-655)	Implementing e-Government in Lagos State: Understanding the impact of cultural perceptions and working practices	Lagos State's e-government's initiative [p.649]	Understand the interplay between the implementation of a project for the provision of public e-services in a developing country and the working practices of the involved actors. [p.647]	Technological, cultural, political, and power aspects (regimes of control) and work practices to be understood [p.654]	ICTs as an integral part of e-government [p.655] ICTs allow citizens and businesses to interact with the government, the dissemination of information, and the support of commercial relationships with private sector organizations, openness, and transparency reducing corruption	ICTs can contribute towards increasing efficiencies, productivity,, and transparency
7	(Triyason, Tassanaviboon & Arpnikanondt, 2017:181)	Proceedings of the 9th International Conference on Management of Digital Eco Systems	Cloud Architecture for Thai Government Agency	To study and compare existing cloud architectures and services in terms of security, privacy, pricing, flexibility, reliability, and management [p.181]	Hybrid Community Cloud model for government agencies	Cloud computing as cutting-edge technology	Silo-based design is seen in IT infrastructure architecture of government agencies

8	(Sangki, 2017:2)	Vision of future e-Government via new e-Government maturity model: Based on Korea's e-Government practices	e-Government development model based on Korea's e-Government practices	To propose a new e-Government development model based on the paradigm shift in the smart society, to explain the changes at e-Government level and services, and diagnose the current status by applying Korea's e-government practices in a time-series based on the new development model from the comprehensive viewpoint, embracing both technological and social paradigms while overcoming fragmentary thinking and differences in views. [p.2]		Bureaucratic e-Government, information management e-Government, participatory e-Government, governance e-Government as types of e-Government	
9	(Alameri, Bostan & Akman, 2017:1236-1237)	Cloud computing fitness for e-Government implementation: Importance-Performance Analysis	How cloud computing fits into E-Government [p.1236]	To analyse the importance and performance of the factors that influence the fitness of cloud computing for e-Government implementation [p.1236]	Governance challenges as challenges of developing countries; poor literacy, poor education level, expense,	ICT in e-Government systems to increase efficiency in internal processes, and offer better services to citizens	Cloud computing may enhance the delivery of government services and their internal work activities Citing Hailu, discussed that the cost-effectiveness, reliability, organizational need, and security effectiveness of cloud computing were assessed in relation to the perspectives of IT experts (in developing states) on the utilization of cloud

							computing [p.1237]
10	(Lallmahomed, Lallmahomed & Lallmahomed, 2017:59-62)	Factors influencing the adoption of e-Government Services in Mauritius	Investigating the antecedents of e-Government adoption in a small island developing state	To address this gap as well. The UTAUT2 model is relatively new to the Information System field; it is currently being employed to investigate mobile government adoption in Saudi Arabia [p.59]	Trust in government, Trust in the Internet as negative effect on resistance to change performance, social influence and effort expectancy as positive effect on resistance to change [p.62]	Discusses that the adoption of e-Government services relies upon the belief that government agencies have the necessary resources to implement electronic services effectively and are capable of securing such systems [p.62]	The success of e-Government services depends on the adoption these services [p.59]
11	(Kurfalı, Arifoğlu, Tokdemir & Paçin, 2017:165-170)	Adoption of e-Government services in Turkey	Adoption of e-Government services in Turkey	To investigate underlying factors that play role in citizens' decision to use e-government services in Turkey [p.165]	Citizens' needs and expectations in terms of e-Government services; also discusses-Government development index scores. [p.170]	Discusses that despite its unique potential, e-government's success depends to a large extent on the number of citizens using it. [p.169]	Citizen trust is the main component of e-government adoption, with others being "perceived risk", "perceived behavioural control", "perceived usefulness", and "perceived ease of use"
12	(Kumar, Sachan & Mukherjee, 2017:299)	Qualitative approach to determine user experience of e-Government services	User experience of e-government services	To investigate how citizens experience e-Government services and how that experience influences their behaviour [p.299]	Concept of providing extensive access to government services electronically from devices such as computers, laptops, smart-phones and other handheld devices [p.299]	Technology mediation as characteristic of e-service with two inherent characteristics: e-service as information service, and e-service as self service [p.300] Unlike traditional services, e-Government services are not constrained by distance and opening hours, and are therefore delivered conveniently. Convenience is linked with customer control	E-Government (E-Gov1) services provide new opportunities to citizens by allowing them to use government services (paying electricity bill, e-filing, e-ticketing, get information about government policies & schemes etc.) anytime from anywhere, irrespective of geographical location, and releases citizens bound by government official hours. [p.299]

13	(Kenenissa & Cho, 2017)	Evaluating e-Government implementation in public service delivery	Stakeholders/customers trust, public service delivery and e-Government service, and factors affecting e-Government implementation.	To investigate e-government implementation in public service delivery, and to recommend good practices and procedures for successful e-Government implementation	ICT infrastructure, human capital, online service, and risks and barriers as factors that affect implementation of e-government; to improve operations such as access to information and services to public, citizen and public involvement, and the very process of governance	e-Government can be used to provide better services to citizens by public sector and government organizations; e-Government services two-way government-citizen communication	One of the important features of e-Government is that it can be used as a tool to improve and develop public policies; e-Government as a solution to bureaucracy and lack of accountability, reducing organizational layers, and in re-engineering business processes in public administration
14	(Jadi & Jie, 2017:138-139)	An implementation framework of business intelligence in E-Government systems for developing countries	On elements of an e-Government data warehouse implementation framework of business intelligence in Morocco's e-Government system. [p.138]	-	ICTs offer governments an effective resource to serve citizens and other stakeholders through e-government Elements of e-Government framework based on the different types of e-Government interactions: government-to-government (G2G), government-to-business G2B, and government-to-citizen (G2C)	Low levels of infrastructure and human capital, a lack of access to both ICT and education infrastructure in emerging countries remain at lower levels of e-Government development with seriousness of the digital divide [p.138]	Regarding the e-Government program in Morocco some of the main tasks and activities of government entities discussed include: formalize the vision and ambitions; define the strategy and action plan; ensure the allocation of means and resources; achieve inter-jurisdictional arbitrage; assess the achievements and redirect initiatives in trouble. [p.139]
15	(Hodijah, 2017:114-115)	Analysing enterprise architecture model for services-based e-Government towards good government governance	Enterprise architecture model for services-based e-Government	-	Discusses that success of E-Government requires enterprise architecture (EA) for the so -called Good Government Governance (GGG) [p.114]	E-Government is defined as a set of online application services to citizens, and good governance is defined as the reference to trusted services in guiding political and socio-economic relationships	Elements of e-Government success include: policy, institution, infrastructure, applications, planning; are related to elements of Good Government Governance (GGG), as: participation, fairness, accountability, transparency, efficiency, effectiveness; elements of stakeholders include:

							government, citizens, business, employee, other government [p.115]
16	(Hapsara, Imran & Turner, 2017:362-368)	Beyond organizational motives of e-government adoption: The case of e-Voting initiative in Indonesian villages	Local government's motives regarding e-Government adoption; several Indonesian villages	(1) Reflecting on the case of Indonesian e-voting initiative, to examine the local government's motives behind e-Government adoption; (2) to identify emerging themes that might have influenced the process of e-voting adoption in several Indonesian villages. [p.362]	Motive as the main underlying reason for initiating a particular information systems adoption; political interference; budget allocation by government	Motives behind e-voting adoption are classified as four clusters: performance, technological, strategic, and operational [p.368]	Technology adoption in public sector organizations are classified into four main themes: performance, technological, strategic, and operational [p.364]
17	(Gasovaa & Stofkovaa, 2017:2225-2227)	E-Government as a quality improvement tool for citizens' services	e-Government services, which are available for citizens of the Slovak republic	To introduce ICTI Business Model from the both perspectives: theoretical and practical. Theoretical [p.227]	E-Government ensures quality digital content development and dissemination of the broadband Internet [p.226] Mandatory provided information includes information on citizenship, civil registers, registration of companies, immigration, tax rates, tax returns etc.	ICTI Business Model ICTI e-Government Business Model consists of four separate models: Information, Communication, Transaction and Integration model	The information and communications technologies are now being used for communication and services provision in public administration due to the Internet [p.225] Based on UN e-Government ,is defined as "continuing duty of public administration to improve relationships between citizens and the public sector by providing cheap and efficient services, information and knowledge. Practical realisation of What can the public administration offer?"
18	(Gao & Lee, 2017:627-628)	E-Government services and social media adoption:	Relationship between different types of e-		Information services, transactional services, and policy services as	E-Government is defined as "the use of	Social media as new tools complement existing e-Government services;

		Experience of small local governments in Nebraska state	Government service and social media adoption by small local governments		types of online services; and Face book, Twitter as social media adoption	information and communication technologies (ICTs) for a better government or to improve the quality of its services, especially through the use of the Internet and Web technologies". Government is the main technology adopter, content contributor, and system manager [p.628]	security, privacy, records management, employee use/abuse, and time free for staff constrain active use of social media in local governments [p.627]
19	(Das, Singh & Joseph, 2017:415-418)	A longitudinal study of e-Government maturity	Maturity of e-Government	To measure and explain e-Government maturity as demonstrated behaviour, in contrast to other measures that assess the potential of a country to enact e-Government [p.416]	E-Government can be conceptualized as the application of the general purpose technology (World Wide Web (web servers and browser clients communicating over the HTTP protocol)) to the specific domain of government. [p.415] The online presence of governments is realized through the features implemented in e-Government web sites such as free access to online publications, access to databases, and a variety of online services (free and paid)	Conceptual model with: GDP, ICT infrastructure, human capital and governance as elements of e-Government maturity [p.418]	Changing levels of affluence, information communication technology (ICT) infrastructure, human capital, and governance may influence the maturity of e-Government [p.415] e-Government as hard to be theorized [p.415] A country's income (gross domestic product (GDP)), the munificence of its macroeconomic environment, the quality of its information communication technology (ICT) infrastructure, the level of trust in the society, and the quality of its public institutions and civic life as factors of e-Government
20	(Cortés-Cediel, Cantador & Gil, 2017)	Recommender systems for e-governance in smart cities: State of the	The state of the art in recommender systems for the e-governance domain	To apply recommendation solutions in e-governance	e-Government as the use of information and communication technologies in the public sector with the aim of	G2C, G2B, G2E and G2G services as components of the state of the art of	E-governance has been defined as the application of ICT in the interactions of government with citizens and businesses –e.g., delivery of

		art and research opportunities			improving information and service delivery, reinforcing government transparency, accountability and credibility, and encouraging citizen participation in decision-making processes	recommender systems in e-governance	services, exchange of information, communication, and transactions–, and in internal government operations, aiming to simplify and improve democratic, business and governmental aspects of governance
21	(Alkhwaldi, Kamala & Qahwaji, 2017:300)	From E-Government to cloud-government: Challenges of Jordanian Citizens' acceptance for public Services	Cloud technologies for governments	Empirical investigation into the impact of these challenges on the acceptance and security of cloud computing applications in the public sector	Cloud technology, perceived as one of the most promising information technologies today, has a number of inherent distinguishing characteristics, including broad network access, pooled resources, on-demand self-service, rapid elasticity, and measured service	Cloud technology is adopted as a novel delivery channel for public services; it can contribute to significant improvements in the performance of government sectors, also creating novel public services worldwide. Around the world, governments have begun to deliver their services depending on cloud computing applications and platforms to develop service quality, reduce costs, and realize efficiency	Countries are using cloud computing for enhanced standardization of IT resources, cost reduction, and more efficient public services Benefits of cloud technologies to deliver public services: dynamic scalability, security management distributed storage, accountability, and green IT. Risks associated with cloud-based e-Government services: availability, infrastructure, and security [p.300]
22	(Alessandro *et al.*, 2017:79-80) (Alessandro *et al.*, 2017:79-80)	E-Government and cloud: Security Implementation for services	Challenges for security and trust	Developing a security framework to ensure a centralized access control system that provides authentication and authorization functions to a wide range of Web applications and services, hosted in the	Federation that plays a key role within cloud computing environments [p.80]	In the context of public administration, security framework implemented using open source tools such as OpenAM access manager, which is discussed as a web-based suite that provides	Cloud computing has also ensured greater efficiency, effectiveness, transparency and interoperability; The cloud, in all its aspects (IaaS / PaaS / SaaS, private/ public/community etc.), covers a wide range of strategic sectors, both public and private, allowing the realization

				(Administration & Management) cloud and distributed according to the SaaS paradigm [p.79]		authentication, Single Sign On, authorization, and federation services [p.80]	of shared infrastructure that greatly facilitates the design, implementation, and management of information systems
23	(Alameri *et al.*, 2017)	Analysing the requirements for e-Government transition of Iraqi ICS Services					
24	(Wu & Zheng, 2016:969-970)	A PaaS-based e-Government security framework and its application	The design and implementation of the whole framework for E-government	To make it easier to develop and manage Integration of the system and development tools are the key methods of this framework, for better efficiency and short development-to-service time [p.970]	Architecture of the e-Government system consisting of: OA Online services, Cache services, DB Cluster, pengyun PaaS, non-structured data, and monitor and backup with e-Government as its central component [p.970]	E-Government framework, with characteristics: combining PaaS and E-government; a complete package of development libraries and templates, including web service, mail & SMS service, form design, public library, application library, system debugging, running monitor, version control, etc., which can be dynamically assembled to support fast deployment; security such as virtualization separation mechanism, access control, network perimeter security defence system, disaster recovery backup system, authentication and electronic seal,	the development of Information Communication and Technology (ICT, cloud computing based E-Government has a trend of increase, which is driven by the rising demands of integration and flexibility; cloud computing technology makes the integration of different departments or organizations possible [p.969]

						which can be easily integrated into the rapid development practice [p.969]	
25	(Thiel, 2016:2913-2920)	The Interplay between e-Government service adoption preferences and e-Government service delivery in Germany	The extent that the current level of e-service delivery and e-service delivery channels match citizens' preferences	To investigate the interplay of citizens' e-service adoption preferences and e-service delivery using six German cities as examples [p.2913]	Level of digital preferences per life event; Services within the life events, as selected based on reach (e.g., share of population involved) and relevance (e.g., frequent contact of citizens with municipality) [p.2920]	Municipal e-service delivery levels in Germany through six typical events in the life of a citizen: Birth, marriage, change of location, change of job, business formation, and death, that were derived from the European Commission's evaluation grid on e-government [p.2915]	National and local governments around the world have recognized the potential of e-government as a means to electronically deliver government services to citizens (G2C), businesses (G2B), or other governments (G2G) [p.2913]
26	(Mishchenko & Hahanov, 2016)	Cloud service for university e-Government	E-Government in university and cloud services		Smart, cyber-security, smart cyber physical system (CPS) , metric, quality, Internet of Things, computing	A cyber physical system (Smart Cyber University) with components: infrastructure, personnel, relationships, management, roadmap, and resources — that have digital representation in cyberspace to perform scientific and educational processes based on exact monitoring and cloud-mobile management.	Smart, as is the characteristic of the process or phenomenon associated with network interaction of the addressable system components in time and space between themselves and the environment, based on self-learning technologies to achieve their goals
27	(Mahmoodi & Nojedeh, 2016:136-137)	Investigating the effectiveness of e-Government establishment in	Investigating the role of e-Government establishment in the quick and correct	To investigate the role of e-Government establishment in the effectiveness of	E-Government is discussed as the easy use of information	-	E-Government, as one of the sub-categories of information technology, has allowed governments to present

		government organizations	transfer of information of government organizations	government organizations [p.137]	technology in order to offer government services to customers directly and all day long. It also makes changes to whatever interacts with the government, such as citizens and commercial centres [p.137]		information and services efficiently in a minimum period of time and cost through modern Information technology. This research investigated the effectiveness of e-Government establishment in government organizations [p.136]
28	(Gongolidis, Evangelia, Loucopoulos & Christos, 2016)	Migrating e-Government services in the cloud: A capability modelling approach	The process of migrating e-Government services to the cloud		Presented a modelling approach based on the use of the notion of *capability* as the abstraction level that can represent relations among models of ecosystem (context),organizational structure (who), their intentions (why), and its process and services	As requirements for migrating e-Government services to the cloud, the cloud is considered as the target environment	Interoperability, inclusion, accessibility, user registration/ single sign-in, transparency, adaptability, use of standards/ prototypes, infrastructure scaling, system/ service availability are adapted from the NIST as the key quality requirements for e-Government services
29	(Choi, Myung, Choi, Chung, Gil & Yu, 2016b:645-649)	Rethinking the assessment of e-Government implementation in developing countries from the perspective of the design–reality gap: Applications in the Indonesian e-procurement system	e-Government implementation in developing countries from the perspective of applications in the Indonesian e-procurement system	To contribute to the assessment methods for developing countries [p.649]	The paper proposed a method for assessing e-Government implementation in developing countries to help them better identify problems and determine the appropriate responses to achieve their goals [p.645]	A model for assessment of both e-governments and their subsystems, such as e-customs and e-immigration, because the definition of each factor can be adapted according to its usage and context. For example, user support can be interpreted in different ways depending on whether the system is government-to-government (G2G), government-to-citizen (G2C), and so on. In a	

						G2G system, the users are government officers, whereas citizens are the users in a G2C system. [p.649]	
30	(Almutairi & Khan, 2016)	Persistent architecture for optimizing web services for e-Government implementation	Creating an architecture for optimizing the information flow within the governmental database schemas, which will pull and push information as and when required by the services	To centralize the data storage and to connect and redesign the web services for inter-process communication, so that information duplication can be reduced and the efficiency of e-government services will improve, and that the security issues related to information storage and retrieval will be addressed.	ICT governance consists of internal processes, structures, and mechanisms that organize the decision making process and guiding government actions	-	Some of the e-Government services: e-democracy, e-voting, e-justice, e-education, e-healthcare, e-reservations, e-market
31	(Sun, Ku & Shih, 2015:507)	An implementation framework for e-Government 2.0	E-Government 2.0	To carry out stakeholder-oriented participatory e-Government 2.0 [p.507]	Web 2.0, more accessible government services, public access to information, make governments more accountable	e-Framework of e-Government 2.0, composed of process integration, resource integration, back-office integration, and front-office integration [p.507]	Building e-Government 2.0 is not easy: current practices need to be updated to support the development of e-Government 2.0.
32	(Sarrayrih & Sriram, 2015:230-234)	Major challenges in developing a successful e-government: A review on the Sultanate of Oman	Challenges faced by the Sultanate of Oman regarding e-Government	To review the development methodologies used in the construction of e-Government in the Sultanate of Oman, one of the Gulf nations that is showing	Mentioned the definition offered by the World Bank fore-Government' as ''the use by government agencies of information technologies (such as Wide Area Networks, the Internet, and mobile	A model for successful e-Government comprised of social and educational development, enhanced policies and strategies, ICT infrastructure development, ICT literacy and training and	e-Government websites and portals found more services and facilities to provide necessary information to all categories of citizens [p.234]

				tremendous developments in all sectors [p.231]	computing) that have the ability to transform relations with citizens, businesses, and other arms of government" [p.230]	public awareness, job opportunities [p.234]	
33	(Ritchi, Wahyudi & Susanto, 2015:674-675)	Research program on key success factors of e-Government and their Impact on accounting information quality	e-Government implications for accounting information quality in Indonesia	To gain better understanding of the effectiveness of e-Government, and to identify success factors for current and future implementation of local government [p.674]	e-Government is defined as the application of ICTs to transform the efficiency, effectiveness, transparency, and accountability of informational and transactional exchanges within government units, and between government units at state and local levels, citizens and businesses, and to empower citizens through access and use of public information and public services [pp.674-675]	A success model of IS, comprising system quality, information quality, service quality, user satisfaction, intention to use, use, and net benefits [p.675]	e-Government is discussed as the delivery of government ICTs, as a tool to achieve better services [p.674] Indonesia's target of e-Government as the establishment of a high quality and affordable network of information and public sector services transaction; the establishment of an interactive relationship with the business community; the establishment of a communication mechanism among government agencies and the provision of facilities for public participation in the government process; the establishment of a management system and work processes are transparent and efficient, and facilitate transactions between agencies and services [p.675]
34	(Prahonoa & Elidjena, 2015:27-28)	Evaluating the role e-Government on public Administration reform: Case of official city government websites in Indonesia	Relationship between e-Government and public administration reform [p.27]	On status of e-Government implementation in public administration reform(PAR) in Indonesia	e-Government is defined as the use of ICTs, especially the Internet, to achieve better communication between G2C, G2B, and G2G to improve efficiency,	Improving online access to information and enabling the delivery of services to citizens and businesses in a convenient way, as some reasons for why e-Government	Emerging, enhanced, interactive, transaction, and connected are discussed as five stages of e-Government, as classified by the UNDP [p.28]

					effectiveness, transparency, and accountability of government implementation [p.28]	can be used in public administration reform [p.28] public service (G2C), business service (G2B), and government institutions (G2G)	
35	(Meijer & Bekkers, 2015:237-238)	A meta theory of e-government: Creating some order in a fragmented research field	Fragmentation of e-Government studies	To distinguish approaches in terms of their assumptions and ambitions for knowledge production about e-government [p.238]	E-Government as a set of techniques is an important driver for the modernization of the public sector; e-government as a practice can be described as the use of ICT to design new, or to redesign existing, information processing and communication practices to achieve a better government — especially in the field of electronic service delivery to companies and citizens, but also for managerial effectiveness and the promotion of democratic values and mechanisms [p.237]	A meta-theory of e-Government, consisting of three dimensions: explaining/understanding, holism/individualism and change/ maintenance [p.237]	Stated the theoretical fragmentation in e-Government studies. The use of innovative new channels has been a key development of e-Government in the past decade [p.237]
36	(Lupua & Lazar, 2015:365-366)	Influence of e-Government on the level of corruption in some EU and non-EU states	Corruption and e-Government relationship	-	Most of the principles of good governance are expressed in the roles of e-government; in other words, focus on transparency, openness, citizen participation, effectiveness, efficiency, accountability. [pp.365-366]	E-Government refers to the use of information and communication technologies by government agencies to transform relations with citizens (G2C), businesses (G2B), and government organizations(G2G).	e-Governance as an efficient and effective means to improve public transparency and reduce corruption [p.365]

						[p.366]	
37	(Katebire, 2015:11-19)	A model for information access and flow for electronic governance in selected local governments in Uganda	Issues in information access and flow in Uganda's local governments	To investigate critical issues in information access and flow in Uganda's local governments, with a view to proposing a model of adoptive information access and flow to support e-governance in these local governments [p.11]	Decentralization, the application of ICTs; e-Governance as an information-age model of governance that seeks to realize the processes and structures for harnessing the potentialities of ICTs at various levels of government and the public sector and beyond, for the purpose of enhancing good governance [p.19]	Citing UNESCO, discussed e-Governance as: … the public sector's use of information and communication technologies with the aim of improving information and service delivery, encouraging citizen participation in the decision-making process, and making government more accountable, transparent, and effective. [p.20] G2C and C2G communications	The term e-Governance denotes a concept that has been born out of the convergence between two fundamental global trends in public administration: decentralization and the application of ICTs; FM radio was the most popular electronic medium of G2C communication [P.150]
38	(Helao, 2015:38-105)	An evaluation of good governance and service delivery at sub-national level in Namibia: the case of the Oshana region	Contributions of good governance practices to service delivery at sub-national levels in Namibia	To evaluate and examine governance structures and practices and service delivery to provide a comprehensive understanding of governance and service delivery situations at sub-national levels in Namibia [p.viii]	A model relevant to governance and service delivery in Namibia. [p.103] The model is framed around key good governance characteristics: democracy and rule of law; inclusive and accountable decision-making; equitable civic participation; effective public service delivery; and government responsibility. [p.104]	A conceptual framework with relationship between public administration, governance, and service delivery; legal frameworks for governance and service delivery, such as the Regional Councils Act, the Local Authorities Act, decentralization policy, and the anti-corruption commission and ombudsman [p.38]	Democracy and rule of law; inclusive and accountable decision-making; equitable civic participation; effective public service delivery; and government responsibility are fundamental to democratic governance and service delivery [p.105]

39	(Gracia & Arino, 2015:4)	Rebuilding public trust in government administrations through e-Government actions	Public e-service quality	To understand the extent to which investing in these actions may affect trust in the public administration as a whole [p.4]	E-service quality, public e-services; inherent properties of services as heterogeneity, intangibility	A research model consisting of e-Service quality, public administration communication (Kurfalı *et al.*), PAC* attitude towards e-Government, trust in the public administration, attitude towards e-Government	E-service quality is probably the most relevant belief considered by the user to evaluate e-services, and it is usually reflected in elements such as efficiency, privacy, fulfilment, and system availability, so that it is mostly conceptualized as a multidimensional construct in previous research [p.4]
40	(Goncalves, Tavares, Nascimento, Sousa, Lins & Alves, 2015:87-89)	Performability, assessment of a government process in the Cloud	Performance and dependability of taxpayer assistance center (Alessandro *et al.*) in the cloud [p.87]	At the evaluation of government the process related to the taxpayer assistance center of a Brazilian City Hall [p.88]	e-Government is benefiting from cloud computing in terms of as service scalability as well as automatic software and hardware updates, performance management [p.88]	One of the proposed models is termed stochastic Petri-nets (SPN) for performability evaluation for the taxpayer assistance center in the cloud; the model provides a mechanism for capacity planning of e-government services, as different configurations/scenarios can be evaluated [pp.87-89]	Governments can take advantage of cloud computing to deal with the pressures and challenges to reduce costs and improve service performance [p.87] Cost reduction with the adoption of cloud computing in e-government [p.88]
41	(Cordella & Tempini, 2015:279-282)	E-government and organizational change: reappraising the role of ICT and bureaucracy in public service delivery	How ICT can be used to support rather than eliminate bureaucracy	To offer a critical discussion of this literature, and to provide a complementary argument that favours the use of ICT in the public sector to support the operations of bureaucratic organizations [p.279]	It is discussed that public sector information systems are generally associated with organizational transformations designed to enhance efficiency and policy effectiveness [p.280] e-bureaucracy, composed of machinery	e-Government can deliver better services by introducing a new inter-organizational layer of bureaucratic coordination [p.279] A digital platform called IRIS (Internet Reporting Information System) designed to provide better and	Information and communication technology (ICT) as an instrument for reducing the role of bureaucracy in government organizations (ICT can be used to reduce the inefficiencies generated by bureaucratic burden) [p.279] ICTs are not

					bureaucracy from professional bureaucracy	quicker solutions to common problems related to the maintenance of the city of Venice [p.282]	simple tools, but rather offer a new way to frame and couple pre-defined logical sequences of actions, mapping the organizational procedures and practices they in tend to mediate [p.281]
42	(Bannister & Connolly, 2015:1)	The great theory hunt: Does e-Government really have a problem?	A theory in the field of e-Government	To build a frame of reference for examining the existence of a theory in e-Government research	Mentioned the current poor quality, methodological weaknesses and lack of theoretical rigour in e-government research [p.1]	Trust ,transformation, and transparency are used in ambivalent ways in e-government	Mentioned the absence of theory in e-Government field [p.1]
43	(Al-Hujran, Al-Debei, Chatfield & Migdadi, 2015:189-190)	The imperative of influencing citizen attitudes toward e-Government adoption and use	Socio-technological, political, and cultural perspectives on e-government	To investigate the influence of socio-technological, political, and cultural factors on citizens' intention to adopt and use e-Government services [p.190]	Better transparency, accountability, and public services are related to e-government Discussed that electronic government (e-government) refers to the use of information and communication technology (ICT) tools and applications to enhance government transparency and accountability in public administration by improving public service delivery, access to information and services, and public governance [p.189]	Proposed a Technology Acceptance Model (TAM) by replacing perceived usefulness with perceived public value, and then integrated it with culture and trust constructs [p.200] e-Government is highly dependent upon citizens' adoption and use of e-Government services [p.189]	The main emphasis of e-Government is not the implementation of new ICT systems to automate the traditional public service processes or to add a new online service delivery channel per se; instead, it aims to improve transparency, accountability, and governance of the public sector services and, in so doing, it can improve government performance and create new public value for citizens and businesses [p.189]
44	(A.Wahsh & Singh, 2015:223)	An investigation of factors affecting the adoption of cloud computing for e-	The factors affecting cloud computing for the implementation	To fill the gap (studies in the field of e-Government adoption using cloud computing	Infrastructure instability, political influence,	Components included: transactions between	e-Government defined as the use of Information and Communication Technology (ICT) to improve

		Government implementation	of E-government; study in Iraq	are limited) and enrich the existing literature [p.323]	corruption, lack of information, communication infrastructure and legal framework, resistance to change by employees of government agencies, and poor resource management as challenges and obstacles to the successful implementation of e-Government in Iraq [p.323]	government and business, government and citizens, government and employees, and among different units and levels of government [p.323]	information sharing, deliver online services to citizens, and facilitate interaction between governmental agencies and outside stakeholders Cloud computing as a solution to overcome the aforementioned challenges [p.323]
45	(Zhao, Shen & Collier, 2014:1005-1009)	Effects of national culture on e-Government diffusion— a global study of 55 countries	The relationship between culture and e-Government	To examine empirically whether and how national culture has an impact on e-Government diffusion [p.1005]	National culture, as a source of acceptable norms and behaviours, may influence the public's online expectations, preferences, and experiences, and its attitudes toward e-government [p.1006]	A model of hypothetical relationships between national culture and e-Government diffusion, moderated by economic development. Components: Uncertainty avoidance, power distance, In-group collectivism, future orientation, performance orientation, and economic development that centralizes e-Government diffusion [p.1009]	It is discussed that e-Government has developed rapidly over the past decade, and is gaining momentum in many countries around the world [p.1006]
46	(Zhao *et al.*, 2014:295-297)	Analysis of the impact of cloud computing technology on e-Government performance evaluation	The cloud computing impact on e-Government performance evaluation	-	It is pointed out that by supporting cloud technology, e-Government can achieve the reliable and stable operation of the internal public service platform, and improve the platform	E-Government as the combination of electronic and information technology and management; it makes government's management work become more transparent	It is discussed that the ultimate goal of e-Government is the more efficient, lower cost of providing more public services. The primary purpose of the e-Government performance evaluation system is to improve the level of

					capabilities of uninterrupted service [p.296]	Cloud computing has been widely used in e-Government infrastructure, government application system construction, government data center construction, etc. [p.295-297]	governance and public satisfaction. [p.295]
47	(Taylor, T.Jaeger, Gorham, Bertot, Lincoln & Larson, 2014:519-524)	The circular continuum of agencies, public libraries, and users: A model of e-Government in practice	The idea of multiple pathways of information and services	-	Offered government entities, non-governmental organizations, public libraries, businesses and users as stakeholders in e-government	A model of e-Government to help public libraries and government agencies better support one another in this continuum [p.524]	Government-to-citizen (G2C) services; the following are also discussed as challenges to the use of e-Government: lack of technical skills to use the online functions, lack of sufficient internet access, or discomfort engaging in online interactions without guidance [p.519]
48	(Sedek, Omar & Sulaiman, 2014:96-98)	A hybrid Architecture for one-stop e-Government portal integration and Interoperability	e-Government portal integration and interoperability	To present a hybrid and distributed architecture for e-Government that consists of a one-stop e-government portal, e- Government service applications, and e-Government service providers [p.96]	Integration and interoperability among e-Governments systems and services; Users access e-Government services through a centralized one-stop e-Government portal [p.96]	e-Government architecture with building blocks of three-layers: one-stop e-Government portal, application provider, service provider [p.98]	A single access point of e-Government application are provided from distributed E-Government application and services Interoperability among e-Government services to allow effective service sharing [p.98]
49	(Savoldelli, Codagnone & Misuraca, 2014:564-566)	Understanding the e-Government paradox: Learning from literature and practice on barriers to adoption	On barriers to adoption, such as institutional and political issues	-	Institutional and political issues as one of the main factors explaining lack of e-Government adoption; key drivers of e-Government adoption and public value production, comprising smart delivery and production of public	e-Government adoption barriers with three major components: technological and economical (lack of bandwidth capacity, lack of interoperability, too high investment and maintenance costs, lack of privacy and security,	It was discussed that e-Government deployment has focused mostly on technological and operational issues, disregarding those aspects (of a more institutional and political character) that might favour adoption. [p.564]

					value, e-Government adoption, citizen's trust, transparency, service design, and participation [p.566]	and lack of open source software and standards); managerial and organizational (lack of project management capabilities, resistance to change, and lack of skills); institutional and political (digital divide, lack of legal bases, lack of political commitment, lack of political coordination, lack of policy cycle management, lack of measurement and evaluation, lack of citizens participation, and lack of trust and transparency) [p.566]	
50	(Nograšek & Vintar, 2014:109-112)	E-Government and organisational transformation of government: Black box revisited?	The role of ICT as a key driver of organizational transformation (OT) in e-government	(1) To develop a clearer explanation of the role of ICT as a key driver of OT in the e-Government era, by contrasting the theoretical background rooted in Leavitt's model with technological determinism/socio-technical theory; and (2) to summarise previous research in the field of OT, unite some views, and develop a more comprehensive framework of OT in the e-Government era	Four organisational elements: Processes, people, organisational culture, and organisational structure	One of the frameworks is to explain the role of ICT in the organisational development of public sector organisations, consisting of processes, organisational culture, people, and structures with technology (ICT) as a central component [pp.111-112]	

				[p.109]			
51	(Nam, 2014:211-212)	Determining the type of e-Government use	The impact of various determinants (i.e., perception-based psychological factors, civic mindedness, information channels, trust in government, and socio-demographic backgrounds) on multiple types of e-Government use	To understand what determines the degree of e-Government use for multiple purposes by analysing the Government Online Survey data that the Pew Internet and American Life Project provide [p.211]	Offered e-Government definition as the use by government of information and communication technologies (ICTs) to deliver information and services to citizens, businesses, and public agencies [p.211]	A conceptual framework of e-Government use determinants, with elements: Demographic conditions, information channels, civic mindedness, psychological predispositions, trust in Government, and e-Government use [p.212]	A change from the bureaucratic, inward-looking approach to a citizen-centric, outward-looking approach that prioritizes the concerns and needs of users or customers [p.211]
52	(Jing & Wenting, 2014)	A Study of G2C e-Government citizens' satisfaction: Perspectives of online service quality and offline service quality	Citizens' satisfaction ofG2C e-Government	To explore factors influencing e-Government citizen's satisfaction and to provide a theoretical basis for e-Government transaction improvement	Offline service quality and online service quality	-G2G, G2C	The online service is divided into three parts: information quality, system quality and service quality.
53	(Guha & Chakrabarti, 2014:327)	Making e-Government work: Adopting the network approach	Factors necessary for making e-Government projects	To examine the nature of e-Government projects, identify the missing elements, and find ways to incorporate them in project designs [p.327]	-	Information technology (IT) as potential for delivering good governance and improving the economic condition of the poor in developing countries [p.327]	Non-availability of adequate infrastructure and existence of design–reality gaps have been identified as two powerful reasons for the failure of e-Government projects [p.327]
54	(Ghazali, 2014:328-329)	The adoption factors of using e-Government services	Relationship between technological acceptance characteristics and behavioural intention to use e-filing	To find the relationship between technological acceptance characteristics and the behavioural intention to use e-filing [p.329]	Computer use self-efficacy belief of individuals is a significant factor in their utilization of technology [p.328]	-	-

55	(Elbahnasawy, 2014:114-116)	E-government, Internet adoption, and corruption: an empirical investigation	Impact of e-Government and internet adoption	To empirically investigate the role that e-Government and the level of Internet adoption play in reducing corruption, both in developed and developing countries [pp.114-115]	Corruption, economic growth, sustainable development E-Government can be defined as the use of information and communication technology (ICT) by the government to work more effectively, share information, and deliver better services to the public [pp.115-116]	e-Government can be seen as an effective tool in restructuring the principal-agent-client relationship to reduce corruption by expanding access to information; simplifying rules and procedures and making them more transparent; providing detailed data on transactions and hence easing the process of tracking actions and decisions made by agents; enhancing the questionability of their unreasonable actions; reducing their discretionary power by standardizing the delivery of services; and promoting accountability [pp.115-116]	E-Government is alleged to lower the interaction between government officials and citizens, and hence diminishes the discretionary power of officials. It may also enhance accountability and transparency by disseminating a greater quantity and a higher quality of information in the economy, which incites citizens and businesses to question arbitrary decisions and un reasonable procedures [p.114]
56	(Danila & Abdullah, 2014:576-579)	User's satisfaction on e-Government services: An integrated model	e-Government services regarding user satisfaction	To seek antecedent factors that influence the intention and usage of e-Government applications by combining the Technology Acceptance Model, theory of planned behaviour, and Information System Success Model [p.576]	IT and Internet as a powerful tool for improving the delivery of government services	G2C, G2B, G2E, and G2G as components of stakeholders of e-Government applications [p.577] Technology Acceptance Model with building blocks: perceived usefulness, perceived ease of use, behavioural intention to	-

						use, and actual system use [p.579]	
57	(Cavalheiro & Joia, 2014:196-197)	Towards a heuristic frame for transferring e-Government technology	Challenges of the adaptation and implementation of e-Government applications	At addressing the underlying issues associated with the transfer of e-Government technology, given different characteristics of donor and recipient organizations in terms of the socio-economic context and dynamics of the technological infrastructure [p.196]	e-Government is concerned with creating better service delivery to citizens and businesses [pp.196-197]	From a techno-centric perspective, e-Government applications can be deemed as isolated technical artefacts that are comprised of a combination of hardware and software [p.196]	-
58	(Arendsen, Peters, Ter Hedde & Van Dijk, 2014:161-164)	Does e-Government reduce the administrative burden of businesses? An assessment of business-to-government systems usage in the Netherlands	Administrative burden on businesses and business-to-government systems	-	A conceptual model with components: Organisational Usage characteristics (quality, frequency, period in use); organisational characteristics (size, attitude, ICT staff; perceived organisational benefits (ease of use, productivity, data entry); perceived innovation characteristics (complexity, compatibility; administrative burden reduction; system implementation and confirmation of system adoption) p.164	Electronic government (e-government) can be defined as "all data, communication and transaction processing activities related to governmental tasks and responsibilities in which ICT is being used" [p.161]	

59	(AlSuwaidi & Rajan, 2014:163-165)	E-Government failure and success factors rank model — an extension of Heeks factor model	Failure and success factors of e-government	-	A conceptual model has been divided into two sub models that can be used to address e-Government failure and success factors in the UAE e-government projects [p.165]	E-Government failure factors rank model, comprising: Capacity deficit, lack of e-service adoption, inefficient leadership role, legalization and policy issues, dominance of politics and self-interests, privacy and security constraints, poor technical infrastructure and lack of interoperability, lack of thoroughly developed strategy, poor change management [p.163]	
60	UNESCO (Ornager & Verma, 2005:7-8) (http://www.unesco.org) ISBN 81-89218-04-2	E-Government tool kit for developing countries	Concepts of e-Government and aspects of e-Government in developing countries	Aims to offer a helping hand to policy makers and senior executives in developing nations by providing comprehensive information on what, how, and when to embark successfully on the road to e-Government [p.7]	The study defined e-Government and discussed e-readiness and an action plan of e-government	An action framework involving all the stakeholders in developing nations, including parliamentarians, government executives, institutions as well as non-governmental organizations [p.7]	Defined e-Government as: "E-Government is the use of Information and Communication Technologies to promote more efficient and effective government, and make it more accessible and accountable to the citizens." [p.8]
61	(Hashemi, 2013:597-602)	Using cloud computing for e-government: challenges and benefits	Challenges and benefits in using cloud computing for e-Government	-	Effective challenges in e-government are classified into three groups: social, economic, and political barriers; technical challenges such as data scaling, auditing and logging, replication and migration, disaster recovery, management policies, system	The cloud architecture can help the government to reduce repetitive operations and increase the effective use of resources [p.598] The use of green and cheap technology,	E-government can change the provided services to citizens, provide access to information for citizens, and enable them to participate in economic and social opportunities so that they can make a better life for themselves and future generations [p.597]

					integration, legacy software, obsolete technologies and migration to new technologies [p.598]	cloud computing as a useful solution [p.602]	
62	(Yadav & Singh, 2013:3241-3244)	E-governance: past, present, and future in India	Applications of e-Governance and challenges in implementing e-Governance as well as future technologies for e-governance	-	e-Governance can be implemented with clouds, as clouds provide a number of benefits to make e-governance more efficient to use [p.43]	Four models of e-Governance: Government to citizens (G2C), Government to government (G2G), Government to employees (G2E), Government to businessmen (G2B) [p.38]	Four pillars of E-Governance: Connectivity, knowledge, data content, and capital [p.37]
63	(Prasad & Atukuri, 2012b:3241-3244)	Cloud computing technology for effective e-Governance	Cloud computing and its applicability for effective e-Governance	To discuss how to utilize cloud computing (CC) applications for effective functioning of E-Governance activities in India [p.3241]	E-Governance (electronic governance) is using Information and Communication Technologies (ICTs) at various levels of the government and public sector and beyond, for the purpose of enhancing governance [p.3241]	Four relationships of e-Governance: Government to citizens (G2C), Government to government (G2G), Government to employees (G2E), Government to businessmen (G2B) [p.3241]	Cloud computing encompasses a whole range of services and can be hosted in a variety of manners, depending on the nature of the service involved and the data/security needs of the contracting organization; We can get the better services than traditional computing with reduced cost, with the help of cloud computing [pp.3243-3244]
64	(Komba, 2013:3-24)	Factors influencing access to electronic government information and e-government adoption in selected districts of Tanzania	Factors in the adoption of e-government in developing countries [p.24]	To investigate the current situation and factors influencing access of e-government information and e-government adoption in Tanzania [p.ii]	e-Government offers public information services to increase citizen participation in political processes; e-Government fosters economic development and helps local businesses to expand globally [pp.3-4]	Adopt e-government services to improve the efficiency and effectiveness of internal government operations, communication with citizens, and transactions with both individuals and organisations [p.4]	E-government is described as a means of improving the provision of government information and services to citizens [p.ii]

65	(Rao & Krishna, 2013a:772-773)	Challenges and future trends in e-Governance	Software architects and software designers in designing software systems	To ensure smooth flow of information between citizens; to make requirements and specifications available in the public domain; and others [p.772]	Concepts such as e-business, e-services, and e-commerce [p.773]	An e-government portal requires a common, integrated architecture framework that allows different organizations, provinces, and municipalities to share and exchange data [p.773]	The cloud infrastructure can greatly reduce overall costs for government departments maintaining and managing E-Services for E-Governance, and help in efficiently utilizing the tax payer's money
66	(Yıldız & Saylam, 2013:141-144)	E-Government discourses: An inductive analysis	Categories of e-government discourses	To empirically document the numerous and sometimes competing discourses used in the media by examining the news paper coverage of e-government in Turkey [p.141].	The provision of government information and services, and opening of additional channels for political participation, transparency and account ability via information and communication technologies (ICTs) is defined as electronic or digital government [p.141]	Discourse concept as constraints of a given time, place, or social, cultural, or institutional setting [pp.141-142]	The following categories are formed through this process: Five positive discourses of (i) government reform, (ii) inevitability, (iii) increase in government revenues, (iv) creating equality of opportunity, and (v) harmonization with the world and the EU; and four negative discourses of (i)overcoming technical problems, (ii) overcoming performance problems in government,(iii) overcoming information security breaches, and (iv) over coming participation problems [p.144]
67	(UNPAN, 2014) (http://www.unpan.org/e-government)	United Nations e-Government survey	Rankings of e-Government index	Rankings of economic growth and human development given to different countries	Ethiopia was in low-income category in 2014 (Ranked 157 th globally).		
68	(UNPAN, 2018:16&222) (http://www.unpan.org/e-government)	United Nations e-Government survey	Rankings of e-Government index	Rankings of economic growth and human development given to different countries	E-Government Development Index (EGDI);Ethiopia was in low-income category in 2018 (Ranked151st globally).[p. 222]		Ethiopia has been very successful in the use of mobile data [p.16]

69	(ICEG http://www.iceg.net, 2014) (http://www.iceg.net)	Different definitions are provided					

APPENDIX H: APPLICABLE ARTICLES AFTER SCOPING REVIEW ON RCES

Table 5.2: Studies which met the inclusion criteria resource-constrained environments

#	Study	Title	Basic concepts and Findings
1	(Dubale, 2010:1)	Telecommunication in Ethiopia	telecommunication industry and communication as indicators of social and economic development of a given country and a vital role in overall development of all sectors related to social, political and economic affairs respectively The Ethiopian Telecommunication Agency (ETA) was established by the Ethiopian Government by Proclamation No. 49/1996, as a regulatory body for Telecommunication Services ETA was providing services such as Public Switched Telecommunication Network (PSTN), Cellular Mobile, Internet and Data communication services to Ethiopian Telecommunication Corporation, which was established by Council of Ministers regulation No 47/1999 as an incumbent state owned operator ETC was then providing services such as PSTN, cellular Mobile, Internet and data communication services [p.1]
2	(Malakar, Natarajan & Vadhiyar, 2010)	An Adaptive Framework for Simulation and Online Remote Visualization of Critical Climate Applications in resource-constrained environments	resource constraints including limited storage and slow networks can limit the effectiveness of online services; an adaptive framework that performs efficient processor allocation and robust disk-space management
3	(Pathak, Belwal, Naz, Smith & Al-Zoubi, 2010:1-3)	Citizens' Perceptions of Corruption and E - Governance in Jordan, Ethiopia, and Fiji — the Need for a Marketing Approach	Only a few people are aware of e-governance and feel that it can help in curbing corruption in Jordan, Ethiopia and Fiji; for addressing negative forces in the implementation of e-governance such as corruption, divide, and urban bias, developing countries need to apply a marketing approach to e-governance services

#	Study	Title	Basic concepts and Findings
			because of the overlap, the terms 'e-governance' and 'e-government' are used interchangeably [p.1] The application of ICT in governance often aims to improve efficiency and effectiveness in the public sector, and boosts transparency and accountability of informational and transactional exchanges within the government. E-governance systems are also designed to reduce discretionary power, and to promote transparency and accountability [p.2] corruption and inefficiency of governments are major barriers to economic and social development in developing countries; four factors- infrastructure, computerization and integration, legislation, and the attitude of enabler the preparedness of governments and citizens, the design and management of services, access limitations, customer focus and the organizational contexts of public agencies are crucial factors affecting adoption of e-Government by citizens [p.3]
4	(Anderson & Kolko, 2011)	Designing Technology for resource-constrained environments: A Multidisciplinary Capstone Sequence	defined resource-constrained environments including limited electric power and limited knowledge Suggest an approach for the unique social, infrastructure and technical constraints posed by resource-constrained environments pointed out the demand of innovative design approaches limited electric power and limited knowledge
5	(Yang, Wang, Wang, Tan & Yu, 2011:1339)	Provable Data Possession of Resource-constrained Mobile Devices in Cloud Computing	discussed about cloud services such as on-demand computing or storage services and the fears of users about their files storage in the cloud The 3G and 4G wireless communication networks, the mobile devices, such as mobile phones, PDA, also want to share the benefits introduced by the cloud on-demand storage and computing service. But the traditional mobile terminals are resource-constrained devices (with low CPU frequency and small memory) and cannot use the existing PDP schemes directly, which require clients encode files with erasure codes, divide encoded files into blocks and sign on every data blocks When the resource-constrained mobile devices use the cloud storage services deployed on traditional IP networks, the end-users are most concerned about whether the CSP stores their files correctly and dutifully [p.1039]

#	Study	Title	Basic concepts and Findings
6	(Lessa, Belachew & Anteneh, 2011)	Sustainability of E-Government project Success: Cases from Ethiopia	The Ethiopian government has been taking practical steps such as: devising ICT policy, developing ICT sector Research & Development strategy and guideline, capacity building efforts to facilitate ICT use; Strong political will and commitment to support ICT-based initiatives on the side of top political leaders to fully leverage the coverage, penetration as well as quality of telecom and ICT services at the national level ICT projects in Ethiopia are WoredaNet (connecting 600+ local administrative districts in the country with broadband Internet access to enhance local administration); SchoolNet (connecting more than 550+ high schools in the country with VSAT based broadband for delivery of video-based distance education); AgriNet (to connect about 26+ agricultural research institutions in the country with broadband Internet access); and RevenueNet (to network the inland revenue and customs offices all over the country to primarily support relevant data exchange) The WoredaNet as an example of a Government-to-Government (G2G) model 'design-actuality' and 'ddesign-reality' gaps, or lack of commitment on the part of political leadership and public managers as constraints to the WoredaNet long term sustainability of e-government initiatives failure reasons: Information, technology, processes, objectives and values, staffing and skills, management systems and structures, and other resources
7	(Mikre, 2011)	The Roles of Information Communication Technologies in Education	divide; inadequacy of existing infrastructures; limited or low access to internet connections; computers, network infrastructure and connections are not compatible to the size of the requirement; lack of the required skill In the case of Ethiopia's education system, ICT use, particularly the computer and internet is very much limited though there is a clear policy direction. The public sector and the education sector have begun to benefit from WoredaNet and the ICT strategy though the accomplishment is not to the perceived standard.
8	(Woldemariam & Lessa, 2011)	The Role of Information System Intent of Managers on Information Systems Implementation in Ethiopia	intent of managers on IS effectiveness; severe restrictions on budget and time The organization's standards and visions is very relevant in the case of IS corporate governance a strategic vision of the role of IS and especially of the role of the IT infrastructure on the part of top management is crucial for the growth of any business today Top and senior management should be very clear about the purpose of IS in their particular business IS-related collective commitment is also an important attribute of IS intent

#	Study	Title	Basic concepts and Findings
			the government of Ethiopia is also investing a lot to strengthen the ICT infrastructure in order to enable different sectors of the economy. WoredaNet, for instance, is one of these initiatives that is aimed at linking all Woredas1 throughout the country so that different e-Government packages can be effectively and efficiently implemented all over the nation
9	(Chen, 2012)	Java Virtual Machine for resource-constrained environments	energy, memory, performance, and reliability as resource-constrained devices
10	(Silva, 2012)	Academic Entrepreneurship in a Resource-constrained Environment	discussed RCEs as resource barriers Citing (Vyankarnam, 1990) pointed out the necessity of effective and efficient utilization of resources to address resource limitations and be successful some of the challenges or resource scarcity posed by RCEs particularly in developing countries include: shortages of skills, finance, physical infrastructure, technology
11	(Sehgal, Perelman, Kuryla & Schönwälder, 2012)	Management of Resource-constrained Devices in the Internet of Things	discussed that Internet of Things can be resource-constrained and also discussed resource constraints to capabilities of memory and processing, radio standards with low-power as constraining the network interfaces resource-constrained devices as low-power low-data-rate wireless personal area networks (WPANs) and included resource-constrained devices are incapable of providing much memory capabilities or storage
12	(Ahmad & A.Hasibuan, 2012)	Government Services Integration Based on Cloud Technology	when government services being silo system are scattered among government agencies results to wastage of resource and this also leads to lack of synchronization making interoperability difficult. energy sustainability, education, infrastructures, natural environment, public safety, and health care are offered as challenges Cloud-based e-government architecture is proposed as a solution
13	(Saidhbi, 2012:2-3)	A Cloud Computing Framework for Ethiopian Higher Education Institutions	the current IT utilization' limitation in Ethiopian Higher Education institutions is discussed and Hybrid Cloud Computing is proposed as a solution for ICT utilization limitedness in terms of decreasing cost and addressing continuously increasing computing and storage challenges as well as addressing constraints that are time-related. The Ethiopian EthERNet is offered as an example that has provided services such as video conferencing, datacenter, e-library and technical support but that still lacks service integration an architecture of the Cloud based deployment of ICT infrastructure to Education System for the benefit of the underlying infrastructure is also discussed and the paper proposed a framework termed as "Ethiopian Universities Hybrid Cloud (EUHC)" [pp.2-3]

#	Study	Title	Basic concepts and Findings
14	(Chaabane, Hadouaj & Ghedira, 2013:102-103)	Multi-Agents Coordination Model in Inter-Organizational Workflow: Applying in E-government	in e-government model implemented based on a centralized architecture, transactions between agencies and government are managed by a middleware used to coordinates the sectors leading to an increase of the time required for transaction and the cost of communication due to the requirement of the rebuild process of IT infrastructure, the e-government projects are costly; the key issue of e-government services development is considered as Interoperability technical and semantic interoperability as well as the dynamic environment are mentioned as e-government problems further technological interoperability and heterogeneity of data provided as problems of software applications in e-government environments "Web Services is considered as an important element for the application of interoperability and integration" [pp. 102-103]
15	(Suhail, Lubega & Maiga, 2013)	Blended Learning Resources in Constrained Bandwidth Environment: Considerations for Network and Multimedia Optimization	constrained bandwidth environment are discussed as challenges of visual media applications as they require high bandwidth low bandwidth causes conditions such as heterogeneous network, affect the delivery of multimedia content efficiently to the users
16	(Frehywot, Vovides, Talib, Mikhail, Ross, Wohltjen, Bedada, Korhumel, Koumare & Scott, 2013:2)	E-learning in medical education in resource-constrained low- and middle-income countries	Discussed challenges of e-learning in resource-constrained countries, of some of the challenges discussed include; shortage of computer facilities, frequent interruption of electrical power, imitations in bandwidth, slow speed of the internet as challenges of e-learning in resource-constrained countries. "Constrained Bandwidth Environment refers to an environment where the Internet bandwidth capacity is insufficient as compared to the demand, coupled with other bottlenecks such as high cost, misuse and mismanagement of available bandwidth, viruses, spam and worms leading to network congestion" [p.2]
17	(Adam, 2014:5)	Policy Paper 3: What is happening in ICT sector in Ethiopia	in order to address low communications penetration, he government of Ethiopia has been investing in communications infrastructure, human resources development and e-applications so as to provide service such as CDMA wireless network that covers rural towns for over 30million subscribers fibre connectivity and expansion of the mobile transmission is done that covered 10 000 KMs deliver a CDMA wireless network The national e-Government Strategy of 2011 lists over 200 e-services to be rolled out over the next two years. The Ethiopian Government has also been building a national "IT Park" with the aim of attracting IT service companies such as those involved in business process outsourcing

#	Study	Title	Basic concepts and Findings
			Broadband internet speeds are extremely slow, operating far below advertised speed, and frequently with a high contention ratio. The low broadband quality of service (QoS) is weakening the investment, economic growth, education, and entrepreneurship needed for the country to progress. [p.5]
18	(Kong, Ang & Seng, 2014:17)	A comprehensive survey of modern symmetric cryptographic solutions for resource-constrained environments	Internet of Things (IOT), radio frequency identification (RFID), wireless sensor network (WSN), wireless identification and sensing platform (WISP) [p.17]
19	(Chetlur, Tamhane, Reddy, Sengupta, Jain, Sukjunnimit & Wagh, 2014)	Enabling Blended Learning in resource-constrained environments	Cost (in resource constrain environments, downloading large size content are costly), lack of IT infrastructure and lack of help (in resource-constrained environments, difficult to get experts help) as a major challenge in the adoption of technology-enabled learning in developing regions
20	(Echeverria, Root, Bradshaw & Lewis, 2014:117)	On-Demand VM Provisioning for Cloudlet-Based Cyber-Foraging in resource-constrained environments	to measure the usefulness of a cloudlet provisioning technique for resource-constrained environments Energy efficiency Application-ready time Automation of provisioning Flexibility “The environment for which provisioning tools are designed has some substantial differences with the resource-constrained environments in which cloudlets may operate” [p.117]
21	(Kettani, 2014:2)	E-Government Applications in the African Context	“E-Government involves the automation or computerization of existing paper-based procedures that will prompt new styles of leadership, new ways of debating and deciding strategies, new ways of transacting business, new ways of listening to citizens and communities, and new ways of organizing and delivering information, new ways of… governing” [p.2]
22	(Lewis, Echeverría, Simanta, Bradshaw & Root, 2014)	Cloudlet-Based Cyber-Foraging for Mobile Systems in Resource-Constrained Edge Environments	discussed about characteristics of resource-constrained edge environments and included the characteristics such as: limited computing resources, dynamic context, high levels of stress, and intermittent network connectivity
23	(Miruts & Asfaw, 2014:95-98)	The Implementation of Civil Service Reforms in Ethiopia: The Woreda-Net as a Sole Promoter to Implement Civil Service Reform of Tigray National Regional State	reforming the civil service was to rearrange and create an efficient and effective public organizations so as to provide quality public services, establish democratic governance, assure better socioeconomic development, professionalize the civil service and create an information society Geographic factors, non-balanced allocation of professionals are of the dominant challenges to implement civil service reform [p.95]

#	Study	Title	Basic concepts and Findings
			the Ethiopian government placed ICT policy to "develop, deploy and use information and communication technology to improve the livelihood of every Ethiopian, and optimize its contribution to the development of the country'' (Ethiopian ICT policy document, 2009) [p.96] the Ethiopian *Woreda*Net was intentionally designed to connect all the 711 *Woredas* in the country through information technology. To support local administrative powers and the commitment to have an informed society, the central government projected the ICT program since 2002 p.98
24	(Odusote & Adigun, 2014)	Technologically Enabling Resource-constrained Enterprises in Developing Nations Through The Implementation of E-Commerce on-Demand Service Portals for a Grid Utility Computing Plat...	high operational costs as RCEs suggested a service portal of on-demand for a platform of Grid Utility Computing (GUC)
25	(Sunkari_et_al., 2015)	Framework for Providing Security and Energy saving Using Elliptic Curve Cryptography in Wireless Sensor Networks	discussed limited bandwidth, limited transmission power, limited resources, vulnerabilities, limited knowledge and limited memory resources as limitations of wireless sensor network within resource-constrained environments
26	(Atnafu, 2015)	Local Internet Content: the Case of Ethiopia	Ethiopia is formally connected to the Internet in January 1997, with the ISP being the then Ethiopian Telecommunication Corporation, now ethio-telecom many initiatives have been launched in Ethiopia to make IT a support to many developmental activities in the country promoting local content and local content applications on the Internet is necessary and is also a means to increase the value for Internet access Currently, the communication infrastructure expansion plan is guided by GTP of the nation. The key focus areas in the GTP plan that will end in June 2015 related to communication infrastructure are: Mobile expansion, Building the International Communication Capacity, Developing the Fixed Telephone Line Infrastructure, and Developing the Internet Capacity.
27	(Kong, Ang & Seng, 2015:17-20)	A comprehensive survey of modern symmetric cryptographic solutions for resource-constrained environments	The term "resource-constrained environment" (referred to as the RCE in this paper) is used in describing a hardware development platform that has very little amount of design space (e.g. battery-life, hardware memory, computation latency, communication bandwidth, etc.). [p.17] 1. Energy constraints 2. Memory limitations 3. High latency in communication 4. Unattended operation of networks [p.20]

#	Study	Title	Basic concepts and Findings
28	(Lessa, Klischewski, Belachew & Anteneh, 2015)	Towards a Conceptual Framework for Pledging Sustainable e-Government Success: The Case of G2G in Ethiopia	Common external reasons are: weak coordination between the regional ICT agency and district administration since project conception; instability of telecom and electricity infrastructure; the technical support from the regional ICT agency was not satisfactory, timely, and problem solving one. Common internal reasons are: top management did not consider ICT as one of their priority agendas and no follow up through ongoing monitoring and evaluation.
29	(Pandey, Pompili & Yi, 2015:479)	Dynamic Collaboration Between Networked Robots and Clouds in resource-constrained environments	A public Cloud consists in a set of networked computers that provide a range of computation as well as storage resources and that give the appearance of *infinite* computing capabilities available on demand and at a nominal price offered a resource-provisioning engine that allocates computational tasks between the Cloud and the local resources based on the objective of minimization of execution time or the price of the executing the application [p.479]
30	(Salerno, Ouma & Botha, 2015)	Developing a Conceptual Model for Facilitating the Issuing of Badges in a Resource-constrained Environment	Discussed that low skill on ICT, limited internet connectivity and lack of electricity are posed by resource-constrained environments and become major issues of Mozilla Open Badges
31	(Bwalya & Mutula, 2016:1184-1186)	A conceptual framework for e-government development in resource-constrained countries: The case of Zambia	lack of adequate understanding of the complex relationships among technologies (how to achieve integration and interoperability), information usage practices, organizational factors and institutional establishments, and the socio-economic contexts [p.1184] quality of platforms to access e-government, content, service availability, cost, fairness of provision, importance, return on investment (ROI) [p.1185] a need to achieve platform/service integration and for interventions which make it possible for e-government to be mainstreamed into the core business structures and processes of the government [p.1186] Integrating ICTs into the business processes of government entails understanding the complex organizational structures of the government units
32	(Kaguma, Karumba, Walcott-Bryant & Weldemariam, 2016)	Towards Cooperative Content Downloading for Resource-constrained Mobile Devices	intermittent connectivity, bandwidth, battery power as resource-constrained environment when downloading content how content can be downloaded collaboratively and efficiently in a resource-constrained environment
33	(Kattepur, Dohare, Mushunuri, Rath & Simha, 2016)	Resource-constrained Offloading in Fog Computing	pointed out, computation, battery (energy), and communication as well as distributed computation, within energy and latency constraints challenges as resource-constrained environments

#	Study	Title	Basic concepts and Findings
			The emerged Cloud computing can allow availability of scalable and on-demand virtual machines and can be useful in energy-efficient computing. The cloud is can also be used as a central storage for IoT devices; centrally stored data can be accessed while the energy-efficiency and elastic scaling of the cloud can be appropriate in many aspects. the sensor networks' sense-actuate-compute capability, large scale data volumes of Big Data applications , and mobility of cellular devices can be combined via the Internet of Things (IoT) "Fog computing builds on top of the edge computing paradigm, by reducing resource contention and scalability issues, while still maintaining low latency overheads. Typically any device with computing, storage, and network connectivity can be a fog node: controllers, switches, routers and embedded servers – virtual machines with relevant computational APIs may be deployed on them"
34	(Kulkarni & Rajamanickam, 2016)	Designing Data Collection Methods for Applying Learning Analytics in Resource-constrained Schools	Described resource as the availability of resources for applying learning analytics which includes the availability of internet, computing devices and man power with skill, which are required for applying learning analytics
35	(Botha & Herselman, 2017)	Teachers become co-creators through participation in a teacher professional development (TPD) course in a resource constraint environment in South Africa	using mobile tablet technology to their own expertise towards enriching their teaching practices in a resource-constrained setting in South Africa Based on the definition of Anderson, Anderson, Borriello, and Kolko (2012). According to them, a resource-constrained context is an environment where there is low-income communities and low bandwidth. These environments provide unique constraints (cultures) where people are unfamiliar with, or afraid of, technology and/or environments where power and network connectivity are scarce and expensive The bandwidth challenges in resource-constrained areas are significant in rural, resource-constrained contexts can be empowered and supported to integrate technology
36	(Kao, Krishnamachari, Ra & Bai, 2017)	Hermes: Latency Optimal Task Assignment for Resource-constrained Mobile Computing	resource cost constraint, There have been systems that augment computing on a resource-constrained device using computational offloading. We classify them by the types of remote computational resources that a local device has access to parallel tasks that might be running at the same device at the same time, which causes resource contention over CPU cycles, memory usage and network access
37	(Nastic, Truong & Dustdar, 2017)	Data and Control Points: A Programming Model for Resource-constrained IoT Cloud Edge Devices	Resource-constrained IoT devices such as sensory gateways.

#	Study	Title	Basic concepts and Findings
			layered architecture and runs inside resource-constrained Edge device, enabling local execution of device-level applications
38	(Pholotho, 2017:17-21)	Toward a Broadband Services Delivery Model over Wireless Technologies to Resource-Constrained Public High Schools in South Africa	proposed a model for broadband services delivery using wireless access technologies [p.17] broadband is defined as internet access in a high-speed and uninterruptable manner via which multiple services can simultaneously be delivered [p.18] A resource-constrained environment creates unique challenges with lack of power, network connectivity broadband and ICTs infrastructure which is also geared by lack of security, deployment costs and maintenance for fixed-line, technical skills, poverty, and geographical landscape as well as unfamiliarity of people with technology [p.21]
39	(Desta, 2018:2-6)	Comments on the ization and Divide in the Horn of Africa (HoA), Kenya and Ethiopia: The Media Perspective	divide: In developing countries, political issues, costs, lack of regulatory, and courtroom feuds, and bigger amount of payment for mobile transaction as barriers of TV transition. Possession and access to computers, laptops, mobile phones, tablets and smart phones grew in Africa. Government policies and regulations causing the divide in the horn of Africa as the governments allow only the development of the sector in a highly controlled. laws and regulations are in place to restrict the open and transparent advancement of ization and also Cost, insecurity, and poverty and rural concentration of the population are big challenge More democratic institutions, liberalized and economic advancement as solutions. Improvement of telecom policies by governments in enhancing competition of the private sector [pp.2-6]