QUALITY OF SERVICE MODEL FOR SOFTWARE AS A SERVICE IN CLOUD COMPUTING FROM USERS’ AND PROVIDERS’ PERSPECTIVES

ATIEH KHANJANI

FSKTM 2015 15
QUALITY OF SERVICE MODEL FOR SOFTWARE AS A SERVICE IN CLOUD COMPUTING FROM USERS’ AND PROVIDERS’ PERSPECTIVES

By

ATIEH KHANJANI

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

July 2015
COPYRIGHT

All material contained within the thesis, including without limitation text, logos, icons, photographs and all other artwork, is copyright material of Universiti Putra Malaysia unless otherwise stated. Use may be made of any material contained within the thesis for non-commercial purposes from the copyright holder. Commercial use of material may only be made with the express, prior, written permission of Universiti Putra Malaysia.

Copyright © Universiti Putra Malaysia
DEDICATION

This thesis is dedicated to:

My wonderful Parents,

Mahmoud Khanjani & Homa Mardan
Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the Degree of Doctor of Philosophy

QUALITY OF SERVICE MODEL FOR SOFTWARE AS A SERVICE IN CLOUD COMPUTING FROM USERS' AND PROVIDERS' PERSPECTIVES

By

ATIEH KHANJANI

July 2015

Chairman : Wan Nurhayati Wan Ab. Rahman, PhD
Faculty : Computer Science and Information Technology

Software as a Service (SaaS) is one of the main service models in cloud computing which enables the application to run on the cloud by eliminating the installation on the personal computer at the client side. Quality of Service (QoS) is a crucial factor for the success of cloud services especially in terms of SaaS, so that if it is not delivered as expected, it might blemish the provider's reputation. In this thesis, we address the problem of the lack of QoS model for SaaS to cover more QoS attributes compared to other existing models and their definitions to be referred as reference model which are useful in both users' and providers' perspectives. There is a high demand for creating a quality model for SaaS since conventional frameworks cannot effectively support specific quality aspects of SaaS such as scalability and reusability. Even though there are some studies that have been performed regarding the QoS models for SaaS but they considered only a few attributes and still many aspects are left. Besides, the users might not have sufficient knowledge and experience of what they want and not be able to clarify their requirements very well. Therefore, the QoS consideration should be from both service users’ and providers' perspectives to be more effective. In this research, QoS attributes for SaaS cloud services from both users’ and providers’ perspectives are presented, defined and categorized. A quality model for SaaS called SaaS-QoS model as a reference model to be useful in both perspectives, also was proposed. First, a set of 29 QoS attributes for SaaS cloud from the literature consisted of QoS attributes specific for SaaS quality models and in overall cloud computing, was obtained. Then, a survey conducted through experts in industry, academician and researchers to measure the acceptability of the attributes using purposive sampling technique. Based on the result of the survey, 32 attributes under 5 categories were determined as QoS attributes for SaaS inspired by Service Measurement Index (SMI) framework and the SaaS-QoS model was then proposed. The SaaS-QoS model was evaluated from both user and provider perspectives through performing two surveys by SaaS providers and SaaS users. The results of evaluation part indicated that the categories and attributes assigned are highly associated and relevant. More than that, the SaaS-QoS model is practical and applicable enough for SaaS from both users' and providers' perspectives. This research has given a wider view of QoS attributes to both users and providers as a reference model and also to add to the body of knowledge and practitioners.
Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk Ijazah Doktor Falsafah

MODEL KUALITI PERKHIDMATAN BAGI PERISIAN SEBAGAI PERKHIDMATAN DALAM PENGKOMPUTERAN AWAN DARIPADA PERSPEKTIF PENGGUNA DAN PENYEDIA

Oleh

ATIEH KHANJANI

Julai 2015

Pengerusi : Wan Nurhayati Wan Ab. Rahman, PhD
Fakulti : Sains Komputer dan Teknologi Maklumat

ACKNOWLEDGEMENTS

First and foremost, have to thank the God to give me power and ability to cope with the PhD thesis.

Second, I would like to thank my supervisory committee Dr. Wan Nurhayati Wan Ab. Rahman, Professor Dr. Abdul Azim Abd Ghani, Assoc. Prof. Dr. Abu Bakar Md Sultan and Dr. Novia Indriaty Admodisastro.

Lastly, I would like to thank all the people who helped and encouraged me to fulfil my PhD thesis.
I certify that a Thesis Examination Committee has met on 13 July 2015 to conduct the final examination of Atieh Khanjani on her thesis entitled "Quality of Service Model for Software as a Service in Cloud Computing from Users' and Providers' Perspectives" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Doctor of Philosophy.

Members of the Thesis Examination Committee were as follows:

Masrah Azrifah binti Azmi Murad, PhD
Associate Professor
Faculty of Computer Science and Information Technology
Universiti Putra Malaysia
(Chairman)

Rodziah binti Atan, PhD
Associate Professor
Faculty of Computer Science and Information Technology
Universiti Putra Malaysia
(Internal Examiner)

Rusli bin Hj Abdullah, PhD
Professor
Faculty of Computer Science and Information Technology
Universiti Putra Malaysia
(Internal Examiner)

Jemal Abawajy, PhD
Professor
Deakin University
Australia
(External Examiner)

ZULKARNAIN ZAINAL, PhD
Professor and Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia

Date: 22 September 2015
This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee were as follows:

Wan Nurhayati Wan Ab. Rahman, PhD
Senior Lecturer
Faculty of Computer Science and Information Technology
Universiti Putra Malaysia
(Chairman)

Abdul Azim Abd Ghani, PhD
Professor
Faculty of Computer Science and Information Technology
Universiti Putra Malaysia
(Member)

Abu Bakar Md Sultan, PhD
Associate Professor
Faculty of Computer Science and Information Technology
Universiti Putra Malaysia
(Member)

Novia Indriaty Admodisastro, PhD
Senior Lecturer
Faculty of Computer Science and Information Technology
Universiti Putra Malaysia
(Member)

BUJANG BIN KIM HUAT, PhD
Professor and Dean
School of Graduate Studies
Universiti Putra Malaysia

Date:
Declaration by graduate student

I hereby confirm that:

- This thesis is my original work;
- quotations, illustrations and citations have been duly referenced;
- this thesis has not been submitted previously or concurrently for any other degree at any other institutions;
- intellectual property from the thesis and copyright of the thesis are fully-owned by Universiti Putra Malaysia, as according to the Universiti Putra Malaysia (Research) Rules 2012;
- written permission must be obtained from supervisor and the office of Deputy Vice-Chancellor (Research and Innovation) before thesis is published (in the form of written, printed or in electronic form) including books, journals, modules, proceeding, popular writings, seminar papers, manuscripts, posters, reports, lecture notes, learning modules or any other materials as stated in the Universiti Putra Malaysia (Research) Rules 2012;
- there is no plagiarism or data falsification/ fabrication in the thesis, and scholarly integrity is upheld as according to the Universiti Putra Malaysia (Graduate Studies) Rules 2003 (Revision 2012-2013) and the Universiti Putra Malaysia (Research) Rules 2012. The thesis has undergone plagiarism detection software.

Signature: ______________________  Date: ________________

Name and Matric No.: Atieh Khanjani (GS31674)
Declaration by Members of Supervisory Committee

This is to confirm that:
- the research conducted and the writing of this thesis was under our supervision;
- supervision responsibilities as stated in the Universiti Putra Malaysia (Graduate Studies) Rules 2003 (Revision 2012-2013) are adhered to.

Signature: ___________________________________________  Signature: ___________________________________________
Name of Chairman of Supervisory Committee: ____________
Wan Nurhayati Wan Ab. Rahman, PhD

Name of Member of Supervisory Committee: ____________
Novia Indriaty Admodisastro, PhD

Name of Member of Supervisory Committee: ____________
Abdul Azim Abd Ghani, PhD

Name of Member of Supervisory Committee: ____________
Abu Bakar Md Sultan, PhD
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>ABSTRACT</th>
<th>i</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABSTRAK</td>
<td>ii</td>
</tr>
<tr>
<td>ACKNOWLEDGEMENT</td>
<td>iii</td>
</tr>
<tr>
<td>APPROVAL</td>
<td>iv</td>
</tr>
<tr>
<td>DECLARATION</td>
<td>vi</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>x</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>xii</td>
</tr>
<tr>
<td>LIST OF ABBREVIATIONS</td>
<td>xiii</td>
</tr>
</tbody>
</table>

## CHAPTER

1 INTRODUCTION

1.1 Background

1.2 Research Problems

1.3 Research Questions

1.4 Research Objectives

1.5 Research Scope

1.6 Research Contribution

1.7 Thesis Organization

2 LITERATURE REVIEW

2.1 Introduction

2.2 Cloud Computing

2.3 Software as a Service in Cloud Computing

2.3.1 The Emergence of SaaS

2.3.2 SaaS Features

2.4 Quality of Software

2.5 Quality of Service

2.6 Existing QoS Models for Cloud

2.6.1 QoS Models for SaaS

2.6.2 QoS Models for Other Cloud Services

2.6.3 SMI

2.6.4 Summary of QoS Models

2.7 Summary

3 RESEARCH METHODOLOGY

3.1 Introduction

3.2 Research Methodology Phases

3.2.1 Development of SaaS-QoS model

3.2.1.1 Determination of SaaS-QoS Attributes

3.2.1.2 Measurement of the Acceptability of the SaaS-QoS Attributes

3.2.2 Evaluation of the SaaS-QoS Model

3.2.2.1 Content Validity Test on Evaluation Survey by Providers

3.2.2.2 Evaluation Survey by Providers’ Perspective

3.2.2.3 Content Validity Test for Evaluation Survey by Users

viii
## LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1 Examples of IaaS, PaaS and SaaS</td>
<td>5</td>
</tr>
<tr>
<td>2.2 SMI attributes</td>
<td>14</td>
</tr>
<tr>
<td>2.3 Summary of QoS Models</td>
<td>15</td>
</tr>
<tr>
<td>3.1 Details of Respondents for the Survey on Measurement of</td>
<td>22</td>
</tr>
<tr>
<td>Acceptability of Attributes</td>
<td></td>
</tr>
<tr>
<td>4.1 Existing QoS Attributes</td>
<td>25</td>
</tr>
<tr>
<td>4.2 Combination of 29 Attributes</td>
<td>27</td>
</tr>
<tr>
<td>4.3 Level of the Respondents</td>
<td>37</td>
</tr>
<tr>
<td>4.4 Specialization of the Respondents</td>
<td>37</td>
</tr>
<tr>
<td>4.5 Years of Experience in Industry</td>
<td>37</td>
</tr>
<tr>
<td>4.6 Years of Experience in Research</td>
<td>37</td>
</tr>
<tr>
<td>4.7 Years of Experience in Academic</td>
<td>38</td>
</tr>
<tr>
<td>4.8 Frequencies and Percentages to be Agreed for the Definition of</td>
<td>38</td>
</tr>
<tr>
<td>the Five Categories by Respondents</td>
<td></td>
</tr>
<tr>
<td>4.9 Frequencies and Percentages to be Agreed for the Definition of</td>
<td>39</td>
</tr>
<tr>
<td>Agility Attributes by Respondents</td>
<td></td>
</tr>
<tr>
<td>4.10 Frequencies and Percentages to be Agreed for the Definition of</td>
<td>40</td>
</tr>
<tr>
<td>Assurance Attributes by Respondents</td>
<td></td>
</tr>
<tr>
<td>4.11 Frequencies and Percentages to be Agreed for the Definition of</td>
<td>41</td>
</tr>
<tr>
<td>Performance Attributes by Respondents</td>
<td></td>
</tr>
<tr>
<td>4.12 Frequencies and Percentages to be Agreed for the Definition of</td>
<td>41</td>
</tr>
<tr>
<td>Security Attributes by Respondents</td>
<td></td>
</tr>
<tr>
<td>4.13 Frequencies and Percentages to be Agreed for the Definition of</td>
<td>42</td>
</tr>
<tr>
<td>Usability Attributes by Respondents</td>
<td></td>
</tr>
<tr>
<td>4.14 Improved Definitions of Categories and Attributes</td>
<td>43</td>
</tr>
<tr>
<td>4.15 Other Attributes for the Categories</td>
<td>44</td>
</tr>
<tr>
<td>4.16 Final Definitions of Categories and Attributes Assigned</td>
<td>45</td>
</tr>
<tr>
<td>4.17 Classification of Attributes Based on Users' and Providers'</td>
<td>48</td>
</tr>
<tr>
<td>Perspectives</td>
<td></td>
</tr>
<tr>
<td>5.1 Frequencies, Percentages and the Median of Association between</td>
<td>51</td>
</tr>
<tr>
<td>Categories and Attributes, Applicability and Practicality of SaaS-QoS</td>
<td></td>
</tr>
<tr>
<td>Model by Providers</td>
<td></td>
</tr>
<tr>
<td>5.2 Frequencies, Percentages and the Median to be Agreed with the</td>
<td>52</td>
</tr>
<tr>
<td>Definition of Agility Attributes for Evaluating the SaaS-QoS Model</td>
<td></td>
</tr>
<tr>
<td>by Providers</td>
<td></td>
</tr>
<tr>
<td>5.3 Frequencies, Percentages and the Median to be Agreed with the</td>
<td>53</td>
</tr>
<tr>
<td>Definition of Assurance Attributes for Evaluating the SaaS-QoS Model</td>
<td></td>
</tr>
<tr>
<td>by Providers</td>
<td></td>
</tr>
<tr>
<td>5.4 Frequencies, Percentages and the Median to be Agreed with the</td>
<td>54</td>
</tr>
<tr>
<td>Definition of Performance Attributes for Evaluating the SaaS-QoS</td>
<td></td>
</tr>
<tr>
<td>Model by Providers</td>
<td></td>
</tr>
<tr>
<td>5.5 Frequencies, Percentages and the Median to be Agreed with the</td>
<td>55</td>
</tr>
<tr>
<td>Definition of Security Attributes for Evaluating the SaaS-QoS Model</td>
<td></td>
</tr>
<tr>
<td>by Providers</td>
<td></td>
</tr>
</tbody>
</table>
5.6 Frequencies, Percentages and the Median to be Agreed with the Definition of Usability Attributes for Evaluating the SaaS-QoS Model by Providers

5.7 Frequencies, Percentages and the Median to be Agreed with the Definition of Agility Attributes for Evaluating the SaaS-QoS Model by Users

5.8 Frequencies, Percentages and the Median to be Agreed with the Definition of Assurance Attributes for Evaluating the SaaS-QoS Model by Users

5.9 Frequencies, Percentages and the Median to be Agreed with the Definition of Performance Attributes for Evaluating the SaaS-QoS Model by Users

5.10 Frequencies, Percentages and the Median to be Agreed with the Definition of Security Attributes for Evaluating the SaaS-QoS Model by Users

5.11 Frequencies, Percentages and the Median to be Agreed with the Definition of Usability Attributes for Evaluating the SaaS-QoS Model by Users

5.12 Frequencies, Percentages and the Median of Association between Categories and Attributes, Applicability and Practicality of SaaS-QoS Model by Users
# List of Figures

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>Three Layer Services of Cloud</td>
<td>5</td>
</tr>
<tr>
<td>2.2</td>
<td>SaaS Features</td>
<td>9</td>
</tr>
<tr>
<td>2.3</td>
<td>Sample SaaS Architecture</td>
<td>9</td>
</tr>
<tr>
<td>2.4</td>
<td>SMI Framework</td>
<td>13</td>
</tr>
<tr>
<td>2.5</td>
<td>Seven Top-Level Categories of SMI</td>
<td>14</td>
</tr>
<tr>
<td>3.1</td>
<td>Research Methodology Phases</td>
<td>17</td>
</tr>
<tr>
<td>3.2</td>
<td>Finding Respondents</td>
<td>20</td>
</tr>
<tr>
<td>4.1</td>
<td>Initial SaaS-QoS Model</td>
<td>28</td>
</tr>
<tr>
<td>4.2</td>
<td>Percentages of Acceptability for Categories Definitions</td>
<td>38</td>
</tr>
<tr>
<td>4.3</td>
<td>Percentages of Acceptability for Attributes under Agility Category</td>
<td>39</td>
</tr>
<tr>
<td>4.4</td>
<td>Percentages of Acceptability for Attributes under Assurance Category</td>
<td>40</td>
</tr>
<tr>
<td>4.5</td>
<td>Percentages of Acceptability for Attributes under Performance Category</td>
<td>41</td>
</tr>
<tr>
<td>4.6</td>
<td>Percentages of Acceptability for Security Attributes</td>
<td>42</td>
</tr>
<tr>
<td>4.7</td>
<td>Percentages of Acceptability for Usability Attributes</td>
<td>43</td>
</tr>
<tr>
<td>4.8</td>
<td>Final SaaS-QoS Model</td>
<td>45</td>
</tr>
</tbody>
</table>
### LIST OF ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>QoS</td>
<td>Quality of Service</td>
</tr>
<tr>
<td>SaaS</td>
<td>Software as a Service</td>
</tr>
<tr>
<td>IaaS</td>
<td>Infrastructure as a Service</td>
</tr>
<tr>
<td>PaaS</td>
<td>Platform as a Service</td>
</tr>
<tr>
<td>SMI</td>
<td>Service Measurement Index</td>
</tr>
<tr>
<td>IT</td>
<td>Information Technology</td>
</tr>
<tr>
<td>NIST</td>
<td>National Institute of Standards and Technology</td>
</tr>
<tr>
<td>ROI</td>
<td>Return On Investment</td>
</tr>
<tr>
<td>EC2</td>
<td>Amazon’s Elastic Compute cloud</td>
</tr>
<tr>
<td>SLA</td>
<td>Service Level Agreement</td>
</tr>
<tr>
<td>KPI</td>
<td>Key Performance Indicator</td>
</tr>
<tr>
<td>CSMIC</td>
<td>Cloud Service Measurement Initiative Consortium</td>
</tr>
<tr>
<td>SE</td>
<td>Software Engineering</td>
</tr>
<tr>
<td>UI</td>
<td>User Interface</td>
</tr>
<tr>
<td>ISO</td>
<td>International Organization for Standardization</td>
</tr>
<tr>
<td>IEC</td>
<td>International Electronically Commission</td>
</tr>
</tbody>
</table>
CHAPTER 1

INTRODUCTION

1.1 Background

Nowadays, with merging multi-core processors and distributed computing network environments, software developers tend to use new computing paradigm such as cloud computing to provide easiest way to use computing resources similarly to public utility such as water, electricity and etc. (Buyya et al., 2011). Cloud computing is the best Internet-base computing alternative for handling Information Technology (IT) resources and utilize IT as a service (Rawat et al., 2012). There are three main service categories for cloud computing including Software as a Service (SaaS), Infrastructure as a Service (IaaS) and Platform as a Service (PaaS). Among main services of the cloud, SaaS is the most commonly heard term and one of the important branches of cloud computing which enables the application run on the cloud eliminating the installation on the personal computer at the client side (Marston et al., 2011). From the beginning of using software, the quality of software is taken into consideration. With the prevalence of SaaS cloud and increasing its popularity, considering the QoS as vital factor to distinguish the services from both user’s and provider’s side and also to user satisfaction and company profitability (He et al., 2012), (La & Kim, 2009). Moreover, QoS is crucial factor for the success of cloud computing so that if it is not delivered properly and as expected, it may tarnish provider’s reputation (Ferretti & Ghini, 2010). In addition, SaaS services are multi-tenant, therefore they are dealing with many users with different preferences and profiles and the only way to distinguish these services is to consider QoS from provider as well as user side. Therefore, researchers should pay more attention to the QoS so that the final services provided satisfy customer and bring more benefits to the providers as well. QoS for SaaS cloud services consist of many aspects involved in the business side, network side and service (application) side. Moreover, QoS includes many attributes such as customizability, availability, scalability, performance, supporting multi-tenant and etc. that can be achieved from the specific features of SaaS. Service Measurement Index (SMI) has presented a holistic view of overall cloud services attributes (Garg et al., 2011) and there are some researches which used the SMI attributes to create a QoS model for IaaS. However, although there are some QoS models for SaaS, but they considered only a few attributes and since QoS is very important in any type of cloud services specially SaaS, this motivate us to create a QoS model for SaaS based on SMI framework. Moreover, since SaaS is commonly utilized now and provides advantages rather than traditional software model, so to realize these advantages it is necessary to consider its quality and therefore manage higher level of its quality level according to the evaluation result (Akojwar et al., 2012).

1.2 Research Problems

There is a high demand for creating a quality of service model for SaaS since conventional quality models cannot effectively support specific quality aspects of SaaS such as scalability and reusability (Lee et al., 2009). However, there is a lack of
work on QoS model for SaaS since quality of service models proposed in current researches (Lee, et al., 2009; Nadanam & Rajmohan, 2012) considered a few QoS attributes only and still many aspects such as Suitability, Accuracy, Extensibility, Serviceability, Resilience, Operability and Learnability are left out. The definitions of SaaS QoS attributes are still missing and some are not well-defined. A study showed that the success of cloud services especially SaaS cannot be guaranteed and achieved without user satisfaction especially in terms of QoS (Badidi, 2013). The users, on the other hand, might not have enough knowledge and experience of what they want and not able to clarify their requirements very well. Therefore, the QoS consideration should be from both users’ and providers' perspectives to be more effective.

1.3 Research Questions

In order to contribute for proposing solutions to the stated problems, these are the research questions that need to be answered in this research:

- What is the most relevant QoS model for SaaS cloud computing?
- What are the main QoS attributes required for SaaS cloud?
- Why QoS attributes should be considered from both users' and providers’ perspectives?

1.4 Research Objectives

The main objective of this study is to propose a quality of service model for SaaS cloud services as a reference model to be used by both users and providers. The specific objectives of this research are as follow:

- To determine the QoS attributes for SaaS useful for both users and providers;
- To classify the QoS attributes into related category, specifically for SaaS;
- To verify the new definitions of QoS attributes proposed in SaaS-QoS model by experts.

1.5 Research Scope

Cloud computing is a wide range of new computing paradigm. SaaS is a kind of cloud computing services which delivers software applications as an online service usable through the Internet. The quality of SaaS services is crucial for the success of cloud SaaS services. Besides, SaaS has special features which need to be considered when it comes to quality, because the quality of SaaS is different from other types of cloud services. QoS model for SaaS cloud is important to be used by users and providers. Thus, this research is concentrating on proposing QoS model for SaaS. There are five categories for SaaS-QoS model in this research which are Agility, Assurance, Performance, Security and Usability. The categories inspired by SMI framework and every category has three or more QoS attributes.
1.6 Research Contribution

The main contribution of this research is to construct SaaS-QoS model from both users' and providers' perspectives. For this matter, QoS attributes were gathered from literature review and obtained a set of 29 attributes under five categories such as Agility, Assurance, Performance, Security and Usability. Then, the attributes were assigned to the respective categories inspired by SMI framework followed by (Buyya et al., 2011) which used SMI to create QoS for IaaS. A survey was performed to measure the acceptability of attributes and categories. Based on the result, the definition of attributes and categories and the initial SaaS-QoS model was improved and finally the final version of SaaS-QoS model consisted of 32 attributes under five categories was designed. The final version of SaaS-QoS model then, was evaluated by both users and providers through performing two surveys by SaaS providers and users.

1.7 Thesis Organization

This thesis comprises six chapters, including this introductory chapter covering the background of the study, problem statement, research objectives, scope of research, and thesis organization.

Chapter 2 reviews literature on cloud computing concepts, services in cloud computing, software as a service delivery model, importance of QoS in cloud SaaS, SMI and researches on QoS models for cloud computing specially in terms of SaaS. This chapter provides important information to be taken into consideration in an effort to meet the research goal, which is to develop a QoS model for SaaS cloud.

Chapter 3 explains the research methodology comprising constructing the SaaS-QoS model steps such as determining QoS attributes from literature and standard, performing justification for attributes, check for their redundancy, performing a purposive sampling survey for measurement of the acceptability of attributes and performing the second survey to assess the quality of service model constructed.

Chapter 4 expresses the result and outcome of constructing the SaaS-QoS model including determination of the QoS attributes for SaaS cloud, justification for those attributes, check for redundancy and the survey was done for measurement of acceptability of the attributes.

Chapter 5 explains the findings and results of model evaluation including performing a purposive sampling survey from both users' and providers' perspective to evaluate the model. Finally, Chapter 6 presents the conclusion, summary of contribution and future works of this research.
REFERENCES


