University of Alberta

A Service Quality Based Evaluation Model for SaaS Systems

by

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A thesis submitted to the Faculty of Graduate Studies and Research
in partial fulfillment of the requirements for the degree of

Doctor of Philosophy

Department of Computing Science

Fall 2010
Edmonton, Alberta

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To My Beloved Mother

Abstract

With the emergence of a new service delivery model, Software-as-a-Service (SaaS), interest in quality management in the planning and operation of SaaS systems is increasing significantly. Most current quality management approaches for SaaS focus primarily on the perspective of service provider. They largely ignore the perspective of service customer as well as the nature of ongoing business relationship between the service provider and customer. Based on an extensive exploration of this relationship, the thesis research makes contributions in the following four areas:

1. A theory of SaaS business relationships is introduced by integrating an adapted quality paradigm with the notion of value co-creation (co-value) for the service provider and customer. In the theory, we define a specification of four quality-based service types (*Ad-hoc*, *Defined*, *Managed* and *Strategic*).

2. The theory is used as the foundation for building a model that assists service customers in SaaS evaluation in support of service planning and ongoing operations.

3. Based on the model, an evaluation tool is designed and used in a particular service area. As an example, a case study is undertaken to assist the decision making of email service adoption in the University of Alberta.

4. Two surveys are conducted to assist in the building and evolution of the evaluation model, as well as in the use of an email service evaluation tool.

Acknowledgements

I owe my deepest gratitude to my supervisor, Dr. Paul G. Sorenson, whose guidance, support, enthusiasm, patience and encouragement in the past six years enabled me to develop a thorough understanding of the subject. This thesis would not have been possible without his acute academic insight and valuable suggestions.

I am also very grateful to my candidacy and thesis examination committee members, Dr. Eleni Stroulia, Dr. H. James Hoover, Dr. Janelle Harms, Dr. Ofer Arazy, and Dr. Anthony Finkelstein, for spending precious time carefully reviewing my candidacy document and thesis. Their challenging questions and invaluable comments not only provided thoughtful views on my research, but also helped me improve and complete the thesis.

My special thanks go to Abhishek Srivastava, who has been working with Dr. Sorenson and me for the last four years. As a wonderful friend rather than an ordinary colleague, he made many helpful suggestions as well as sharing his research with me.

I would like to show my gratitude to the supporting and academic staff of the Department of Computing Science at the University of Alberta for supplying a first-class research and educational environment. I would like to specially thank Edith Drummond for helping me throughout my six-year study; and Sunrose Ko and Linda Jiao for handling my travel claims.

For various reasons, I am greatly indebted to the following people during my work and life in Edmonton (in no particular order): Baochun Bai, Yuxi Li, Cheng Lei, Guohua Liu, Jiyang Chen, Dean Cheng, Zhipeng Cai, Lihang Ying, Shen Jiang, Yutong Gao, John Willson and Margarita Stewart.

Finally and most importantly, I offer my topmost blessing to my father, who has

been supporting me all the time in my life. No words can express my appreciation to him.

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Chapter 1

Introduction

This thesis develops a new SaaS evaluation model based on a theory that integrates service quality management and the notion of value co-creation (co-value) in SaaS business relationships between the service provider and customer. The evaluation model has the following features:

- It incorporates three types of quality approaches that form the basis of service quality management;
- It supports the notion of co-value in SaaS business relationships between the service provider and customer;
- It defines a specification of four service types with respect to the maturity levels of SaaS business relationships.

Based on the model, an evaluation tool is designed and used for selecting and monitoring a SaaS system in a particular service area. Surveys are conducted to assist in building and evolution of the model.

1.1 Background

In the past decade, information technology (IT) development has focused more intensely on service-oriented architecture (SOA) and Software-as-a-Service (SaaS). It is not always evident, however, that these solutions provide high quality IT service delivery. As a result, interest in service quality management in the development and

operation of IT service systems has increased in accordance with the growth in these systems.

Service quality management is related to two basic questions on how to deliver services better [53]:

1. *What is the most efficient way to produce an effective product and/or service?* Once service providers know how to improve the efficiency while addressing essential requirements, they can save time and resources, and thereby become more successful.

2. *What type of product and/or service attracts customers?* When a service provider delivers a service exactly as required by customers, the customers will reuse it and tell others about it. In this manner, service providers become more successful in knowing what they are going to deliver and how they can successfully reproduce the service every time.

The goal of service quality management is to provide lower cost, better products and services, and higher customer satisfaction. If the service providers understand what customers want from a product and/or service, define detailed specifications based on the customer needs, manage the variables in the service delivery process that can lead to deviation from specifications, and deliver the service accurately, they are properly managing service quality [53].

In practice, when existing customer expectations are not met, a new expectation benchmark must be set. This dictates a need for continuous customer-driven quality management, using approaches such as total quality management (TQM), which will be described in greater detail in Chapter 3 of the thesis.

1.2 Motivation

The growth of the web service technologies resulted in the emergence of service-oriented architecture (SOA) solutions, involving UDDI registries and QoS/SLA specification languages. The need to address service quality management in IT service systems has resulted in the development of a variety of service management

frameworks, such as IT Infrastructure Library (ITIL) [49], Control Objectives for Information and related Technology (COBIT) [33], IT Service Capability Maturity Model (IT Service CMM) [48], and Application Services Library (ASL) [55]. These yield opportunities to explore hierarchical approaches to measure and improve quality for IT services.

However, most of the current quality management approaches for IT services focus on the perspective of service providers, and thus only help us to answer the first question presented in the previous section. With respect to the view of customers, we need to take account of other approaches, such as SERVQUAL [51], American Customer Satisfaction Indices (ACSI) [21], and Balanced Scorecard [35]. A new concept called Crowdsourcing [34] also provides a possible solution to collect and manage the voices of service customers.

In the meantime, the growing maturity of the Internet and the software industry has made it possible for software vendors to deliver effective software applications as a web-based service using a new delivery model: *Software-as-a-Service (SaaS)*. SaaS applications are generally charged on a per-user basis and shared by multiple independent customers [44]. With SaaS, the service customer receives the benefits of the running software, based on clearly defined costs and service levels [64]. While successful commercial SaaS applications like Salesforce.com and Google Apps, have grown at great pace, quality management remains one of the biggest challenges for SaaS. The business characteristics of SaaS that we will present in Chapter 4 make SaaS a good candidate for the focus of a study on service quality management.

What is not emphasized in the existing literature is a quality management approach that combines the perspectives of both service provider and service customers in SaaS systems.

Therefore, at a general level, we are interested in addressing the following research problems:

1. How to explore an integrated evaluation model that takes into account the shared nature of service quality involving both the service provider and customer in SaaS systems?

2. How to best track and improve the service quality effectively by applying the model?

In addressing the first problem we will develop an initial theory of co-value in SaaS business relationships and use this as a basis for a SaaS evaluation model. In addressing the second problem we will specify the design and use of a tool to support the evaluation model.

The remainder of this thesis is organized as follows. Chapter 2 investigates and discusses other research work that has influenced our work. Chapter 3 presents a quality paradigm with the definitions and approaches on four types of service quality. Based on the quality paradigm, Chapter 4 describes a theory of co-value in SaaS business relationships between the service provider and customer. The theory is used as the foundation for developing a SaaS evaluation model. Chapter 5 presents the design of the model. In Chapter 6, an evaluation tool is built supporting the model in selecting and monitoring SaaS systems. Finally in Chapter 7, we summarize the contributions of our research and conclude with a discussion of future research extending our work in the area.

Chapter 2

Related Work

In the process of developing our SaaS evaluation model we explored a number of related models for assessing service system delivery and management. These models are relevant and complementary to SaaS evaluation; however, their scope is generally broader than SaaS systems and primarily concentrates on service delivery from the perspective of service provider. In this chapter we began by reviewing two models proposed for dealing with the SaaS maturity levels. Other related IT/SOA maturity models are sketched in section 2.3.

This chapter is mainly based on a chapter published in [2].

2.1 Microsoft SaaS Maturity Model

Microsoft introduced the first widely published SaaS maturity model in 2006 [9]. A four-level SaaS maturity model was proposed mainly to assess the maturity of single-packaged SaaS applications. According to the model description, SaaS applications can be classified by three key attributes of architectures: configurability, multi-tenant efficiency, and scalability. Each level is distinguished from the previous by the addition of one key attribute. A brief explanation of each level is as follows (see Figure 2.1 [9]):

- *Level 1: Ad-Hoc/Custom*: At the first maturity level, each customer has a customized version of the application and runs its own instance of the application on the servers hosted by the provider. Migrating a traditional non-networked or client-server application to this level typically requires the least develop-

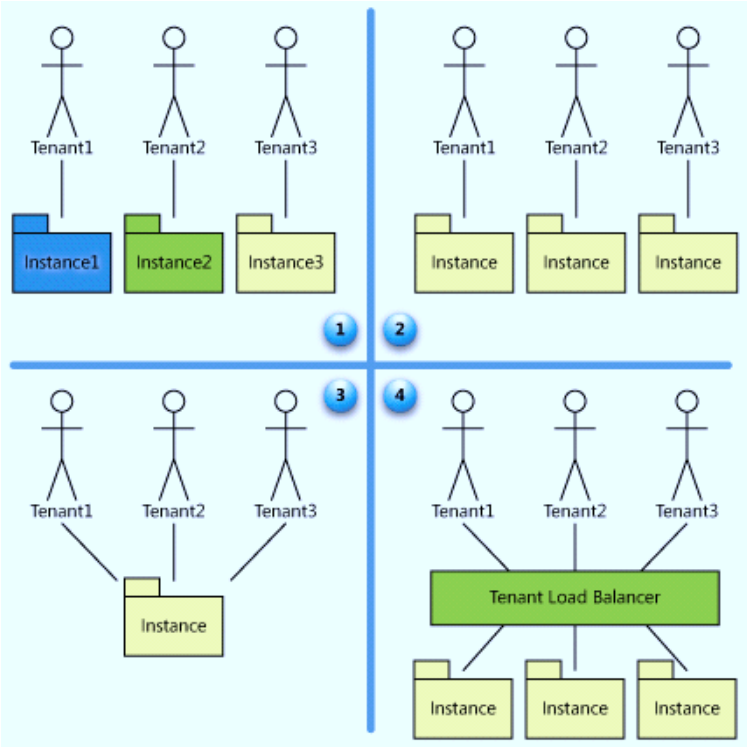

Figure 2.1: Microsoft SaaS maturity model (taken from [9])

ment effort and cuts down operating costs primarily by consolidating server hardware and administration.

- *Level 2: Configurable*: The second maturity level provides greater application flexibility through configurable metadata that enable customers to use separate instances of the same application code. This allows the provider to meet the different needs of each customer through detailed configuration options, while simplifying maintenance and updating of a common code base.

- *Level 3: Configurable, Multi-Tenant-Efficient*: At the third maturity level, the provider adds multi-tenancy support to the second level capabilities, enabling a single application instance to service all customers. This approach allows better use of the provider's server resources without any apparent difference to the customer.

- *Level 4: Scalable, Configurable, Multi-Tenant-Efficient*: Better overall scalability for the provider's service delivery is the goal at the fourth level. This is

typically achieved through a multitier architecture supporting a load-balanced farm of identical application instances, running on a variable number of servers. Effectively, a “cloud computing” [40] [23] approach is adopted by the provider to support a set of application instances. The capacity of the provider’s system can be increased or decreased dynamically to match demand by adding or removing servers without requiring changes to the application software.

2.2 Forrester SaaS Maturity Model

Forrester’s model, the other major SaaS maturity model, provides guidance on strategy transformations for software vendors working with services providers who are considering a SaaS business model. This model classifies the maturity of SaaS solutions on five levels, according to the way a SaaS system is delivered as shown in Figure 2.2 [57]:

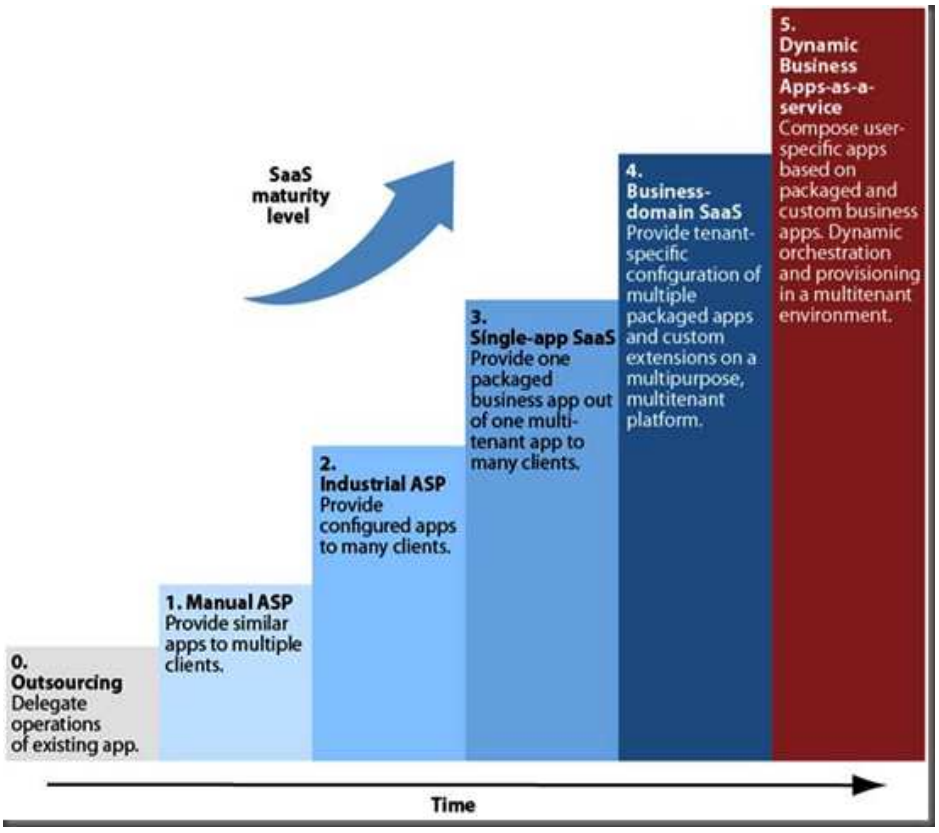

Figure 2.2: Forrester SaaS maturity model (taken from [57])

- *Level 0: Outsourcing*. In outsourcing, a service provider operates one application or suite of applications for a large customer organization. Typically an outsourcing provider is obligated under contract to the one customer and cannot directly leverage that customer's application for a second customer. Because of this restriction outsourcing does not qualify as SaaS, thus this level is not considered as a formal maturity level. It is included as level 0 because SaaS providers often launch their business operations through outsourcing arrangements with a few preferred customers.

- *Level 1: Manual ASP (Application Service Provider) Service*. The model at this level is mainly targeting midsize companies. An ASP hosts packaged applications (e.g. SAP and PeopleSoft ERPs) for multiple customer organizations. Typically, the service provider allocates to each customer a dedicated server running that customer's instance of the application. This allows, as deemed necessary, the ability for a provider to customize the installation in the same way as self-hosted applications.

- *Level 2: Industrial ASP Service*. At this level, an ASP introduces advanced IT management software to provide identical packaged application with customer-specific configuration options to many small-to-medium sized customer organizations. A key element of the industrial ASP service is that the core elements of software package are the same for all customers and therefore a significant amount of the operating costs can be shared amongst multiple customers.

- *Level 3: Single-app SaaS*. From this level on, SaaS capabilities become built into the business applications. These include web-based user interface access to all services and the ability to service a great number of customers with one scalable infrastructure. Single-application SaaS adoption focuses on small-to-medium size businesses. Like the industrial ASP service of level 2, the only way to customize the application is through configuration. Salesforce.com's customer relationship management (CRM) application initially entered the market at this level [57].

- *Level 4: Business-domain SaaS*. At this level, the SaaS provider offers not only well-defined business applications but also a platform supporting additional business logic. This allows the single-app SaaS of level 3 to be augmented with third-party packaged SaaS solutions and optional customized extensions. The model can now satisfy some of the requirements of large enterprises by migrating a whole business domain like "customer care" to a SaaS solution.

- *Level 5: Dynamic Business Apps-as-a-service*. At this level, Forrester's model claims that a new Dynamic Business Application imperative "design for people, build for change" is embraced. Advanced SaaS providers coming from level 4 will offer a comprehensive application as well as an integration platform on demand, and pre-populate the platform with business applications or business services. Customer-specific and even user-specific business applications at various levels can be composed dynamically. The resulting process agility should be attractive to everyone, including large enterprise customers.

2.3 Other Maturity Models

Apart from the SaaS maturity models discussed above, there have been many other models and specifications of best practices defined for IT maturity evaluation.

Frank Niessink et al.'s IT Service CMM (IT Service Capability Maturity Model) [48] is a maturity model that enables IT service providers to assess and further improve their capabilities with respect to the IT service delivery. The structure of the model is similar to that of CMU/SEI's Software CMM (Capability Maturity Model) with five maturity levels: *Initial*, *Repeatable*, *Defined*, *Managed* and *Optimizing*, yet the contents are focused on the key process areas needed for provisioning mature IT services. Like the Software CMM, the model provides a clear guideline and introduces practical assessment approaches to determine and improve the maturity of the organization. However, the model only aims at the implementation of service processes within service provider organizations, and largely ignores service quality from the perspective of service customers.

The OGC (Office of Government Commerce)'s Information Technology Infrastructure Library (ITIL) [49] is a framework of best practices in information technology primarily focusing on IT service strategy, design, transition, operation, and improvement. It has been adopted worldwide as one of the most popular service level standards in IT organizations. Instead of using ordered levels and process areas as in the IT Service CMM, ITIL organizes the processes as areas of best practices and describes the details of process implementation and activities. Although ITIL provides some general guidance to sourcing strategies and externally delivered services, its main emphasis is on the delivery of IT services in-house by the Information Technology department.

The adoption of SOA solutions in IT requires more specific maturity models to assess the SOA implementation and identify the SOA business value. Sonic Software's SOA Maturity Model (SOA MM) [15] is one such model, defining maturity levels with key business impact within the organization. The model was extended to consist of five aspects by Inaganti and Sriram's Model [31]: Scope of SOA Adoption, SOA maturity levels, SOA expansion stages, return on SOA investment, and SOA cost effectiveness and feasibility. Other SOA maturity models specialized in different areas of IT services include: IBM's SOA integration model [3] for SOA integration and HP's SOA domain model [13] for SOA domain management.

Although these models are relevant and complementary, they are focused on the deployment of IT services, and are not directly relateto our narrower focus on SaaS evaluation.

2.4 Summary

Table 2.1 lists similarities and some distinct differences between the two SaaS maturity models from Microsoft and Forrester. Both models describe a set of greater capabilities needed by the SaaS provider to manage common software architectures and infrastructure as the levels of maturity increase. Microsoft's model focuses on the increased capabilities of a SaaS deployment through the re-architecting of single application packages delivered on common infrastructure. These capabili-

ties are embodied in three key attributes: configurability, multi-tenant efficiency, and scalability. Forrester's model takes an evolutionary approach that provides prescriptive guidance to software vendors and service providers in the transformation of enterprise-wide software. If we restrict our attention to single application deployment of SaaS, levels 1 through 3 have significant similarities in the two models. The major difference at level 4 is the support for software across an entire business domain in the Forrester's model. Level 5 of the Forrester's model appears to have no counterpart in the Microsoft's model. A scan of the SaaS literature indicates that there is likely no SaaS implementation that would be rated at Forrester's level 5 in existence today.

An important observation of these SaaS maturity models is that neither focuses on the service quality. Without the ability to assess the quality of service delivery, the decision makers (i.e., the service customers and the service providers) will have a difficult time planning and managing service improvements. In addition, these models largely ignore the perspective of service customers, and only emphasize what the service provider can do. It is our strong belief, based on the two fundamental assumptions about service systems identified in chapter 1, that it is necessary to incorporate the perspectives of both the service provider and customer in any SaaS evaluation model.

Table 2.1: Summary of SaaS maturity models

Maturity Level	**Microsoft SaaS Maturity Model (2006)**	**Forrester SaaS Maturity Model (2008)**	**Configurability**	**Multi-tenant Efficiency**	**Scalability**
Features	Focused on SaaS application architecture and three key attributes: Configurability, Multi-tenancy, Scalability	Guidance on realistic strategy transformation for software vendors and service providers considering a SaaS business model			
Level 0		Outsourcing			
Level 1	Ad-hoc	Manual ASP			
Level 2	Configurable	Industrial ASP	×		
Level 3	Multi-tenant efficient	Single-app SaaS	×	×	
Level 4	Scalable + custom extension	Business-domain SaaS	×	×	×
Level 5	Scalable + dynamic composition	Dynamic Business-domain Apps-as-a-Service	×	×	×

Chapter 3

Quality Paradigm in IT Services

The definition of "quality" has been addressed and discussed for a long time in a number of academic and industrial publications. In his seminal work on quality, David Garvin identified five major perspectives to the definition of product quality [22]. Unfortunately, in modern-day IT systems it is difficult to separate product quality from service quality. As a result, a product-based view of quality, while considered in this research, was not explicitly adopted. For service quality in IT systems, especially in SaaS systems, we examine the following four quality types based on the work in [27] [56] [6]:

- *Conformance Quality*: Equivalent to many aspects of a combination of Garvin's product-based and manufacturing-based perspectives focusing on conformance to specifications. Typically the focus is internal and on determining that performance matches original design specifications. In IT service systems conformance quality is often expressed in service level agreements (SLAs).

- *Gap Quality*: Equivalent to Garvin's user-based perspective focusing on whether customer expectations are met or exceeded. This is the most pervasive definition of quality particularly as applied to business management. It is typically complex to define but is important in determining a quality improvement strategy.

- *Value Quality*: Equivalent to Garvin's value-based perspective focusing on the direct benefits (value) to the customer. It is a universal measure for widely

differing types of objects, and can be an appropriate guideline for continuous quality improvement.

- *Excellence Quality*: Equivalent to Garvin's transcendent perspective focusing on recognition of excellence. It stresses the features and characteristics of quality, but it may change dramatically and rapidly. In IT services, excellence quality is marked by uncompromising standards and high performance, and can be used directly as promised and advertisement.

In order to construct a better understanding of service quality for both the SaaS product and service support, we briefly review the total quality management (TQM), a process improvement strategy, on which our evaluation model is based. We then analyze each quality type, as defined above, with respect to the quality measurement and improvement approaches, especially for SaaS systems. Finally, we summarize the characteristics of the four quality types in the form of a quality paradigm.

3.1 Total Quality Management (TQM)

TQM started in early 1980s and was originally introduced in managing product quality in manufacturing industries. The term TQM refers to a broad set of management and control processes designed to focus on an entire organization and all of its employees in order to provide products or services that are the best possible in satisfying the customer. According to [59], TQM means that the organization's culture is defined by, and also supports the constant attainment of customer satisfaction through an integrated system of tools, techniques and training. This involves the continuous improvement of organizational processes, resulting in high quality products and services. Thus, TQM is customer-focused and incorporates the concepts of product quality, process control, quality assurance and quality improvement.

Since its inception, TQM has had a dramatic impact on the creation of quality standards for a large number of industries including information technology. In this sense, TQM is a fundamental concept for the study of service quality management.

The traditional TQM strategy is defined as a four-step service quality improvement cycle depicted in Figure 3.1:

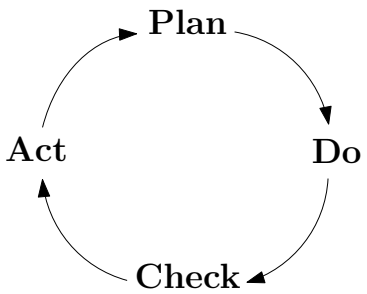

Figure 3.1: TQM cycle

1. "Plan" refers to identifying the improvement opportunities and planning a change for the improvement;

2. "Do" refers to testing the changes based on the plan, often on a small scale, and collecting the resulting data;

3. "Check" refers to reviewing the results from the "Do" step, and verifying whether the changes resulted in the desired improvement;

4. "Act" refers to studying the results and redefining the systems. The cycle is repeated with a refined plan if the observed effects do not conform to the desired improvement. Otherwise the experience is used for building new improvements in the plan, and the cycle is restarted.

The cycle prescribes a process for quality improvement that can be adapted and used as the one of important factors for analyzing the quality types in the following sections.

3.2 Conformance Quality

From the perspective of the conformance to specification, quality is quantified as an objective measurement on performance from established standards. According to this definition, an organization can monitor the quality of IT services by measuring

how well the delivery of those services conform to the established specifications. With this approach, analysts can use objective measurements to define and assess levels of quality in IT services, across companies and over time.

With the focus only on quantifiable measurement, the tasks to manage conformance quality in IT services include [56]: (a) establishing a means of defining quality requirements; (b) correctly translating the requirements (or guarantees) into specifications/standards; and (c) monitoring, reporting and analyzing the performance against the specifications by measurement.

At least two types of existing approaches in IT services can be applied to manage conformance quality. The first is to define a QoS/SLA specification language [17] in which the quality requirements, quality capabilities and quality agreements are expressed and managed. The second is to apply service level standards such as ITIL [49] and IT Service CMM [48]. As we have seen in Chapter 2, these approaches usually focus on processes rather than service performance measurements, and generally ignore the service customer's perspective. Since our evaluation model incorporates the perspectives of both the service provider and customer, we will focus on the specification language approaches. Further details will be discussed in the following subsections.

The measurement against specifications of service levels does not by itself provide guidelines on how to perform quality improvement. In addition, it may be easy to define the quality specifications for an IT product, but more difficult or in appropriate for service support, especially when a high degree of human interaction is involved. Conformance quality facilitates measurement and assurance, which is necessarily but not sufficient to support service improvement. Specifically, conformance quality is focused on sufficiency of performance and is not necessarily TQM-focused in order to achieve service improvement from the customer's perspective.

In reviewing the literature we see that existing models for managing conformance quality must be able to support the definition, measurement and monitoring of QoS/SLA specifications. In particular, a service-oriented specification language should meet the following requirements [17]:

- It should be extensible and XML-based;
- It must allow more complex specifications than simple bounds;
- It must include failure and non-compliance semantics;
- It cannot exist in isolation.

The extensibility and support of complex specifications makes it possible to integrate service level standards like ITIL [49]. Therefore, it is necessary to examine the representation and features of the QoS/SLA specification languages according to these requirements.

3.2.1 Web Service Level Agreement (WSLA)

One of the candidate languages, IBM's Web Service Level Agreement (WSLA) [46], already goes some way to meeting all of the criteria and is widely adopted in QoS-related activities. IBM developed a WSLA framework [38] that provides a number of ways of establishing an SLA including i) the service provider offering a service with a fixed SLA, ii) the service provider offering a service with differing SLAs, and iii) an SLA being fully negotiated between the parties.

An SLA defined in the WSLA language contains three sections:

- *Parties* section: describes the parties (service provider, customer and/or optional third side parties) involved in the management of the Web service.
- *Service Definition* section: describes one or more services applicable to the SLA.
- *Obligation* section: defines the service level that is guaranteed with respect to the SLA parameters provided in the service definition section.

The WSLA language is extensible, but the details of SLA negotiation are not specified in WSLA. It remains to be seen whether it gains widespread use and support.

3.2.2 Web Services Management Language (WSML)

HP's Web Services Management Language (WSML) [58] is another prominent candidate for an SLA specification language. It was introduced in Open View Internet Services and specified SLAs in a Web service QoS parameter specification model. The SLA emphasizes precision, flexibility, and instant reporting when SLA violations occur.

An SLA defined in the WSML language contains two sections:

- *Basic Information*: defines SLA **name**, **start date**, **end date**, **next evaluation date**, **service provider** and **service consumer**.
- *Service Level Objective (SLO)*: describes a set of service level objectives (**SLO**). An SLO has typically a **day/time constraint** (day, start time and end time) and a set of clauses that provide the details on the expected performance.

Automated SLA compliance monitoring is realized with the Business Management Platform Agent, a third party in the agreement. Furthermore, QoS-aware service choice is achieved through dynamic service ranking according to the different effects that the SLAs in question have on a composite business process. Processes are simulated in HP's Business Process Simulation Environment on the basis of Service Level Information (SLI) provided by service providers.

3.2.3 Web Service Offering Language (WSOL)

While both WSLA and WSML focus on the specification of individually negotiated customized SLAs, Web Service Offering Language (WSOL) [63] enables distinct service offerings for one Web service. WSOL was defined by a research group from the Carleton University. In WSOL, the service offering is defined as a formal specification of one class of Web service. As service offerings are determined by combination of various constraints, WSOL enables formal specification of functional constraints, some non-functional constraints, simple access rights, price, and relationships with other service offerings of the same Web service.

WSOL is defined using an XML schema and is compatible with the WSDL (Web Services Description Language) 1.2 standard. It contains a list of service offering consisting of a set of constraints, statements and constraint groups that all refer to a Web service.

The main benefits of WSOL are its expressive power, reduction of run-time overhead and orientation towards management applications. It can be actually used for monitoring, metering, management, accounting, billing, and dynamic adaptation of Web services and Web service compositions.

3.2.4 Web services QoS (WS-QoS) Framework

The Web services QoS (WS-QoS) framework developed in [62] provides a specification on the QoS properties. The approach enables an efficient and dynamic QoS-aware selection and monitoring of Web services. QoS issues related to web services are investigated and a prototype is implemented with following functionalities:

- QoS properties associated with Web services that can be expressed by application developers through an API or using a graphic user interface (GUI).
- Requirement manager for retrieving and updating client application QoS requirements.
- Web service broker for dynamic and efficient service selection.
- Monitor for checking the compliance of service offers.
- QoS proxies that map the QoS requirements from the Web service and application layer onto the actual QoS-enabling network technology at runtime.

Both QoS offers and requirements are defined with the WS-QoS XML schema, which contains three kinds of XML documents:

- **WSQoSRequirementDefinition** element specifies service client's QoS requirements.

- **WSQoSOfferDefinition** element contains one or more specifications of QoS offers that a service provider is willing to deliver at a price related to a certain QoS level.

- **WSQoSOntology** element holds definitions of custom QoS parameters and protocol references.

By introducing the WS-QoS XML schema and the web service broker, the WS-QoS architecture allows QoS integration and selection for Web services. Furthermore, the WS-QoS monitor helps users to check the compliance of service offers and to identify inappropriate definitions of QoS requirements. The shortcoming of this approach is that WS-QoS XML schema has no formally defined semantics and therefore the semantics would be open to misinterpretation by developers [18]. Moreover, it is not possible to define the SLA documents in the WS-QoS Framework.

3.3 Gap Quality

From the perspective of defining the gap between the quality of service provided and the quality of service expected, quality is perceived and evaluated as the extent to which a service meets and/or exceeds the expectations of customers. This can be both one of the most complex and most accurate ways to define quality. There is a strong belief that in the marketplace, only customers can articulate how well a service works and how useful they find the service [56]. Using a gap quality approach, it is possible to capture the most important parts of services for customers rather than establishing standards or specifications in support of a service management that may not reflect customer expectations. Therefore, most marketing researchers have concentrated on this perspective.

Many approaches that manage gap quality use the Gaps Model of Service Quality [65]. Some approaches measure the gaps explicitly by considering both customer perceptions and expectations, such as SERVQUAL [51], ACSI [21] and TechQual+ [8]. Other approaches only consider customer perceptions, such as

SERVPERF [16] and the Software Customer Satisfaction Evaluation Model [43]. Further details will be discussed in the following subsections.

Gap quality is usually evaluated using customer interviews and/or surveys, and therefore should be responsive to marketing changes. In IT services, it can be measured on both product and service support. However customers, particularly those with little user experience, often do not know what their expectations are. In practice, the expectations such as preferences of interface also vary over time. As a result, the improvement plan sometimes cannot be defined accurately. Therefore, gap quality can be viewed as an approach that partially supports a TQM focus.

3.3.1 Gaps Model of Service Quality and SERVQUAL

The Gaps Model of Service Quality [65] defines a framework to identify service quality in the form of gaps that indicate how much customer expectations are exceeded or not met. The Gaps Model approach is supported by the SERVQUAL instrument [51] to measure the difference between perceived quality and expected quality. SERVQUAL is widely used in service management.

SERVQUAL is a survey based assessment designed to be administered to service customers. The basic form of the questionnaire consists of 21 pairs of statements about factors that a service provider delivers. The first set of statements measures the customer expectations of the service level. The second set measures the customer perceptions of the service level. The 21 statements in each set are grouped into five interrelated dimensions: (1) tangibles, (2) reliability, (3) responsiveness, (4) assurance and (5) empathy. For each pair of statements, the difference between the perception and expectation is calculated as a gap score. The average of these gap scores is the SERVQUAL overall quality score.

A later version of SERVQUAL [52] asks respondents to comment on a series of statement from three contexts: minimum service expectations, desired service expectations, and the perception of service performance. Many researchers prefer the three-column form because it re-conceptualizes the expectations into desired and minimum expectations.

Many approaches have been used to integrate and modify SERVQUAL to work

as a measurement tool in various aspects of IT services, such as [39], [45], [54]. Based on this work, one shortcoming of SERVQUAL instrument is that it requires customers to remember the expectation before their use of a service. This is typically difficult to do given that, in many instances, customers may not have had or remember their initial expectations. Some other models that do not use or emphasize expectations appear as good substitute instruments, such as SERVPERF (which only measures by perceived quality) [16] and American Customer Satisfaction Indices (ACSI) model [21].

3.3.2 American Customer Satisfaction Indices (ACSI)

ACSI provides an evaluation model to measure impact from both perceived quality and customer expectations on customer satisfaction. It uses a multiple indicator approach to measure the following six latent variables:

- *Overall Customer Satisfaction (ACSI)*: the overall customer satisfaction with a particular product or service support.
- *Customer Expectation*: the served market's prior consumption experience with the firm's offering.
- *Perceived Quality*: the served market's evaluation of recent consumption experience.
- *Perceived Value*: the perceived level of product quality relative to the price paid.
- *Customer Complaints*: The voices from customers when they are dissatisfied with the product or its service support.
- *Customer Loyalty*: The confidence and future option of exiting from customers.

The overall customer satisfaction is embedded in a chain of relationships running from three antecedents of overall customer satisfaction (customer expectation,

perceived quality and perceived value) to the two consequences (customer complaints and customer loyalty). The primary objective in estimating this model is to explain customer loyalty.

ACSI was originally designed to be representative of the American economy as a whole, but now it can be used to evaluate the performance of any firm. The firm interviews the customers with the customer satisfaction questionnaire. Each questionnaire contains a set of 10-scale or 100-scale questions related to 15 measurement variables. These measurement variable are used in the model estimation to identify the associated latent variables.

3.3.3 Higher Education TechQual+

The Higher Education TechQual+ Assessment [8] (abbreviated TechQual+) is a web-based survey modeled on the existing SERVQUAL [51], IS SERVQUAL approaches [39] and LibQual+ model [50]. The goal of the instrument is mainly to assess technology services on campus for institutions of higher education.

TechQual+ consists of multiple questions grouped into separate focus areas. The focus areas are designed to assess some or all of these six categories of services: (1) inclusive planning, (2) connectivity and access, (3) campus information systems, (4) web presence, (5) service support, and (6) computing and classroom technology.

Each of these focus areas usually includes five separate questions that refer specifically to service dimensions corresponding to the focus area. For each question, respondents are requested to rate the service dimension by indicating the following three values based on a rating scale:

- *Minimum Service Level Expectation*: the number that represents the minimum level of service that the respondent finds acceptable.
- *Desired Service Level Expectation*: the number that represents the level of service that the respondent personally wants.
- *Perceived Service Performance*: the number that represents the level of service that the respondent believes is currently provided.

Although TechQual+ provides a suitable instrument that can be used to track the quality of technology services from the perspective of customers, it is highly focused on technology organizations in higher education and thus hard to extend or adapt to general IT services and, in particular, to SaaS.

3.3.4 Maturity Model and Evaluation System of Software Customer Satisfaction

The maturity model and evaluation system of software customer satisfaction, introduced in [43], shows a good example on how to assess qualities of product and service support respectively and hierarchically in IT service.

The maturity model of software customer satisfaction is based on an assumption that customer satisfaction is determined by the combined perception of a software product and its service and therefore considers both of them as highly related. It can be viewed as an integration of IT Service CMM [48], SERVPERF [16] and ACSI model [21]. Four maturity levels of software customer satisfaction are defined as: (1) initial level, (2) ready-made level, (3) tailored level and (4) customer-oriented level. Each maturity level of software customer satisfaction is described in three aspects:

1. the extent of collection and reflection of customer opinions;
2. the decision factors of product customer satisfaction;
3. the decision factors of service customer satisfaction.

Based on the maturity model, an evaluation system of software customer satisfaction consists of an evaluation framework, evaluation factors, evaluation attributes, and evaluation indices. The evaluation framework of software customer satisfaction is divided into two parts: (1) product satisfaction; and (2) service satisfaction.

Evaluation factors like technology and functions are measured in product satisfaction. Various software service issues such as installation support, education and training, maintenance and repair, and customer care are measured in service satisfaction.

In the framework, two levels of attributes are developed for product satisfaction and service satisfaction. Evaluation indices for measurement are generated from the second-level attributes. The model defined six first-level attributes, fourteen second-level attributes and thirty-eight evaluation indices. These indices are then measured with fifty-four measurements used in designing the questionnaires and conducting the interviews.

The approach helps software providers or companies to evaluate their present customer satisfaction levels and trace any changes in customer satisfaction levels so that the company can understand customer requirements more precisely. Furthermore, the observed values of software customer satisfaction can be utilized in the development of new products and services, corresponding marketing strategies, and related decision making.

3.4 Value Quality

From a value perspective, quality includes aspects of both cost and benefit. This observation comes directly from the marketplace, where the consumption of services is based on both price and perceived usefulness. In IT services, especially in SaaS, value quality allows one to compare explicitly disparate product and service support. This capability can help build the service strategy.

Considering value quality of SaaS systems enables the business to achieve lower costs and higher revenue. It can also improve efficiency in the service delivery. For example, in ITIL, a set of processes and best practices is defined in service level management (SLM). Combined with effective financial management, the improvement in service quality and the reduction in service disruption achieved through effective SLM can ultimately lead to significant financial savings [49].

Value quality can be linked to strategic partnership between the service provider and customer, because the approaches on value quality use more business-oriented measurements that should provide greater insight into business goals and objectives. Several useful approaches in this regard include Economic Value Added (EVA) [10], Economic Value Sourced (EVS) [24], Balanced Scorecard [35], Customer

Index [19] and Applied Information Economics (AIE) [30]. Further details will be discussed in the following subsections.

Both product and service support can be measured with value quality. It can be appropriately used in TQM focused quality improvement, although the differentiation between constructs of product quality and value, and weight of individual components of value judgment needs to be complemented by conformance and gap quality approaches.

According to [37], none of the traditional IT measurements (e.g. MIPS, uptime, utilization, cost) directly lead to the achieved business goals or affect company strategy in a major way. Thus, it can be argued that it is necessary to use more business-oriented measurements to assess the real value of IT Services. Several approaches and tools used in areas such as financial accounting may be applicable to IT services.

3.4.1 Balanced Scoreboard

The Balanced Scorecard method [35] aims to establish a direct link between business strategy and overall business performance. It does this by balancing the standard financial indicators against essential qualitative indicators such as customer relationship, operational excellence, and the organization's ability to learn and improve. Thus, the Balanced Scorecard allows for continuous assessment of the intangible value of information access and management.

In the organization's "scoreboard" there are three or four appropriate metrics for each of the four scorecard perspectives, which are: (1) financial, (2) customer, (3) internal business process, and (4) learning and growth.

Three types of metrics are specifically customized to an individual organization's particular environment:

- Metrics used to describe internal technical functions, such as reliability and defect rate. These measures are easy to aggregate into information elements that can help technical managers assign value to the security aspect of the IT function.

- Metrics that form the ingredients of comparisons or "report cards", such as operation costs broken out on a per-user basis. These are intended for use by senior executives.

- Metrics that are intended for use by the business side, such as cost and budget projections. These measures allow an organization to estimate the business impact of a given activity.

With these metrics, the Balanced Scorecard allows an organization to value all of its assets in a balanced manner. It encourages the organization to collect data or analyze existing information formulated from discrete measures to support the relative valuation of its information assets.

In IT organizations, a measurement system similar to the Balanced Scorecard called IT Scorecard [42] is sometimes used to track the IT operation's financial contribution and alignment with corporate strategies. This approach focuses strictly on IT and defines the metrics that characterize the business benefits from IT. The IT scorecard incorporates five perspectives: (1) mission, (2) customer, (3) internal process, (4) technology, and (5) people/organization [4].

3.4.2 Applied Information Economics (AIE)

Applied information economics (AIE) [30] is a decision analysis method built on several methods from decision theory and risk analysis. Even though AIE is a theoretically well-founded set of techniques, it is a very practical approach. All output from an AIE analysis is in support of specific practical business objectives.

Methods used as part of a fully documented formal procedure in AIE include: *"Unit of Measure" Definitions*, *Uncertainty Analysis*, *Calculation of the Economic Value of Information* and *IT Investments as an Investment Portfolio*.

The AIE analysis method is conducted using the following five steps [30]:

1. *Scope the decision model*: The objectives are to provide a brief description of the investment decision by listing the benefit elements, the cost elements, and the identified risk factors.

2. *Build decision model*: The objectives are to convert the intangible costs and benefits into tangibles, and construct the cost/benefit model.

3. *Conduct measurement*: The objective is to provide an estimate of the probable values for each parameter in the cost/benefit model.

4. *Conduct risk/return analysis*: The objective is to identify whether the expected return is enough to justify the risk according to the organization's investment criteria.

5. *Provide recommendations*: The objectives are to summarize the results of the assessment and provide clear recommendations to support the decision-making process.

3.4.3 Crowdsourcing

Crowdsourcing is a recent phenomenon that represents the act of a company or institution taking a function once performed by employees and outsourcing it to an undefined (and generally large) network of people in the form of an open call [34]. Examples that take advantage of crowdsourcing include creating products (like Wikipedia), predicting markets (like Yahoo! Buzz), and organizing data (like Google).

Applied to quality improvement, crowdsourcing can be viewed as the deployment of customers (crowds) to leverage new (or future) innovation as part of a collaborative service delivery strategy. It is potentially a strategic approach to capture value quality. The following rules must be considered when using crowdsourcing [5]:

1. Crowds should operate within constraints. To harness the collective intelligence of crowds, there need to be rules in place to maintain order.

2. A core team (or single expert) is sometimes required. The core team can provide the necessary guidance and make the ultimate decision to prevent crazy ideas from wreaking havoc on the product and/or service support.

3. Crowds must retain their individuality. The group is encouraged to disagree, and any members of the group should not disproportionately influence the rest.

4. Crowds are better at vetting content than creating it. It is important to note that in most of the examples mentioned above, the group merely votes on the final product; they do not actually create it.

3.5 Excellence Quality

From the perspective of excellence, quality means investment of the best skill and effort possible to produce the best possible results [56]. For example, to buy Rolex watches, target customers may want to pay extremely high prices for what is perceived as a best brand in the market. Excellence quality as applied to a product or service is marked by uncompromising standards, high performance, and use directly as promised in the advertisement. Therefore, it focuses mostly on market perceptions and not necessarily on customer needs.

Excellence quality offers little guidance to IT managers, because the definition of excellence is difficult to articulate and agree upon universally. Researchers also find it difficult to measure and compare the impact of excellence quality on the performance of product and service support. The concept of excellence in the view of marketing can be volatile and thus hard to measure for both product and service support, which makes its application to quality improvement strategies very difficult. It is not really TQM-focused.

3.6 Summary

The quality definitions and approaches discussed in this chapter can be summarized as a quality paradigm shown in Table 3.1.

From the table, we see that the first three quality types (*Conformance*, *Gap* and *Value*) have direct relevance to the quality of SaaS delivery. Furthermore, *Gap Quality* and *Value Quality* can be used as part of a continuous improvement strategy for SaaS delivery. Because of its inherent focus on the performance of the

service provider, conformance quality is more difficult to incorporate as part of a continuous improvement strategy for customers. We did not examine in detail the characteristics of the *Excellence Quality* because it offers little guidance in identifying quality improvement opportunities. Therefore, we focus only on the first three quality types in our research work [6] [7]. The rest of this thesis will only consider these three quality types for the service quality management of SaaS systems. The term “service”, unless explicitly stated otherwise, will refer to SaaS in the following chapters.

Table 3.1: Quality paradigm in IT services

Quality Type	**Conformance Quality**	**Gap Quality**	**Value Quality**	**Excellence Quality**
Strengths	Facilitates precise measurement and assurance	Evaluated by the customers and accurate in marketplace, making it possible to capture the most important parts of services for customers	Valuation can really help determine the aspects of quality improvement	Can be used directly as promised in the advertisement
Weaknesses	- Does not provide guideline on how to perform quality improvement for the service customer	- Complex to define and measure - Customers may make choices by a number of features and characteristics that may not be improvable	- The constructs of quality and value are different - The weight of individual components of value judgment is difficult to determine	- Hard to define in advance, measure and compare
Measurability	Straightforward to measure for product and service support	Complex to measure for both product and service support	Relatively easy to measure for both product and service support, but business tools and analysis are required	Hard to measure both product and service support
Improvability	Focus is not on TQM from customer perspective	Partially TQM-focused	TQM-focused	Marketing focused with little guidance for improvement, not TQM-focused
Example Measures	Availability, Reliability, Accuracy, Efficiency	Usability, Adaptability, Changeability	Cost, ROI, Risk estimate and management	No accepted IT measures
Approaches	QoS/SLA specification languages (WSLA, WSML, WSOL)	SERVQUAL, ACSI, TechQual+	Balanced Scorecard, AIE, Crowdsourcing	No IT metrics-based approaches

Chapter 4

Towards the Theory of SaaS Business Relationships

In this chapter, we introduce a theory of value co-creation (co-value) in SaaS business relationships between the service provider and customer, which will be used as the foundation for developing our SaaS evaluation model in Chapter 5. We begin proposing our theory with a discussion of quality management and co-value in SaaS business relationships. Using the characteristics of these business relationships combined with the quality paradigm presented in Chapter 3, four SaaS service types are defined as *Ad-hoc*, *Defined*, *Managed* and *Strategic*. We conjecture that when the business relationship moves from *Ad-hoc* to *Strategic*, more quality measures will be emphasized. This conjecture is validated by a web-based survey with a selected group of service customer organizations.

The first three sections of this chapter are mainly based on a chapter published in [2].

4.1 Quality Management in SaaS Business Relationships

In order to build the SaaS evaluation model supporting the views of both the service provider and customer, we need to examine how the quality types discussed in Chapter 3 are managed in SaaS business relationships between the service provider and customer. Two of these relationships, presented from a provider organization's view, are shown pictorially in Figure 4.1.

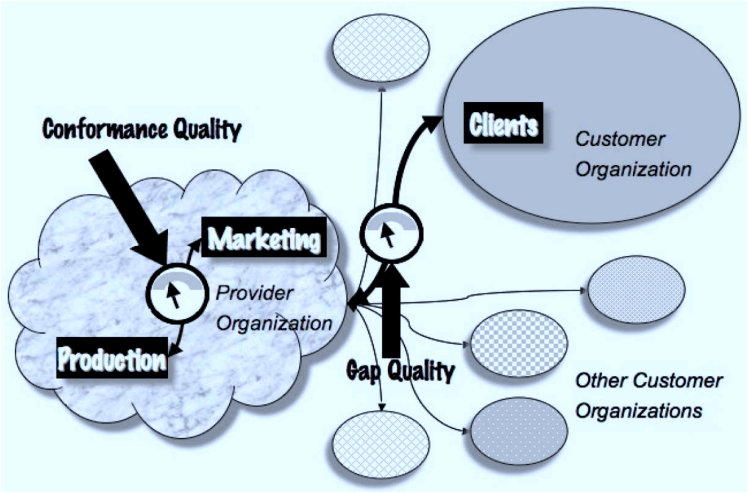

Figure 4.1: Provider's view of a SaaS business relationship

The relationships labeled *Conformance Quality* and *Gap Quality* are depicted as measures in the diagram. These are measures that should be managed by service providers as part of their business relationship with their customers. In most service arrangements, conformance quality is expressed in service levels agreed upon with the client. With SaaS, service levels are often advertised in advance as part of the provider's marketing strategy and finalized under contract when a service sales agreement is reached with the customer. Therefore, in SaaS the focus on conformance quality aspects such as service availability, response time, transactions per minute, etc. are usually negotiated and agreed to up front between the production department (responsible for running service support) and the marketing and sales departments of the provider organization.

Providers are also involved in gap quality measurements with customer organizations. Typically, gap quality concerns related to ease of use, responsiveness to failures, and user training are determined by the provider using survey tools involving the customers. This form of user input identifies gaps between what the customers are experiencing in using a service and what they would like to be experiencing. This feedback is critical if a provider wishes to improve their service.

The customer organization's view of SaaS business relationships is shown in Figure 4.2 in which two relationships are depicted. The first, named *Functional*

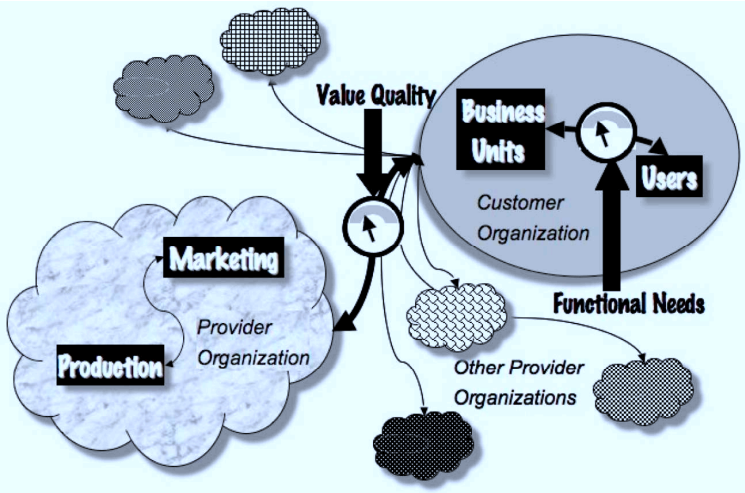

Figure 4.2: Customer's view of a SaaS business relationship

Needs, expresses the user requirements for supporting their workplace activities in the customer organization. The Business Units of the customer organization usually consults with their users to determine if these service requirements can be met through a service offering by one or more service providers.

The second relationship, labeled as *Value Quality*, captures the value the customer organization places on deploying a service using a SaaS. The value quality approaches mentioned in Chapter 3, which use ROI (Return on Investment) and risk analysis, exemplify value-based measurements. These measurements can be used in a customer value proposition (CVP) where the provider promises the total benefits a customer will receive.

In the discussion of this section, the *Functional Needs* represent the required support for the business activities of the customer organization. From the SaaS aspect, we use the term *functionality* to express the functional attributes of the service, and *quality attributes* for all the non-functional attributes measured by *Conformance Quality*, *Gap Quality* and *Value Quality* approaches. *Functionality* and *quality attributes* compose the *service attributes* that are used in service selection and/or service monitoring. In particular, a *service attribute* is defined as a property of a service that is quantified and measured by the service provider and customer. *Service attribute* is an important term used in our theory of co-value in SaaS busi-

ness relationships developed in the remainder of this chapter.

4.2 Co-Value Driven SaaS Business Relationships

The discussion of value quality in the previous section was from the perspective of the customer organization. However, one of the fundamental definitions from the emerging area of service science [60] is that a "...service system is a value co-production configuration of people, technology, other internal and external service systems and shared information." The question arises is how is the notion of value co-creation (co-value) in a SaaS offering supported in value quality measures?

We start to explore this question by considering the possible co-value situations that can exist between a service provider organization and a service customer organization. These situations can be represented in Figure 4.3 where we express the customer and provider values respectively on simple x-y axes, each axis ranging in scale from low to high value. In general, the value measures for the provider and the customer are dependent on the nature of the service offering. For the purpose of this discussion, let us assume simplistically that the customer value is determined primarily by ROI (Return on Investment) analysis and the provider value is determined by the total profit (income after all expenses) from providing the service. In the diagram we have characterized the five regions with names that reflect the relative maturity of the service offering [61]. When a service is first developed it is typically done as a limited offering (or research prototype) based on research of market opportunities and the innovative application of new or advanced technologies or processes. From the perspective of value quality, the service provider sees low value (little or no profit) and a customer also sees low value because the prototype service is limited in functionality with little commitment to sustainability due to the trial nature of its deployment.

Assuming the service is well received based on its initial functionality and responsiveness, and its user base increases, the value (as determined by ROI) will increase for the customer. During the early stages of growing the service from prototype to an initial release in the marketplace, the value to the provider (profit)

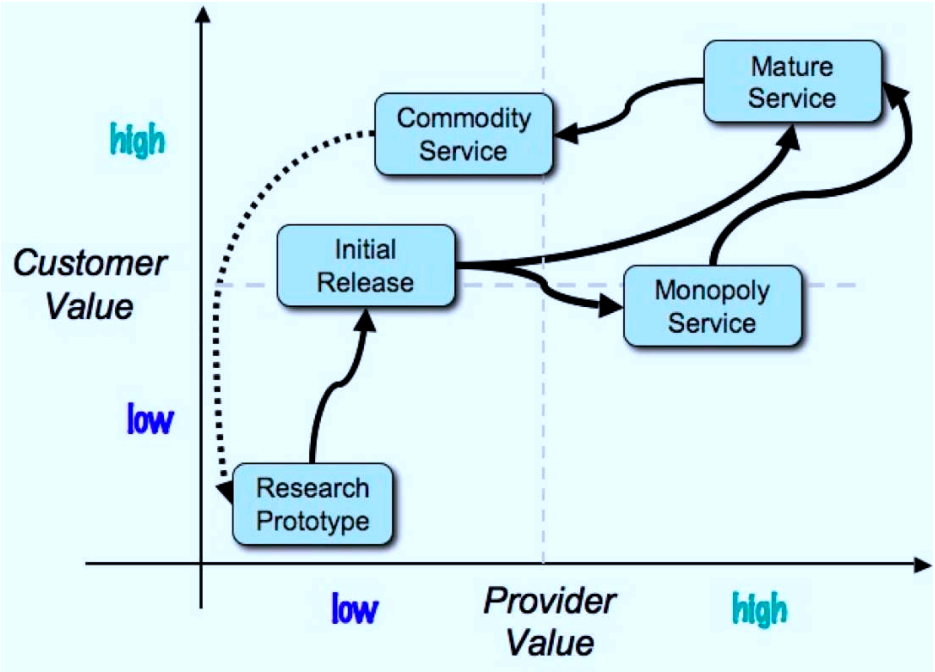

Figure 4.3: Phases of service delivery based on co-value to the provider and customer

remains low or at best increases slightly.

Once the service takes hold in a marketplace and large numbers of customers acquire the service, the value for the provider (profit) increases substantially in proportion to the number of customers. The value to the customer (ROI) is very dependent on the costs associated with the delivery of the service within a growing marketplace. If there is little or no competition for the provider, we move to a monopoly situation typically generating higher costs and therefore lower relative value for the customer (ROI). Alternatively, the marketplace could quickly yield a healthy set of service providers that should lead to an increase value for customers (ROI) because cost of service should not rise substantially if at all. This stage, labeled the mature service, represents the situation when the co-value of the service business relationship for providers and customers is at its peak (we refer to it as a "win-win" value situation).

Note that it is rare for a software service marketplace to remain in a monopoly situation for an extended period because the capital investment for new providers to develop competitive services is usually not extensive. Therefore, generally for

SaaS, a monopoly service should quickly transition to a mature situation.

A fifth stage that can occur is when service competition increases for the provider and marketplace adoption becomes so widespread that the service becomes commoditized. At this commodity service stage, the value to the provider (profit) can decrease significantly because of decreased profit margins on a per customer basis. The value to the customer can also decrease at this stage because the commoditized service is no longer a strategic advantage for a customer organization, which may have its own set of competitors.

The transition from a commodity service to a research prototype is represented as a dotted line to show that often a new provider organization creates a new service innovation that impacts the commoditized marketplace. This new service will begin its own service maturation process that can displace the commodity service in that marketplace. An example of this is the rise of email services in the last decade to replace much of the standard mail services that had been commoditized.

Of course, not all service offerings follow this form of "life cycle". Many new services do not make it past the prototype stage or linger in the initial release stage without garnering significant market presence. Some services, given the nature of their potential marketplace, may never be commoditized. Ideally, both the service provider and customer continue to seek ways of maintaining a "win-win" business relationship where new or added co-value is continually being created for a service offering. Therefore, a major factor affecting the business relationship is a clear understanding of the co-value present in the service offerings. In the next section, we will introduce the core of our SaaS evaluation model by exploring the characteristics of the business relationships between the service provider and customer in the service delivery.

4.3 Specification of Quality-Based SaaS Business Relationships

By integrating the quality management and co-value in SaaS business relationship, we can produce a specification of SaaS business relationships and illustrate its fea-

tures using existing SaaS applications. The specification prescribes four service types based on the maturity levels of business relationships between the service provider and customer. These service types are called *Ad-hoc*, *Defined*, *Managed* and *Strategic*.

4.3.1 SaaS Service Types

- *Ad-hoc Service*

  A SaaS is called an *Ad-hoc Service* if it is used by a customer on an as-needed basis in response to business requirements. The goal of the service customer is to ensure that the service meets the critical functional needs of its users. Typically few, if any, service attributes are tracked by the provider on behalf of the customer. Examples of Ad-hoc services are Amazon.com and Expedia.com when used widely in an organization to facilitate book and travel purchases respectively.

- *Defined Service*

  A SaaS is called a *Defined Service* if it is described in a contract or an agreement which outlines service usage and guarantees the service level capabilities typically through service level agreements (SLAs). The service quality concerns focus on measurable, performance-oriented attributes such as availability and responsiveness. A good example of a *Defined Service* is Google Apps Enterprise Edition [12] which has a defined SLA focusing on availability. Another example is SAP's Business ByDesign [1], which provides SaaS capabilities for ERP level applications (integrated accounting, supply chain, HR, CRM, etc).

- *Managed Service*

  A SaaS is called a *Managed Service* if it is a *Defined Service* with additional agreed upon commitments by both the service customer and provider to share the responsibilities of managing the service. Examples of shared responsibilities include monitoring the service quality and refining the service to meet changing quality requirements. A good example of a *Managed Ser-*

vice is Salesforce.com's CRM (Customer Relationship Management) service. Salesforce.com provides customization and integration capabilities that allow customers to set up their own unique CRM service and share customer developed applications. Salesforce.com also supports tracking of service issues and commitments.

- *Strategic Service*

  A SaaS is called *Strategic Service* if it is a *Managed Service* in which both the service customer and provider are able to identify the common, agreed upon, business value of the service delivery, typically defined in a CVP. Typically the decision to adopt a *Strategic Service* is based on business value analyses such as Cost-Benefit analysis, ROI (Return on Investment) and/or risk analysis. A good example of a *Strategic Service* in today's SaaS solutions could be the use of Google Apps in an academic institution by building a strategic partnership with Google Corporation.

4.3.2 Quality Measures in Business Relationships

We have a strong belief that quality measures play an increasing role in a business relationship as this relationship intensifies from *Ad-hoc* to *Strategic*. Based on this belief and towards a theory of SaaS business relationships, we establish the following four-statement conjecture:

1. The service attribute of primary interest in an *Ad-hoc Service* is functionality.
2. The service attributes of primary interest in a *Defined Service* are those measured by functionality and conformance quality approaches.
3. The service attributes of primary interest in a *Managed Service* are those measured by functionality, conformance and gap quality approaches.
4. The service attributes of primary interest in a *Strategic Service* are those measured by functionality, conformance, gap and value quality approaches.

In the above statements, by "primary interest" we mean that the service attributes are normally measured and used for service selection and monitoring in the service type.

Table 4.1: Summary of SaaS service types

Maturity Level	**Service Type**	**Service Provider Goals**	**Service Customer Goals**	**Quality Measures**
Level 1	Ad-hoc	Service delivered on an as-needed basis	Critical functional needs achieved	No quality measures are necessarily in place
Level 2	Defined	Service delivered on a regular basis with defined capability	Functional needs achieved plus desirable performance requirements guaranteed such as availability and responsiveness	Conformance quality approaches (SLAs defined and tracked)
Level 3	Managed	Service delivered with shared responsibility in monitoring service quality	Goals of Level 2 plus agreement on monitoring of service quality assurance	Conformance plus gap quality approaches
Level 4	Strategic	Service delivered with the shared goal of continuous service improvement with customer	Proper governance of service to ensure value goals defined and achieved using approaches such as Cost-Benefit analysis, ROI and/or risk analysis	Conformance, gap and value quality approaches

In general, an *Ad-hoc Service* has little or no emphasis on service quality measures, a *Defined Service* includes conformance quality measures, a *Managed Service* adds gap quality measures to conformance quality measures, and a *Strategic Service* includes value quality measures as well as conformance and gap quality measures. The goal of both the service provider and customer is to find an appropriate service type for their business relationship. These are summarized in Table 4.1.

4.4 Survey Approach: Validating the Theory on Service Attributes

To assist in validating the conjecture in the theory of our model, we conducted a survey involving primarily CIOs (Chief Information Officers), which we call the Generic Survey. This survey is intended to capture the service customer's general view on the service attributes in selecting and monitoring SaaS systems. The survey results are analyzed and used to confirm or refute our conjecture relating to SaaS business relationship. The survey analysis is described in this section.

4.4.1 Background

In July 2009, we sent an invitation letter by email to the Chief Information Officers (CIOs) of 70 commercial, governmental and academic organizations from Edmonton and Calgary areas to ask for participation in the survey, and initially received 30 positive responses. We then sent a second invitation letter to the 30 CIOs and directed them to a web-based online survey.

At the end of August 2009, we received answers from 20 CIOs, ten of which were willing to participate in a follow-up study should we wish to conduct one. To explore in greater detail some aspects of SaaS, we did a brief follow up questionnaire study in September 2009 with these ten CIOs. Seven of the ten CIOs responded and the result of this follow up study will be described later in this section. Table 4.2 shows the participation of the Generic Survey.

Table 4.2: Participation of the Generic Survey

Invited population	70
Initially agreed to participate the online survey	30
Participants of the online survey	20
Initially agreed to participate the follow-up study	10
Participants of the follow-up study	7

4.4.2 Questions

In the Generic Survey, which can be found in Appendix A, 19 questions were asked in the following six sections:

1. *Background Information*: questions about the background of the customer organization, such as size and nature of market focus, and respondent's role in the organization;

2. *Use of external IT services/SaaS services*: questions about the use of external IT services in the customer organization;

3. *Service attributes*: questions about the priority of certain service attributes considered by the customer decision-maker (typically CIOs) when planning the use of IT services/SaaS services in four service types (i.e., *Ad-hoc, Defined, Managed,* and *Strategic*).

4. *IT service governance*: questions addressing the issues of IT governance strategy used in the customer organization and how a SaaS evaluation model might support the organization's IT governance approach.

5. *Strategic planning of IT*: questions about how the customer takes the external IT services and SaaS services into account in strategic planning.

6. *Use of personal web-based services*: questions about the impact of personal web-based services such as eBay, wikipedia, Google Maps, facebook and youtube on IT services planning in the customer organization.

In this thesis, we only focus on the first three sections of the survey that are related to our analysis on service attributes with respect to the four service types.

4.4.3 Survey Results

Tables 4.3 and 4.4 show the background information of the Generic Survey. For the size of the organizations, the majority of the total population (12 out of 20, 60%) are organizations with more than 250 people. Four small organizations have less

than 25 people and four medium organizations typically have 51-250 people. For the market focus of the organizations, because most of the organizations that participated in the survey are governmental departments, academic institutions and local commercial companies, the majority of the total population (13 out of 20, 65%) are completely domestic market focused. All the other organizations are primarily domestic focused, and no organizations are primarily international market focused.

Table 4.3: Size of the organizations

Indicator	**Respondent #**	**Respondent %**
10 or less people	1	5.0
11-25 people	3	15.0
26-50 people	0	0.0
51-100 people	3	15.0
101- 250 people	1	5.0
More than 250 people	12	60.0
Total	20	100.0

Table 4.4: Market focus of the organizations

Indicator	**Respondent #**	**Respondent %**
Domestic market	13	65.0
Partly international market	7	35.0
Primarily international market	0	0.0
Total	20	100.0

Tables 4.5 and 4.6 show the use of external IT services and SaaS services in the organizations. The use of services is defined as estimated percentage of the annual IT operating budget that the organization expends on these services. In the survey, we defined the SaaS services as a subset of external IT services. As a result, the level of participation in SaaS services relative to external IT services is substantially less as shown in Tables 4.5 and 4.6. The majority of total population (12 out of 20, 60%) expend 5%-15 % annual budget on external IT services. Three organizations expend 20%-45% annual budget and four organizations expend 50%-75%. The majority of total population (14 out of 20, 70%) expend no more than 5% of their annual budget on SaaS services. Seven expend 0% and another seven expend 5%. Only four organizations expend 10% and more annual budget on SaaS services.

Table 4.5: Use of external IT services

Indicator	Respondent #	Respondent %
0%	0	0.0
5%	2	10.0
10%	7	35.0
15%	3	15.0
20%-45%	3	15.0
50%-75%	4	20.0
80%-100%	0	0.0
Not sure	1	5.0
Total	20	100.0

Table 4.6: Use of SaaS services

Indicator	Respondent #	Respondent %
0%	7	35.0
5%	7	35.0
10%	2	10.0
15%-20%	0	0.0
25%	1	5.0
30%	1	5.0
35%-100%	0	0.0
Not sure	2	10.0
Total	20	100.0

In the online survey, we asked respondents to select the best estimate of the priority of eight typical service attributes for each of the four service types defined in Section 4.3.2 (*Ad-hoc*, *Defined*, *Managed*, *Strategic*). We used a 5 point scale for the priority, where 5 stands for “high”, 3 stands for “medium” and 1 stands for “low”. Therefore if a priority of 5 is selected this indicates that the respondent would rate this service attribute as high when making decision about selecting a SaaS system. Table 4.7 shows for each service attribute the mean values of priority across four service types. To extend our study to other service attributes related to the business such as ROI and risk, we asked the participants of the follow-up study to select a priority for five additional service attributes, using the same scale system. Table 4.8 shows the results of the follow up study. From the tables we see that for almost all the service attributes there is an increasing trend across the four levels,

although some attributes have a minor decrease from Managed to Strategic. Our analysis will concentrate on the priority data.

Table 4.7: Priority of initial service attributes in four service types

Service Attribute	**Mean of Priority**			
	Ad-hoc	**Defined**	**Managed**	**Strategic**
Functionality	4.75	4.55	4.67	4.56
Security	4.65	4.75	4.83	4.89
Availability	4.30	4.85	4.89	4.72
Reliability	4.32	4.80	4.89	4.72
Usability	4.45	4.55	4.44	4.44
Efficiency	3.85	4.30	4.44	4.35
Sustainability	3.89	4.35	4.56	4.44
Adaptability	3.15	3.65	4.00	4.06

Table 4.8: Priority of additional service attributes in four service types

Service Attribute	**Mean of Priority**			
	Ad-hoc	**Defined**	**Managed**	**Strategic**
Cost	3.33	4.21	4.50	3.93
ROI	2.29	3.36	3.83	3.64
Risk	3.29	4.36	4.50	4.64
Continuity	3.00	4.07	4.36	4.07
Dedication to CSI*	1.83	2.93	3.07	3.36

* CSI: Continuous Service Improvement

4.5 Analysis on Service Attributes

4.5.1 Analysis Strategy

To assist in validating our conjecture about SaaS business relationships and quality measures, we undertook data analysis to examine:

1. The categorization of service attributes, i.e. categorizing the service attributes in terms of when they reach the maximum priority in the four service types.

2. The robustness of the theory, i.e. determining if the conjecture applies consistently across different subpopulations of the participants.

To categorize the service attributes, the most intuitive way is to calculate and compare the mean values of the priority as in Tables 4.7 and 4.8. However, analysis on the mean values may not reflect the relative priorities of service attributes due to the following two reasons:

1. Some service attributes are not always considered or available in all the cases. For example, some survey participants may not consider ROI in *Ad-hoc service*. This will cause the variation of actual population answering questions, therefore making the comparisons between service types inappropriate.

2. The 5 point scale system for priority does not provide a unified standard. The meaning of priority 5 for one participant may not necessarily be same as for another participant. As a result, personal biases may not be removed by simply using the arithmetic mean.

Instead of using the mean value, we calculate the *relative importance* for service attributes in the four service types. The *relative importance* of a service attribute in a service type is defined as the percentage of population that consider the priority of that service attribute in that service type higher than or equal to all the other three service types. For example, if 18 out of 20 respondents rank the priority of *Security* in the *Defined Service* the highest over the four service type, the relative importance of *Security* in the *Defined Service* is equal to 90%. By comparing the relative importance, we avoid the difference of rating standards between individual participants. In the analysis tables to follow (Tables 4.9 through 4.22), a shaded cell denotes when the relative importance of a service attribute is highest across the four service types.

To determine the robustness of the theory, we distinguish the data into subgroups by the size, market focus and expense of annual IT budget. Our analysis is based on the difference between percentages from total population and eight subgroups where the participants are from:

- *Smaller-size organizations*: The organizations with 250 people or less;
- *Larger-size organizations*: The organizations with more than 250 people;

- *Domestic organizations*: The organizations with market focus of the organization fully on domestic market;
- *Partly international organizations*: The organizations with market focus primarily on domestic, and partly international market;
- *Less use of external services*: The organizations that expend 0-15% annual IT budget on the use of external services;
- *More use of external services*: The organizations that expend 20-100% annual IT budget on the use of external services;
- *Organizations virtually not using SaaS services*: The organizations that expend around 0% annual IT budget on the use of SaaS services;
- *Organizations using SaaS services*: The organizations that expend more than 0% annual IT budget on the use of SaaS services.

The *Average Distance of Percentages* (*abbr. AD%*) is calculated between each subgroup and the total population to examine the consistency of the relative importance over the different subgroups. The *AD%* for a specific subgroup G is defined as:

$$(|P_{G,Ad-hoc} - P_{Total,Ad-hoc}| + |P_{G,Defined} - P_{Total,Defined}| \\ +|P_{G,Managed} - P_{Total,Managed}| + |P_{G,Strategic} - P_{Total,Strategic}|)/4 \times 100\%$$

where $P_{g,s}$ is the relative importance of a service attribute in service type s considered by group g ($Total$ refers to the total population).

The value of *AD%* shows the approximate percentage of the subgroup population that have different opinion on the relative importance from the total population.

4.5.2 Analysis on Initial Service Attributes

In the original survey questionnaire, the questions about priority focused on the eight initial service attributes: security, availability, reliability, usability, efficiency, sustainability and adaptability. We now analyze each service attribute by the definition, measurement characteristics and relative importance in total population and subgroups.

1) Functionality

According to [32], functionality is "...the capability...to provide functions which meet stated and implied needs when...used under specified conditions." It is defined when the service provider publishes the service offerings, but is measured and used by the service customer. The functionality measurement is usually more important for short-term relationships such as *Ad-hoc services*.

In Table 4.9, the total population and all the subgroups consider functionality the most important in *Ad-hoc Service* (Note that the numbers in the parentheses are the population of the groups). It is more important in organizations with less annual IT budget on services. These results are not too surprising since functionality is one of the first and fundamental service attributes to be considered in decision making.

Table 4.9: Relative importance of functionality

Group	**Ad-Hoc**	**Defined**	**Managed**	**Strategic**	**AD%**
Total (20)	90.0%	70.0%	75.0%	70.0%	
250 ppl or less (8)	87.5%	62.5%	62.5%	50.0%	10.6%
More than 250 ppl (12)	91.7%	75.0%	83.3%	83.3%	7.1%
Domestic (13)	84.6%	69.2%	69.2%	69.2%	3.2%
Partly international (7)	100.0%	71.4%	85.7%	71.4%	5.9%
0-15% IT budget on external services (12)	91.7%	66.7%	66.7%	75.0%	4.6%
20-100% IT budget on external services (7)	85.7%	71.4%	85.7%	57.1%	7.3%
˜0% IT budget on SaaS (7)	100.0%	57.1%	85.7%	85.7%	12.3%
$>$0% IT budget on SaaS (11)	90.9%	72.7%	72.7%	63.6%	3.1%

2) Security

According to [32], security is "...the capability...to protect information and data so that unauthorized persons or systems cannot read or modify them and authorized persons or systems are not denied access to them." It is typically measured by the service provider or a third party security auditing firm and used by both the service provider and customer. It is often defined and monitored using conformance quality approaches such as SLAs.

In Table 4.10, the total population and most subgroups consider security the most important in *Defined Service*. In some subgroups such as organizations with more than 250 people or organization expending more than 20% IT budget on external services, it is considered more important in *Managed Service*. The reason is that these organizations may want to share with the provider more of the responsibility in managing security.

Table 4.10: Relative importance of security

Group	Ad-Hoc	Defined	Managed	Strategic	AD%
Total (20)	85.0%	90.0%	80.0%	85.0%	
250 ppl or less (8)	75.0%	87.5%	50.0%	75.0%	13.1%
More than 250 ppl (12)	91.7%	91.7%	100.0%	91.7%	8.8%
Domestic (13)	84.6%	92.3%	76.9%	84.6%	1.5%
Partly international (7)	85.7%	85.7%	85.7%	85.7%	2.9%
0-15% IT budget on external services (12)	91.7%	100.0%	75.0%	83.3%	5.8%
20-100% IT budget on external services (7)	85.7%	85.7%	100.0%	85.7%	6.4%
˜0% IT budget on SaaS (7)	100.0%	100.0%	100.0%	100.0%	15.0%
$>$0% IT budget on SaaS (11)	81.8%	90.9%	72.7%	72.7%	5.9%

3) Availability

The definition of availability is not included in ISO/IEC 9126-1 [32]. According to [20], availability is "...the degree to which a system...is operable and in a committable state." This service attribute is typically measured by the service provider and used by both the service provider and customer, using conformance quality approaches such as SLAs.

In Table 4.11, the total population and all subgroups consider availability the most important in *Defined Service*.

4) Reliability

According to [32], reliability is "...the capability...to maintain a specified level of performance when used under specified conditions." Similar to availability, relia-

Table 4.11: Relative importance of availability

Group	Ad-Hoc	Defined	Managed	Strategic	AD%
Total (20)	45.0%	95.0%	85.0%	70.0%	
250 ppl or less (8)	50.0%	100.0%	75.0%	62.5%	6.9%
More than 250 ppl (12)	41.7%	91.7%	91.7%	75.0%	4.6%
Domestic (13)	53.8%	92.3%	92.3%	69.2%	4.9%
Partly international (7)	28.6%	100.0%	71.4%	71.4%	9.1%
0-15% IT budget on external services (12)	41.7%	91.7%	75.0%	75.0%	5.4%
20-100% IT budget on external services (7)	42.9%	100.0%	100.0%	57.1%	8.8%
˜0% IT budget on SaaS (7)	14.3%	100.0%	85.7%	71.4%	9.5%
>0% IT budget on SaaS (11)	54.5%	90.9%	81.8%	72.7%	4.9%

bility is typically a service attribute measured by the service provider with SLAs, and used by both the service provider and customer.

Reliability and availability are correlated by sharing similar characteristics. This is strongly supported in Table 4.12, where the total population and all subgroups consider reliability the most important in *Defined Service*.

Table 4.12: Relative importance of reliability

Group	Ad-Hoc	Defined	Managed	Strategic	AD%
Total (20)	50.0%	90.0%	85.0%	70.0%	
250 ppl or less (8)	25.0%	87.5%	75.0%	62.5%	11.3%
More than 250 ppl (12)	66.7%	91.7%	91.7%	75.0%	7.5%
Domestic (13)	53.8%	92.3%	84.6%	69.2%	1.8%
Partly international (7)	42.9%	85.7%	85.7%	71.4%	3.4%
0-15% IT budget on external services (12)	50.0%	91.7%	75.0%	66.7%	3.8%
20-100% IT budget on external services (7)	57.1%	100.0%	100.0%	71.4%	8.4%
˜0% IT budget on SaaS (7)	71.4%	100.0%	100.0%	85.7%	15.5%
>0% IT budget on SaaS (11)	36.4%	90.9%	72.7%	54.5%	10.6%

5) Usability

According to [32], usability is "...the capability...to be understood, learned, used and attractive to the user, when used under specific conditions." It is a service attribute typically captured through a customer survey. Usability can be measured and used by both the service provider and customer.

In practice, usability is often associated with functionality by service customers. Decision makers in the customer organizations tend to take it into consideration when adopting a *Defined Service*. In Table 4.13, the total population and all subgroups consider usability the most important in the *Defined Service*. However, it is necessary to point out that conformance quality approaches such as SLAs are typically not able to define and measure usability. It is not easily implementable as a service attribute until the service provider and customer establish a set of ground rules to which they both agree upon how usability is measured and assessed.

Table 4.13: Relative importance of usability

Group	Ad-Hoc	Defined	Managed	Strategic	AD%
Total (20)	70.0%	80.0%	60.0%	60.0%	
250 ppl or less (8)	50.0%	75.0%	37.5%	62.5%	12.5%
More than 250 ppl (12)	83.3%	83.3%	75.0%	58.3%	8.3%
Domestic (13)	61.5%	69.2%	46.2%	61.5%	8.7%
Partly international (7)	85.7%	100.0%	85.7%	57.1%	16.1%
0-15% IT budget on external services (12)	75.0%	75.0%	58.3%	50.0%	5.4%
20-100% IT budget on external services (7)	57.1%	85.7%	57.1%	71.4%	8.2%
˜0% IT budget on SaaS (7)	71.4%	71.4%	71.4%	71.4%	8.2%
$>$0% IT budget on SaaS (11)	72.7%	81.8%	54.5%	54.5%	3.9%

6) Efficiency

According to [32], efficiency is "...the capability...to provide appropriate performance, relative to the amount of resources used, under stated conditions." In practice, efficiency has two levels for consideration in decision making: a technical level such as network performance issues, and a resource level such as time and use of

materials. At the technical level, it can be defined and measured with SLAs. At the resource level, it is appropriate to measure efficiency with gap quality approaches such as customer surveys. When considering coverage of both levels, the service provider and customer often share the responsibility of measuring efficiency and finding ways to improve efficiency.

In Table 4.14, the total population and most subgroups consider efficiency the most important in *Managed Service*. Organizations with 250 people or less and organizations with less IT budget on external IT services or SaaS services consider it the more important in a *Defined Service*. This is likely the case because both of these types of organizations are resource constrained and are less able to participate in the shared management of this service attribute.

Table 4.14: Relative importance of efficiency

Group	**Ad-Hoc**	**Defined**	**Managed**	**Strategic**	**AD%**
Total (20)	55.0%	70.0%	75.0%	65.0%	
250 ppl or less (8)	50.0%	75.0%	50.0%	50.0%	12.5%
More than 250 ppl (12)	58.3%	66.7%	91.7%	75.0%	8.3%
Domestic (13)	53.8%	69.2%	69.2%	61.5%	2.8%
Partly international (7)	57.1%	71.4%	85.7%	71.4%	5.2%
0-15% IT budget on external services (12)	50.0%	75.0%	66.7%	66.7%	5.0%
20-100% IT budget on external services (7)	57.1%	57.1%	85.7%	57.1%	8.4%
˜0% IT budget on SaaS (7)	57.1%	85.7%	71.4%	71.4%	7.0%
$>$0% IT budget on SaaS (11)	54.5%	63.6%	72.7%	63.6%	2.6%

7) Sustainability

The definition of sustainability is not included in ISO/IEC 9126-1 [32]. According to [29], sustainability is "...the capacity of a system to maintain itself, to remain congruent with changing realities." Sustainability requires commitment by the service customer, with input from their users, as to how quick (or slow) they should accept service changes. This input can be captured by both the service provider and customer with gap quality approaches such as customer surveys.

In Table 4.15, sustainability is more emphasized in *Managed Service* and *Strategic Service*. The total population and almost all subgroups consider sustainability the most important in *Managed Service*. The exception is for organizations with 250 people or less, where relative importance peaks in *Defined* and *Strategic Service*.

Table 4.15: Relative importance of sustainability

Group	Ad-Hoc	Defined	Managed	Strategic	AD%
Total (20)	40.0%	65.0%	75.0%	60.0%	
250 ppl or less (8)	37.5%	62.5%	50.0%	62.5%	8.1%
More than 250 ppl (12)	41.7%	66.7%	91.7%	58.3%	5.4%
Domestic (13)	38.5%	69.2%	69.2%	53.8%	4.4%
Partly international (7)	42.9%	57.1%	85.7%	71.4%	8.2%
0-15% IT budget on external services (12)	41.7%	66.7%	83.3%	58.3%	3.3%
20-100% IT budget on external services (7)	42.9%	71.4%	71.4%	57.1%	3.9%
˜0% IT budget on SaaS (7)	28.6%	57.1%	85.7%	57.1%	8.2%
$>$0% IT budget on SaaS (11)	45.5%	72.7%	81.8%	63.6%	5.9%

8) Adaptability

According to [32], adaptability is "...the capability...to be adapted for different specified environments without applying actions or means other than those provided for this purpose for the software considered." This service attribute is measured by both the service provider and customer with customer surveys, and is mainly used by the service customer for IT planning and governance.

In Table 4.16, the total population and all subgroups consider adaptability the most important in either *Managed Service* or *Strategic Service*. It is the most important in the *Managed Service* for larger organizations, organizations with smaller IT budgets for external IT services and organizations with larger IT budget on SaaS.

4.5.3 Analysis on Additional Service Attributes

After completing the online survey on the initial eight service attributes, we decided to validate our conjecture by incorporating additional service attributes that are of-

Table 4.16: Relative importance of adaptability

Group	Ad-Hoc	Defined	Managed	Strategic	AD%
Total (20)	25.0%	50.0%	70.0%	70.0%	
250 ppl or less (8)	37.5%	50.0%	62.5%	75.0%	6.3%
More than 250 ppl (12)	16.7%	50.0%	75.0%	66.7%	4.2%
Domestic (13)	23.1%	53.8%	69.2%	76.9%	3.4%
Partly international (7)	28.6%	42.9%	71.4%	57.1%	6.3%
0-15% IT budget on external services (12)	16.7%	58.3%	66.7%	58.3%	7.9%
20-100% IT budget on external services (7)	28.6%	42.9%	85.7%	85.7%	10.5%
~0% IT budget on SaaS (7)	28.6%	42.9%	57.1%	85.7%	9.8%
>0% IT budget on SaaS (11)	18.2%	63.6%	81.8%	54.5%	11.9%

ten used in ITIL service management best practices [49]. These service attributes include cost, ROI, risk, continuity and dedication to Continuous Service Improvement (CSI). We undertook this study in a set of follow up questions with seven organizations similar to those in the online survey.

1) Cost

According to [49], cost is defined as "...the amount of expenditure (actual or notional) incurred on, or attributable to, a specific activity or business unit." In particular, the cost of a service is the monetary value used to acquire and adopt the service. It is measured and used by the service customer. Cost is often predefined and nonnegotiable in *Ad-hoc Service* and *Defined Service*. But it is one of the important service attributes in *Managed Service* and *Strategic Service*. In Table 4.17, cost is considered the most important in *Managed Service* by the total population and all subgroups.

2) ROI (Return on Investment)

According to [49], ROI (Return on Investment) is defined as "...revenue or benefit...which is attributable to the project...divided by the expenditure required to complete the project." Compared to cost, ROI focuses on the ratio of monetary values, rather than just the monetary value of the customer's expenditure. ROI analysis

Table 4.17: Relative importance of cost

Group	Ad-Hoc	Defined	Managed	Strategic	AD%
Total (20)	42.9%	71.4%	85.7%	57.1%	
250 ppl or less (4)	50.0%	75.0%	75.0%	50.0%	7.1%
More than 250 ppl (3)	33.3%	66.7%	100.0%	100.0%	17.9%
Domestic (5)	20.0%	60.0%	80.0%	60.0%	10.7%
Partly international (2)	100.0%	100.0%	100.0%	50.0%	26.8%
0-15% IT budget on external services (4)	25.0%	50.0%	100.0%	75.0%	17.9%
20-100% IT budget on external services (2)	50.0%	100.0%	100.0%	50.0%	14.3%
˜0% IT budget on SaaS (2)	0.0%	50.0%	100.0%	100.0%	30.4%
>0% IT budget on SaaS (4)	50.0%	75.0%	100.0%	50.0%	8.0%

is one approach to measuring value quality by calculating the ROI over multiple periods in order to compare the profit over time or between different products and services. It can be measured and used by both the service provider and customer for long-term IT service planning and governance.

ROI is a service attribute mainly considered when establishing a *Strategic Service*. This is supported by the results in Table 4.18 where the total population and most subgroups consider ROI the most important in *Strategic Service*.

Table 4.18: Relative importance of ROI

Group	Ad-Hoc	Defined	Managed	Strategic	AD%
Total (7)	28.6%	71.4%	71.4%	85.7%	
250 ppl or less (4)	25.0%	75.0%	100.0%	75.0%	11.6%
More than 250 ppl (3)	33.3%	66.7%	33.3%	100.0%	15.5%
Domestic (5)	20.0%	60.0%	60.0%	80.0%	9.3%
Partly international (2)	50.0%	100.0%	100.0%	100.0%	23.2%
0-15% IT budget on external services (4)	50.0%	75.0%	50.0%	75.0%	14.3%
20-100% IT budget on external services (2)	0.0%	100.0%	100.0%	100.0%	25.0%
˜0% IT budget on SaaS (2)	0.0%	50.0%	0.0%	100.0%	33.9%
>0% IT budget on SaaS (4)	50.0%	100.0%	100.0%	75.0%	22.3%

3) Risk

According to [49], risk is "...a measure of the exposure to which an organization may be subjected." It can be calculated as the product of the likelihood of a business disruption occurring and the possible loss that may result from such business disruption. Risk can be measured and used by both the service provider and customer, using risk analysis that identifies the level of risks by assessing the values of assets and levels of threats to the assets in an IT project. It is critically important for building a strategic partnership.

Similar to ROI, risk is considered the most important in *Strategic Service*. In Table 4.19, the total population and most subgroups consider risk the most important in *Strategic Service*.

Table 4.19: Relative importance of risk

Group	Ad-Hoc	Defined	Managed	Strategic	AD%
Total (7)	14.3%	57.1%	71.4%	85.7%	
250 ppl or less (4)	25.0%	50.0%	50.0%	75.0%	12.5%
More than 250 ppl (3)	0.0%	66.7%	100.0%	100.0%	16.7%
Domestic (5)	20.0%	40.0%	60.0%	100.0%	12.1%
Partly international (2)	0.0%	100.0%	100.0%	50.0%	30.4%
0-15% IT budget on external services (4)	0.0%	50.0%	75.0%	100.0%	9.8%
20-100% IT budget on external services (2)	50.0%	100.0%	100.0%	50.0%	35.7%
˜0% IT budget on SaaS (2)	0.0%	50.0%	100.0%	100.0%	16.1%
$>$0% IT budget on SaaS (4)	25.0%	75.0%	75.0%	75.0%	10.7%

4) Continuity

According to [49], service continuity is "...the ability of business to diminish or amend service targets in the event of an incident or a disaster." By definition, this service attribute is related to risk. It is measured by the service provider and used by both the service provider and customer for monitoring a long-term business relationship. In Table 4.20, the total population and most subgroups consider continuity as the most important in either *Managed Service* or *Strategic Service*.

Table 4.20: Relative importance of continuity

Group	Ad-Hoc	Defined	Managed	Strategic	AD%
Total (7)	14.3%	42.9%	71.4%	71.4%	
250 ppl or less (4)	25.0%	50.0%	75.0%	50.0%	10.7%
More than 250 ppl (3)	0.0%	33.3%	66.7%	100.0%	14.3%
Domestic (5)	20.0%	40.0%	80.0%	80.0%	6.4%
Partly international (2)	0.0%	50.0%	50.0%	50.0%	16.1%
0-15% IT budget on external services (4)	25.0%	25.0%	50.0%	75.0%	13.4%
20-100% IT budget on external services (2)	0.0%	100.0%	100.0%	50.0%	30.4%
˜0% IT budget on SaaS (2)	0.0%	50.0%	100.0%	100.0%	19.6%
>0% IT budget on SaaS (4)	25.0%	50.0%	50.0%	50.0%	15.2%

5) CSI (Dedication to Continuous Service Improvement)

The dedication to the CSI (continuous service improvement) is an important attribute in IT governance frameworks such as ITIL [49] and COBIT [33]. This service attribute is measured and used by both the service provider and customer. Similar to continuity, it is used for monitoring a long-term business relationship. In Table 4.21, the total population and most subgroups consider it the most important in *Strategic Service*.

Table 4.21: Relative importance of dedication to CSI

Group	Ad-Hoc	Defined	Managed	Strategic	AD%
Total (7)	14.3%	57.1%	57.1%	71.4%	
250 ppl or less (4)	25.0%	50.0%	50.0%	50.0%	11.6%
More than 250 ppl (3)	0.0%	66.7%	66.7%	100.0%	15.5%
Domestic (5)	0.0%	40.0%	40.0%	80.0%	14.3%
Partly international (2)	50.0%	100.0%	100.0%	50.0%	35.7%
0-15% IT budget on external services (4)	0.0%	75.0%	75.0%	75.0%	13.4%
20-100% IT budget on external services (2)	50.0%	50.0%	50.0%	50.0%	17.9%
˜0% IT budget on SaaS (2)	0.0%	50.0%	50.0%	100.0%	14.3%
>0% IT budget on SaaS (4)	25.0%	75.0%	75.0%	50.0%	17.0%

4.5.4 Analysis Conclusion

The summary of the relative importance of all the service attributes discussed previously is shown in Table 4.22.

Table 4.22: Summary of relative importance of service attributes in the four service types

Service Attribute	Ad-Hoc	Defined	Managed	Strategic
Functionality	90.0%	70.0%	75.0%	70.0%
Security	85.0%	90.0%	80.0%	85.0%
Availability	45.0%	95.0%	85.0%	70.0%
Reliability	50.0%	90.0%	85.0%	70.0%
Usability	70.0%	80.0%	60.0%	60.0%
Efficiency	55.0%	70.0%	75.0%	65.0%
Sustainability	40.0%	65.0%	75.0%	60.0%
Adaptability	25.0%	50.0%	70.0%	70.0%
Cost	42.9%	71.4%	85.7%	57.1%
ROI	28.6%	71.4%	71.4%	85.7%
Risk	14.3%	57.1%	71.4%	85.7%
Continuity	14.3%	42.9%	71.4%	71.4%
CSI	14.3%	57.1%	57.1%	71.4%

In Table 4.22, we have categorized the service types into four groups separated by dashed lines. The stair-like shaded areas strongly support conjecture in Section 4.3.2. When the business relationship intensifies from *Ad-hoc* to *Strategic*, the service customer needs to use progressively more types of quality approaches to manage the service quality.

The only two outliers in the grouping results are usability, which is typically measured by gap quality approach (surveys) on the customer experience, and cost, which is directly measured by a value quality approach (monetary value). From the comments from the survey respondents, we conjecture that the reason for the misplacement of usability may be caused by the misunderstanding of the definition (confusion with user capability of a system, which is considered as part of functionality by our definition). Both outliers need to be further investigated in future, more extensive and intensive studies.

With the two outliers adjusted, the service attribute groups are consistent with

the types of quality measures:

1. *Functionality* is the basic operational attribute required whenever a service is delivered successfully, i.e. *Ad-hoc*, *Defined*, *Managed* and *Strategic Service*.

2. *Conformance quality attributes* (*Security*, Availability and Reliability) are measured by conformance quality approaches and typically required when a service is delivered as a *Defined* and *Managed* and *Strategic Service*.

3. *Gap quality attributes* (*Usability*, *Efficiency*, *Sustainability* and *Adaptability*) are measured by gap quality approaches and typically required when a service is delivered as a *Managed* and *Strategic Service*. Gap quality attributes take into account more perspective from service customers.

4. *Value quality attributes* (*Cost*, *ROI*, *Risk*, *Continuity* and *CSI*) are measured by value quality approaches and are typically required when a service is delivered as a *Strategic Service*. In this sense, the value quality attributes are the most closely aligned with the business strategic objectives of both the service customer and provider.

As an example, when a customer organization makes a decision to adopt a *Defined Service*, the focus of service attributes should at least include *functionality* and *conformance quality attributes*. Therefore, the first four service attributes we analyzed in the survey (functionality, security, availability and reliability) should have higher priority, and other service attributes usually have lower priority. On the other hand, if the customer organization emphasizes the first four service attributes, the most appropriate business relationship they should build with the service provider is a *Defined Service*.

The robustness of the theory above can be determined by the *AD%* values. For the eight service attributes studied in the online survey, the *AD%* values rarely exceed 15%. For the five service attributes studied in the follow-up questions, the *AD%* values are relatively higher, but never exceed 40%. In consideration of the low participation of the follow-up study, the relative importance of these service attributes needs to be further studied with a larger population.

4.6 Hypothesis Test on the Significance

From the survey results and the analysis, we can see that priority of service attributes changes with the service type, yet the significance of the change remains unknown. To test the significance of differences of priority between any two of the four service types, we use the Wilcoxon signed-rank test as an approach for hypothesis test.

Wilcoxon signed-rank test is a non-parametric statistical hypothesis test used typically for the case of two related samples or repeated measurements on a single sample by ranking the differences between related data. As an alternative to the paired student's t-test, it can be used without assuming the data population to follow the normal distribution.

In our Wilcoxon signed-rank test, the priority values assigned by the survey respondents are paired up according to the service types. With four service types, we have six pairs of samples for each service attribute.

The null hypothesis of the test is that the median difference θ of the paired samples is zero, i.e. $H_0 : \theta = 0$. It implies that there is no significant difference between the paired samples. To reject the null hypothesis, the calculated p-value (or asymptotic significance) of the Wilcoxon sign-rank test should be less than the 0.05 for a 95% confidence interval (C.I. = 95%).

Table 4.23 shows the p-values of the hypothesis test. A value prefixed with asterisk means that the null hypothesis for the paired samples can be rejected. In other words, there is significant difference between the data from the paired service types. The (+) or (-) sign suffixing the number shows the trend of the difference between the paired samples. For example, the p-value for Availability between *Ad-hoc* and *Defined Service* is *0.004(+), which means priority of availability increases significantly from *Ad-hoc* to *Defined Service* (with null hypothesis rejected).

Considering the test results according to the four service attribute groups, we see that:

1. There is no significant difference for functionality over the four service types;
2. The differences between *Ad-hoc Service* and any of other three service types

Table 4.23: Asymptotic significance of priority

Service Attribute	Asymptotic Significance (C.I. = 95%)					
	Ad-hoc - Defined	**Ad-hoc - Managed**	**Ad-hoc - Strategic**	**Defined - Managed**	**Defined - Strategic**	**Managed - Strategic**
Functionality	0.257(-)	0.317(-)	0.157(-)	1.000(+)	0.564(+)	1.000(-)
Security	0.157(+)	0.655(+)	0.157(+)	1.000(+)	0.317(+)	1.000(+)
Availability	*0.004(+)	*0.011(+)	*0.035(+)	1.000(+)	0.317(-)	0.157(-)
Reliability	*0.014(+)	*0.011(+)	*0.034(+)	0.564(+)	0.564(-)	0.157(-)
Usability	0.783(+)	0.655(-)	0.414(-)	0.180(-)	0.257(-)	1.000(-)
Efficiency	0.070(+)	*0.026(+)	0.052(+)	0.257(+)	0.317(+)	0.157(-)
Sustainability	*0.023(+)	*0.021(+)	0.057(+)	0.102(+)	0.480(+)	0.180(-)
Adaptability	*0.019(+)	*0.006(+)	*0.005(+)	*0.025(+)	0.071(+)	0.763(+)
Cost	0.180(+)	0.141(+)	0.581(+)	0.414(+)	0.414(-)	0.157(-)
ROI	0.066(+)	0.066(+)	0.058(+)	0.157(+)	0.414(+)	1.000(-)
Risk	*0.024(+)	*0.026(+)	*0.026(+)	0.317(+)	0.317(+)	0.564(+)
Continuity	0.071(+)	0.058(+)	0.292(+)	0.157(+)	1.000(+)	0.414(-)
CSI	*0.038(+)	*0.038(+)	0.078(+)	0.317(+)	0.334(+)	0.480(+)

are significant for most service attributes in Group 2 and Group 3;

3. The difference between *Defined Service* and *Managed Service* for adaptability in Group 3 is also significant.

The differences between *Strategic Service* and *Defined/Managed Service* are not significant for all the service attributes. On the contrary, there is a decreasing trend between *Strategic Service* and *Managed Service* for service attributes, especially the service attributes in Group 2 and Group 3. One possible explanation is that service customers may assume that when the business relationship moves from *Managed* to *Strategic*, these service attributes will be well managed by both the organizations, and therefore leave them to focus on the service attributes related to IT strategic planning, such as ROI and risk. Since the sample size is only seven for these attributes, the significance of difference between service types needs to be further tested.

4.7 Limitations and Risks of the Survey Approach

Although a survey is an accepted research tool that assists in capturing data involving the perspectives of people (in this case, the service customers), its limitations may lead to failure or non-confidence in the analysis results. Therefore, we need to examine the limitations of our survey and recommend approaches to eliminate the potential risks. In general, two types of error are recognized in survey statistic [25]:

1. **Observational errors** are deviations of the answers of respondents from the true values for what is being measured. In other words, there are observable inaccuracies in the answers from respondents. If a tendency to make such errors exists in majority of the population, the overall survey results will deviate from the correct ones. In an online survey, observational errors are most frequently caused by the failure of understanding the survey motivation. An effort is made to define and explain the background information before the participation of respondents; however, they still may not know the reason for answering specific questions, and the interviewer has no chance to interact with the participants during the survey. To reduce observational errors, it is necessary to conduct follow-up surveys that clarify those questions having suspicious answers.

2. **Errors of non-observation** are the errors arising because measurements were not taken on part of the population. In other words, there are incompleteness in the answers from distinct groups of respondents. When using an online survey instrument, perhaps the most common errors of non-observation come from the bias due to non-response. People who are not willing to participate in the online survey (e.g., people who are too busy or people who do not like to answer questions online, etc.) may have different opinions from those who are, therefore yielding biased opinions. To reduce errors of non-observation, the survey should be conducted with a larger number of and a broader range of the population.

Apart from the general limitations in conducting survey, the Generic Survey has following risks in particular:

- The goal of the Generic Survey focuses on the use of external IT services, especially SaaS. The questions are asked about the percentage of the annual IT operating budget spent on external IT services and SaaS, nevertheless, this provides insufficient information on the direct experience of the participants in external IT services and SaaS. For example, we have no information on the percentage of SaaS applications that these companies have adopted involving the service types *Ad-hoc*, *Defined*, *Managed* and *Strategic*. Since SaaS is a relatively new service delivery model, the respondents may not have sufficient experience in using it to answer the questions in an informed manner. Even when they have adopted SaaS, most of the experience may be only limited in *Ad-hoc* or *Defined Service*. In analyzing the results it may be more appropriate that the answers from those who have more experience in a specific service type be given higher weight in our analysis than those who have little experience. Having as background the participants experience information in the four service types would provide more confidence in our analysis.

- The definitions of the service attributes may not be clearly understood. As discussed in Section 4.5.4, this may be the reason for the two outliers as shown in Table 4.22. In reality, people have their own definitions of the terms and some participants may ignore those given by standard documentation. To achieve a better understanding of the exact meaning of a service attribute, we should introduce example measures as part of the service attribute explanation. For example, the definition of usability can be consolidated by including example measures such as usefulness of the service and satisfaction with features, which are typically rated in a scale system in a customer survey.

- From March to May in 2009, we conducted an initial survey with the companies recognized by Salesforce.com on their website as successfully adopting their service. The questionnaire of that survey is the preliminary version of the one we used in the Generic Survey. We contacted the company represen-

tatives by telephone calls to request participation of the survey. In addition, we searched for the information on CIOs from these companies through internet tools. Finally, we collected 55 email addresses of the CIOs and then invited them to participate in the survey. However, we only received two responses by the end of May 2009.

The lack of the responses was due to the difficulties in communicating with the invited participants. We started with company names and email addresses, and had no other information such as CIO's names and email addresses. It would appear that the goal of our study was not easily recognized or well understood by the invited participants. Consequently, most invitees refused to respond.

To achieve a higher response rate we conducted the Generic Survey in which participants were selected from the local area and therefore were much more likely to recognize the credibility of the survey. We also contacted individuals to complete the survey rather than company representatives and this did result in a much higher participation rate, but a major risk emerged because the survey had a geographical bias.

- One of the goals for the survey analysis is to produce a predictive view on building the SaaS business relationships. To use statistical instruments, it is required to quantify the survey data. Therefore, in the Generic Survey we adopted a rating scale system for the priority of service attributes considered in different service types.

  As summarized in [26], the commonly used rating scale systems include the 3 point scale, the 5 point scale, the 7 point scale, the 10 point scale and the 11 point scale. The 10 and 11 point scales are generally used for rating customer satisfaction. We felt that these scales were not suitable for the Generic Survey because they provided too large a scale for responses that prioritize service attributes. The 3 point scale, which in the case of the Generic Survey can be High (3), Medium (2) and Low (1), provides less ambiguity. However, it does not allow measurable space especially when we want to examine the relative

variance of a service attribute across the four service types. For example, a customer may rate the priority of *reliability* four in *Ad-hoc Service* and five in *Defined Service*, but both values would likely lead to a response of High (3) in a 3 point scale system. An extensive study of many past surveys analyzed the relationship between scale length and reliability of the results. It showed "that 5 or 7 point scales produced the most reliable results." [41]

Based on what is commonly used in the survey literature, we decided to choose a 5 point scale for rating the priority of service attributes. This resulted in some ambiguity between scale values. People may be hesitant in selecting high priority; one person never rated anything a five, while other chose to rate most high priority attributes as a five and rarely choose a four. The risk of inaccuracy is significantly high when we use mean values in analysis. However, it can be largely eliminated by using the *relative importance* in the statistical analysis. The *relative importance* is defined in this thesis and shown to be a successful factor in getting response differentiation.

In conclusion, to reduce the potential risks listed above and ensure the reliability of the results, this research would benefit with a follow-up survey to reduce the observational errors. The survey should also deal with the following issues:

- To reduce the inaccuracy of responses, the follow-up survey should have a more clearly stated description of the background. In particular, example measures and related measurement approaches can be added in the definition section of the service attributes. For instance, typical measures for *functionality* are number and percentage of functions (or features) as needed, while typical measures for *usability* include the satisfaction with functions (or features) of the service.

- To collect more information on experience in using SaaS applications, the survey should include the questions on the SaaS experience of the participants in the four service types. Questions can ask about the percentage of services adopted as *Ad-hoc, Defined, Managed* and *Strategic*. Or more qualitatively,

we can ask the respondents to rank the level of experience in the four service types from high to low. Note that this measure can be used as an important factor in the hypothesis test discussed in Section 4.6.

- To reduce the errors of non-observation and eliminate the geographical bias in the Generic Survey, the survey should select participants from a broader range of the survey population while keeping the response rate at the same or even higher level. This can be achieved by investigating typical SaaS service areas and selecting most experienced and successful customer organizations in these service areas. With more experience of preparing the surveys related to SaaS services (see Email Survey in Chapter 6), we now know much better how to prepare such surveys and contact the potential participants.

Based on our experiences in conducting the initial Salesforce.com survey and the Generic Survey, the follow-up survey will require significant time and resources. Major factors that should be considered in completing this study include:

- Before the study is launched, detailed interviews should be made with the 7 participants that provided their names as part of the follow-up study undertaken as part of the Generic Survey. Survey expertise[1] should be sought in preparing these interview sessions in order to improve the existing survey questions.

- The survey preparation will undoubtedly require more time (greater than 3 months) and more research funding (more than $3,500) than the previous surveys. Acquisition of these resources must be sought.

- There will still be difficulties in contacting and communicating with the potential survey participants. Realistically, unless participants are confident in the research study group and can see benefits in participating, they are unlikely to expend the effort to complete the survey. CIOs are an "over sur-

[1]Expertise from Dr. Stanley Varnhagen of the Faculty of Extension's Learning Solutions Division and Dan Precht from AICT's Test Scoring and Survey Services was used in developing previous surveys. It is recommended that assistance from Professor Walter Bischof from Department of Computing Science be used in this part of the research.

veyed" population today. A possible solution to this problem is to seek the assistance of a professional organization such as CIO Canada [see www.ciocan.ca] to recommend the survey to their membership. Seeking and confirming this support will significantly increase the completion time of a survey.

The completion of the follow-up survey is included as part of the future research activities for this thesis.

4.8 Summary

In this chapter, we discussed quality management and value co-creation (co-value) in SaaS business relationships. In order to determine the co-value for both the service customer and provider, a specification of four service types (*Ad-hoc*, *Defined*, *Managed* and *Strategic*) was defined according to the maturity levels of the business relationships in SaaS delivery. This led to a conjecture that the intensification of the service type can be managed by the addition of quality measurement approaches. A web-based survey called the Generic Survey was conducted with a selected group of service customer organizations to validate this conjecture.

In the Generic Survey, we observed that more service attribute groups are considered and with higher priority by customer organizations when the business relationship moves from *Ad-hoc* to *Strategic*. Four service attribute groups are identified in the survey results which can be aligned with the incremental evolution of the four service types: *Ad-hoc Service* with *functionality*, *Defined Service* with addition of *conformance quality attributes*, *Managed Service* with addition of *gap quality attributes* and *Strategic Service* with addition of *value quality attributes*. Finally, a hypothesis test of the survey results and an analysis of the survey risks led to the conclusion that a follow-up survey would be helpful in addressing some of the risks of the Generic Survey and could assist in explaining the two outlier that appeared in this study.

In Chapter 5, we will address the issue of designing the SaaS evaluation model based on the theory of SaaS business relationship. A two-cycle based evolutionary approach will be presented to implement and validate the evaluation model.

Chapter 5

Defining the SaaS Evaluation Model

In this chapter, we develop a SaaS evaluation model that assists the service customer in selecting an appropriate SaaS system and provides the service provider and customer with a guide to monitor the service operation. The decisions related to both service selection and monitoring should be driven by the perceived co-value of the service provider and customer in establishing their business relationship.

A two-cycle evolutionary approach will be used in building our model (see Figure 5.1). At the core of the two cycles is the theory of SaaS business relationships and derived service types that were developed in Chapter 4.

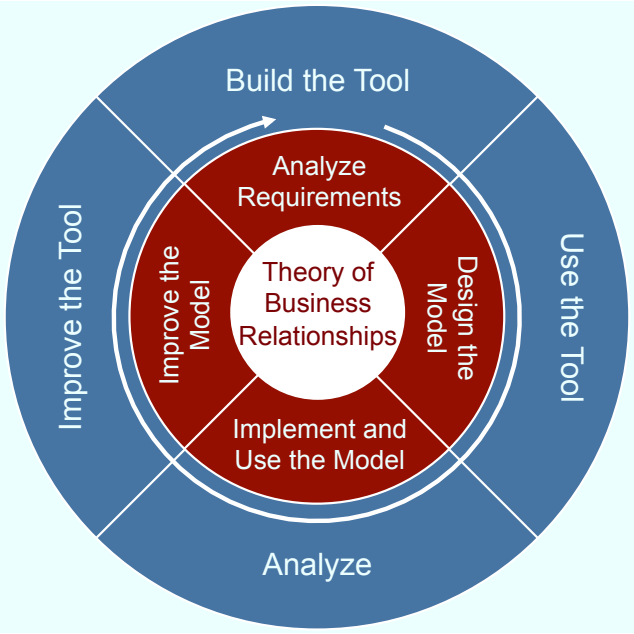

Figure 5.1: Evolutionary cycles for the SaaS evaluation model

The inner cycle around the core theory lists the steps in defining and refining the SaaS evaluation model. We first analyze the requirements that the model should achieve from the perspectives of both the service customer and provider. We then design the model using the UML object-oriented design tool. The model is then implemented and used by developing an evaluation tool, which starts the evolution of the outer cycle.

The outer cycle focuses on the evolution of the evaluation tool, which can used in various SaaS service areas. Based on the evaluation model, the tool is built and used in a particular service area. The result of the tool use is analyzed and the tool can be improved. The update of the tool leads to the beginning of next cycle. The lessons learned in the development of a specific tool are also used to improve the model in the inner cycle.

In the remainder of this chapter and Chapter 6, we discuss in greater detail and illustrate how we deploy the two cycles.

5.1 Service Map: Instrumenting the Theory of Business Relationships

Before we start designing the evaluation model, it is necessary to find an instrument to link the theory of business relationships with the evaluation behaviour performed by the model.

In Chapter 4, we observed that the *business objectives* (or as defined in [28], the set of characteristic changes an organization intends to accomplish in the business) of the service customer and provider must be taken into consideration in the strategic planning of building business relationships. For example, if a small organization wants to use a SaaS for only one year, they may just focus on conformance quality aspects such as the reliability of product and may not be concerned with the value quality. On the other hand, if an organization plans to build a strategic partnership with a service provider, all quality types (i.e. conformance, gap and value quality) should be considered in developing the strategic partnership.

Our challenge is to map a large variety of business cases into one framework

that enables the service provider and customer to evaluate and manage the service quality. Strategy Mapping [36] is a tool that can be adopted to integrate service quality types and instrument our model.

As described in [28], "Strategy mapping approach produces a graphic big picture in which objectives are visually organized and interrelated with each other with an illustration of cause-effect logic." The strategy map requires a clearly-defined, well-structured and extensible tool that is capable of sharing the whole picture and showing the logic relationships. In designing the SaaS evaluation model, we use a tabular diagram to organize and visualize the related elements into sections similar to strategy map, which we call a *service map*.

In the service map, the two principal axes represent the dimensions of business goals and organizations:

- *The Vertical Axis of Business Goals*. The axis of business goals shows the goals of business relationship in terms of service offering between the service provider and customer. The axis covers from bottom to top: *Defined Service*, *Managed Service* and *Strategic Service*. *Ad-hoc Service* is assumed to be achieved once the service is successfully delivered, so it is not shown in the axis. As identified in Chapter 4, there is an association between the quality type and the business relationship. If the desired business relationship is at a higher level, more types of quality measurements should be introduced in the evaluation model. Therefore, the vertical axis can also be viewed as providing a dimension of quality types.

- *The Horizontal Axis of Business Organizations*. The axis of business organizations is shown horizontally, with service provider on the left and service customer on the right. The direction of the axis depicts the dominant organization in business activities.

The two axes divide the map into six sections, as depicted in Figure 5.2. The steps to build an instance of the service map are introduced as follows:

1. Identify business objectives for the service provider and the service customer.

2. Discover co-value and alignment in business objectives.

3. Identify the related quality metrics and targets that realize the agreed upon business objectives.

4. Map the quality metrics and targets into sections.

We now discuss each step in greater detail.

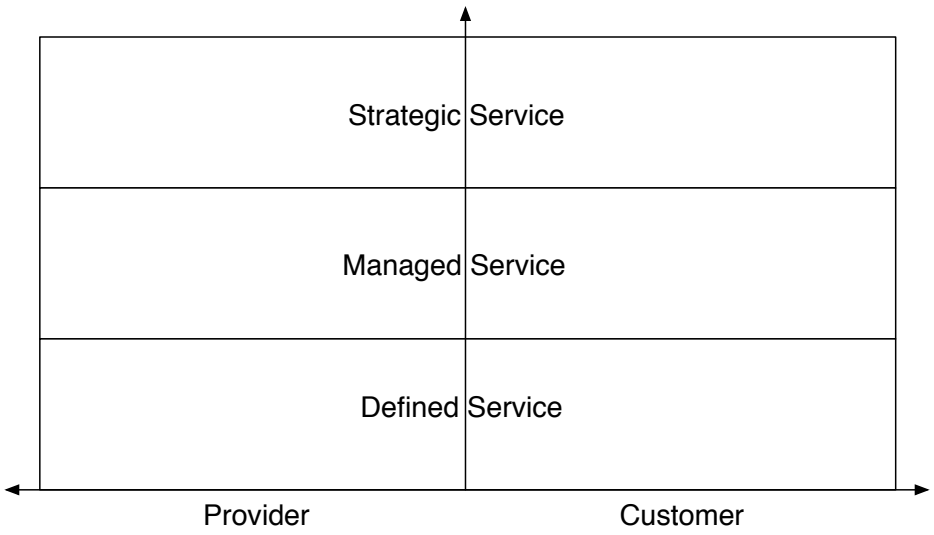

Figure 5.2: Two axes of the service map

5.1.1 Identify Business Objectives for the Service Provider and Customer

The business objectives for the service provider and customer can be related to the goals of service quality management described in Chapter 1. In particular, the service provider is to deliver an effective service efficiently to the customers, while the service customer is to use the service with high satisfaction to meet a defined purpose.

As an example, let us assume that there are a pair of business organizations: one as a service provider P and the other a service customer C. P's business objective is to become a leader in the market by selling a SaaS S. This may include making S one of the most successful services in the market, and establishing more strategic

partners. C's business objective is to achieve business requirements by using a SaaS, with best performance, highest satisfaction and lowest cost/risk.

5.1.2 Discover Co-value and Alignment in the Business Objectives

In practice, the business objectives of the service provider and customer often match well but can conflict with each other. This reveals the opportunities for discovering co-value and alignment between the two organizations. The objectives that show the co-value of both organizations are redefined, and the inconsistent objectives are modified and removed. The detailed input for the alignment can be collected through SLAs, CVPs, surveys, customer requirements, project charter and other documentation. After the alignment, business objectives are summarily defined as a set of goals that will be mapped into the axis of business goals.

In our example, the customer C discovers that the service S generally meets its business requirements, so C sets up an alignment with P to achieve their business objectives. P's business goals include delivering S to C with guaranteed performance for a long term. C's goals are to have S meet its business requirements by delivering the service with high satisfaction and low cost. In the long run, both organizations have the business objective to build a strategic partnership with each other.

5.1.3 Identify the Related Quality Metrics and Targets

The next step is to define for each business goal identified in the previous step the quality metrics for evaluating each goal and the achievement targets for each metric. Figure 5.3 shows an example of the quality metrics and achievement targets that clarifies a business objective and makes it tangible.

In addition to describing a business objective explicitly, well-chosen quality metrics and achievement targets also quantify the expected strategic value, facilitate the service improvements and assist in calibrating strategic evaluations. Specifically we need to provide answers to the following four questions for each quality metric:

- What is the definition of the quality metric?

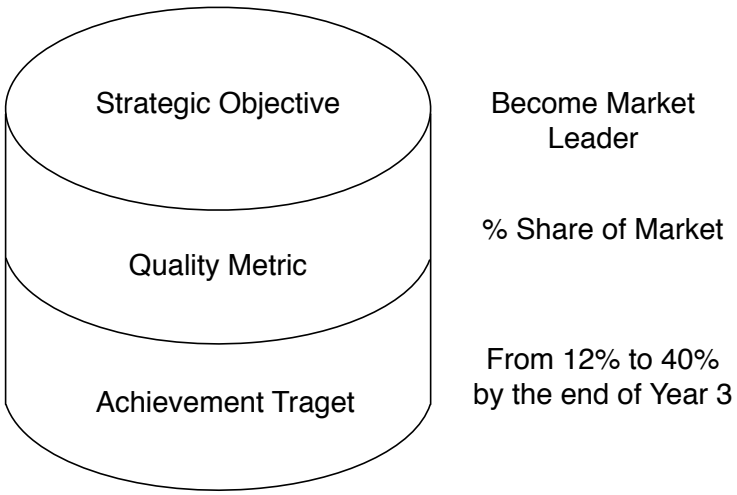

Figure 5.3: Metrics and targets make objectives tangible (example taken from [28])

- Who will implement the measurement of the metric?
- How will it be measured?
- By whom will it be measured and used?

In this step, quality measurements including SLA-based conformance quality approaches, customer survey-based gap quality approaches and value analysis-based value quality approaches can be applied to help both the service customer and provider calculate and monitor the defined quality metrics and evaluate the performance.

In our example, P and C identified the following quality metrics according to the four questions for quality measurement (Table 5.1).

The achievement targets related to these metrics are defined based on the business objectives identified and aligned in the previous steps:

- Availability: 99% guaranteed;
- Productivity: $50 per hour achieved;
- Customer satisfaction: 85% achieved;
- Cost: Lower;
- Risk: Lower.

Table 5.1: Measurement of the quality metrics

Quality Metric	**What is the definition of the quality metric?**	**Who will implement the measurement of the metric?**	**How will it be measured?**	**By whom will it be measured and used?**
Availability	Percentage of the uptime	Service provider	Defined in SLA	Service provider and customer
Productivity	Profit per unit time	Service customer	Defined in SLA	Service customer
Customer satisfaction	Rating (in %) of the use experience	Service provider	Measured by customer surveys	Service customer and provider
Cost	Monetary value of expense	Service customer	Cost estimation	Service customer and provider
Risk	Product of the likelihood of a business disruption occurring and the possible loss	Service customer	Risk analysis	Service customer and provider

5.1.4 Map the Quality Metrics and Targets

Once the quality metrics and achievement targets are chosen, they constitute sub-goals towards the expected business objectives. These sub-goals are then mapped to sections in the service map.

In the dimension of business organizations in our service map, the sub-goals evaluated by the service provider are placed in the provider sections, while those evaluated by the service customer are in the customer sections. The sub-goals evaluated by both organizations are placed in the middle, with the vertical axis passing through.

In the dimension of business goals, the sub-goals of performance based on conformance quality, such as guaranteed availability and achieved productivity, are placed in the sections at the *Defined Service* level. Those of customer satisfaction based on gap quality are in the sections at the *Managed Service* level. Those of

business value like cost and risk are placed in the sections at the *Strategic Service* level. After the sub-goals are in place, the achievement order can be developed by adding the links between the sub-goals. In general, these links are directed from the lower goals to upper ones. Typically, the borders between sections represent demarcations between the SaaS service types.

The service map for the example discussed in this section is depicted in Figure 5.4. Note that the co-value of the relationships between the service provider and customer is defined as the summation of the value achieved for both the service provider and customer.

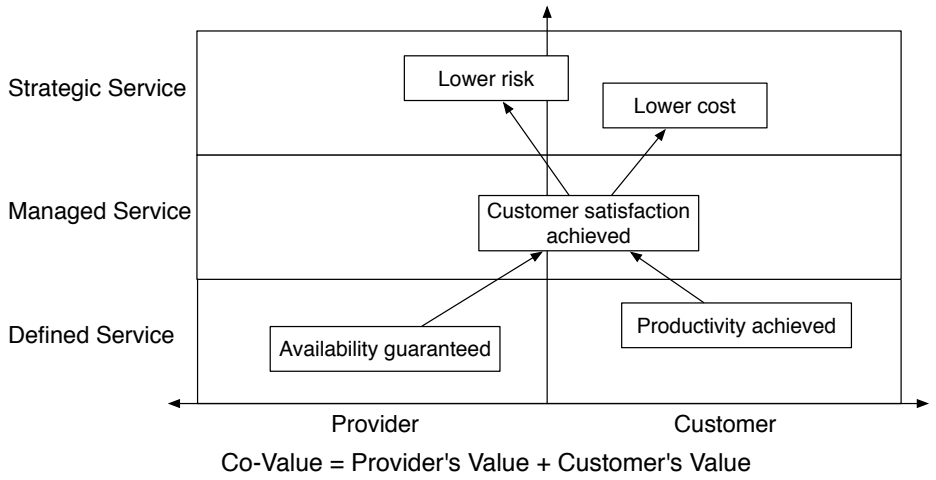

Figure 5.4: Service map with related sub-goals

5.2 Analyze the Model Requirements

The SaaS evaluation model should provide the basis for a web-enabled, sharable and road-map tool supporting the three quality types over time. All the participants of the service delivery, including the service provider, the service customer and other third parties use the model in both the pre-purchase service planning and post-purchase service operation phases.

Therefore, the functional requirements of the SaaS evaluation model focuses on the following two aspects:

- The model assists the service provider to assess service quality and make decision to select SaaS systems in service planning by:
  - perceiving functional and quality requirements from the service customer;
  - obtaining service offerings from service providers;
  - producing service evaluation reports with the help of an evaluation tool, based on the theory of business relationships and using the service map;
  - supporting the service purchase and delivery after the decision making by the service customer.
- Once the service is delivered and in operation, the model executes the quality-based monitoring by:
  - reporting the on-going quality data of the service;
  - supporting the improvement of the service;
  - supporting the alignments between the service customer and provider at the strategic level.

Four roles are involved in the use of the model. They are defined as follows and will be used as actors in the use cases:

- **Service Customer** is a role that selects and purchases the SaaS from the service provider. The service customer perceives the quality requirements and aims to receive higher satisfaction with the service.
- **Service Provider** is a role that provides services to the service customer. The service provider develops SaaS systems and publishes service offerings with specifications of service quality.
- **Service Broker** is an optional role that centralizes service quality data, such as customer requirements and service offerings, and assists the service customer to use the SET (see below).
- **Service Evaluation Tool (SET)** is a role that assists in the evaluation of the SaaS systems with quality measurement approaches. The SET performs the

role of coordinator in the model. It processes all necessary data, including customer requirements and service offerings, and produces the evaluation report for service selection and monitoring. In practice, the SET can be used by an individual department inside the service customer organization or an independent service broker.

5.3 Design the Model

In this section, we use object-oriented design approach to analyze and define our quality-based SaaS evaluation model. The design process has the following steps:

1. Analyze the model using UML use case diagrams and activity diagram;
2. Identify the classes exposed from the use cases and define the model architecture using UML class diagrams;

5.3.1 Analyze the Use Cases

As identified in the requirements, the use of the model can be divided into two parts: service selection in the planning phase and service monitoring in the operation phase.

Service Planning for Customer

In the planning phase, the use cases are separated for the service customer and the service provider. The use case diagram that includes the primary use cases for the service customer is shown in Figure 5.5. With the service customer identified as a primary actor, the use cases are described as follows:

- *Perceive Requirements* Use Case:
  - **Primary actor**: Service customer.
  - **Goal**: To establish functional and non-functional (quality) requirements for a SaaS.
  - **Precondition**: Business objectives are clearly understood by the service customer.

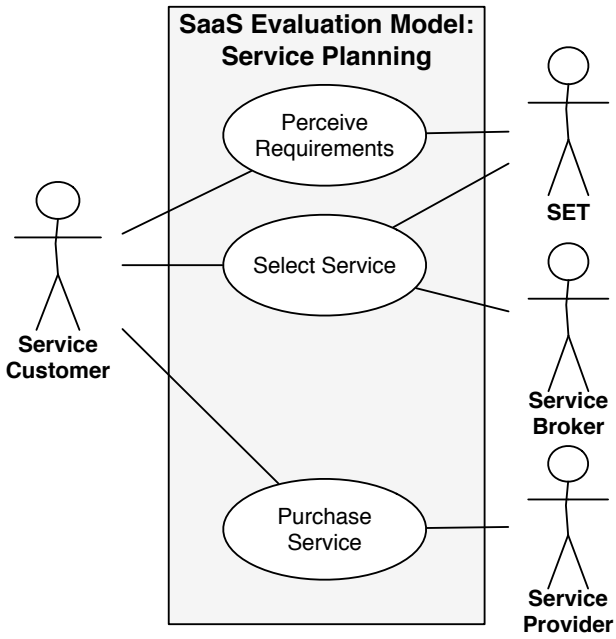

Figure 5.5: Use case diagram of service planning for customer

- **Scenario**:

  1. Service customer: identifies the business objectives, including the business motivation, existing problem functionality and desired quality.
  2. SET (optional): provides experiential business cases for reference.
  3. Service customer: produces the initial functional and quality objectives as requirements.

- **Secondary actor**: SET (optional).

- *Select Service* Use Case:

  - **Primary actor**: Service customer.
  - **Goal**: To receive information of service candidates providing the functional and quality requirements.
  - **Precondition**: Functional and quality requirements are identified by the service customer; and the SET has established a service repository for

service offerings and an experiential data repository for experiences of using services in the same service area from other service customers.

  - **Scenario**:
    1. Service customer: initiates the request for service selection.
    2. Service customer/service broker: inputs the functional and quality requirements in the SET.
    3. SET: analyzes the functional and quality requirements.
    4. SET: produces the service selection report with service candidates and the service map based on the information of service offerings and experiential data.
  - **Secondary actors**: SET, service broker (optional).

- *Purchase Service* Use Case:
  - **Primary actor**: Service customer.
  - **Goal**: To make the decision to purchase a qualified SaaS from a service provider.
  - **Precondition**: The service selection report has been produced by the SET.
  - **Scenario**:
    1. Service customer: understands the service selection report.
    2. Service customer: selects the most appropriate service system and the service type.
    3. Service customer: negotiates with the service provider as necessary on the SLA/CVP details and the business relationship.
    4. Service customer: signs the service contract including SLA/CVP with the service provider.
    5. Service customer: pays the price agreed upon in the contract.
    6. Service provider: accepts the payment for the service from the service customer.

– **Secondary actor**: Service provider.

Service Planning for Provider

The use case diagram that includes the primary use cases for the service provider is shown in Figure 5.6. With the service provider identified as primary actor, the use cases are described as follows:

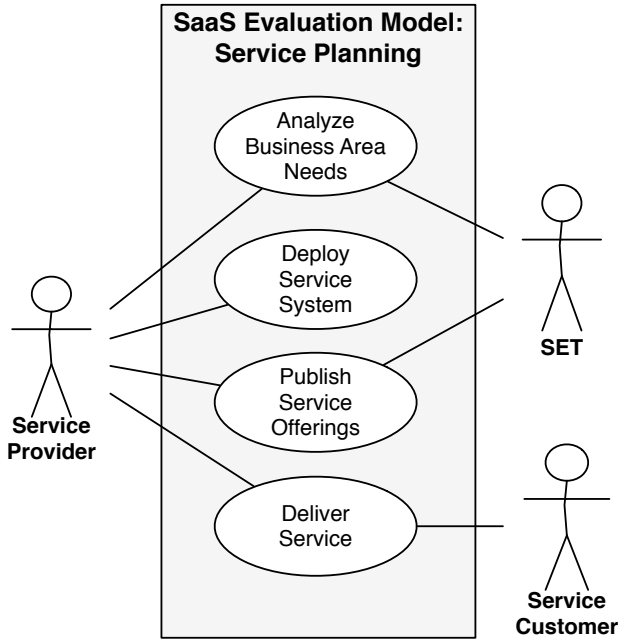

Figure 5.6: Use case diagram of service planning for provider

- *Analyze Business Area Needs* Use Case:
  - **Primary actor**: Service provider.
  - **Goal**: To analyze the business area needs for service development.
  - **Precondition**: The business objectives for a service offering are clearly understood by the service provider.
  - **Scenario**:
    1. Service provider: identifies the business objectives.
    2. SET (optional): provides information of similar service offerings for reference.

3. Service provider: produces business area needs including the functional and quality objectives for building a service system.

– **Secondary actor**: SET (optional).

- *Deploy Service System* Use Case:
  – **Primary actor**: Service provider.
  – **Goal**: To deploy the service system.
  – **Precondition**: The business area needs have been identified by the service provider.
  – **Scenario**:
    1. Service provider: develops the service system based on the defined functional and quality objectives.
    2. Service provider: deploys the service system.
  – **Secondary actor**: None.
- *Publish Service Offerings* Use Case:
  – **Primary actor**: Service provider.
  – **Goal**: To publish the service offerings to a service repository.
  – **Precondition**: The service system has been deployed by the service provider.
  – **Scenario**:
    1. Service provider: produces the service offerings with functional and quality information of the deployed service.
    2. Service provider: registers the service offerings in a service repository, such as world-wide web or a service registry managed by the SET.
    3. SET (optional): updates the service repository with the published service offerings.
  – **Secondary actor**: SET (optional).

- *Deliver Service* Use Case:
  - **Primary actor**: Service provider.
  - **Goal**: To deliver the service to the service customer.
  - **Precondition**: The service customer and provider have agreed upon the functional and quality guarantees of the service with the contracted SLA/CVP; and the service customer has made the purchase.
  - **Scenario**:
    1. Service provider: delivers the requested service in the way defined in the service contract.
  - **Secondary actor**: Service customer.

Service Operation

When the service is in operation, the use cases are related to both the service customer and provider. As a result, the service customer and provider are both considered as primary actors in the use case diagram of service operation, which is shown in Figure 5.7.

In the service operation phase, the use cases of the model include:

- *Monitor Service Quality* Use Case:
  - **Primary actors**: Service provider and service customer.
  - **Goal**: To monitor service quality against the defined functional and quality expectations.
  - **Precondition**: The service is in operation. The functional and quality expectations have been identified by the service provider and customer.
  - **Scenario**:
    1. Service provider and customer: define the strategy of the quality monitoring, including frequency, measurements and responsibilities.

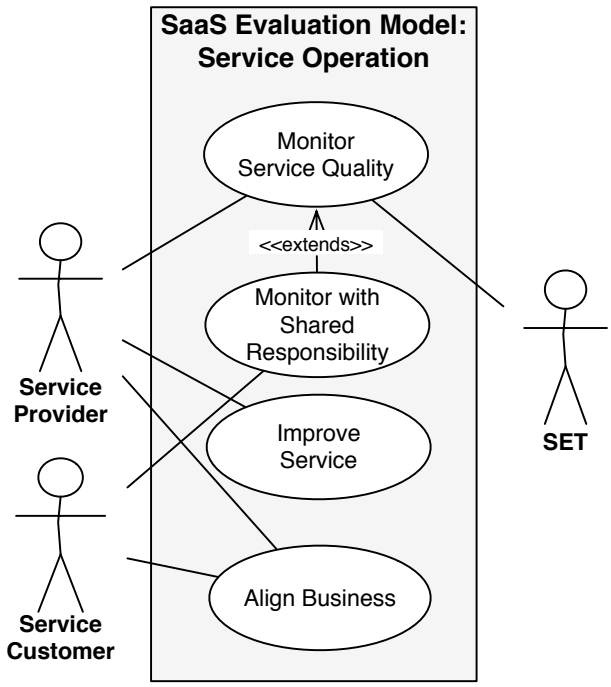

Figure 5.7: Use case diagram of service operation

2. Service provider/service customer: request(s) service monitoring from SET. If the service type is *Managed* or *Strategic*, the service customer should also share the responsibility of monitoring.
3. SET: produces the service monitoring report based on the quality measurements.
4. SET: updates the experiential data.

– **Secondary actor**: SET.

- *Improve Service* Use Case:
  - **Primary actor**: Service provider.
  - **Goal**: To improve the service functional and quality performance.
  - **Precondition**: The monitoring report has been produced by the SET.
  - **Scenario**:
    1. Service provider: understands the monitoring report and proposes the improvements.

2. Service provider: develops the improvement plan.
3. Service provider: implements the improvements according to the plan.

– **Secondary actor**: None.

- *Align Business* Use Case:

  – **Primary actors**: Service provider and service customer.

  – **Goal**: To align the business of the service customer and provider based on the experience of service operation. This use case only happens when the service type is *Strategic*.

  – **Precondition**: The monitoring report has been produced by the SET.

  – **Scenario**:

    1. Service provider and customer: understand the monitoring report and decide to align the business.
    2. Service provider and customer: adjust the business objectives based on the service use experience.

  – **Secondary actor**: None.

From an analysis of the use cases, a set of activities for using the model can be described in the following UML activity diagram (Figure 5.8).

1. *Perceive Requirements*: The service customer recognizes the business objectives, including the business motivation, existing problem functionality and desired quality, and produces the initial functional and non-functional requirements.

2. *Provide Experiential Data*: The SET provides the experiential data in the service area for requirement analysis.

3. *Analyze Business Area Needs*: In the current business market, the service provider completes the analysis of the business strategy and defines business area needs.

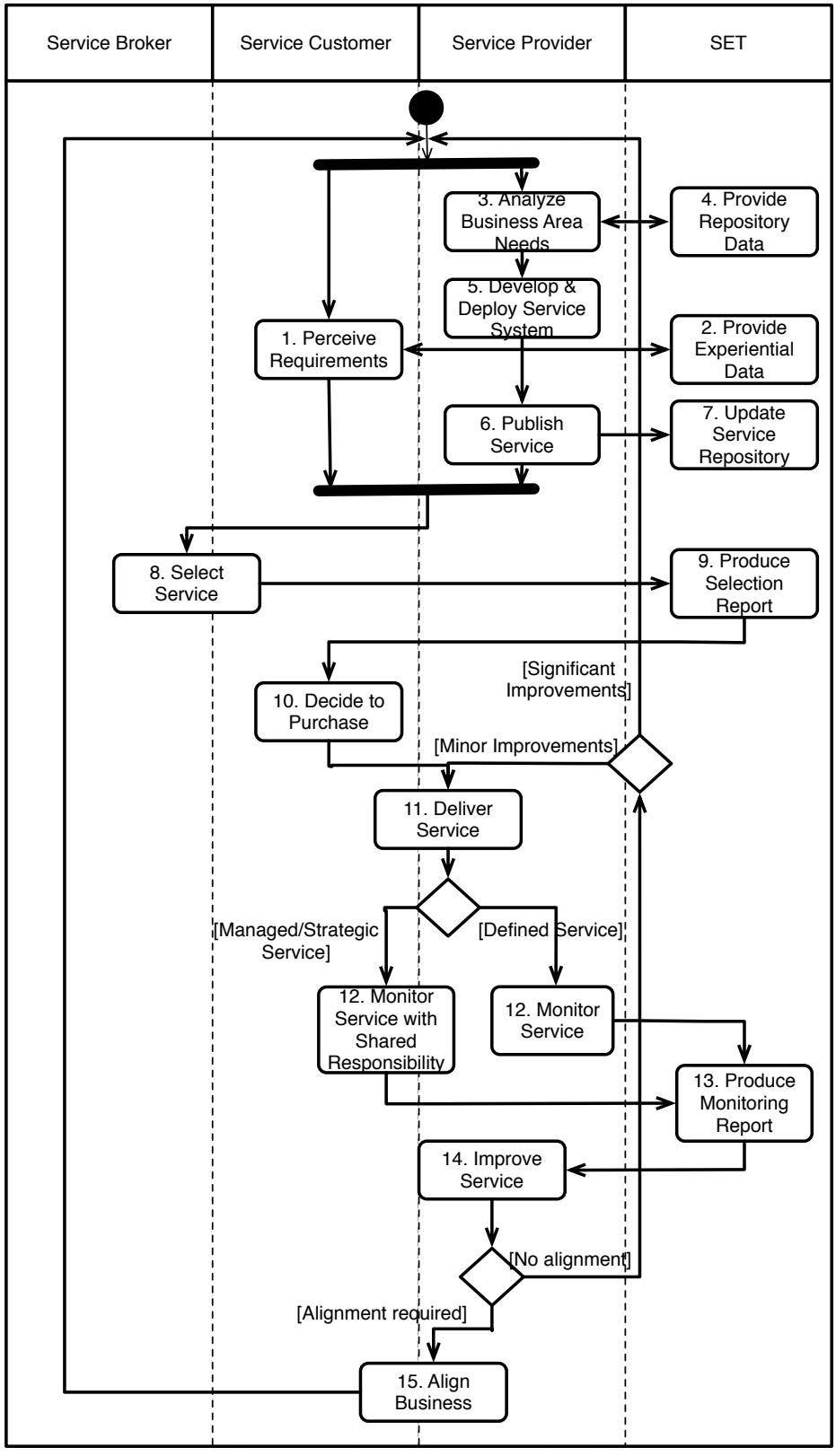

Figure 5.8: Activity diagram of SaaS evaluation model

4. *Provide Repository Data*: The SET provides the service repository data with historical service offerings in the service area for business area needs analysis.

5. *Develop and Deploy Service System*: Based on the business area needs, the service provider develops and deploys the service system.

6. *Publish Service*: After the service deployment, service offerings are published to a service repository. The repository can be simply the world wide web, or be part of a service registry managed by a service broker.

7. *Update Service Repository*: The SET updates the service repository with the newly published service offerings.

8. *Select Service*: The service customer uses the SET for discovery and/or selection of SaaS systems. The tool takes as input the requirements from the customer, service offerings from the providers, and the experiential data from other customers by either tool use commentaries or user survey.

9. *Produce Selection Report*: The SET assists in service candidate analysis by producing a selection report. Service candidates and an appropriate service type are proposed in the report.

10. *Decide to Purchase*: The service customer uses the selection report to assist in decision making for the adoption of SaaS systems. At this stage, a service contract is negotiated as necessary, agreed upon and signed between the customer and the provider.

11. *Deliver Service*: The service provider delivers the service in accordance with an agreed-upon service contract.

12. *Monitor Service*: After service delivery commences, the service provider defines the monitoring plan and executes service monitoring as the basis of service improvement. If the service type is *Managed* or *Strategic*, service monitoring becomes the responsibility of both organizations.

13. *Produce Monitoring Report*: The SET assists in both monitoring the service as frequently as agreed upon by the customer and provider, and in producing the monitoring report. The SET also updates the experiential data with the monitoring results.

14. *Improve Service*: The service provider acts on the monitoring report by proposing a set of service improvements. Minor improvements can be made by the provider and delivered as an improved service to the customer. Significant improvements would take both organizations back to the beginning of the cycle (i.e., requiring a review of the requirements perception for the service customer, and business needs analysis for the service provider).

15. *Align Business*: If after the monitoring, both the service customer and provider think it is necessary, they can bring their requirements and business needs together for business alignment. The alignment will produce the aligned requirements for customer and business need for provider that can be used for a new activity cycle. This process only happens when the service type is at a *Strategic* level.

5.3.2 Design the Class Diagram

An analysis of the model use cases and activity diagram suggests the following classes:

- Entity objects representing the roles involved in the model:
  - Service customer;
  - Service provider;
  - Service broker;
  - SET.
- A controller object corresponding to the service evaluation, with two specializations responsible for service selection and monitoring.
- Boundary objects representing the input and output components of the model:

- Service repository;
- Experiential data repository;
- Report: responsible for producing both selection and monitoring reports.

- Entity objects representing the service, service offerings and service quality measurements.

Figure 5.9 illustrates the initial class diagram of the evaluation model. The CRC cards of these classes are shown in Table 5.2.

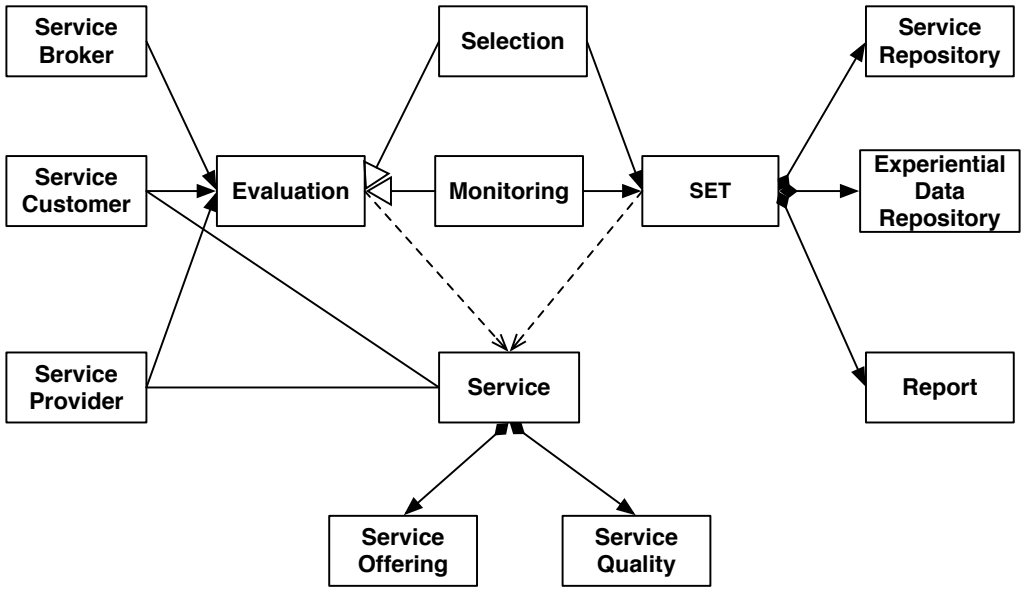

Figure 5.9: Class diagram of the SaaS evaluation model

Table 5.2: CRC cards of classes in the evaluation model

Class Name	**Responsibility**	**Collaborator**
Service Customer	Initiate the activities in which the service customer is the primary actor	Evaluation, Service
Service Provider	Initiate the activities in which the service provider is the primary actor	Evaluation, Service
Service Broker	Initiate the activities in which service broker is the primary actor	Evaluation

SET	Perform the activities in which SET is involved	Evaluation, Service Repository, Experiential Data Repository, Report
Evaluation	Perform all the use cases	Service Provider, Service Customer, Service Broker, SET
Selection	Perceive the requirements	Service Customer, SET
	Analyze business area needs	Service Provider, SET
	Deploy the service system	Service Provider, Service
	Publish the service	Service Provider, SET, Service Offering
	Select the service	Service Customer, Service Broker, SET, Service Quality
	Purchase the service	Service Customer, ServiceProvider, Service
	Deliver the service	Service Provider, Service Customer, Service
Monitoring	Monitor the service	Service Provider, Service Customer, Service, SET
	Improve the service	Service Provider, Service
	Align the business	Service Provider, Service Customer
Service Repository	Represent the service repository in the model	
Experiential Data Repository	Represent the experiential data repository in the model	
Report	Represent the report produced in the model	
Service	Represent information related to services	
Service Offering	Represent information related to service offerings	
Service Quality	Represent information related to service quality measurements	

5.4 Summary

In this chapter, a two-cycle evolutionary approach was presented to define the quality-based SaaS evaluation model. After instrumenting the theory of business

relationship with the service map, the first two steps of the inner cycle were defined. We analyzed the functional requirements of the evaluation model that can be used to select and monitor SaaS systems effectively in both the service planning and operation phases. The model consists of four roles: service customer, service provider, service broker and the SET that performs the evaluation of the service. With the assistance of UML diagrams, we identified use cases in service selection and monitoring, and then built the model architecture by designing the classes that performs these use cases.

The next two steps of the inner cycle, *Implement and Use the Model* and *Improve the Model*, will be discussed in Chapter 6 in combination with the design and use of the evaluation tool.

Chapter 6

Design and Use of the Evaluation Tool

In the previous chapters, we defined a quality-based evaluation model in the selection and monitoring of the SaaS systems. In this chapter, we follow the outer cycle in Figure 5.1 and show how the Service Evaluation Tool (SET) in Chapter 5 is built and used in a particular service area. This cycle includes the following four steps:

1. Build the tool: Similar to the design of the evaluation model, we use UML object-oriented design to identify the functional requirements, define the use cases and design the architecture of the tool.

2. Use the tool: We simulate the use of the tool by a service expert in the service customer organization for a particular SaaS service area: the adoption of email services. A customer survey is incorporated in building the experiential data. An example case study is undertaken which shows how the tool is used for assistance in decision making of service selection.

3. Analyze the results: We analyze the results of the case study and detect the existing problems in the evaluation tool.

4. Improve the Tool: With the lessons learned from the analysis, we can redesign and improve the tool.

6.1 Build the Tool

The evaluation tool can be used in two scenarios: either by a service expert in the service customer organization, or by a third-party agent, serving as a broker between the service customer and provider. In building the first version of the tool, we only consider the first scenario where the tool is used inside the service customer organization. In this scenario, the roles involved in the service evaluation are the service customer and provider.

The procedure of building the evaluation tool is as follows:

1. Identify the key requirements from a functional perspective;
2. Analyze the use cases of the tool;
3. Based on the use cases, define the tool architecture using the UML class diagram;
4. Design the interactions in the tool using the UML sequence diagrams.

6.1.1 Identify the Functional Requirements

In Chapter 5, we saw that the SET can be used in *Requirement Perception*, *Business Needs Analysis*, *Service Publishing*, *Service Selection* and *Service Monitoring*, but it is optional for the first three activities. In this chapter, we only focus on how the evaluation tool is built and used for *Service Selection* and Service Monitoring in a particular SaaS service area. Therefore, the tool should address the following functional issues:

- Obtaining inputs of quality data globally from the service customer and provider;
- Retrieving and updating the experiential data in the particular service area;
- Producing service selection reports in the service planning phase;
  - Determination of inconsistency, incompleteness and comparison analysis based on quality measurements;
  - Recommendations of candidate services and service type.

- Monitoring and reporting on a delivered service system in the service operation phase.
  - Service performance analysis based on quality measurements;
  - Recommendations of improvements.

6.1.2 Analyze the Use Cases

By analyzing the functional requirements, we define two use cases of the evaluation tool: *Select Service* use case with the service customer as primary actor, and *Monitor Service* use case with both the service provider (in *Defined*, *Managed* and *Strategic Service*) and the service customer (in *Managed* and *Strategic Service*) as primary actors. The use case diagram is shown in Figure 6.1. The use cases are described as follows:

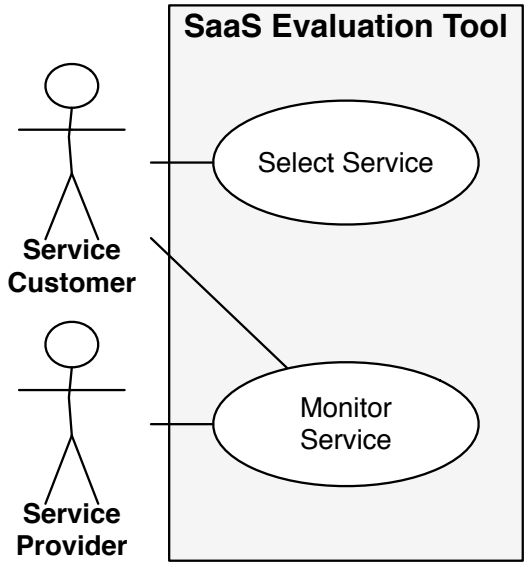

Figure 6.1: Use case diagram of the evaluation tool

- *Select Service* Use Case:
  - **Primary actor**: Service customer.
  - **Goal**: To produce the service selection report with respect to the analysis and recommendations of candidate services and service type.

- **Precondition**: Functional and quality requirements are identified by the service customer. Service offerings are published by the service provider. Experiential and service quality data are ready for analysis.
- **Scenario**:
  1. The service customer logs in the evaluation tool through the web browser.
  2. The service customer requests for the service selection report in a particular service area;
  3. The service customer inputs the business objectives, functional and quality requirements;
  4. The evaluation tool takes inputs from service providers by automatically collecting the published service offerings;
  5. The evaluation tool analyzes the inputs and produces the selection report to the service customer.
- **Secondary actor**: Service provider.

- *Monitor Service* Use Case:
  - **Primary actors**: Service provider and service customer.
  - **Goal**: To produce the service monitoring report with respect to the quality analysis and recommendations of the service improvements.
  - **Precondition**: The service is delivered by the service provider with an agreed-upon contract. The service quality measurements are in place to provide on-going quality data.
  - **Scenario**:
    1. The service provider or customer logs in the evaluation tool through the web browser.
    2. The service provider or customer requests for the service monitoring report of a specific service delivered by the service provider to the service customer;

3. The evaluation tool collects the service quality data through quality measurements;
4. The evaluation tool analyzes the quality data against service level agreement (SLA)/customer value proposition (CVP) and produces the monitoring report;
5. The evaluation tool updates the experiential data with the monitoring report.

6.1.3 Design the Class Diagram

The use cases analysis suggests that two entity objects are required to represent the roles in the tool: service customer and service provider. Two controller objects are responsible for the interaction of service selection and monitoring. There should also be boundary objects responsible for the internal and external components that perform the service quality management, including the three types of quality measurement and service data repository. As a result, the evaluation tool includes the following classes (see the UML class diagram in Figure 6.2):

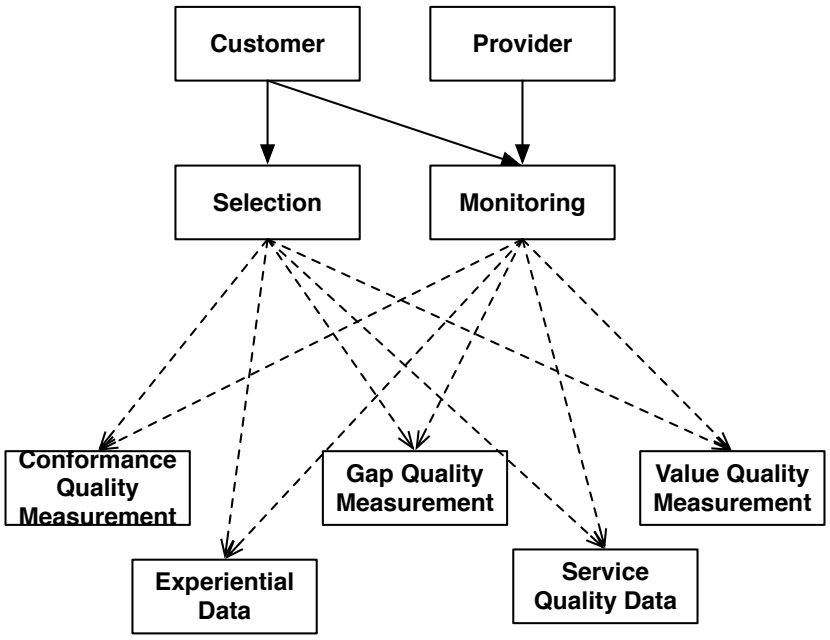

Figure 6.2: Class diagram of the evaluation tool

1. *Customer*: The *Customer* class takes the inputs such as business objectives and requirements from the service customer. It also manages all the service-related information of the service customers.

2. *Provider*: The *Provider* class takes the inputs such as service offerings and SLAs from the service provider. It also manages all the service-related information of the service providers.

3. *Selection*: The *Selection* class assists in service selection based on the service quality information from the *Service Quality Data* and *Experiential Data*. It produces selection reports to assist in decision making of service selection.

4. *Monitoring*: The *Monitoring* class assists in service monitoring based on the service quality information from the *Service Quality Data*. It produces monitoring reports to assist in the service improvement.

5. *Conformance Quality Measurement*: The *Conformance Quality Measurement* class is focused on the development of SLAs for the measurement of conformance quality. An SLA-language based service is typically used for performing the conformance quality measurements.

6. *Gap Quality Measurement*: The *Gap Quality Measurement* class is focused on the support for the measurement of gap quality. However, the quality information is not only provided by the service customer. The service provider should also participate in the design of the survey questionnaires that align with their business objectives. A survey based service is typically used for performing the gap quality measurements.

7. *Value Quality Measurement*: The *Value Quality Measurement* class is focused on the measurement of value quality, such as the ROI and risk analysis. The analysis results is generally used as part of the alignment between the service customer and provider. Value quality measurements establish an important starting point for delivering services at a *Strategic* level. An ROI and/or risk analysis based service is typically used for performing the value quality measurements.

8. *Service Quality Data*: The *Service Quality Data* class manages all the service quality information provided by the three quality measurement classes and the service publishings.

9. *Experiential Data*: The *Experiential Data* class manages the experiential data of the service use.

In practice, the functionality of the three quality measurement classes can be implemented by external services, such as an SLA definition tool for conformance quality measurement, a web survey tool for gap quality measurement, and an ROI/risk analysis tool for value quality measurement.

The CRC cards of the classes are shown in Table 6.1.

Table 6.1: CRC cards of classes in the evaluation tool

Class Name	**Responsibility**	**Collaborator**
Customer	Initiate service selection	Selection
	Initiate service monitoring with Provider if the service type is *Managed* or *Strategic*	Monitoring
Provider	Initiate service monitoring	Monitoring
Selection	Capture the functional and quality requirements from the service customer	Customer
	Capture the quality information in the particular service area	Conformance Quality Measurement, Gap Quality Measurement, Value Quality Measurement, Service Quality Data
	Produce the selection report	Service Quality Data, Experiential Data
Monitoring	Capture the SLA/CVP from the service provider and customer	Provider, Customer
	Capture the service quality performance	Conformance Quality Measurement, Gap Quality Measurement, Value Quality Measurement, Service Quality Data
	Produce the monitoring report	Service Quality Data, Experiential Data

Conformance Quality Measurement	Measure and provide the conformance quality of service	
Gap Quality Measurement	Measure and provide the gap quality of service	
Value Quality Measurement	Measure and provide the value quality of the service	
Service Quality Data	Retrieve and update the service quality data for the purpose of selection and monitoring	
Experiential Data	Retrieve and update the service experiential data for the purpose of selection	

6.1.4 Design the Tool Interactions

The sequence diagram in Figure 6.3 depicts the flow of information that must be supported for service selection in the evaluation tool. The interactions in the diagram are as follows:

1. The *Customer* class initiates the *Select* event and calls the *Selection* class with the functional requirements Fc and quality requirements Qc in a particular service area sa;

2. The *Selection* class captures the quality information in the service area sa from the three quality measurement classes;

3. The *Selection* class passes customer requirements Fc and Qc, and the quality information, to the *Quality Data* class, which returns the candidate services;

4. The *Selection* class passes the information to the *Experiential Data* class and receives analysis results such the proposed service type that the service customer should have with the provider;

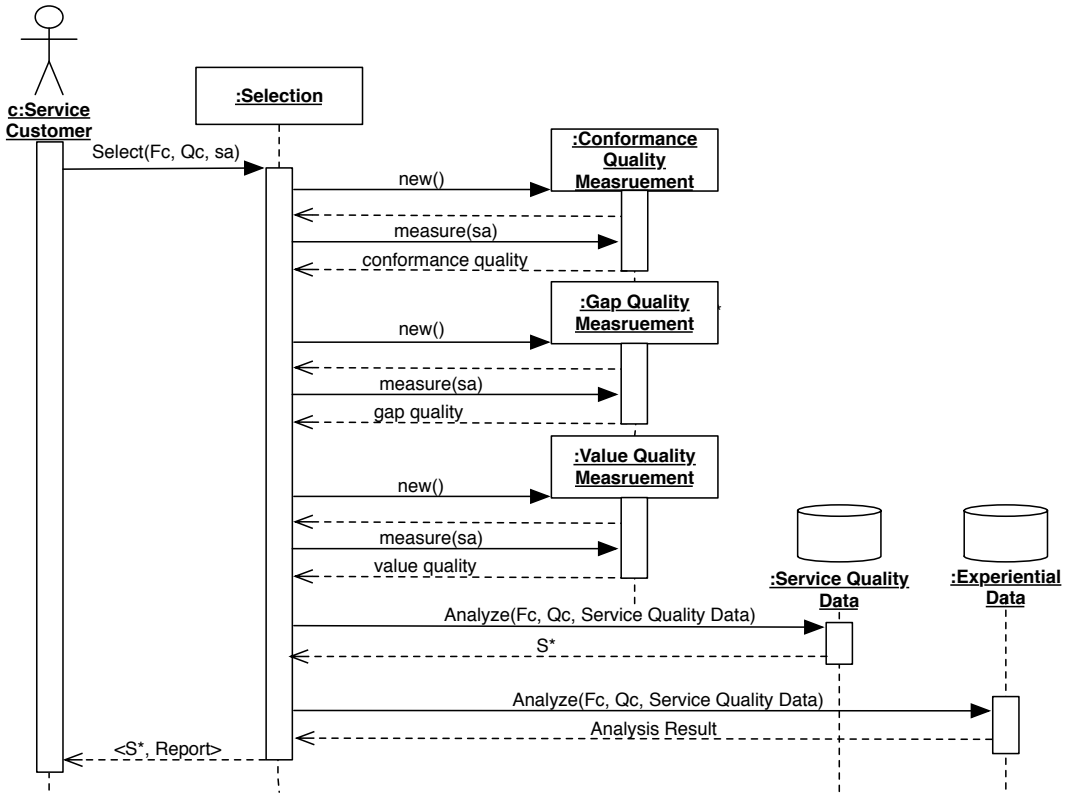

Figure 6.3: Sequence diagram of service selection

5. The *Selection* class produces the selection report and returns it to the *Customer* class.

The sequence diagram in Figure 6.4 depicts the flow of information supported for service monitoring in the evaluation tool. The interactions in the diagram are as follows:

1. The *Provider* and *Customer* classes initiate the *Monitor* event and call the *Monitoring* class with the SLA/CVP of a specific service s;

2. The *Monitoring* class captures the quality information of the service s from the three quality measurement classes;

3. The *Monitoring* class passes SLA/CVP and service quality to the *Quality Data* class, which returns the actual functional performance Fs and quality performance Qs of s;

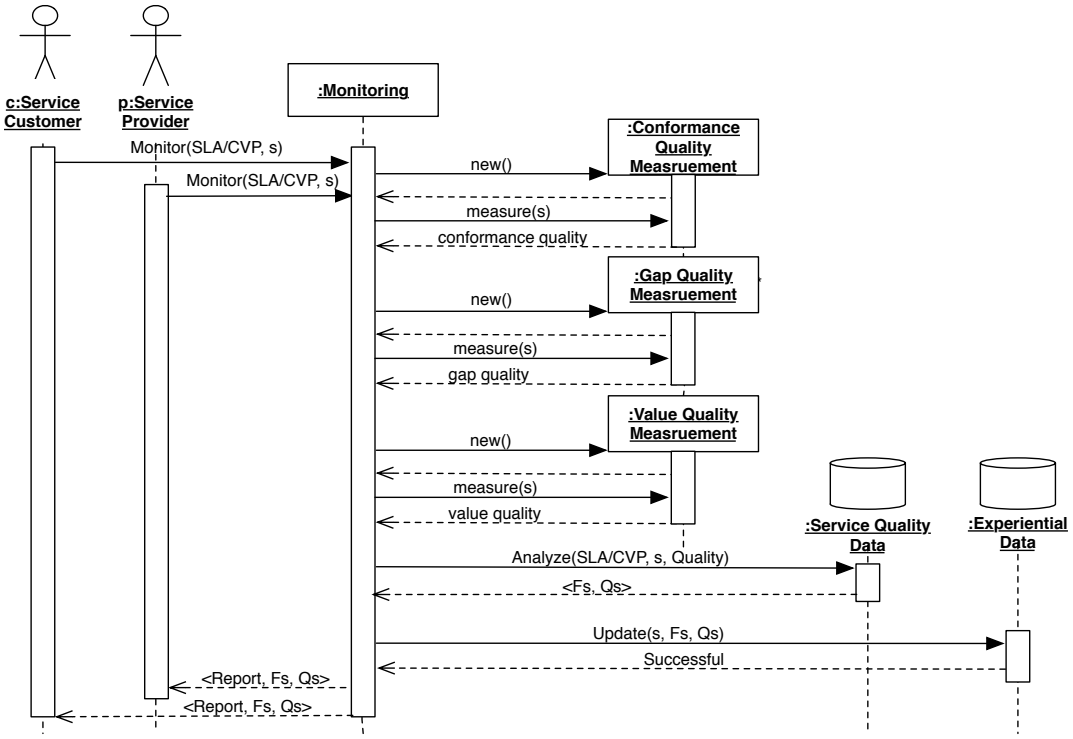

Figure 6.4: Sequence diagram of service monitoring

4. The *Monitoring* class then updates the information to the *Experiential Data* class for future service selection in the service area;

5. The *Monitoring* class produces the monitoring report and returns it to the *Provider* and *Customer* classes.

6.2 Use the Tool

In this section, we demonstrate the use of the evaluation tool by simulating how the tool assists in selecting SaaS in a particular service area, email services, in the service planning phase. This corresponds to the first use case in Section 6.1. Three steps are followed in the service selection procedure:

1. Build the experiential data. In this step, an online survey is conducted to collect experiential data in the adoption of SaaS solution for email systems. The data will be used for service selection.

2. Take inputs for service selection in a particular service area. In this step, the evaluation tool takes inputs from the service customer and provider as the basis of the analysis and report producing.

3. Produce the service selection report. In this step, the selection report is produced. The example selection report for the adoption of email service is used as template showing the main content of the report.

6.2.1 Build the Experiential Data: Email Survey

In the use of the evaluation tool, the experiential data are typically retrieved in service selection and updated in service monitoring. However, when we initially use the tool, there is no real experiential data. To assist in building the experiential data for the evaluation tool, an online survey was conducted to collect experiential data in the particular SaaS service area - a SaaS solution for email systems. The survey is called Email Survey and it focuses on the adoption of a specific SaaS email service, such as those provided by Google Mail and Microsoft Hotmail.

Background

The Email Survey was undertaken from June to July in 2009. We sent survey participation requests to the CIOs of 30 academic institution worldwide that were listed as successful adopters by Google Apps for Education and Microsoft Live@edu. Initially 20 institutions agreed to participate in the survey. We then sent the 20 institutions an invitation letter directing the CIOs to an online survey. From this invitation, we received 14 answers in total. Table 6.2 summarizes the participation of the Email Survey.

Table 6.2: Information of the Email Survey

Invited population	30
Initially agreed to participate	20
Participants	14

Questions

The Email survey contains 11 questions grouped into 4 sections:

1. *Background information* section asks questions about background information of the institute and the respondent's role in the institute;

2. *Service type* section asks the respondent to identify and describe the service type based on the business relationship they have formed with the email service provider;

3. *Service attributes* section asks the respondent to identify the priority of service attributes considered in service planning and the monitoring frequency in service operation;

4. *IT governance and strategic planning* section asks questions on how IT governance frameworks and strategies are used when the email service is adopted in the institute.

A primary goal of the survey was to discover the relationship between service attributes and service type for a particular SaaS service area, in this case, an email service system. We summarize and analyze the results in the first three sections as they pertain directly to building the experiential data required in service selection. The rest of the results together with the survey questionnaire can be found in Appendix B.

Results

Tables 6.3 and 6.4 show the background information of the institutes with which we conducted the Email Survey. The majority of the institutes are of medium size with 10001-50000 staff, faculty and students (10 out of 14), and are research intensive or primarily teaching universities (11 out of 14).

Table 6.5 shows the service type of the email service identified by survey respondents. As in the Generic Survey, we listed the four service types (*Ad-Hoc*, *Defined*, *Managed* and *Strategic*) that were clearly defined in our evaluation model. The survey respondents were asked to select the service type that best described

Table 6.3: Size of the institutes

Indicator	Respondent #	Respondent %
1000 or less staff, faculty and students	1	7.1
1001-10000 staff, faculty and students	2	14.3
10001-25000 staff, faculty and students	5	35.7
25001-50000 staff, faculty and students	5	35.7
More than 50000 staff, faculty and students	1	7.1
Total	14	100.0

Table 6.4: Type of the institutes

Indicator	Respondent #	Respondent %
Research intensive university	6	42.9
Primarily teaching university	5	35.7
Community college	2	14.3
Professional institute	0	0.0
Other	1	7.1
Total	14	100.0

the business relationship they had with the email service provider. They could also provide comments if the definitions did not describe the business relationship accurately. From the result, we see that exactly half of the respondents (7 out of 14) had built a *Defined Service* with the service provider. Four and three respondents were using the email service as *Managed Service* and *Strategic Service* respectively. The service type is used as a factor to cluster the survey results in the following two questions: priority and monitoring frequency of service attributes.

Table 6.5: Service type identified by respondents

Indicator	Respondent #	Respondent %
Ad-hoc service	0	0.0
Defined service	7	50.0
Managed service	4	28.8
Strategic service	3	21.4
Total	14	100.0

Table 6.6 shows the mean values of priority for the service attributes considered in decision making of service selection. As in the Generic Survey, respondents were

asked to rank the priority on a 1 to 5 scale where 5 stands for "high", 3 stands for "medium" and 1 stands for "low". The mean values are calculated according to the selection of service type, and can be used as an important reference when other customers select services in the particular service area, in this case the email services. From the table, we see that in the *Defined Service*, the *Functionality* and conformance quality attributes are relatively more important than other service attributes; in the *Managed Service*, most of the gap quality attributes, such as *Usability* and *Efficiency* reach their maximum; in the *Strategic Service*, all the service attributes are considered important (over 4). The overall trend is consistent with the analysis results of the Generic Survey.

Table 6.6: Priority of service attributes in three service types

Service Attribute	**Mean of Priority**		
	Defined	**Managed**	**Strategic**
Respondent #	7	4	3
Functionality	5.00	4.50	4.67
Security	4.43	4.75	4.67
Availability	4.71	4.75	5.00
Reliability	4.57	4.75	5.00
Usability	4.14	4.75	4.67
Efficiency	3.86	4.25	4.00
Sustainability	3.71	4.25	4.67
Adaptability	3.14	3.75	4.00
Cost	3.86	3.75	4.67
ROI	3.80	4.25	4.67
Risk	3.57	3.25	4.67
Continuity	3.29	4.25	4.67

However, due to the small population of the survey and the personal biases, it is not accurate to only compare the mean values. To eliminate the limitation of the mean values, we calculate the frequency and percentage of priority values in the three service types (see Table 6.7). The shaded cell denotes the priority value selected by the majority of the population ($\geq 50\%$). The table clearly shows that (1) in the *Defined Service*, *Functionality* and conformance quality attributes, such as *Security*, *Availability* and *Reliability*, are considered of highest priority; (2) in the *Managed Service*, gap quality attributes, such as *Usability* and *Efficiency*, and

even value quality attributes become important; (3) in the *Strategic Service*, almost all the service attributes are considered of highest priority. The priority of service attributes is one of the key factors in determining the most appropriate service type the service customer should have with the provider.

In the Email Survey, the measurements for monitoring frequency are nominal rather than ordinal, so we only calculate the frequency and percentage. Table 6.8 shows the monitoring frequency of service attributes in service delivery. The monitoring frequency attributes were defined in the survey as follows:

6 = Continuously monitored;
5 = Frequently monitored (More frequent than monthly);
4 = Often monitored (More frequent than yearly no more than monthly);
3 = Occasionally monitored (No more frequent than yearly);
2 = Monitored as needed;
1 = Never monitored.

The two service attributes that have significantly higher monitoring frequency, which is typically *Frequently* or *Continuously*, are the conformance quality attributes *Availability* and *Reliability* managed by SLAs. In contrast, most gap quality attributes are monitored *As needed*, *Occasionally* or *Often* because they are managed by surveys that are usually conducted with much lower frequencies (e.g. quarterly or even annually).

Table 6.7: Frequency of priority in three service types

Service Attribute	Defined						Managed						Strategic					
	5*	4	3	2	1	N/A	5	4	3	2	1	N/A	5	4	3	2	1	N/A
Functionality	7	0	0	0	0	0	2	2	0	0	0	0	2	1	0	0	0	0
(%)	100	0	0	0	0	0	50	50	0	0	0	0	67	33	0	0	0	0
Security	4	2	1	0	0	0	3	1	0	0	0	0	2	1	0	0	0	0
(%)	57	29	14	0	0	0	75	25	0	0	0	0	67	33	0	0	0	0
Availability	5	2	0	0	0	0	3	1	0	0	0	0	3	0	0	0	0	0
(%)	71	29	0	0	0	0	75	25	0	0	0	0	100	0	0	0	0	0
Reliability	4	3	0	0	0	0	3	1	0	0	0	0	3	0	0	0	0	0
(%)	57	43	0	0	0	0	75	25	0	0	0	0	100	0	0	0	0	0
Usability	1	6	0	0	0	0	3	1	0	0	0	0	2	1	0	0	0	0
(%)	14	86	0	0	0	0	75	25	0	0	0	0	67	33	0	0	0	0
Efficiency	2	3	1	1	0	0	2	1	1	0	0	0	1	1	1	0	0	0
(%)	29	43	14	14	0	0	50	25	25	0	0	0	33	33	33	0	0	0
Sustainability	1	3	3	0	0	0	1	3	0	0	0	0	2	1	0	0	0	0
(%)	14	43	43	0	0	0	25	75	0	0	0	0	67	33	0	0	0	0
Adaptability	0	2	4	1	0	0	1	1	2	0	0	0	1	1	1	0	0	0
(%)	0	29	57	14	0	0	25	25	50	0	0	0	33	33	33	0	0	0
Cost	3	1	2	1	0	0	1	1	2	0	0	0	2	1	0	0	0	0
(%)	43	14	29	14	0	0	25	25	50	0	0	0	67	33	0	0	0	0
ROI	2	1	1	1	0	2	2	1	1	0	0	0	2	1	0	0	0	0
(%)	29	14	14	14	0	29	50	25	25	0	0	0	67	33	0	0	0	0
Risk	1	3	2	1	0	0	1	1	1	0	1	0	2	1	0	0	0	0
(%)	14	43	29	14	0	0	25	25	25	0	25	0	67	33	0	0	0	0
Continuity	0	4	1	2	0	0	2	1	1	0	0	0	2	1	0	0	0	0
(%)	0	57	14	29	0	0	50	25	25	0	0	0	67	33	0	0	0	0

* Priority: 5 = High, 3 = Medium, 1 = Low, N/A = Not Applicable

Table 6.8: Frequency of monitoring frequency in three service types

Service Attribute	Defined							Managed							Strategic						
	6*	5	4	3	2	1	N/A	6	5	4	3	2	1	N/A	6	5	4	3	2	1	N/A
Functionality	1	1	2	1	2	0	0	0	0	1	2	1	0	0	0	0	1	0	1	1	0
Security	1	1	1	1	3	0	0	0	1	2	1	0	0	0	0	0	0	1	1	0	1
Availability	4	1	1	0	1	0	0	2	1	1	0	0	0	0	1	1	0	0	1	0	0
Reliability	2	4	0	0	1	0	0	2	1	1	0	0	0	0	2	0	0	0	1	0	0
Usability	0	1	4	0	2	0	0	1	0	0	2	1	0	0	1	0	0	1	1	0	0
Efficiency	0	1	1	2	2	0	1	0	0	0	1	2	0	1	0	0	0	0	2	1	0
Sustainability	1	0	2	1	3	0	0	0	0	0	2	2	0	0	0	0	1	1	1	0	0
Adaptability	0	1	2	0	4	0	0	0	0	0	2	2	0	0	0	0	0	0	3	0	0
Cost	0	0	0	3	1	0	3	0	0	0	1	2	0	1	0	0	0	0	1	1	1
ROI	0	1	0	1	2	1	2	0	0	0	2	1	0	1	0	0	0	0	2	0	1
Risk	0	2	1	1	2	1	0	0	1	1	0	2	0	0	1	0	0	0	2	0	0
Continuity	0	2	1	2	2	0	0	1	1	1	0	1	0	0	1	0	0	0	1	1	0

* Monitoring Frequency:

6 = Continuously monitored
5 = Frequently monitored (More frequent than monthly)
4 = Often monitored (More frequent than yearly no more than monthly)
3 = Occasionally monitored (No more frequent than yearly)
2 = Monitored as needed
1 = Never monitored
N/A = Not Applicable

Hypothesis Test

To use the experiential data collected from the Email Survey in service selection, the priority values shown in Tables 6.6 and 6.7 need to be tested for statistical significance. Similar to the Generic Survey, we use the Wilcoxon signed-rank test as a non-parametric hypothesis test to avoid personal biases in the ranking schema. In the Generic Survey all participants ranked the priority of the service attributes for each of the four service types. In the Email Survey, the participants were first asked to identify the service type for their business relationship with the service provider. They were then asked to rank the priority of service attributes in decision making of service selection.

Using the survey results, we are able to test if there is a significant differences between service attribute priority ranking within service types. Since we have three subgroups that identified their email service as *Defined*, *Managed* and *Strategic Service*, we can find if one service attribute is significantly more important than other service attributes in a specific service type. Since the size of the population is small, we group the data into two according to the identified service type: *Defined Service* and *Manage/Strategic Service*. To simplify the test, we select six typical service attributes representing the four service attribute groups: *Functionality*, *Availability*, *Usability*, *Adaptability*, *ROI* and *Risk*.

The null hypothesis of the test is that the median difference θ of the paired samples (priority of any two service attributes) is zero, i.e. $H_0 : \theta = 0$. It implies that there is no significant difference between the paired samples. To reject the null hypothesis, the calculated p-value (or asymptotic significance) of the Wilcoxon sign-rank test should be less than the 0.05 for a 95% confidence interval (C.I. = 95%).

Table 6.9 shows the p-values of the hypothesis test. A value prefixed with asterisk means that the null-hypothesis can be rejected. In other words, one service attribute is significantly more important than the other one. The results show that: (1) in the *Defined Service*, priority values of *Functionality* and *Availability* are significantly higher than almost all the other service attributes, with the only exception between *Availability* and *Usability*, and all the other service attributes have no sig-

nificant difference in priority; (2) in the *Managed/Strategic Service*, the priority values of all the service attributes almost have no significant difference. The test results support the conclusion of the Generic Survey in two aspects:

1. *Functionality* and *Conformance quality attributes* such as *Availability* are typically emphasized when a service is delivered as a *Defined Service*.

2. The four quality attribute groups (*Functionality*, *Conformance quality attributes*, *Gap quality attributes* and *Value quality attributes*) are all emphasized when a service is delivered as a *Strategic Service*.

Table 6.9: Significance of priority in the three service types

Service Attribute	**Asymptotic Significance (C.I. = 95%)**				
	Defined Service				
	Availability	Usability	Adaptability	ROI	Risk
Functionality	0.157	*0.014	*0.016	*0.042	*0.026
Availability	-	0.102	*0.016	*0.039	*0.039
Usability	-	-	*0.038	0.168	0.194
Adaptability	-	-	-	0.863	0.317
ROI	-	-	-	-	0.398
Service Attribute	**Managed/Strategic Service**				
	Availability	Usability	Adaptability	ROI	Risk
Functionality	0.157	0.317	*0.025	0.705	0.180
Availability	-	0.317	*0.038	0.180	0.059
Usability	-	-	*0.034	0.414	0.102
Adaptability	-	-	-	0.194	0.705
ROI	-	-	-	-	0.157

Risks

Similar to the Generic Survey, there are risks in conducting the Email Survey. The general limitations due to observational errors and errors of non-observation still affect the confidence of the survey results. Moreover, the survey has particular risks that need to be reduced in future:

- Although we used the survey results as the experiential data for the evaluation tool, the survey respondents did not see the design of the tool when they

answered the questions in the survey. This may lead to inaccurate answers biasing the analysis.

- Compared to the Generic Survey, the population of the Email Survey is much smaller, especially when we group the answers according to the identified service type. With only three responses adopting *Strategic Service* and four adopting *Managed*, the answers for the priority and monitoring frequency have no statistical significance. More responses are required in future surveys to increase the size of the experiential data.

6.2.2 Take Inputs for Service Selection

Typically, the tool user is an expert in a service area working under the authority of the CIO of a customer organization that wants to adopt a SaaS system to meet desired functional and non-functional requirements. The service selection procedure takes inputs from both the service customer on the functional and non-functional requirements and the service provider by capturing the service offering description and/or SLA templates from the worldwide web.

In Appendix C, we show an example of how the evaluation tool is used for service selection in a particular SaaS service area. In the example, the tool is used by VPIT (Vice Provost Information Technology) of University of Alberta (UofA) for evaluating the adoption of an email service offering in UofA.

Input from the Service Customer

From the service customer's perspective, the evaluation tool collects the requirements from service customers. In general, the following information is taken as the input from the service customer. (See Appendix C for the case study of the email service adoption. As per our case study, the customer organization is the University of Alberta and the service is an email service)

1. General business motivation and business objectives for the adoption of a particular service is provided by the customer organization.

2. Specific objectives to be achieved by adopting an email service system (ranking of these specific objectives, if applicable). This provides the business objectives from the specific view of the service customer.The first two parts correspond to the step 1 of building the service map in Chapter 5.

3. The service type (*Ad-hoc*, *Defined*, *Managed* or *Strategic*) the customer believes is most appropriate for the service is then determined. This part corresponds to the step 2 in Chapter 5.

4. Estimate of the priority of the service attributes used in making the decision to adopt a SaaS system. The customer should also determine the measurement plan, a plan on the responsibility and approaches of measuring the service attributes.

5. Estimate of the monitoring frequency of service attributes when using the SaaS system. The customer should also determine the monitoring plan, a plan on the responsibility and approaches of monitoring the service attributes.

6. IT governance frameworks or strategies used when selecting and monitoring the SaaS system. Part 4-6 correspond to the step 3 in Chapter 5.

To assist the decision maker in determining the requirements on service quality, we chose the following twelve service attributes used for decision making of service selection and monitoring of service operation: *Functionality*, *Security*, *Availability*, *Reliability*, *Usability*, *Efficiency*, *Sustainability*, *Adaptability*, *Cost*, *ROI (Return on Investment)*, *Risk* and *Continuity*. All these service attributes have been defined in Chapter 4.

Input from the Service Provider

From the service provider's perspective, the evaluation tool needs to determine if the service offerings are consistent with the service customer's requirements collected in the previous step. In the email example, Google Apps for Education and Microsoft Live@edu are selected as the candidate service providers for the email system. Both applications provide email services for educational institutions. The

input from the service provider includes the service terms and the initial version of SLAs, which can be captured from the Google and Microsoft's websites.

For Google Apps for Education, the general SLA template [12] and Google Apps Education Edition Agreement [11] are taken as starting points in assessing the service offerings. In the template, the following quality metrics are defined [12]:

- *Downtime*: The time when there is more than a 5% user error rate for a domain.

- *Downtime Period*: A period of ten consecutive minutes of *Downtime* for a domain. Intermittent *Downtime* for a period of less than ten minutes will not be counted towards any Downtime Periods.

- *Monthly Uptime Percentage*: Total number of minutes in a calendar month minus the number of minutes of *Downtime* suffered from all *Downtime Periods* in a calendar month, divided by the total number of minutes in a calendar month. This can be expressed as $\frac{M-D}{M}$ where M =Number of minutes in a calendar month, D =Number of minutes of *Downtime* suffered from all *Downtime Periods* in a calendar month.

For Microsoft Live@edu, the email application Outlook Live is hosted on Exchange, so the Microsoft Exchange Online Service Level Agreement [14] is considered as the initial version of an SLA template. In the template, the following quality metrics are defined [14]:

- *Downtime*: Any period of time when end users are unable to send or receive email with Outlook Web Access.

- *Scheduled Downtime*: The times where Microsoft notifies the customer of periods of Downtime at least five days prior to the commencement of such Downtime. Scheduled Downtime of fewer than ten hours per calendar year is not considered Downtime for purposes of this SLA.

- *Monthly Uptime Percentage*: total number of minutes in a calendar month multiplied by the total number of licensed users minus the total number of

minutes of Downtime experienced by all users in a given calendar month, all divided by the total number of minutes in that calendar month multiplied by the total number of users. This is reflected in the following formula: $\frac{M \times U - D}{M \times U}$ where M =Total number of minutes in a month, U =Total number of users, and D =Total minutes of *Downtime* experienced by all users in that month.

Both SLA templates above only provide the information on *Monthly Uptime Percentage*, which is the metric of availability and reliability typically managed by SLA approaches. And the *Monthly Uptime Percentage* is only used to calculate the *Service Credit* in favour of the service customer. Therefore the initial version of the service offered can achieve a customer-provider relationship at the *Defined Service* level.

6.2.3 Produce the Selection Report

The selection report summarizes the information from both the service customer and provider, finds the potential problems such as incompleteness and inconsistencies with the views of other customers in the service area, and recommends the appropriate service candidates and service type in the business relationship between the service customer and provider. It also generates the service map based on the analysis of the information from the service customer and provider. In our example, the selection report provides a reference document for decision making of UofA. The Google Apps for Education is selected as the preference for UofA.

The selection report typically contains parts addressing the following concerns:

- *Introduction*. The background section defines key terms such as the service types and service attributes introduced in the evaluation tool and outlines the report contents and major findings.

- *Comparisons*. The tool compares the service customer's input to the historical results as derived from surveys of existing customers that use the provider's service.

  In our example, UofA's input is compared with the experiential data collected from the Email Survey on the priority values of the four subgroups:

Table 6.10: Priority of availability compared to the Email Survey results

Group	Num	Min	Max	Mean	S.D.	#S.P.	%S.P.
Total	14	4	5	4.79	.426	11	78.6
More than 25,000 people	6	4	5	4.83	.408	5	83.3
Research intensive university	6	4	5	4.83	.408	5	83.3
Defined service	7	4	5	4.71	.488	5	71.4

#S.P.: Number of respondents that selected the same priority as U of A.
%S.P.: Percentage of respondents that selected the same priority as U of A.

  - All the institutes;
  - Institutes having the size similar to UofA (More than 25,000 staff, faculty and students);
  - Institutes of the type similar to UofA (Research intensive university);
  - Institutes that recognize the service type as the *Defined Service*, just like UofA.

  As an example of this comparison, the priority of availability ranked by UofA is 5 and this is compared to the Email Survey results in Table 6.10. The comparison shows that UofA's priority of availability was reasonably consistent with other institutions.

  In the comparisons, the tool detects potential issues the service customer may want to examine more closely, such as the priority of some attributes in UofA's input significantly deviate from the survey results. These are analyzed in the "*Analysis and Evaluation*" section of the report.

- *Analysis and Evaluation*. The tool analyzes the inputs from the service customer and the service provider, and points out inconsistencies and incompleteness for decision making.

  According to our evaluation model, four groups of service attributes can be directly related to the four service types: *Functionality*, *Conformance quality attributes*, *Gap quality attributes*, *Value quality attributes*.

In UofA's input, the service attributes from the first two groups were assigned a priority of 5, which is appropriate for the *Defined Service*. However, three non-conformance quality attributes have also been assigned the same priority: usability, efficiency and risk. This appears to be a deviation from the model of a *Defined Service* that emphasizes functionality and conformance quality attributes. This might be explained as a misunderstanding of the definitions, which is admitted by UofA. On the other hand, it could mean that the service provider may have to provide more information on the attributes important to the service customer.

The tool also detects incompletenesses. For example, the monitoring plan and adopted IT governance framework are missing for UofA in our email service case study. Both should be required in a completed service selection activity. It is important that these be in place before the service is delivered.

- *Recommendations*. Based on the analysis, the tool recommends the appropriate service type for the business relationship that should be established in the service delivery and produces the service map.

  In our example, the service type expected by UofA is *Defined Service*. However, the tool detects that from the service customer's point of view service factors such as usability and efficiency are significant concerns. As a result, it is recommended that it may be appropriate to establish the service type as a *Managed Service* rather than the *Defined Service* proposed by the customer. This change in the service type might be considered immediately or perhaps within the first year of service delivery.

  Other important activities are also recommended in this part of the analysis, such as conducting a user survey to assess the value of the service system once it is in place for a defined period such as six months.

Note that although our discussion has focused on the decision making of service selection, a similar procedure can also be followed in the monitoring of service operation once in place.

6.3 Analyze and Improve the Tool

The first version of the evaluation tool is designed to be used inside a customer organization where data sources are typically gathered through targeted user surveys and exploration of service offerings on the worldwide web. If the sources of appropriate services are unknown to the service customer, the whole procedure may not be complete and efficient.

To improve the procedure, a new class called *Broker*, can be introduced in the tool. In practice, the *Broker* class is driven by an independent third-party agent that manages a service registry centralizing the service information published by service providers. Some of the functions of the *Customer* class in the first version are then performed by the *Broker* class, who uses the service registry as the source of service knowledge for service selection.

The sequence diagram of service selection with the service broker is shown in Figure 6.5. The interactions for the new version of the evaluation tool are as follows:

1. The *Provider* class publishes the service s through *Selection* class to the *Service Quality Data* class, updating the service registry managed by the *Broker* class;

2. The *Customer* class initiates the *Select* event and calls the *Broker* class with the functional requirements Fc and quality requirements Qc in a particular service area sa;

3. The *Broker* class passes the requirements (Fc and Qc) and the service area sa to the *Selection* class;

4. In the service registry, the *Selection* class searches in the serve area sa by calling the *Service Quality Data* class and receives the service set S';

5. The *Selection* class captures the quality information of the services in S' from the three quality measurement classes;

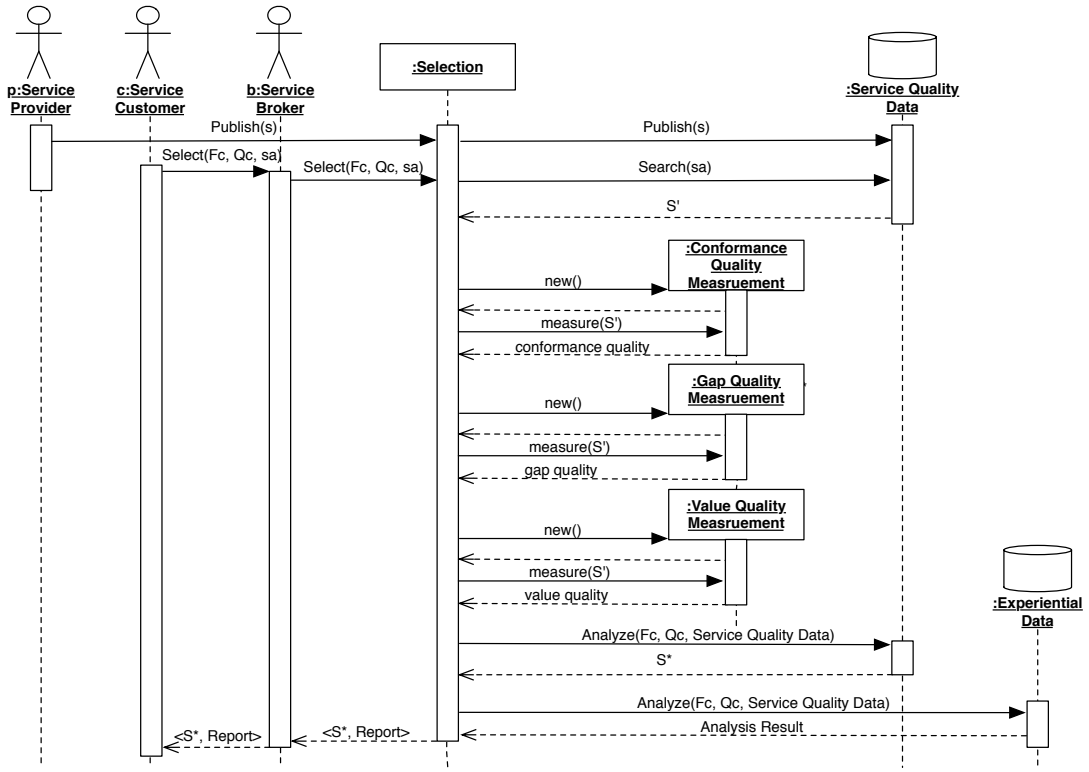

Figure 6.5: Sequence diagram of service selection with a service broker

6. The *Selection* class passes customer requirements Fc and Qc, and the quality information, to the *Quality Data* class, which returns the candidate services;

7. The *Selection* class passes the information to the *Experiential Data* class and receives analysis results such as the recommended service type that the service customer should have with the service provider;

8. The *Selection* class produces the selection report and returns it to the *Broker* and *Customer* classes.

With the introduction of the *Broker* class, the evaluation tool is able to collect information from more services published by service providers in the particular service area. As a result, it can find a more suitable service and determine a more appropriate service type for the service customer and provider.

6.4 Summary

In this chapter, we followed the outer cycle of the evolutionary approach in Chapter 5. The first version of the evaluation tool was designed using requirement analysis and UML diagrams. We then discussed how the evaluation tool can be used for service selection in a particular SaaS service area. The Email Survey was used for building the experiential data.

Using this case study, we demonstrated the evaluation procedure when the tool is used for service selection inside the customer organization. The tool produced a service selection report linking the quality requirements to the strategic objectives from the viewpoint of business relationships between the service customer and provider. In future, the tool can also be enhanced and used more independently by a third party agent, service broker, working with the service customer and provider in order to provide a better view of creating the co-value for both the organizations.

Chapter 7

Conclusion

7.1 Contributions

In this thesis, we studied the nature for an evolutionary SaaS evaluation model focused on service quality. The important aspects of our work include the recognition that SaaS evaluation must take into account the generation of co-value by both the service provider and customer, and that additional tools are needed to assist both the provider and customer in assessing and improving the service quality on an ongoing basis. The main contributions are as follows:

- A theory of SaaS business relationships between the service provider and customer in SaaS delivery is introduced by integrating an adapted quality paradigm with the the notion of co-value in SaaS business relationships. In the theory, we define a specification of four quality based SaaS service types: *Ad-hoc*, *Defined*, *Managed* and *Strategic*. The key discovery is that more groups of service attributes are emphasized when the SaaS business relationship moves from *Ad-hoc* to *Strategic*.

- With the assistance of a service map process, the theory is used as a foundation for building the SaaS evaluation model that helps service customers in selecting and monitoring SaaS systems in service planning and operation.

- Based on the model, a SaaS evaluation tool is built and used for the assistance of the SaaS adoption in a particular service area. In particular, a case

study was run to assist the decision making of email service adoption at the University of Alberta.

- Two surveys were conducted: the Generic Survey assisted in the building and evolution of the evaluation model, and the Email Survey was used in the email service evaluation tool and in the further evolution of the SaaS evaluation model. The limitations and risks of the survey approach were discussed for both surveys and specific recommendations and procedures were identified for conducting follow-up surveys with the goal of confirming and enhancing the research results.

7.2 Future Work

The research results of this thesis are important initial steps in building a better understanding of co-value in business relationships between the service customer and provider in SaaS delivery. Based on these studies, a list of research work can be pursued in future:

- *Refinement of our initial prototype evaluation tool according to the UML design*. In Chapter 6, we have defined the requirements, use cases and class functions of the evaluation tool. All the information can be directly used in the refinement of our initial prototype tool.

- *Extending the use of the tool to other scenarios*. The case study setting for tool use in Chapter 6 was an important informative initial study; however, more studies are needed. For example, there is no experience in supporting service monitoring using the evaluation tool. Moreover, the introduction of a service broker in the evaluation is an important enhancement to the tool. We will implement this enhancement in a future version of the tool.

- *Further investigations to assist in evolving the evaluation model*. The use cases of the evaluation model in Chapter 5 were refined based on information gathered from the Generic Survey. In practice, service selection and monitoring might not always follow the prescribed procedures. As well, additional

aspects such as IT governance and shared IP (Intellectual Property) could be considered for inclusion in our evaluation model. Therefore, we need to explore more business cases to refine the design of the evaluation model.

- *More conceptual surveys used as a tool to validate and improve the model*. The results of survey approach in Chapter 4 support the core theory of our model. However, there are outliers related to service attributes like usability and cost that require further investigations. The follow-up survey should not only reduce the potential risks existing in the current surveys, but also explore in greater detail the nature of those service attributes to determine what are the aspects of service attributes that must be well understood in order to use them effectively in our evaluation model. In addition, other more continuous interaction approaches with users should be considered, such as *Crowdsourcing*, in order to gain more insight on a regular basis about the relative importance of commonly used service attributes.

Glossary

Ad-hoc Service A SaaS used by a customer on an as-needed basis in response to business requirements. 38

Adaptability The capability to be adapted for different specified environments without applying actions or means other than those provided for this purpose for the software considered [32]. 53

Availability The degree to which a system is operable and in a committable state [20]. 49

Conformance Quality Conformance to specifications. 13

Continuity Service continuity; the ability of business to diminish or amend service targets in the event of an incident or a disaster [49]. 56

Cost The amount of expenditure (actual or notional) incurred on, or attributable to, a specific activity or business unit [49]. 54

CSI Continuous service improvement; the ongoing improvement process of a service. 57

CVP Customer value proposition; the total benefits which a service provider promises a service customer will receive by purchasing the service. 34, 95

Defined Service A SaaS described in a contract or an agreement which outlines service usage and guarantees the service level capabilities. 38

Efficiency The capability to provide appropriate performance, relative to the amount of resources used, under stated conditions [32]. 51

Excellence Quality Recognition of excellence. 14

Functionality The capability to provide functions which meet stated and implied needs when used under specified conditions [32]. 48

Gap Quality Whether customer expectations are met or exceeded. 13

Managed Service A *Defined Service* with additional agreed upon commitments by both the service customer and provider to share the responsibilities of managing the service. 38

QoS Quality of service; the ability of a service to guarantee a certain level of performance to a specific user. 2

Reliability The capability to maintain a specified level of performance when used under specified conditions [32]. 49

Risk A measure of the exposure to which an organization may be subjected [49]. 56

ROI Return on Investment; the revenue or benefit which is attributable to the project divided by the expenditure required to complete the project [49]. 54

SaaS Sotware-as-a-Service; a software application that is hosted as an external IT service, explicitly priced on a per-user basis, delivered by a service provider and shared by multiple customers across the Internet [44][9]. 3

Security The capability to protect information and data so that unauthorized persons or systems cannot read or modify them and authorized persons or systems are not denied access to them [32]. 48

SLA Service level agreement; a negotiated agreement typically between the service customer and the service provider where the level of service is formally defined. 2, 13, 38, 95

SOA Service-oriented architecture; a paradigm for organizing and utilizing distributed capabilities that may be under the control of different ownership domains [47]. 2

Strategic Service A *Managed Service* in which both the service customer and provider are able to identify the common, agreed upon, business value of the service delivery. 39

Sustainability The capacity of a system to maintain itself, to remain congruent with changing realities [29]. 52

TQM Total quality management; a quality management strategy in which the organization's culture is defined by, and also supports the constant attainment of customer satisfaction through an integrated system of tools, techniques and training [59]. 2, 14

Usability The capability to be understood, learned, used and attractive to the user, when used under specific conditions [32]. 51

Value Quality Direct benefit to the customer. 13

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Appendix A

Results of the Generic Survey

In July 2009, we contacted 70 Chief Information Officers (CIOs) of commercial, governmental and academic organizations from Edmonton and Calgary areas to ask for their participation in a survey on service quality-based SaaS evaluation model, which we later called the Generic Survey. We received 30 responses and asked the Test Scoring & Questionnaire Services at University of Alberta to formally invite these 30 CIOs to participate in the survey. The final population of the survey responses was 20. Following are the results we collected from the Generic Survey.

A.1 Background

Q1. What is the size of your organization?

Indicator	Respondent #	Respondent %
10 or less people	1	5.0
11-25 people	3	15.0
26-50 people	0	0.0
51-100 people	3	15.0
101- 250 people	1	5.0
More than 250 people	12	60.0
Total	20	100.0

Q2. Which of following phrases best describes the nature of your organization's market focus?

Indicator	Respondent #	Respondent %
Domestic market	13	65.0
Primarily domestic, partly international market	7	35.0
Primarily international market	0	0.0

Total	20	100.0

Q3. What is your primary role in your organization?

Indicator	Respondent #	Respondent %
CIO	16	80.0
Not CIO	4	20.0
Total	20	100.0

A.2 Use of External IT Services and SaaS Services

Q4. Please estimate to nearest 5%, the percentage of the annual IT operating budget that your organization expends on the external IT services? Do not include capital expenditures in your estimate.

Indicator	Respondent #	Respondent %
0%	0	0.0
5%	2	10.0
10%	7	35.0
15%	3	15.0
20%	0	0.0
25%	1	5.0
30%	0	0.0
35%	1	5.0
40%	0	0.0
45%	1	5.0
50%	0	0.0
55%	1	5.0
60%	1	5.0
65%	0	0.0
70%	1	5.0
75%	1	5.0
80%-100%	0	0.0
Not sure	1	5.0
Total	20	100.0

Q5. Please estimate to nearest 5%, the percentage of the annual IT operating budget that your organization expends on the SaaS services? Again, do not include capital expenditures in your estimate.

Indicator	Respondent #	Respondent %
0%	7	35.0
5%	7	35.0
10%	2	10.0

15%	0	0.0
20%	0	0.0
25%	1	5.0
30%	1	5.0
35%-100%	0	0.0
Not sure	2	10.0
Total	20	100.0

Q6. If you estimated 0% for Question 5, does this mean your organization is not currently using any SaaS services?

Indicator	**Respondent #**	**Respondent %**
Yes	3	15.0
No	5	25.0
Not applicable	12	60.0
Total	20	100.0

A.3 Service Attributes

Q7. When deploying *Ad-hoc Services*[1], provide your best estimate of the priority (low to high) of each of the following service attributes that are considered in your organization? (5=High, 3=Medium, 1=Low)

Service Attribute	**Respondent #**	**Min.**	**Max.**	**Mean**	**S.D.**
Functionality	20	4	5	4.75	.444
Security	20	2	5	4.65	.813
Availability	20	3	5	4.30	.657
Reliability	19	3	5	4.32	.749
Usability	20	3	5	4.45	.686
Efficiency	20	3	5	3.85	.813
Sustainability	19	2	5	3.89	.875
Adaptability	20	1	5	3.15	1.040
Other	2	4	5	4.50	.707

Q8. When deploying *Defined Services*, provide your best estimate of the priority (low to high) of each of the following service attributes that are considered in your organization? (5=High, 3=Medium, 1=Low)

Service Attribute	**Respondent #**	**Min.**	**Max.**	**Mean**	**S.D.**
Functionality	20	4	5	4.55	.510
Security	20	3	5	4.75	.550
Availability	20	4	5	4.85	.366

[1]In the Generic Survey and the Email Survey, we provided definitions for *Ad-hoc*, *Defined*, *Managed* and *Strategic Services* that are the same as those given in Chapter 4.

Reliability	20	4	5	4.80	.410
Usability	20	3	5	4.55	.605
Efficiency	20	3	5	4.30	.571
Sustainability	20	4	5	4.35	.489
Adaptability	20	2	5	3.65	.813
Other	3	4	5	4.67	.577

Q9. When deploying *Managed Services*, provide your best estimate of the priority (low to high) of each of the following service attributes that are considered in your organization? (5=High, 3=Medium, 1=Low)

Service Attribute	Respondent #	Min.	Max.	Mean	S.D.
Functionality	18	4	5	4.67	.485
Security	18	4	5	4.83	.383
Availability	18	4	5	4.89	.323
Reliability	18	4	5	4.89	.323
Usability	18	3	5	4.44	.616
Efficiency	18	3	5	4.44	.705
Sustainability	18	3	5	4.56	.616
Adaptability	18	2	5	4.00	.907
Other	3	4	5	4.67	.577

Q8. When deploying *Strategic Services*, provide your best estimate of the priority (low to high) of each of the following service attributes that are considered in your organization? (5=High, 3=Medium, 1=Low)

Service Attribute	Respondent #	Min.	Max.	Mean	S.D.
Functionality	18	3	5	4.56	.616
Security	18	4	5	4.89	.323
Availability	18	4	5	4.72	.461
Reliability	18	4	5	4.72	.461
Usability	18	3	5	4.44	.705
Efficiency	17	3	5	4.35	.702
Sustainability	18	3	5	4.44	.616
Adaptability	18	2	5	4.06	.998
Other	5	3	5	4.40	.894

A.4 IT Service Governance

Q11. What types of IT governance frameworks or strategies have you adopted in your organization? (Multiple choices)

Indicator	Respondent #	Respondent %
IT Infrastructure Library (ITIL)	14	70.0

Control Objectives for Information and related Technology (COBIT)	11	55.0
CMMI	3	15.0
Six Sigma focus on quality assurance	0	0.0
ISO/IEC 27001 [BS7799] for IT security	4	20.0
ISO/IEC 38500 for corporate governance of IT	3	15.0
Defined and implemented own strategy	10	50.0
Have not developed a framework or strategy	3	15.0
Not sure	1	5.0
Total	20	100.0

Q12. A primary goal of our research is to build a SaaS evaluation model " to assess service quality and to improve/accelerate decision making related to the adoption of service systems". If such a model existed, how useful would it be in your IT service governance approach?

Indicator	**Respondent #**	**Respondent %**
Extremely useful	0	0.0
Quite useful	8	40.0
Somewhat useful	9	45.0
Very little use or not useful at all	1	5.0
Not sure	2	10.0
Total	20	100.0

A.5 Strategic Planning of IT

Q13. How would you rate the priority (low to high) of the following attributes when you are considering external IT services as part of strategic planning of IT? (5=High, 3=Medium, 1=Low)

Attribute	**Respondent #**	**Min.**	**Max.**	**Mean**	**S.D.**
Cost	20	3	5	4.50	.607
Return on Investment (ROI)	19	3	5	4.00	.816
Risk	20	3	5	4.45	.686
Continuity	20	3	5	4.35	.875
Dedication to continuous service improvement	19	2	5	3.95	.780
Other	5	4	5	4.60	.548

Other attributes include:

- Innovation and impact on business process improvement
- Fit with business requirements
- Support
- Alignment with business strategy
- Proven experience

Q14. In your opinion, extending the SaaS evaluation model to support SaaS operation monitoring is:

Indicator	Respondent #	Respondent %
Not important	1	5.0
Somewhat important	4	20.0
Important	8	40.0
Very important	3	15.0
Essential	3	15.0
Not sure	1	5.0
Total	20	100.0

Q15. In future, do you expect the use of external IT services in your organization to:

Indicator	Respondent #	Respondent %
Increase significantly	3	15.0
Increase marginally	11	55.0
Change very little or not at all	4	20.0
Decrease marginally	1	5.0
Decrease significantly	1	5.0
Total	20	100.0

Q16. In future, do you expect the use of SaaS services in your organization to:

Indicator	Respondent #	Respondent %
Increase significantly	4	20.0
Increase marginally	11	55.0
Change very little or not at all	5	25.0
Decrease marginally	0	0.0
Decrease significantly	0	0.0
Total	20	100.0

A.6 Use of Personal Web-based Services

Q17. Does your organization have any defined strategy or policy related to adoption and use of personal web-based services for business activities?

Indicator	Respondent #	Respondent %
No, and we don't anticipate to the creation of any strategies or policies	1	5.0
No, but we are discussing the creation of some strategies or policies	5	25.0
We are in the process of developing some strategies or policies	8	40.0
Yes, we already have defined and adopted some strategies or policies	6	30.0
Total	20	100.0

Q18. If your answer to the previous question is 2 or 3, when do you anticipate will your organization define and adopt strategies or policies related to the use of personal web-based services for business activities?

Indicator	Respondent #	Respondent %
In 1 year	8	40.0
In 2 years	4	20.0
In 3 years	0	0.0
In more than 3 years	0	0.0
Not applicable	8	40.0
Total	20	100.0

Q19. Consider the following statement, The tremendous increase in the use of personal web-based services such as eBay, Travelocity, wikipedia, Amazon, facebook and youtube have created a culture of service expectation among today's knowledge workers. This expectation is forcing organizations (business, governmental and educational) to examine more seriously the adoption of external services as opposed to the maintenance of existing internal services as part of their IT planning. Select your level of agreement or disagreement with this statement.

Indicator	Respondent #	Respondent %
Strongly disagree	0	0.0
Somewhat disagree	4	20.0
Neutral	1	5.0
Somewhat agree	10	50.0
Strongly agree	5	25.0
Total	20	100.0

Appendix B

Results of the Email Survey

From June to July in 2009, we sent survey participation requests to Chief Information Officers (CIOs) of 30 academic institutions all over the world that were listed as successful adopters by Google Apps for Education and Microsoft Live@edu. Initially 20 CIOs responded and agreed and agreed to participate. We then asked the Test Scoring & Questionnaire Services at University of Alberta to build the online survey and formally invite these 20 CIOs to participate. The final population of the survey is 15. However, one participant did not provide answers to most of the questions. Therefore, the following results only include the 14 respondents that have completed all the questions.

B.1 Background

Q1. What is the size of your institute?

Indicator	Respondent #	Respondent %
1,000 or less staff, faculty and students	1	7.1
1,001-10,000 staff, faculty and students	2	14.3
10,001-25,000 staff, faculty and students	5	35.7
25,001-50,000 staff, faculty and students	5	35.7
More than 50,000 staff faculty and students	1	7.1
Total	14	100.0

Q2. Which of following best describes the type of your institute?

Indicator	Respondent #	Respondent %
Research intensive university	6	42.9
Primarily teaching university	5	35.7
Community college	2	14.3

Professional institute	0	0.0
Other*	1	7.1
Total	14	100.0

* Other: Bible college

Q3. What is your primary role in your institute?

Indicator	Respondent #	Respondent %
CIO or equivalent overall responsibility for IT management	7	50.0
Not CIO*	7	50.0
Total	14	100.0

* Not CIO include: Associate Vice President for IT, IT Manager, Coordinator for Distance Education, Director of web programming, Director of Student-Oriented Technology, Director of IT Planning, Assistant Vice Chancellor

B.2 Service Type

Q4. Please select from the four service types defined as follows the one that most closely describes the relationship you have with your e-mail service provider:

Indicator	Respondent #	Respondent %
Ad-hoc service	0	0.0
Defined service	7	50.0
Managed service	4	28.8
Strategic service	3	21.4
Total	14	100.0

Q5. If your business relationship with your e-mail service provider is not well described by the one you chose please add comments that identify the aspects of your business relationship that are not covered. (Comments)

- This service relates only to Student and Alumni email. Staff email is provided by an in house Exchange solution.
- Our employee email service is provided internally at this time. All our student email is provided by Google.
- The university has its' own email service provider for faculty, students and staff. We have, however, begun to provide GMail accounts to students if they

choose to use them.

- We use SaaS Microsoft Live@Edu for Students (Managed Service) and In house deployment of Microsoft Exchange for Staff.

B.3 Service Attributes

Q6. Please provide the best estimate of the priority (low to high) of each of the following quality and non-quality service attributes that were considered in your institute when making the decision to adopt an e-mail service system: (5=High, 3=Medium, 1=Low)

Service Attribute	Respondent #	Min.	Max.	Mean	S.D.
Functionality	14	4	5	4.79	.426
Security	14	3	5	4.57	.646
Availability	14	4	5	4.79	.426
Reliability	14	4	5	4.71	.469
Usability	14	4	5	4.43	.514
Efficiency	14	2	5	4.00	.961
Sustainability	14	3	5	4.07	.730
Adaptability	14	2	5	3.50	.855
Cost	14	2	5	4.00	1.038
ROI	12	2	5	4.17	1.030
Risk	14	1	5	3.71	1.204
Continuity	14	2	5	3.86	1.027
Other	2	4	5	4.50	.707

Q7. Please provide the best estimate of the monitoring frequency of each of the following quality and non-quality service attributes when using the e-mail service system in your institute:

6 = Continuously monitored
5 = Frequently monitored
4 = Often monitored (More frequent than yearly no more than monthly)
3 = Occasionally monitored (No more frequent than yearly)
2 = Monitored as needed
1 = Never monitored
N/A = Not sure or not applicable

Service Attribute	Total	6	5	4	3	2	1	N/A
Functionality	14	1	1	4	3	4	1	0
Security	14	1	2	3	3	4	0	1
Availability	14	7	3	2	0	2	0	0
Reliability	14	6	5	1	0	2	0	0

Usability	14	2	1	4	3	4	0	0
Efficiency	14	0	1	1	3	6	1	2
Sustainability	14	1	0	3	4	6	0	0
Adaptability	14	0	1	2	2	9	0	0
Cost	14	0	0	0	4	4	1	5
ROI	14	0	1	0	3	5	1	4
Risk	14	1	3	2	1	6	1	0
Continuity	14	2	3	2	2	4	1	0

Q8. A user survey may have been conducted in your institution to assess the value to the users of the external e-mail service. Based on the results of the survey, how have the users rated the service?

Indicator	Respondent #	Respondent %
Excellent	5	35.7
Very good	3	21.4
Acceptable	1	7.1
Marginally acceptable	0	0.0
Unacceptable	0	0.0
User survey not conducted	5	35.7
Total	14	100.0

B.4 IT Governance and Strategic Planning

Q9. What types of IT governance frameworks or strategies are used in your institute to make decisions like the adoption of an external service such as email? (Multiple choices)

Indicator	Respondent #	Respondent %
IT Infrastructure Library (ITIL)	6	42.9
Control Objectives for Information and related Technology (COBIT)	1	7.1
CMMI	0	0.0
Six Sigma focus on quality assurance	0	0.0
ISO/IEC 27001 [BS7799] for IT security	2	14.3
ISO/IEC 38500 for corporate governance of IT	0	0.0
Defined and implemented own strategy	9	64.3
Have not developed a framework or strategy	4	28.6
Total	14	100.0

Q10. A primary goal of our research is to build a SaaS evaluation model to assess service quality and to improve/accelerate decision making related to the adoption of service systems. If such a model existed, how useful would it be in your service governance?

Indicator	Respondent #	Respondent %
Extremely useful	4	28.6
Quite useful	4	28.6
Somewhat useful	4	28.6
Very little use or not useful at all	0	0.0
Not sure	2	14.3
Total	14	100.0

Q11. In future, do you expect the use of SaaS services in your organization to:

Indicator	Respondent #	Respondent %
Increase significantly	8	57.1
Increase marginally	6	42.9
Change very little or not at all	0	0.0
Decrease marginally	0	0.0
Decrease significantly	0	0.0
Total	14	100.0

Appendix C

Case Study: Evaluation on Adoption of Email Service System in University of Alberta

C.1 Background

Since April 2009, University of Alberta (UofA) has been considering a common email service system across campus with a SaaS solution (Google Apps for Education). As a service customer, UofA needs to understand the quality issues and discover potential problems in the service adoption of a SaaS solution. To assist in this understanding, we conducted a study from September to October 2009 based on our SaaS evaluation tool. The primary purposes of this study were to:

- test the usefulness and effectiveness of our approach, and
- evaluate the adoption of email service systems in UofA from the customer's point of view.

In our study, the VPIT (Vice Provost Information Technology) of UofA was invited to participate by answering questions and discussing issues related to the adoption of email service systems. His interaction with our evaluation tool follows a four-step procedure that is described in the next subsection.

C.2 Study Procedure

Step 1: Questionnaire

In step 1, the VPIT was provided with a background introduction and questionnaire asking him to return the questionnaire within a week. The questionnaire was designed similar to that of the Email Survey as described in Chapter 6 and Appendix B, with more questions specifically on the business views of email service adoption. In the questionnaire, the VPIT was required to answer questions organized in following three sections:

1. *Business Objectives and Service Type*. This section asks questions about issues that the VPIT is considering when establishing a business relationship with the email service provider. Issues such as the general motivation, specific objectives and service type desired are covered.

2. *Service Attributes*. This section asks questions about the service attributes that are considered in the planning and operation of an email service. Service attributes related to the priority when making decision of selection and the monitoring frequency when using the email service are requested.

3. *IT Governance and Strategic Planning*. This section asks the question about the IT governance used when the email service is adopted in UofA.

Step 2: Interview

After receiving the questionnaire answers from the VPIT, a one-hour interview was arranged to review and expound on his answers from the questionnaire. Some answers were missing or unclear in step 1. For example, the questions on monitoring frequency and IT governance were not answered. Therefore, step 2 basically emphasized further explanation and clarification of the answers provided in step 1. The following is a list of the follow-up questions prepared in advance of the interviews:

1. For *Business Objectives and Service Type*, I asked for an explanation of why a *Defined Service* was chosen.

2. For *Service Attributes*, I asked for the reasons of ranking the priority of various service attributes as he did. The discussion was focused on the results that deviated from the assumptions of our model and results from the previously conducted Email Survey. We also discussed why the monitoring frequency plan on the service attributes was not provided in the questionnaire response.

3. For *IT Governance and Strategic Planning*, I asked for the plan of IT governance framework and the VPIT's opinion on the future use of SaaS services in the university.

Step 3: Selection Report

Within a week of the interview, a selection report based on information gathered in step 1 and step 2 was produced. The report provided a summary of key issues to consider during the negotiation between UofA and the email service provider. It also incorporated the previous results from Email Survey conducted with other academic institutions.

The report consisted of the following parts:

1. Introduction with the purpose of the study, the definitions of terms and the summary of results;

2. Comparisons with the Email Survey results, including comparisons on the priority of service attributes, and differences between results;

3. Analysis and perceived problems of UofA's response, including the inconsistencies and incompleteness detected in the study.

4. Summary and recommendations that can be used as reference for the service adoption in the phases of decision-making and service operation.

Step 4: Assessment and Refinement

After the VPIT received and reviewed the selection report, another meeting was arranged to discuss the report and assess the effectiveness of the evaluation tool. The report was then refined according to the results of the discussion.

The next section presents the key results in the selection report from our study.

C.3 Results

Comparisons

An important focus of our questionnaire was on the priority and monitoring frequency of service attributes in the comparisons. However, the monitoring frequency question was unanswered since UofA was still relatively early in the decision making phase. As a result, we were only able to compare UofA's answers to the priority questions to the Email Survey results. We did so based on the following four groups (see Table C.1):

- Institutes participating in Email Survey;
- Institutes having a similar size to UofA (More than 25,000 staff, faculty and students);
- Institutes of a similar type to UofA (Research intensive university);
- Institutes that recognize the service type as the *Defined Service*, same as UofA.

Table C.1: Comparisons on the priority of service attributes

Attribute	UofA	Total		More than 25,000 people		Research intensive university		Defined service	
		Mean	%S.P.	Mean	%S.P.	Mean	%S.P.	Mean	%S.P.
Functionality	5	4.79	78.6	4.83	83.3	4.67	66.7	5.00	100.0
Security	5	4.57	64.3	4.67	66.7	4.50	50.0	4.43	57.1
Availability	5	4.79	78.6	4.83	83.3	4.83	83.3	4.71	71.4
Reliability	5	4.71	71.4	4.83	83.3	4.83	83.3	4.57	57.1
Usability	5	4.43	42.9	4.33	33.3	4.17	16.7	4.14	14.3
Efficiency	5	4.00	35.7	4.33	66.7	3.83	33.3	3.86	28.6
Sustainability	4	4.07	50.0	4.00	66.7	4.00	66.7	3.71	42.9
Adaptability	4	3.50	71.4	3.50	33.3	3.17	33.3	3.14	28.6
Cost	4	4.00	21.4	3.83	0.0	4.17	50.0	3.86	14.3
ROI	4	4.17	25.0	4.00	0.0	4.00	50.0	3.80	20.0
Risk	5	3.71	21.4	3.67	33.3	4.00	33.3	3.57	14.3
Continuity	4	3.86	42.9	3.83	33.3	3.83	50.0	3.29	57.1

% S.P.: Percentage of respondents that selected the same priority as UofA.

The significant trends and differences detected from the comparisons are as follows:

1. For each service attribute, UofA's ranking of priority is higher than (or equal to) almost all the mean values of the four groups. The few exceptions are:

   - Sustainability for total (4.07 vs. 4)
   - Cost for research intensive universities (4.17 vs. 4)
   - ROI for total (4.17 vs. 4)

2. By considering both the mean values and the percentage of same priority (% S.P.) (difference < 0.5 and percentage $< 20\%$), three attributes in UofA's answers significantly deviate from the mean values of the four groups: usability, efficiency, adaptability and risk.

   - For usability, the mean values are lower than UofA's priority of 5. Only 16.7% of research-intensive universities and 14.3% of *Defined Services* chose the same priority as UofA.
   - For risk, the mean values are much lower than UofA's priority of 5. Only 14.3% of *Defined Services* chose the same priority as UofA.

3. Other deviations: For efficiency, adaptability, cost and ROI, only 28.6%, 28.6%, 14.3% and 20.0% of *Defined Services* chose the same priority as UofA.

Analysis

Inconsistencies

In the theory of our model, we grouped the service attributes into four categories (see Chapter 4): (1) *Functionality*, (2) *Conformance quality attributes*, (3) *Gap quality attributes*, (4) *Value quality attributes*.

In UofA's answers, the service attributes from the group (1) and (2) were assigned a priority of 5, which is appropriate for the *Defined Service*. Three other attributes also had a priority of 5: usability, efficiency and risk. At the same time,

we observed a strong deviation for usability and risk from Email Survey results. There are two possible reasons behind this:

1. There appears to be some an inconsistency between the definition of service attributes in the questionnaire and UofA's connotation of the attributes: usability and efficiency. According to ISO/IEC 9126, the usability is defined as effort needed for use and efficiency is defined as relationship between the level of performance of a system and the amount of resources used under stated conditions. In discussion with the VPIT it became clear that for UofA's answers, the usability was viewed as simply the system capabilities the service provider offers, which is more like functionality. In addition, UofA appeared to interpret efficiency as primarily a network performance issue such as speed of accessing, instead of relationship between general system performance and resources used. As a result, from UofA's point of view, the usability and efficiency also have the highest priority and can be measured by conformance quality approaches typically used for *Defined Service* management.

2. The risk was assigned a priority of 5 because it is the biggest concern in the current stage of decision-making. In this particular case, the risk is mostly focused on the issue of privacy. The priority of risk might change in future.

Incompleteness

In the study, we found that UofA's answers did not include the following two parts:

1. The plan on monitoring frequency of service attributes when using email service system. Although a set of service attributes is recognized as critical or important to UofA, as yet few related measurements and achievement targets have been defined. Furthermore, no plan is now in place for monitoring the critical service attributes recognized in the priority question.

2. The IT governance frameworks or strategies used when making decision to adopt an email service system.

In the followup interview, we recognized that the email steering committee that is currently in place might become the basis for the potential IT governance framework at UofA, but this was not yet been explicitly defined. The results from the Email Survey showed that IT Infrastructure Library (ITIL) and "homegrown strategies" turn out to be the most popular IT governance frameworks used to make decision and oversee service operations.

Recommendations

The following activities were recommended to the VPIT in the phases of decision-making and service operation:

1. Define measurements and achievement targets related to the critical and important service attributes;

2. IT governance frameworks or strategies are necessary during the decision-making and the service operation. We recommend the establishment of an IT governance strategy by incorporating relevant parts of ITIL (Service Portfolio Management within the Service Strategy area).

3. Establish a monitoring plan of service attributes prior to any agreement to partake in a service with the SaaS provider. The following monitoring frequencies are recommended:

    - Continuously monitored: security, availability, reliability;
    - Occasionally monitored: usability, efficiency;
    - Monitored as needed: risk, continuity.

4. From the user's point of view gap quality attributes such as usability and efficiency are significant concerns for UofA. Therefore, it may be more appropriate to establish a service type of *Managed Service* with the email service provider either at the beginning or within the first year of service operation.

5. A user survey is recommended once the service system has been in place for a defined period (say 6 months). The results of our Email Survey show that

64.3% of the institutes had conducted a user survey to assess the value of the email service system.

C.4 Assessment and Improvement

With the experience of using the evaluation tool, the VPIT found the most useful part was to have the comparisons with the Email Survey results. He also gave the following suggestions for the improvement of the tool use in the particular service area:

- It will be nice to enlarge the data set our tool is using. The tool user will feel more confident if the tool has more data from other organizations and for other services. In this particular case, it was suggested that other Canadian universities that were undergoing the similar situations could also be invited to use the tool and provide the inputs.

- The tool analysis can include the impact of the email service adoption. In other words, the tool should evaluate disruptions, resistance or impediment that will be caused based on the business strategy and quality information given by tool user. For example, since UofA was mainly concerned about the risk of privacy, the selection report could be more helpful by including the analysis of impact on privacy.

As for the usefulness of the tool, we received positive evaluations on the ease of use, relevance, completeness and consistency. The VPIT may also want to use the tool for non-SaaS services such as desktop support and backup systems if another opportunity comes up in future. Since the privacy impact analysis on UofA's email system adoption has not yet finished, the full impact is still going to be determined.

By assessing the selection report produced in this case, we believe that two components should be included in the future report versions:

1. *Outline of the major findings*. In addition to the term definitions and the report contents, the "Introduction" section of the report should also summarize the analysis results and outline the major findings from the evaluation, such as

the proposed service type and missing information that needs to be brought to the tool user's attention.

2. *Inclusion of the service map*: The service map was missing in the selection report of this case. It should be produced as the important output of the evaluation and placed into the "Recommendations" section of the selection report. For example, Figure C.1 illustrates the service map that can be used for UofA's email system adoption.

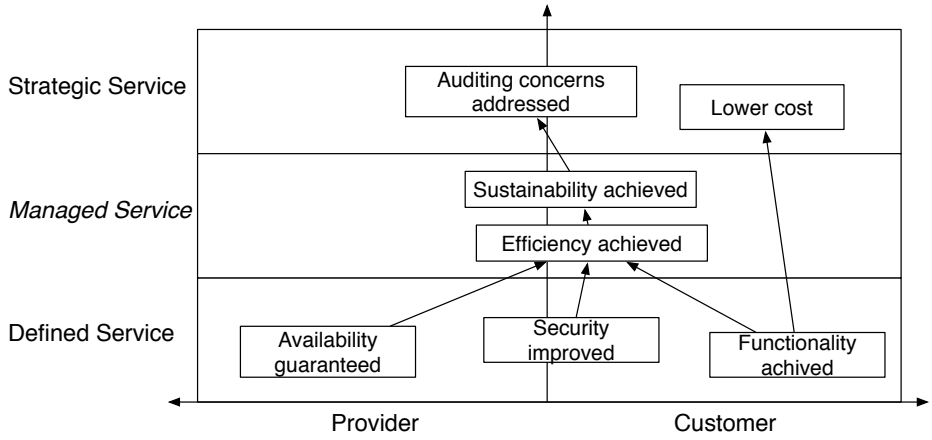

Figure C.1: Service map for UofA's email system adoption

From the four-step case study, there are two major findings regarding the improvement of our SaaS evaluation tool and approach:

1. Ideally, the input procedure should have both questionnaire and interview steps, but this may not be practical because it is not always possible to have the face-to-face interview as we did in UofA's case. If we are not able to do a follow up interview, we will have to revise the questionnaire by integrating more questions to get greater clarification and explanation of user's answers. In case that user's answers are significantly different from the tool's data set (i.e., the data collected from other user's answers), the procedure should also have the ability to request the user's permission to answer follow up questions.

2. The tool users might not be able to understand the quality terms correctly only given the standard definitions. In UofA's case, the misunderstanding of "usability" and "efficiency" led to inconsistent results. In an effort to eliminate such confusions, the tool should have the ability for users to see examples that provide context for and clarification of the standard definitions.