# Using Cloud Computing to Support a Mobile Business

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A dissertation submitted to the

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in partial fulfillment

of the requirements

for the degree of

Master of Science in Computer Science

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# Declaration

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# Acknowledgement

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In recent years, the influence of information technology on business has grown rapidly. Mobile business has become popular because it can provide services to a large number of users, without time limitations and geographical restrictions. The potentially huge number of users and lower set-up threshold attracts many start-up entrepreneurs to target this market. Because of a lack of funds, start-up entrepreneurs have to find a balance between system functionality and cost. In other words, they face a trade-off between function and finance.

In the development stage, which server to use to provide the company's service is a big decision, and there are two primary choices available: to build a traditional server, or to deploy the service to a cloud computing platform.

This dissertation analyses the benefits of using a cloud computing service by investigating cloud computing's architecture, technologies and service types (SaaS, PaaS and IaaS) and comparing cloud computing platforms offered by various companies. The dissertation also investigates business models and the status of cloud computing services, reviewing the differences between various cloud computing solutions.

Following the conclusions from the theory research, this dissertation designs and

develops a real mobile business application, setting up two kinds of servers for comparison: one that uses a traditional server and the other that deploys a server to the cloud. In the evaluation of the experiment, the dissertation mainly considers the service latency, reliability and cost saving.

The primary conclusions of this dissertation are: Service latency using the cloud server is similar to that of the traditional server, though the cloud server performs slightly better. However, the traditional server is more reliable than the cloud server. From the standpoint of cost, Amazon's Cloud service is relatively cheap in small-scale and so could be used when the business is first starting up, while Google Cloud is a good choice for a business when it has the potential to grow to a medium-size enterprise, as its performance is good and the cost is lower at medium-size scale. With regards to the traditional server, it is more suitable for a business that has grown to a large-scale enterprise.

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# Chapter 1 Introduction

## 1.1 Background

The Internet has led a technological revolution, brought about a fundamental change to people's life and achieved the interconnection of each individual and object. On the web, everyone and everything can link together all the time, realizing the real-time communication online. It also brought a huge opportunity of business and makes it into the electronic information age. The traditional business is that sell something to make money. From the social sense, it is the problem of redistribution of resources, the exchange of information and the premise of this transaction. A change by the Internet is that it improves the efficiency of resources allocation in market, because there are a lot of pluralism and diversity of information on the web.

With the development of science and technology, computer-related hardware got an extreme enhancement, for example the computing capability of the central processing unit (CPU) and memory space of the storage hardware. Especially the creation and popularity of mobile phone bring a greater technology support to break the geographic limitation and time restriction of information exchange. According to figures from the eMarketer Company shows that there are about 1.64 billion Smartphone users across the globe in 2014, and it will increase to near 2.16 billion until 2016. So the popularization of mobile phone not only enhances the development of the information age, but also brings many chances of mobile business.

At the same time, many large companies purchased a large number of server and storage facilities so that they can satisfy the requirement of users. For example Microsoft Company has over one million servers, but the demand of the user is not static, which led to the fact that part of the resource of many large-scale information technology companies will be idle in different time. In order to fully utilize the resources of those resource, many large companies have launched the cloud service, which is a "pay as you use" model to lease the unused servers and idle storage resources to creating win-win business in terms of economic benefits and saving resources.

## 1.2 Motivation

Even has entered the information age, there are still many problems, such as lack of information, people cannot get real-time data, some information is scattered so it needs more effort to collect them, and people always get the data which are out of date or useless. Besides this, some businesses still far away from the information management, especially like some small-scale retail shops, they lack of adequate technology knowledge to develop a system by themselves, in addition they do not have the time and money to support such system. In terms of the customers who want to buy some product they can only get product information in the physical shop if the small business owner never shared the information of their goods in one Internet platform.

To achieve the information management, the dissertation plans to design a complete location-based real-time information retrieving platform to manage the details information about objects for the physical shop owners.

Cloud is a great platform to store such information. Above all the utilization of cloud services is far from the upper limit. There are a large number of idle servers and storage resource. Secondly, as an emerging industry it is obvious that cloud computing is a kind of industry which has a bright future. Cloud computing usually has one or more data centers with strong computing capability and storage space as their support. What's more many cloud service providers are large-scale IT companies with rich experience like Google Company, Amazon, and Microsoft. So that there are many different kinds of services gives users a wide range to choose a satisfy one.

*"Finance defines the bottom line of most of the services to be designed."[41]* It is not uncommon that lots of start-up projects are facing the same problem: lack of funds, so that they have to find a balance between system functionality and financial cost. Under the circumstances, they need to make a decision on what kind of server the project plan to use and how to ensure the server can provide the correct function with minimal cost.

## 1.3 Research Question

The research question is that:

How to develop a mobile business which can help the physical shop owner to target their potential customers, and increase the interaction between them? In addition, figure out how to deploy servers to the cloud platform and what benefits will cloud platform brings into the mobile business.

## 1.4 Research Goal

The research goals are:

- Develops a complete information system calls Soosokan. In order to solve the problems which have been mentioned in the last section, this dissertation plan to design a geographic location-based information retrieving platform. Physical shops usually have a lot of products so that is a pain to manage. In this case, the Soosokan provide an orderly, convenient platform for the shop owners to organize the details about goods and advertising they want to show. As for users, they can review near advertising and search for the specific product which they need to buy base on their current location.
- Analyses the benefits and drawbacks of using a cloud computing service and deploys. And clarify what kind of role the cloud plays in the Soosokan system. Then the dissertation plan to deploy the servers of Soosokan to a cloud computing platform then compares it with the traditional server though experiment.
- This dissertation plans to investigate what kinds of technologies the cloud used so that they can provide complete service within as minimal resources as possible, meanwhile it researches the architecture of the cloud computing in order to figures out how they can realize an orderly and systematic management of the hardware device and energy resources in the data center. Because of lack of funding, the dissertation studies the different service types of cloud service and finds an appropriate one for the Soosokan system then and compares different cloud computing platform providers.
- Evaluate the cloud computing. After getting the system prototype and

determining an appropriate cloud platform, the dissertation will deploys the server to the cloud platform then evaluates the cloud server with traditional server in terms of service latency, reliability and cost saving.

## 1.5 Structure of the dissertation

This detail structure of dissertation is fellow:

**Chapter 1** introduces the background and motivations to set the topic and illustrates the research question and goals that will be achieved by this dissertation.

**Chapter 2** investigates the state of the art in the cloud computing area, and also research the limitation and benefits of a Small and Middle Enterprise to adopt the cloud computing.

**Chapter 3** presents the development and design progress of the business idea. In addition it also investigates the user requirements, competitive strategy and the promotion strategy of the mobile business.

**Chapter 4** proposes the architecture of the system and the details function the system will provides.

**Chapter 5** deploys the servers, then designs and realizes a experiment to achieve the research objects. According to the experiment result, it also summary and make a details scheduler of the mobile business to adopt the cloud computing.

**Chapter 6** concludes this dissertation and makes a plan about the future development of the mobile business.

# Chapter 2 State - of - the-art

## 2.1 Definition and Development

Base on definition from the NIST(National Institute of Standards and technology), “Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.”[1]

The ideas which are similar with the cloud computing can date back to the 1961, John McCarthy who makes significant contributions to the Artificial Intelligence proposed the concept of utility computing in a speech. Utility computing goal is to integrate the resource like server or storage system which is geographically dispersed around the world, and share those resources to users. The charge method of utility computing is “Pay and Use”.

In 1990s, “The Grid: Blueprint for a new computing infrastructure” has been published by Ian Foster and Carl Kesselman introduced the new conception “Grid Computing”. Grid Computing can be seen as a distributed system which collects the computer resource to solve a huge task. Each computer in the grid is a slave to finish different task which designated by the master. [32]

The word “Cloud computing” first proposed by Eric Schmidt, CEO of Google Company, in August of 2006. But before that, “Amazon promotes the Elastic Computing Cloud (EC2) AND Simple Storage Service (S3) provide the computing and storage service.”[2] Besides this, Amazon also introduced a variety of new cloud services (e.g. SimpleDB and Simple Queue) later, these are the cloud computing -related product. After Amazon many IT companies like Google, IBM, Microsoft and Yahoo carried out the research about cloud computing and published related products.

## 2.2 Technology Background

This section mainly talks about the technologies support of the cloud computing, it

includes the hardware and software two parts.

### 2.2.1 The progress of Information Technology

With the development of the computer industry, the performance and capacity chip, RAM, hard disks and other computer-related hardware got an extreme enhancement. What's more, the multi-core technology enables the processing power of computer has reached an unprecedented level. Besides this the development of mobile phones and other mobile devices provides a great technology support and platform.

In addition to hardware technology, “the information and communication technology advanced significantly within the last half century.”[3] So that people can access the Internet without geographic and time limitation. Nowadays, “it becomes a utility, like other existing utilities (water, electricity, gas, and telephony) to meet the daily needs general community.”[3] Those enable the connections between customer device and the cloud computing.

### 2.2.2 Virtualization

“Virtualization is a technology that abstracts away the details of physical hardware and provides virtualized resources for high-level applications.”[4] Along with the development of *"virtualization technology, VMware, vSphere and the Xen becomes popular"*[46], a server can integrate several servers’ loads. Thereby virtualization improves the utilization of hardware greatly, reduce the usage of resource and decrease the acquisition cost of related hardware. Virtualization becomes the foundation of cloud computing, *“as it provides the capability of pooling computing resources from clusters of servers and dynamically assigning or reassigning virtual resources to applications on-demand.”*[4]

## 2.3 Features

- Very large scale

Most Cloud Computing Platforms be supported by very large scale physical device. For example, Google and Microsoft have over one million servers, and the data centers of

those companies which integrate and manage such large scale servers can provide unprecedented computing power and storage capacity to users. [33]

- Abstract

Users can connect to the cloud by using any kinds of devices and get the service in everywhere without knowing the details about the specific information of the cloud service such as how it executing and how it realizes the distributed storage. [36]

- Customizable and pay as you go

Cloud computing can provide different application according to the diversified requirement of customers. One cloud computing can execute different applications simultaneously. As a huge resource pool like electricity and water the payment of cloud is based on how much resource customers used.

## 2.4 Cloud computing services

The cloud computing services can be categorized into three groups according to the service they provide. One is Software as a service (SaaS), this type of model encapsulates specifies functions of the services, and provides the services like the web application. The second is the Platform as a Service (PaaS), "it provides a development environment and a deployment platform"[11], ensures the customers' application can be executed successfully in the platform. The other one is Infrastructure as a Service (IaaS), it is the kind of product that rent the underlying hardware resource (CPU, Storage Space and Operation system) to the user. From the user's point of view, those services are independent. However there are dependent relationships between those three services from a technology perspective.

Figure 1 shows the architecture of the three kinds of service and lists some typical cloud service of different cloud service. The diagram also shows the support technologies mainly used in each
service.

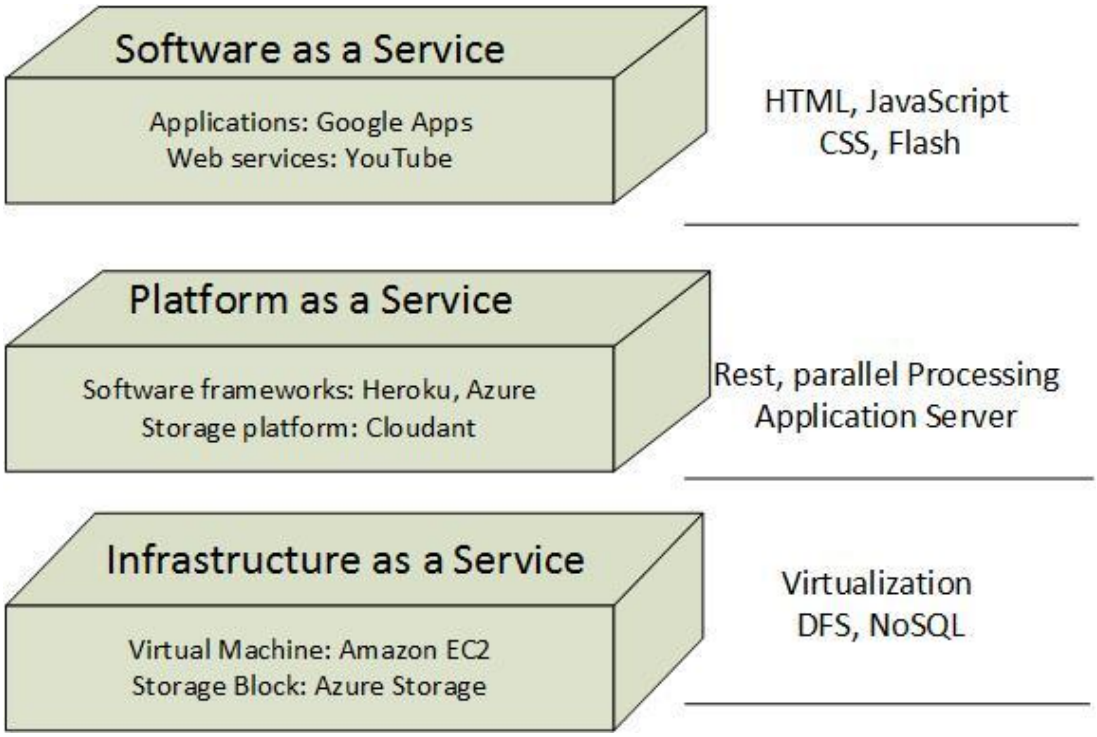


Figure 1 Three Layer Service

## 2.4.1 SaaS

SaaS is the first cloud computing service, because it's early start and low cost. There are large numbers of quantities and category SaaS services. For example, salesforece.com as one of the earliest company which provides SaaS service, it mainly offers a customer relationship management system and it gets the success. Google Apps for work is also a very popular SaaS product, which includes the Email service (Gmail), Storage service (Google Drive), office service (Docs, Sheets and Slides), customer can use the product for free and charged.

- Advantages

As the earliest cloud service, SaaS has following advantages:

- Low initial cost: When enterprises use the cloud computing service they do not need to purchase the relative devices and licenses and most cloud service company offers the free trial.
- Easy access: Many cloud services support lots of standard mainstream

networking protocols (like HTML4, HTML5) and have some security protocols (HTTPS), no matter when the users are and where they are they can access the services as long as they can connect the Internet.

- Technology

The SaaS mainly use the following technologies:

- HTML: The standard web page technology, mainly are HTML4 and HTML5, it promotes the development of web pages in some degree.[33]
- JavaScript: JavaScript is a dynamic programming script language and based on the web page.
- CSS and Flash: Enhance the performance of the web page and improve the user experience.

### 2.4.2 IaaS

IaaS is the basis cloud service of the other cloud services. It mainly offers the physical and virtual machines as service and users can get the computing and storage resource to deploy their application does not need to manage relate machine.[27] In 2006 Amazon published the Elastic Compute Cloud (EC2) which is the earliest IaaS product which provides different kinds of computing resource. It can meet the requirement of an enterprise in capability, scalability, reliability and security in some degree. Blue cloud a typical IaaS product for an enterprise which is introduced by IBM, *it offers an open cloud infrastructure of IT "operations to deploy both virtual and dedicated bare metal servers develop applications and run production-ready workloads."[6]*

- Advantages

Compare to the traditional service the IaaS has following advantages:

- Multiple Supports: The IaaS service is mainly based on the virtual machines, and the virtual machine usually supports many different kinds of operation systems, so it is compatible with various applications.

- Low resource spends: On the one hand, it reduces the acquisition costs of hardware in early stage; On the other hand it can provide a service within several minute (It usually cost one week or more to build a traditional server). After building the server, the maintenance and management will be done by the IaaS supplier. [31] So that customers do not need to concern those problems.

- Technologies

  - Virtualization: One physical server can generate several virtual machines by using the virtualization technology. In addition, each virtual machine is completely isolated like a stand-alone system. [34][38] It can reduce the acquisition cost of service and save the relative resource to manage the service.

  - Distributed File System: Because cloud needs to store and manage large amount of data, cloud needs a complete and perfect system to handle relate data. The Google file system is a typical case.

  - Database: On the one hand the relation database needs to improve and make it suitable for the cloud; on the other hand the NoSQL solve the problem that relation database cannot perfectly support big data. The BigTable of Google Company is a typical case.

### 2.4.3 PaaS

*"A PaaS is built on an IaaS and uses a multi-tenanted deployment and development tools."[5]* It provides a development platform and storage space for the developer. Compare to the SaaS, the product number of PaaS is not as many as the former one.

Google App Engine was provided by Google Company in 2008, which provide development tools and SDK and supports different programming languages.

Windows Azure Platform is a kind of PaaS product which is offered by Microsoft. The Azure provides a series of develop deploy and manage API to help users to manage their project with a more friendly way.

- Advantages

- Customize and Elastic: Because there are many different services, users can choose the required service. What's more, PaaS also meet the customized requirement in some degree. Meanwhile, many PaaS can adjust its resource automatically to fit with the real-time requests and handle the sudden highly traffic. [40]

- Multiple Services: PaaS can support different service to users for example, the mobile server, web server and database.

- Friendly development environment: The PaaS usually provide SDK and IDE to users, so that they can program in their own machine and deploy the project into cloud.

- Technologies

  - Rest: Representational State Transfer is a kind of architecture used to build scalable web services. [36]

  - Parallel Processing: In order to process large amount of data, the cloud computing has to use the parallel processing for large-scale task, for example the MapReduce of Google Company, which is a programming model for processing and generating large data set.

  - Application Server: The server was optimized for cloud computing based on the original server. For example, the Jetty server is a kind of server which usually be used for large software framework, and Google App Engine adopts this technology.[37]

## 2.5 Architecture

Cloud computing platforms manage and allocate their huge amount of resources (computing, storage, and bandwidth), offer SaaS, PaaS, and IaaS. In order to provide a better service to users, the cloud needs to achieve various functions like customer management, operating and maintenance, resource management, connection manager, security management and fault tolerance.

- Customer manager: It is the users-oriented management, to records, tracks, and users' information and provides necessary user guidelines and support services. Meanwhile, it collects the information of how many resources and service the user used then calculates the cost and provides bills to users.

- Service manager: First it needs to ensure that the cloud should be processing professionally and automatically, so that can reduce the operational cost of the cloud data center.

- Maintenance: It needs adjust the resource of the cloud data center for example it should shut down the idle machine to reduce energy consumption. It also needs to detect the exception events in the cloud.

- Resource manager: First it needs to manage the physical machine like the server, storage machine and the network equipment when users request relevant resource it should allocate resource and load working balance.

- Connection manager: The main function it provides is routing and protocol analysis and it needs to ensure the different components can connect successfully.

- Security manager:  It should ensure that the data can only be access by the authorized users and the cloud should have a series of security rules (security audit, data encryption and data backup) to protect server and data from attacks.

- Fault tolerance: It needs to build a back-up data center to ensure the cloud can provide as usual when natural disaster occurs. And when it detects that a physical machine cannot work as usual, the system should try to repair the machine.

*"According to the research about the cloud computing, there is a uniform cloud computing architecture based on the service-oriented cloud computing"[7]* which is the layer structure.

- *"Resource Layer"*[7]: This layer contains the cloud resource and the resource

manager. It also provides the standardized interface so that the upper layer can access this layer.

- "Service Package Layer": *"The main function of this layer is to mask the difference between the different individual cloud providers and it can help cloud application to migrate from one cloud to another."*[7]

- *"Link Layer"[7]*: This layer contains the connection manager and the device such as the router and switch.

- Service Process Layer: It contains the service manager and the customer manager to provide correct functions to correct users.

- Display Layer: It offers standard interface to satisfy the requirements change and heterogeneous environment from different users.

The detail diagram is shown on the Figure 2 which illustrates the details of the cloud architecture and how those managers work on the whole system.

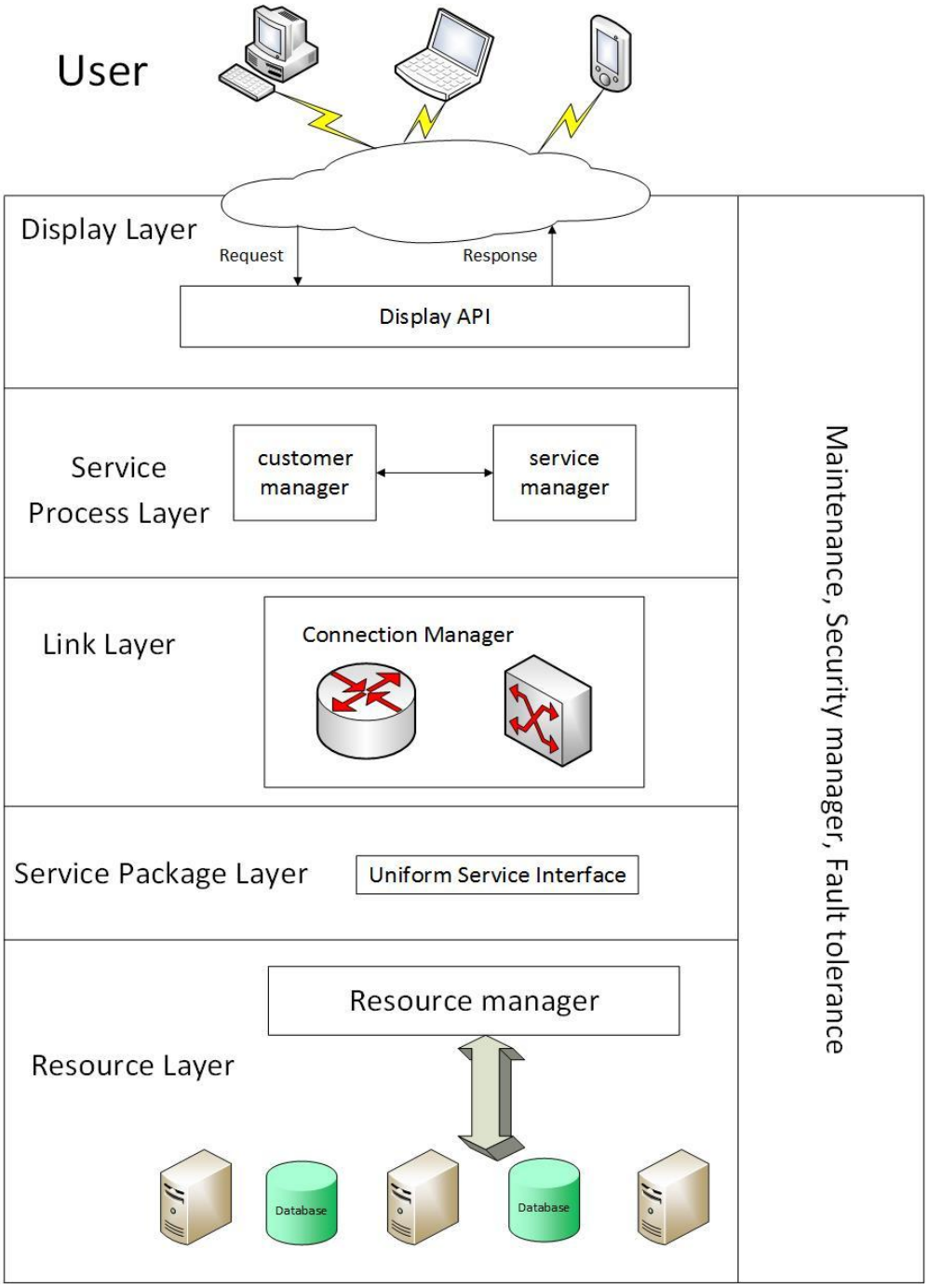


Figure 2 Cloud Architecture

## 2.6 Comparison of representative cloud platform

In this section, the dissertation will compare three typical commercial products of cloud service.

### 2.6.1 Amazon Web Services (AWS)

AWS provides many different web services [8], like the Amazon Simple Storage Service (Amazon S3), Amazon Simple Queue Service (Amazon SQS) and one of the most popular cloud products is the Amazon Elastic Compute Cloud (Amazon EC2). Users can connect the service over the HTTP protocol and it also supports the REST and SOAP frame.

- *"Amazon EC2 is a web service that provides resizable compute capacity in the cloud. It is designed to make web-scale computing easier for developers. Amazon EC2's providing a web service interface allows users scale capacity both up and down."[9]* The cost of Amazon EC2 is according to the capacity that the users actually use. User can controlled EC2 via Web Services. Beside the user GUI there are also a set of Java interfaces to let the users connect the instances from a command line in a different operation system like windows, IOS and Linux.

- *"Amazon S3 provides a secure, durable, highly-scalable object storage platform to users. Users can use the Amazon S3 through web browser, it supports store and retrieve any amount of data from anywhere on the web. There is no minimum fee and no setup cost when user use the cloud storage."[10]* The charging Standard of using Amazon S3 is "pay as you use" model, so user only needs to pay for the storage space the user actually used. Amazon S3 can be used alone and it can also be used with other AWS.

### 2.6.2 Google Cloud Platform

Google cloud platform provides a set of services that users can build web applications and servers on the platform. It provides different kinds services like the Google Compute Engine and Google Cloud Storage. Google cloud platform supports various programming languages like Python, Java and PHP. The API that provides by the cloud platform enables user to build servers and database to stores data in those services.

- Google Cloud Storage provides is a storage platform that enables users to store their data into the platform and access and retrieve those data in the world-wide

range on the web by using the interface which provide by the service. It also provides a REST API for users to support the REST frame. The payment of the Google Cloud Storage is also using the "pay as you use" model as the Amazon cloud.

- Google Compute Engine is an IaaS service that allows users to create and a run a virtual machines on the infrastructure. Users can adjust and configurations their virtual machine then install software on it and deploy what user want in the virtual machine.

### 2.6.3 Microsoft Azure

Microsoft Azure provides a set of complete cloud services, mainly service it offers are the cloud services, virtual machines, database and storage. The main characteristic of Microsoft is it provides a perfect platform to support the .Net framework and it support different kinds of language like Java, C#, C++ and other programming language. Users can connect the service over the HTTP protocol and it also supports the REST style. Azure storage is mainly using Azure blobs, tables, queues, and users can access the storage by using the API by many languages.

The Tab 2.4 compares those three cloud computing platforms from different points of view.

| **Cloud Provider** | **Amazon EC2** | **Google App Engine** | **Microsoft Azure** |
|---|---|---|---|
| **Service Type** | IaaS | PaaS | PaaS |
| **Target Applications** | General applications | Web applications | Windows applications |
| **Computation** | Operation System and virtual machine like Xen | web application frameworks | Redefined role of application instances |
| **Storage** | Amazon EBS; Simple Storage Service; SimpleDB | BigTable MegaStore | SQL Database and the Azure storage |

| | | | |
|---|---|---|---|
| **Auto Scaling** | Support(specify by user) | Support(transparent to user) | Support(specify by user) |

Tab 2.4*"Comparison of representative cloud products" [4]*

## 2.7 Cloud Computing of SME

This section will focus on the research the limitation factors of small and middle enterprise (SME) to adopt the cloud computing, and analyzes what benefits cloud will bring into the SME.

### 2.7.1 Limitation factors

As the most common problem for SME is the limited financial resource. *"One of the effective ways of increasing efficiency is the use of the modern information technologies including the cloud services."*[39] However, the fact shows that no so many SME choose the cloud computing platform to deploy their servers. According to the eurostat statistics Explained[1] there are only 19% Enterprise adapt the cloud computing service in the Europe Union (EU).

When enterprises use the cloud computing, there are many factors they will corner about, the figure 3 shows the limit factors of large enterprise and SME:

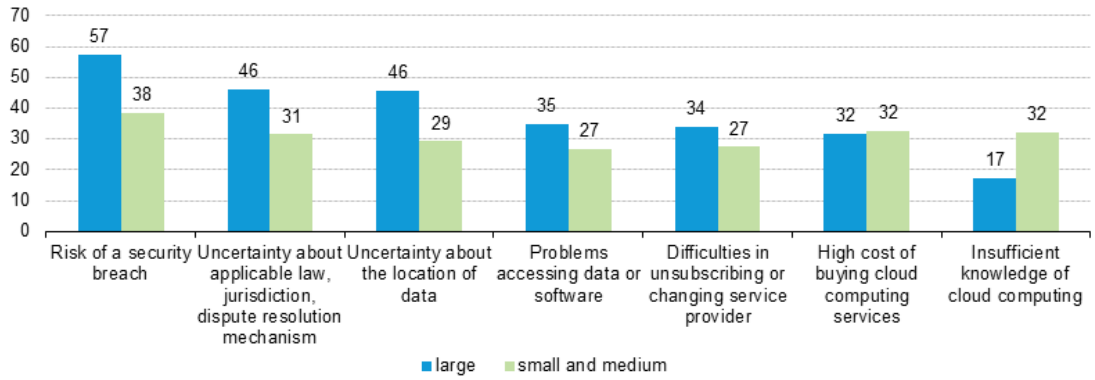


Figure 3 *"Factors limiting enterprises use cloud computing"[17]*

In terms of the SME, the risk of a security breach is the biggest factor limit the enterprise to utilize the cloud computing. Obviously, enterprises afraid data breaches

[1] ec.europa.eu

[2] www.soosokan.com

when they use cloud computing. The key issues of cloud security are: *"trust, multi-tenancy, encryption and compliance."[18]* Actually the keep data security of a manageable process. Above all, enterprise can use the private cloud rather than the public cloud to store the sensitive data. Then enterprise should trust cloud computing because the clouds have security auditing mechanism, security manager, fault tolerance, data backup redundancy mechanism and restore when it loss.[33], [35]

When enterprise uses the cloud computing, it is necessary to have a technology person who equip with the specific skills about those area and it is also very important to estimate the consumption of cloud to support the business can operate as usual. Therefore, the lack of knowledge or expertise is equally become a limitation for some SME to adopt the cloud computing. And they also regard the cloud computing needs high cost, so it becomes another factor.

What's more, the cloud provides service to all over the world and the provider companies usually have many data centers distributed globally, so firms do not have clearly knowledge about the physical location to store their data. Besides this, they are uncertainty about the applicable law and jurisdiction, dispute resolution mechanism.

## 2.7.2 Adoption parameters

There are many benefits when adapt the cloud computing, and the Figure 4 shows how technology person regards the cloud computing and list the benefits.

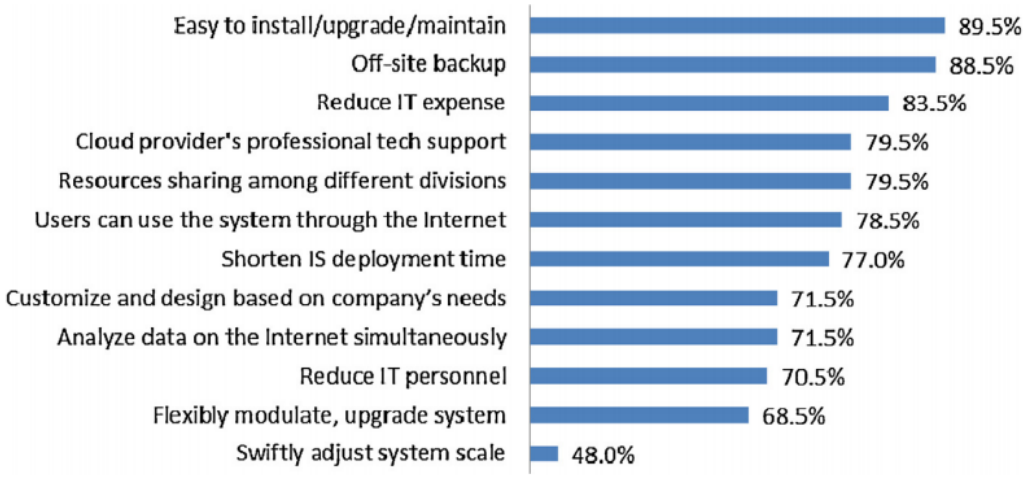


Figure 4*"Benefit use cloud computing"[19]*

In some degree, most IT managers believe cloud computing can provide a professional, cheaper, more convenient service, and more security of data (redundancy and back-up).

| Literature details in chronological order | Inference on SMEs adoption of cloud computing | Importance of cloud computing parameters on SMEs adoption | Detailed discussion on features of each parameter | Expectations of SMEs from future usage and adoption of cloud computing |
|---|---|---|---|---|
| Rising above the din (Ferguson, 2008) | Alternate ways and SaaS model for revenues by DELL, focusing on providing services to SMBs, an untapped market | Software and services needs of SMBs to help manage their emails, licensing of software, other assets etc. | No | Not analyzed |
| Small businesses moving to cloud computing services (King, 2008) | Availability of secured IT infrastructure, minimal up-front investment, disaster recovery, software upgrades | Cost reduction, avoiding natural disaster mishaps, better security but lack of reliability in using cloud computing are the most important parameters | Yes – emphasized on SMEs comfort with cloud computing | SMEs are showing positive inclination toward cloud |
| SMEs can benefit most from the cloud (Clark, 2009) | Security, reliability, trust, cost reduction, online collaboration are the major influences for cloud computing usage | Trust in cloud providers, incremental cost and reliability are the most important parameters | Yes – the success of the cloud computing adoption and its image in the mind of SMEs discussed in detail | SMEs can explore cloud computing with relatively little risk |
| Untitled (Grant, 2009) | DELL launched three cloud based services for SMEs | 30% IT cost reduction for SMEs, customized services like storage and minimizing their email outage, security breaches and service disruption are the most important factors | No | Major inclination toward SMEs by a big corporate like DELL, offering cloud services |
| Should You Move Your Business to the Cloud? (Martin, 2010) | Security and privacy are top concerns of 51% SMBs, availability versus sudden downtime, migration across cloud services | The importance of moving to cloud step by step is recommended using couple of tips for SMEs. Moving to cloud is emphasized | Yes – with specific focus on privacy, availability, data loss, data mobility and ownership, tool robustness | Strongly emphasized for small businesses |
| Untitled (Grant, 2011) | SMEs prefer to buy from a local cloud provider and are willing to pay | Collaboration, data storage, backup, scalable, pay as you go are the primary factors | No | Awareness, acceptance, usage and adoption of cloud by SMEs is on the rise |
| This research paper | Core variables have been focused and studied in detail | SMEs have shown strong inclination for three out of the five core variables for using and adopting cloud, as per this research | Yes – future recommendations for the remaining two parameters have been discussed in detail that would help in designing the cloud framework for improved usage and adoption of cloud computing by SMEs | Five existing core factors and few new factors are identified and inference is drawn, using extensive quantitative survey across the APAC region using structural equation modeling (SEM) |

Figure 5*"Compare empirical studies on the cloud computing adoption by SMEs"[20]*

The Figure 5 shows a set of researches of different years which about the cloud computing. And list the point of the cloud computing about the limitation factors and benefits of enterprise uses the cloud, it also presents the features and expectations of the SME use cloud computing.

# Chapter 3 Market

## 3.1 Inception and development of the idea

The details about the development of the Soosokan are shown at the Figure 6.

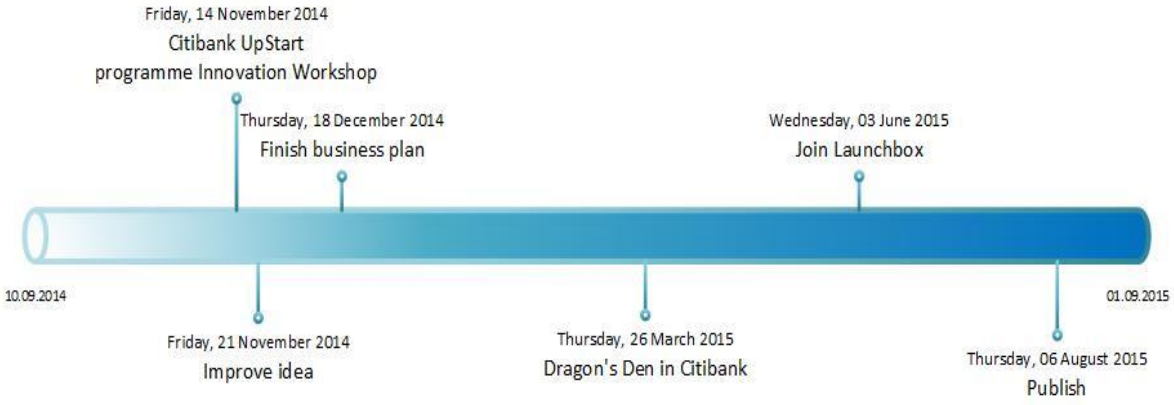


Figure 6 Important Time stone of Soosokan

### 3.1.1 Development of idea

The original idea to establish a location based information interact system stems from the business innovation course of the M.Sc. in Computer Science of (Network and Distributed Systems) at Trinity College Dublin. This course demands that every four persons be a group and submit a complete and demonstrate the business at end of the semester.

As for the idea, it is from the actual experience. In our class, members are from differing countries rather than Ireland and study at the Trinity College Dublin. Beginning it is really a hard time. It is very difficult to find require stuffs. For example, a member of our group wants to get a programming book written by her native language, but it was really tough to buy it. After a long-term searching, the member got the book from another student who just finished his degree at the same college. At that time, we just wondered why there was not such an information platform which provided the physical goods information. So we set it as our business idea in this model.

The first change of the idea because the Citibank Upstart programmer Innovation

Workshop in 14th November 2014, after the presentation we got many guidance from the professional staffs of Citibank. They point out the shortages of the idea and put forward the recommendations for improvement of the idea. We were inspired by those suggestions, so we started to divide the target customers into two parts and begin to considering the retailers who own a physical shop are potential users.

In 18th December 2014, we finished the business plan, at this point, the basic business model of Soosokan has established. In addition, we also purchased the domain name[2] and registered the ID of major social networks (e.g. Facebook, Twitter) and e-mail (e.g. Gmail, Hotmail).

### 3.1.2 Designing processing

In the second semester, the course "Software Engineering / Middleware Group Project" demands us to implement the project which has been raised in the business innovation lesson. So we spend about 1 month to enhance the business model and select an appropriate framework of the system, specify the functions that will be provided, design the architecture of the system. Then we spent a lot of time and effort to achieve the business model and get a prototype of the system.

On March 26th 2015, we presented the concept and showed the prototype in the Dragon's Den which is the Startup Challenge hold by the Citibank. In that day, we got various proposals from other participants and the entrepreneurs who have made great achievements. Besides those we also received praise from the expert panel. Those commendations from professionals make us aware the prospects to develop our idea. What's more we also get some practical support that we got the opportunity to take part in the TCD Launchbox accelerator programme[3], and gain support from Microsoft.

We joined the Launchbox accelerator programme on June 03 2015 which is aiming to trinity student (undergraduate and postgraduate) and help the early-stage business for three months. In the Launchbox, we got the mentorship and professional advice from

[2] www.soosokan.com

[3] www.launchbox.ie

successful entrepreneurs, opportunities to gain investment and an ideal collaborative environment to launch the Soosokan project. And about two months later we publish the test version of Soosokan and get many feedbacks from different peoples.

## 3.2 Marketing Research

According to the framework of Mobile Business which is shows as Figure 7, it illustrates the key points of the business can be the several blocks.

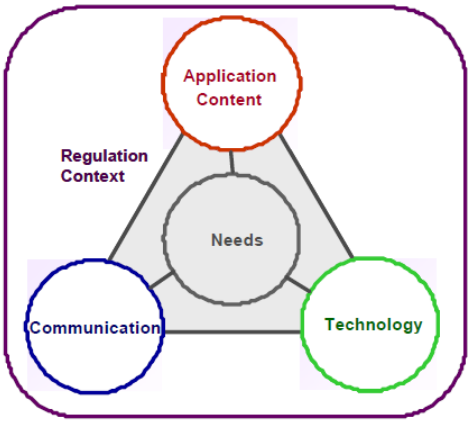


Figure 7 Mobile Business Framework[23]

The needs of users are a core part in the business framework. What's' more one of the most common acknowledgement of a business is the user satisfaction. [24]

So, in this section, the dissertation mainly shows the efforts we did to figure out the needs of the business framework, and the objects are the target user, correct market position and simply define the service of Soosokan and its value proposition.

### 3.2.1 User investigation

In order to understand consumers' requirements, we designed a questionnaire to collect residents' perspectives about the product and advertising information in Dublin city.

In the questionnaires, there are two main parts. First part is about respondent's basic information such as gender, age range and occupation, which to ensure samples of

questionnaires survey is diverse. The second part is about local information, and their attitude about those information, includes people are interested in what type of shops (e.g. retail shops, restaurant or hotel) and what's kind of information (e.g. promotion, new product, coupon or discount).

As for the result of the questionnaire, that most people are interested in retail shops which sell the goods for daily use, such as supermarkets and shopping malls. There also are some people focused on accommodation and catering.

In terms of what kinds of information that people are interested in. The result shows that most attractive information is the price of product. Approximately 88% people would like to know the price. Discount and promotion information also popular, about 70% people want to take this kind of information.

### 3.2.2 Seller investigation

In order to a better understand about the seller who is the most important role in the Soosokan platform. It is very significant to catch seller requirements, so we also interview some sellers who owner different kind's retail stores including cafe, fast food restaurant and so on.

In interviews, we concentrated how much of the cost they paid on advertisements to promote their product per month. We also investigate the wishes of sellers if they are interesting in publishing their product information and advertising on the Soosokan platform.

### 3.2.3 Business Model canvas

In the initial stage, the start-up projects can develop their business model by using the business model canvas. *"The Business Model Canvas is a strategic management and lean startup template for developing new or documenting existing business models."[16]* Actually, the business canvas is a visual chart that includes many different factors which describing the details information such as the value proposition, target

users and finance of product and extremely contributed on" illustrate the hypotheses and how the customer segments map to their corresponding needs."[25] The details business model canvas of Soosokan is appends in the appendix1.

When we complete the business canvas, we put ourselves into the real situation and consider the following factors of Soosokan development:

Customer Segments: The target customers of the Soosokan are two types, sellers and users. Users can be dividing according to the shop category and scale, like the retailer, hotel owner, restaurant owner and the big-scale supermarket like Tesco.

Customer Relationships: It is about the relationship of the user, though Soosokan has two different group of user, they are all cross-side Network effects. Cross-side network also called two-sided market. There are two different groups of users and the deal can on be conclude by the two user group take part in.

Channels: Path to customer. The main channel of Soosokan is the two android applications which provide the essential interface of user and sellers. In the mean time, we also consider to publish the advertising in social network as one of our marketing strategy. Beside this the official website of Soosokan is also a great approach that can help customers obtain official dynamic information of Soosokan.

Value Propositions: The selling points for the seller are that they can popularize shop, improve competitiveness of the product, and break the physic shop's geographic limitation and target users with higher possibilities by suing Soosokan. As for seller, Soosokan enables them to search specific product and compare price, they can also get advertising information like the new product, discount and coupon.

Key Activities: Soosokan will improve the service quality by doing the research by questionnaire and interview some shop owner. After publishing the application, Soosokan will keep improving according to the user's feedback.

Key Resources: Resources be used by Soosokan is the technology infrastructure to build our server and database, and the social network to do the market promotion.

Key Partners: The key partners will provide various assistances like the technology support and the market support. The main partners of Soosokan are Microsoft Azure (provide cloud computing platform), IBM Cloudant (provide cloud database) and the API from other third party applications.

Cost Structure: The main cost of Soosokan is the Database and Server, marketing promotion and research and development.

Revenue Streams: The revenue of Soosokan from the advertising fee and membership fee from sellers.

### 3.2.4 Feedback Loop

Feedback is another critical part of the business model. A complete business will end with a balancing feedback loop. *"Feedback loop is commonly used in economics to refer to a situation where part of the output of a situation is used for new input."*[30] The goal of Soosokan is to build a positive feedback loop as the Figure 8 shows:

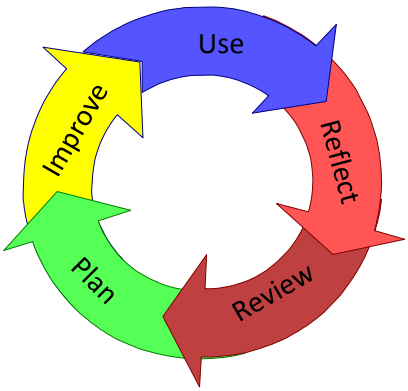


Figure 8 Target Feedback Loop of Soosokan

In the loop, the more customers use of Soosokan, the more reflect Soosokan get, the more study and research Soosokan dose and the greater functions Soosokan provides, the more number of users Soosokan won.[29]

After being published the test version application (for user) we received many messages which are report bugs in the application. In addition, we also received

various kinds of feedback and recommendations from different people. There are some interesting proposals that are worth to implement them to the applications.

For example, some people curious about how large-scale supermarket like Tesco publishes their products into the system. In order to solve this problem, we considering that many big chain stores have their own database to manage their goods, so we plan to develop an API to transfer data from the prior data format to the format that Soosokan support. Nowadays, Soosokan already develop several interfaces which can get data from Tesco, Argos, Currys and Boots etc.

In addition, many people suggest us to add the navigation function to the applications and because the limitation of time, we plan to develop this function later.

After adding some functions and debugging the application we published the official version of the user application, but the application for the seller version is still in the test stage.

## 3.3 Competitive Strategy

"A competitive strategy includes a broad formula for how the business will compete, the goals of the business, and the means whereby the business will achieve the goals."[26] *"Effectively competitive strategies are built upon understanding what defines and threats if another company is a competitor."[44]* Soosokan believe that there is no a firm provides a same service as Soosokan. This section list the potential competitors of Soosokan and the competitive edge of Soosokan compared with the corresponding competitors.

- Website: The official website of some large-scale commercial market like Tesco. In the mean time those product information exchange websites or online shopping platform like the Adverts.ie also are competitors of Soosokan.

  The details comparison of Soosokan with those commercial websites is shows at the Tab3.2.1

| Website | Description | Opportunity |
|---|---|---|
| ***Adverts*** | Focus on personal item transaction, grabbing a bargain and post ads on the go. | Soosokan provides physical store search and comparison. |
| ***Done Deal*** | Search through Ireland's largest buying and selling website. | Soosokan focuses on location-based search and comparison. |
| ***Tesco Ireland*** | Find the products which sells by the Tesco | Soosokan is an integrated information platform which not only includes the Tesco but also contains other shops. |
| ***DealNews*** | Search Deals and pay online | Soosokan focuses on nearby physical shops |

Tab3.2.1 Competitions and Market Opportunity from Website

Other competitors are online sales companies, such as eBay, Amazon, etc. People have formed the habit of online shopping when they need some particular items or service. However, Soosokan has its competitive advantage on real shopping.

Real shopping is still dominant consumption premises and environment in a market economy. New research by CBRE indicates that, despite almost all households in Ireland owning a computer, laptop, tablet or Smartphone, 90 per cent of consumers buy their non-food products in the store. Furthermore, the leading reason of online shopping is that people found difficult to find needed

items. Now the Soosokan supports geographically-based search for physical shops which have items people need, and helps sellers spread promotion and advertisement, forming its own strength.

- Guide application: The application provides the locate function and finds near shops, in addition, some applications also provide the navigation functions.

Compare with those applications Soosokan shows its advantages and has market opportunities as follows in Table 3.2.1.

| APP | description | Opportunity |
|---|---|---|
| **Trip advisor** | City Guides Catalog | Diverse search in this integrated APP |
| ***AroundMe*** | Identifies user's position and shows the nearest bank, cafe.... | Soosokan will provide precise product search and build a bridge that help the sellers interactive with users |

Tab.3.2.1 Competitions and Market Opportunity from Mobile APP

People get used to search particular shop and location via mobile application like the AroundMe. However, it is time-consuming and inefficient to find nearby stores within a small geographical range which has needed item or services, not even to say particular item comparison. In contrast, Soosokan provides effective search for items nearby and effective location in a small area. At the same time, it will bring rise to an effective advertisement for small and medium shops.

In order to keep competitive, Soosokan should achieve the goals:

- Enhance the Product awareness
- Improve Service quality

In order to improve the service quality, Soosokan will make sure of the security and authenticity by registered stores investigation.

## 3.4 Promotion Strategy

In the promotion period (the first 3 months), Soosokan will provide sellers with a free license, the functions including product display, publishing advertisements (3 advertising per day). Let them trust the effectiveness and then continue cooperation with Soosokan.

Besides, many activities will be organized together with seller promotion programs in order to increase Soosokan download and users. For example, Soosokan will organize some programs to invite people to download the application, presenting free gifts, etc.

Depending to the survey on people's shopping tendency, their favorite (the most popular) messages will be advice to the sellers. In this way, the application can gain the welcome and favorable impression of both consumers and sellers.

# Chapter 4 Design and Implementation

## 4.1 Requirements analysis

This dissertation development a software system calls Soosokan, it is an eco-system which based real-time and geographic location. And the search function is the core business, all search results and requests all based on the geographical information.

Soosokan provide two android applications, one could help users to find the right products in the right location right now. For example, it can help the user to search the nearest shop which sells milk or specific product like Iphone 6 and users can also look for a petrol station by using the application. Detailed product information including price and distance would also be listed in the return results.

Another android application could help sellers to popularize their shops to target users with high possibilities. Sellers could use the app to manage their product's information as well as publish advertisements (e.g. voucher or discount information) within a particular range (1km, 2km and 3km). These advertisements will be pushed to users who use the former application and are currently in the target area.

## 4.2 Function requirements

### 4.2.1 Server-side

Users will generate pictures when they use Soosokan and the server of Soosokan needs to process requests and process the picture (compress pictures, generate thumbnails) at the same time. With the growth of user number, there will be a large amount of pictures makes the server overload, so considering the performance of server Soosokan plan to build a stand-alone server to process pictures.

Soosokan has two servers, one is the main server use REST architecture style and Jersey frame are employed, another is the picture server uses the Java Servlet technology.

- Main server needs to handle the general request, get data from database and

logic operations (search, index) then return results to the user.

- Picture server needs to handle all pictures include processing upload then compress the picture and save it to the cloud storage platform, and show the picture to users end when they request pictures.
- Seller application: Locate seller's location then the seller can upload text and image then review and manage (delete, modify) them. The main functions of the sellers application:
  - Register and Login
  - Picture Process (Compression and Save)
  - Locate position
  - Item/Ads Operation
- User application: Gets user's current location, gets text and image file, and user can like some advertising, and login with Facebook identification so that they can subscribe some shops. The main functions of the users application:
  - Locate position
  - Browser advertisings
  - Add advertisings to favorite list
  - Search specific item
  - View specific shop
  - Facebook login
  - Subscribe shops

## 4.3Technical Architecture

The following Figure 9 shows the architecture of Soosokan, Soosokan uses the Microsoft Azure Cloud platform to deploy its server, uses the IBM Cloudant NoSQL

database to store data and the use the Azure storage to save image files.

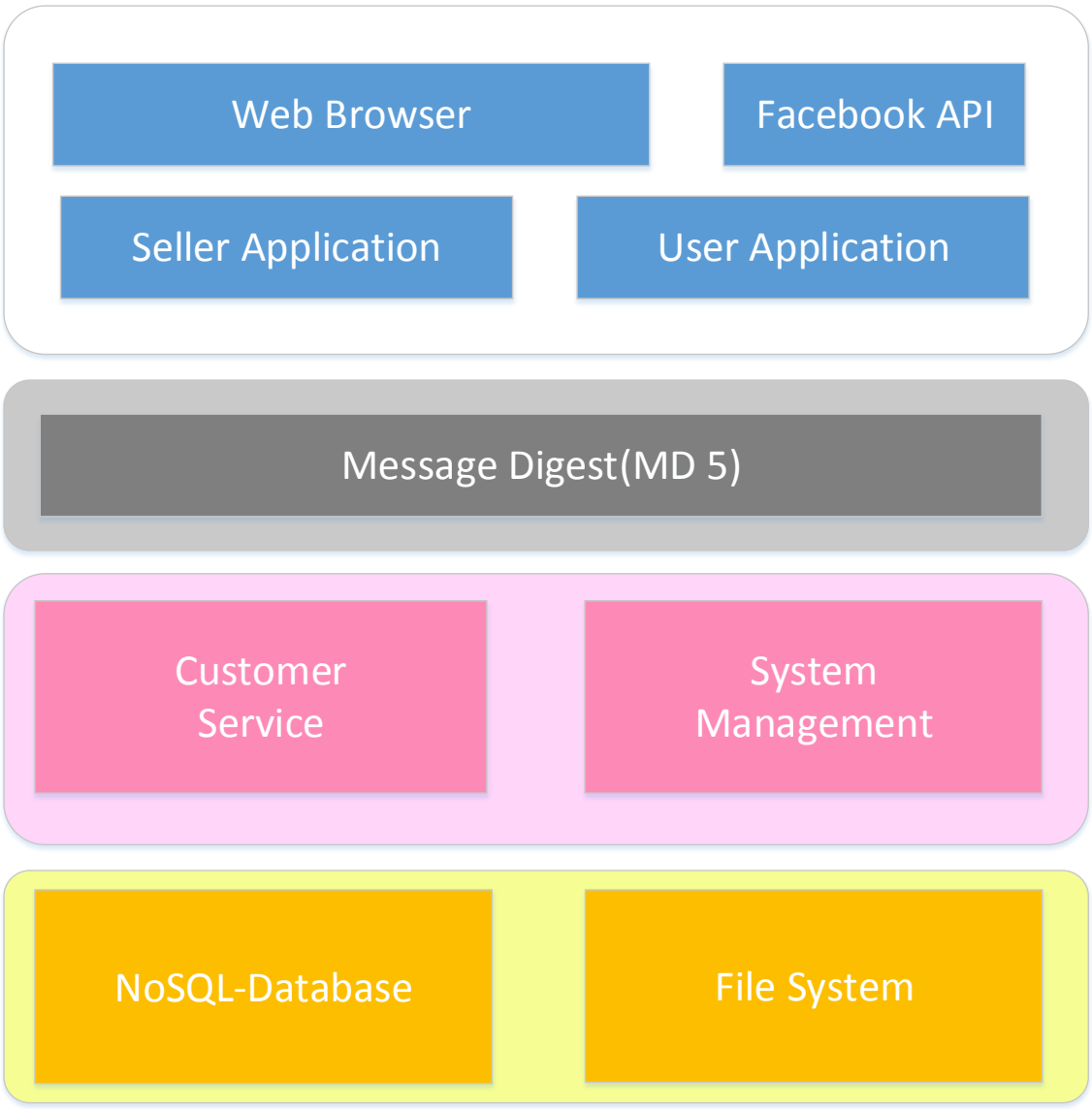


Figure 9Technical Architecture of Soosokan

- The web browser and the two android applications provide a platform that lets user to interact with the servers, so that servers can get the requests from users and shows correspond results to users. Users use the web browser can access to the official website of the Soosokan.

- Facebook API allows users to login the system with their Facebook identification so that Soosokan can save users' information and provide identity self service.

- In order to provide a safe platform which can protect information form

attackers, the Message digest component uses MD5 digest algorithm to encrypt important message like the user's password.

- Customer service offers those functions like search, get data from database and storage file system, rank, so that it can support user's requirement.

- System management needs to manage the file and image that will generate when the Soosokan be used. It will delete expire files and images for saving money and computing resource.

### 4.3.1 Main Server

The main server of Soosokan uses Representational State Transfer (REST) style and the Jersey frame.

> *"Rest has been define by Roy T. Fielding in Principled design of the modern Web architecture as an coordinated set of architectural constraints that attempts to minimize latency and network communication while at the same time maximizing the independence and scalability of component implementations. REST enables the caching and reuse of interactions, dynamic substitutability of components, and processing of actions by intermediaries, thereby meeting the needs of an Internet-scale distributed hypermedia system."[13]*

Rest restricts component interaction, and Jersey frame abstracts all the functions as resource, which can be invoked remotely by user end. So in the server each resource has a single Uri which is the only method that can be used by the clients to access the data and review, add, delete and modify relevant information. In addition, in these resources, the encapsulated HTTP request will be handled and to call the corresponding functions. In addition, Jersey uses the annotations mechanism to encapsulate a resource class as web resources.

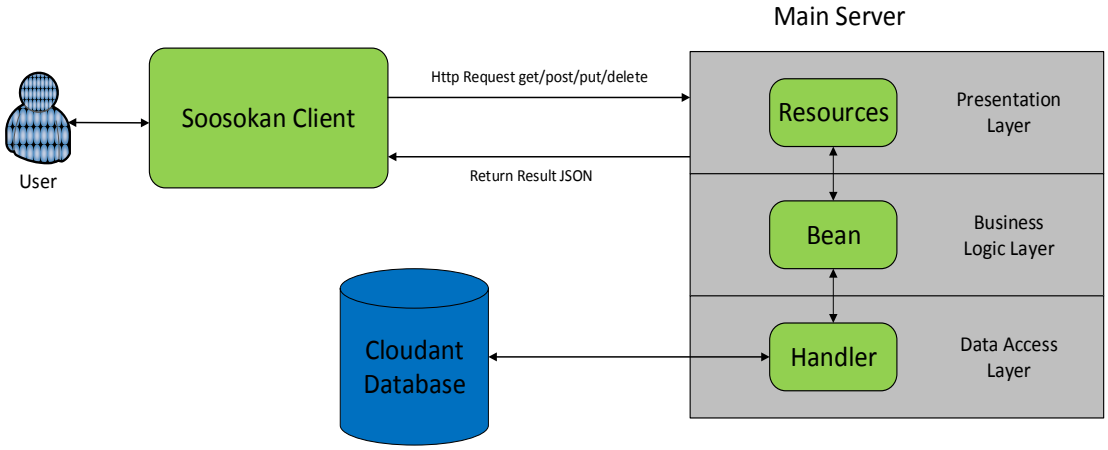


Figure 10 Main Server

The architecture of the main server is a three-tier structure which every layer needs to carry out their task independently, but the each layer can communicate with their neighbors.

Above all, as the name suggests, the presentation layer presents the services to the users and maps users request to the target bean which in lower layer. The business logic layer analyses and processes the coming requests which are form the upper layer, then return the request result. In addition, if the layer needs data during process it wills requests data from the lower layer. As for the data access layer, in order to achieve connection from the server end to the database, Soosokan developed database handlers to do the relevant action about database. The handlers use the API to invoke the whole cloud database.

The Figure 10 shows how the users get information by using the client application. Firstly, the client request the main server by using the specify Uri (e.g. "http://soosokanserver.cloudapp.net/ads/todayads" to request the recent advertisings nearby), in the mean time, the current location (longitude and latitude) will be send with to the main server as the request's parameters. The request is send to the presentation layer the adsResource in this layer will find the corresponded bean. After getting request, the second layer will make correct operation. In this example the main operation of the layer is to get advertisings adat which be published on this day form the lower layer, and rank the advertisings base on the location of the user who sends the request. At last the server will return the result to the client. In this example the

client will receive the advertising list in JSON format.

There are four different kinds of method of the REST API to operate resources.

- Get method is used to get details information of one addressed member or all collection's member.
- Put method to replace all collection's member or add a member to the collection if it not exists.
- Post method to append data to the collection.
- Delete method to delete a member or delete the whole collection.

### 4.3.2 Picture Server

The picture server of Soosokan uses the Java Servlet which is the key component that can be used in the server-side during development. *"A servlet is a small, pluggable extension in the server side that improves the function of server side in the system. Servlets provide a simple to extend and customize any Java-enabled web or application server with a hitherto unknown degree of portability, flexibility, and ease. "[14]* A Servlet is a real object that will be invoked by a request from a remote client and it generates a response according to the request. Java servlet use the HttpServlet class to track requests and responses between client and server. HttpServlet *"can be used by override at least one method of doGet, doPost, doPut, doDelete, init, destroy, or getServletInfo". [45]*

In the picture server of Soosokan, the pictureServlet extends the HttpServlet class, and override the init and doPost methods. The application sends request to the remote web server by suing http protocol, then the web server will invoke the doPost method of pictureServlet class to upload a picture and the image file will be saved to the local file system of the server.

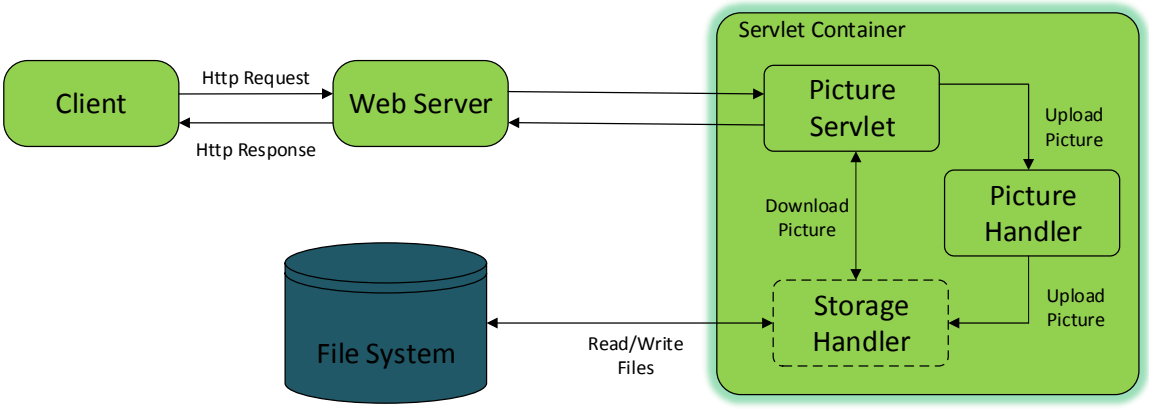


Figure 11 Picture Server

Besides the picture servlet, picture handler and storage handler are also important components of the picture server. It is no doubt that sellers will produce and upload a lot of pictures when they use the Soosokan. Although a simple processing and compression of these pictures have been dealing in the android side, but the system still have lots more to work on.

In order to save bandwidth and storage space, the picture handler will process pictures again. Picture handler use Image.SCALE_SMOOTH algorithm which can generate a picture with high smoothness and quantity, besides, the algorithm also supports many image formats (e.g. jpg, png and gif)However it requires relatively long processing time when use the algorithm.

In terms of the Storage handler, it is the middleware to connect the picture server with cloud storage system. If Soosokan use traditional server, the server does not need this component, so in the Figure 11 marked it with a dashed box.

### 4.3.3 Cloudant Database

Soosokan as an information retrieving platform, faced the biggest bottleneck is the fact that users will generate a lot of data during customers use the system. Considering this situation, in order to provide service that easy to extend and quick search, we plan to choose an appropriate database for the Soosokan system. After absorbing the mentorship from the experienced technicians and comparing with traditional relationship database, we employed the database to the Cloudant platform.

*"Cloudant is the distributed database as a service (DBaaS) built from the ground up to*

*deliver fast-growing application data to the edge."[15]* Cloudant used the NoSQL technology Cloud database which can provide scalability and reliable service.

Soosokan used the Cloudant database to store the seller's information, detail of products, user's information and their preferences as well as the advertisements which be published by sellers. Each entry is described as a document in the Cloudant.

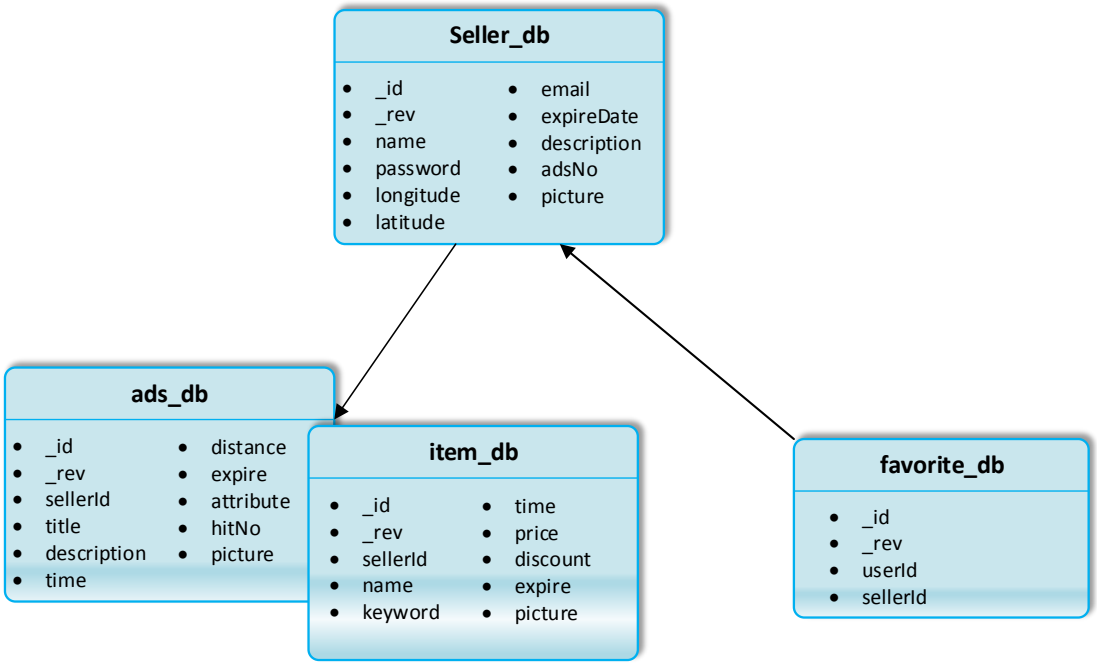


Figure 12 Database Design

The Figure 12 shows the details database of Soosokan, there are four documents to store the sellers, advertisings and items information as well as the user's favorite list. In order to identity each document, the NoSQL database uses the "_id" and "_rev" attributes as the unique identity. The "_id" can be assigned by user or the database. However, the "_rev" can only be auto assigned by the database. In addition, the picture attribute of the ads, items and sellers is a String that specifying the name of the picture.

Cloudant database provides two kinds of method which enable the user to access the database. One method is use API, it supports many programming languages and the other is the GUI which shows as visual graphical that helps developers to manage their data.

## 4.4 Soosokan Application

This section describes the detail functions of the android application provides. Figure 13 shows the interaction between sellers and users. The two applications offer an user-friendly interface which based on the android platform.

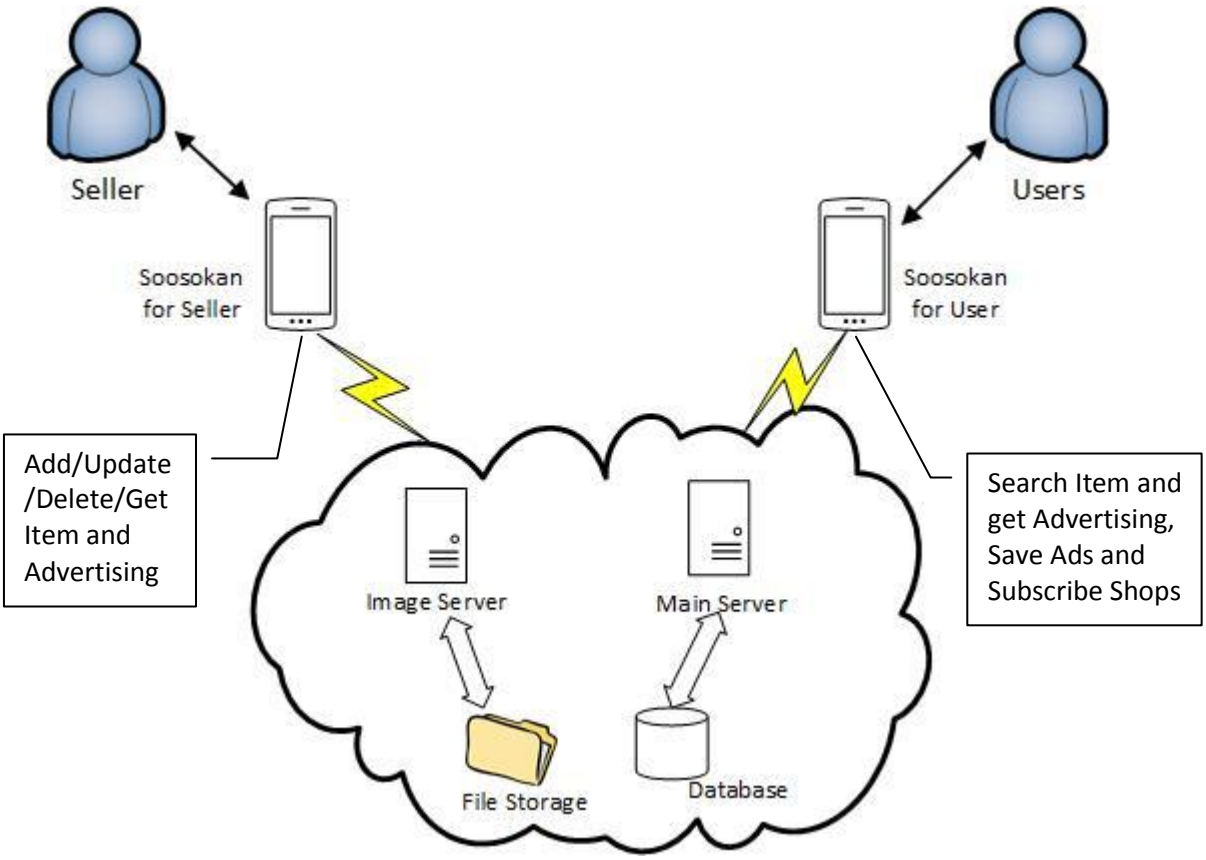


Figure 13 Interaction between Users and Sellers

### 4.4.1 Soosokan for user

1. Advertising function

Figure 14 shows the main tab of the application. Soosokan equipped with a simple style, in the bottom of the page has three buttons that can switch three pages (Home page, Favorites page and Subscriptions page) with a simple and clear way. The home page of the user's application shows the latest advertising automatically base on user's current location while the user launches the application. In order to provide a

convenience service, the search box will always be in the top of the page, so that user can search items immediately when they browse information in the main tab.

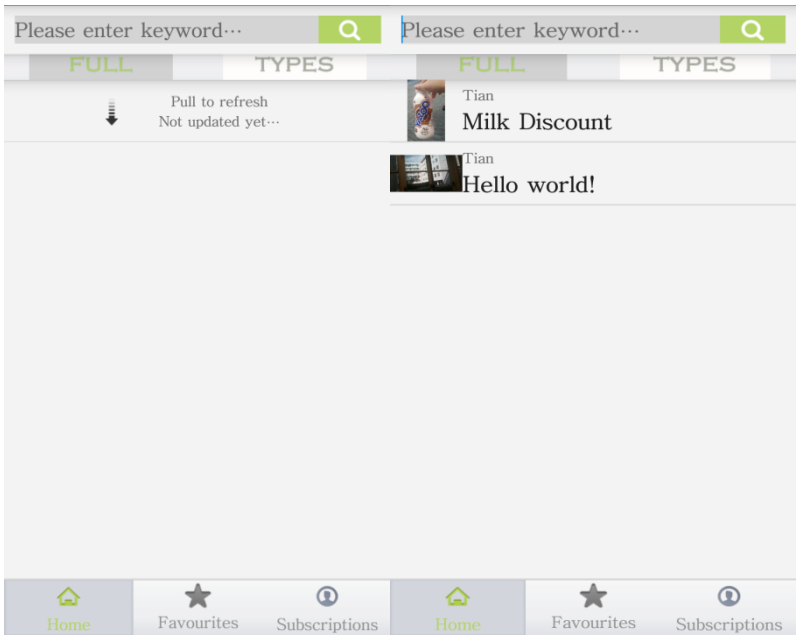


Figure 14 Screenshot of the Soosokan home page (for user)

Users can view the latest advertisings list and browser details about them. If customer wants to get new advertisements, Soosokan support advertising refreshment function that will be triggered simply when users pull the home page.

In addition, users can save the advertising if they have an interest in. The advertising will be stored into the cache of the application and the saved advertisement will be shows at the Favorites page. In order to provide a convenient method, the Home page has two modes so that users can browse the advertising by categories (Discount, Voucher, New product and others).

2. Search Products Function

Users can use the search box which on the top of the application to input the key words they want to purchase, and view the search results.


Figure 15 Screenshot Search Result--Shops list and the products list

As the first diagram shows in the Figure 15 shows, the results shop list is ranked base on the distance from the user's current location to the shop's location. When user clicks a shop in the shops list, Soosokan will shows all details information (picture, name and price) about products in the shop. In addition, Soosokan also provide the function for users to view more details about the product they are interested in when they click a specify item in the items list.

3. Subscribe Function

Soosokan use the Facebook API to support user login with their Facebook ID so that they can subscribe the shops which they are interested in. And the subscribed shops will be shown on the Subscriptions page. The first image in the Figure 16 shows the Facebook login page. As for the second image, it is the subscribe page shows the subscribed shops.

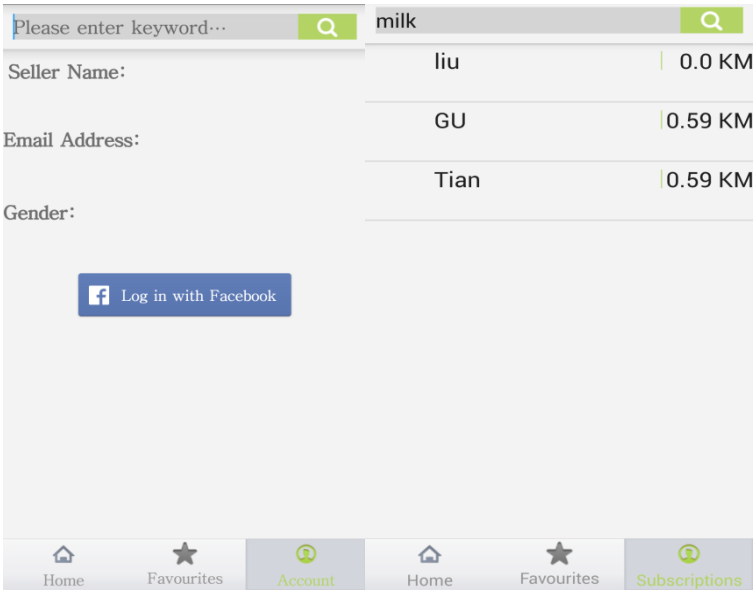


Figure 16 Screenshot Login with Facebook

The shops in the subscribe page are also rank base on the geographic distance, so that can help users to find the nearest, favorite shop.

## 4.4.2 Soosokan for seller

1) Register function

In order to gain first access to the system, sellers are required to register by filling in their name, emails, password, location, description, and phone number.

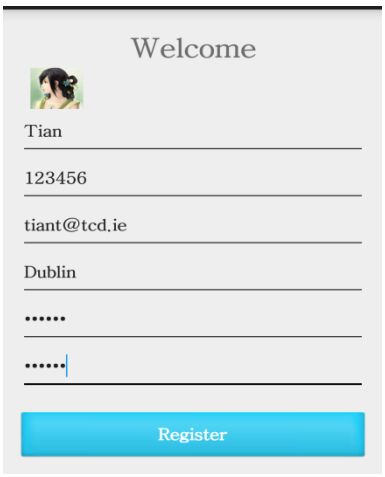


Figure 17 Screenshot Register (Soosokan for Seller)

2) Login

When users login the system they must fill in username and plain text password. Before transfer those data to server, the password was encrypted using one-way hashing, MD5 encryption. It is impossible for attackers to parse password in some degree.

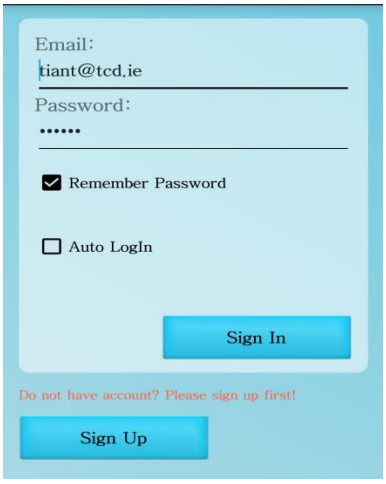


Figure 18 Screenshot Login (Soosokan for Seller)

In order to enhance the user experience, the login page also provides the Remember Password and Automatic Login functions.

3) Seller Main

After login the system user can see the details information about them: include the seller's name and their address.

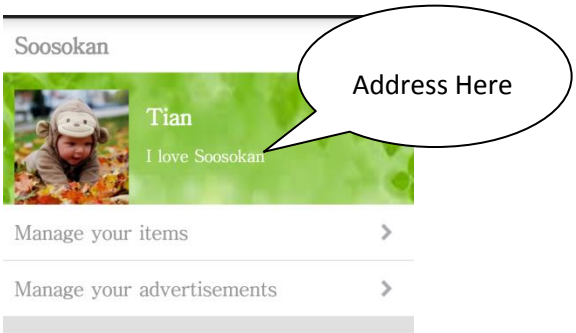


Figure 19 Screenshot of Seller Main

In addition, this page provides the method helps sellers to access the other pages so that they can manage their own data, as the Figure 19 shows they can manage the

items and advertisings.

4) Product Management

The product management page will show the products list, so that users can browse the items which they already published in the Soosokan platform through this page. In terms of the items, the seller can add, modify and delete them.

5) Add product

Sellers can add a product by using the application, sellers must provide the details information about the item, includes the item's name, price of the item and if the item is reduced product, if it is the seller needs to fill in the reduce percentage. The most important is the item keyword, we user search one item, the search engine will match the search words with the keywords of each item.

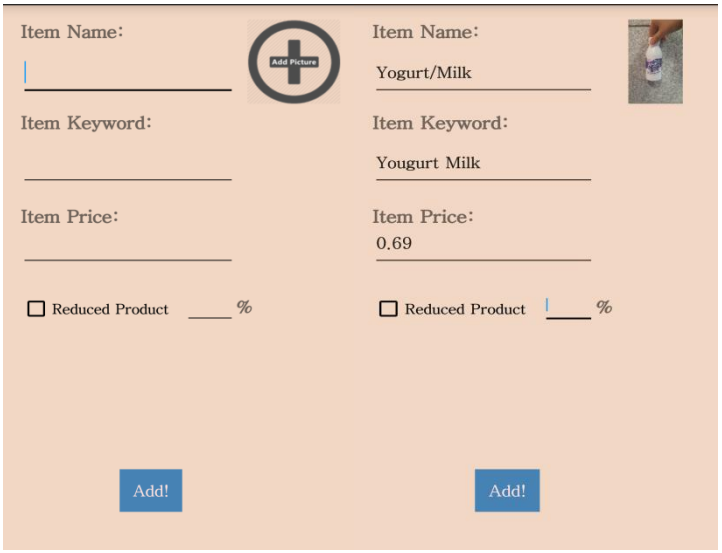


Figure 20 Screenshot of add a new item

6) Advertising Operation

Basically, advertisings and items management follows a similar procedure. However there are also having some difference between items and advertising. Firstly, advertising has four different categories and it does not have keywords. Besides this, advertising has the radius distance as its attribute. Meanwhile, sellers cannot delete

the advertisings which they already published.

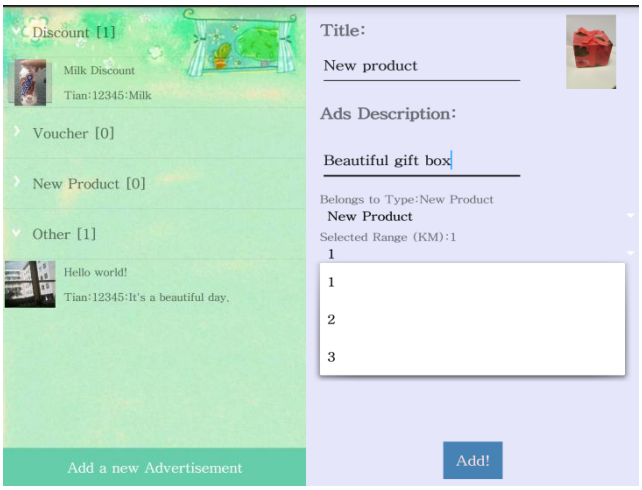


Figure 21 Screenshot Ads Management Page and Add Ads Page

Compare with the product management page, the management page of the advertisement has a sub-list. All advertisings are divided into different sub-list as first diagram of the Figure 21 shows. As for the second diagram, it is the screenshot of the add advertisings page, it shows the details information that sellers need to provide when they add a new advertising.

## 4.5 Picture Download and Cache

Different from the plain text, image is a specify file format of the Soosokan system. In order to enhance the users experience Soosokan use totally different method to deal with the picture. First of all, because of the main server we used is the rest framework which encapsulates the transfer data into JSON format rather than the stream, it cannot provide a perfect picture processing service during transmission. Therefore Soosokan build a stand-alone server to process the picture, which already been discussed before.  Besides the server, Soosokan also develop a component in the android application for the picture processing. This section mainly talks about the functions of this component.

### 4.5.1 Asynchronous Loading

In the android application, the application will throw the unresponsive exception, if the UI thread does not response within five second, so it is not suitable to use the thread gets large-size resource from a remote server. Soosokan uses the AsyncTask to request the remote picture resource. The AsyncTask class *"allows performing background operations and publishing results on the UI thread without having to manipulate threads and/or handlers."[42]* The ImageDownload class extends the AsyncTask and rewrites the doInBackgroud() method to download pictures from the server.

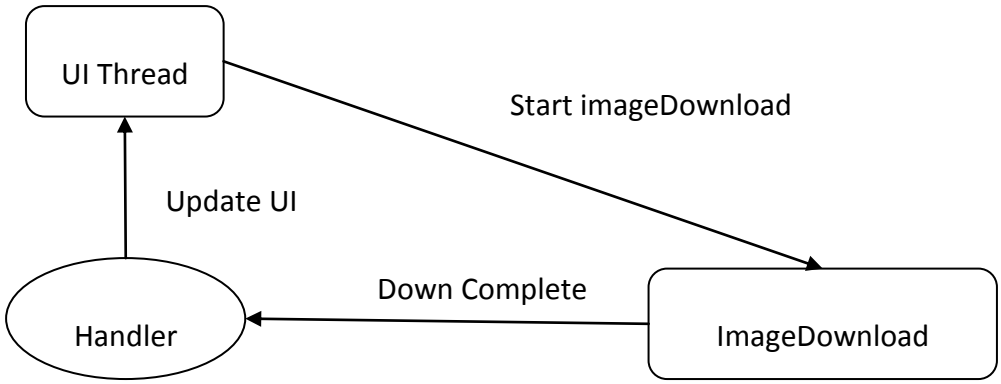


Figure 22 Images download sequence

### 4.5.2 Three-level Cache

Compare with the text resource, the size of image is too big, it will waste lots of computing and bandwidth resource if the application re-request the image from a remote server every time. Therefore, in order to avoid this situation, Soosokan use the three-level cache to save the picture.

The first level uses the cache of android device to store the image file. It uses the LruCache class which is a strong reference will limit the storage size. The data amount cannot be over the top of the limitation. Originally, *"When a value is added to a full cache, the value at the end of that queue is evicted and may become eligible for garbage collection."[43]* However, in the three-level cache mechanism the data which at the end of the LruCache will be saved into the second level. As for the second layer,

it is the SD card of the android device.

So the sequence diagram of the three-level cache shows as the Figure 23.

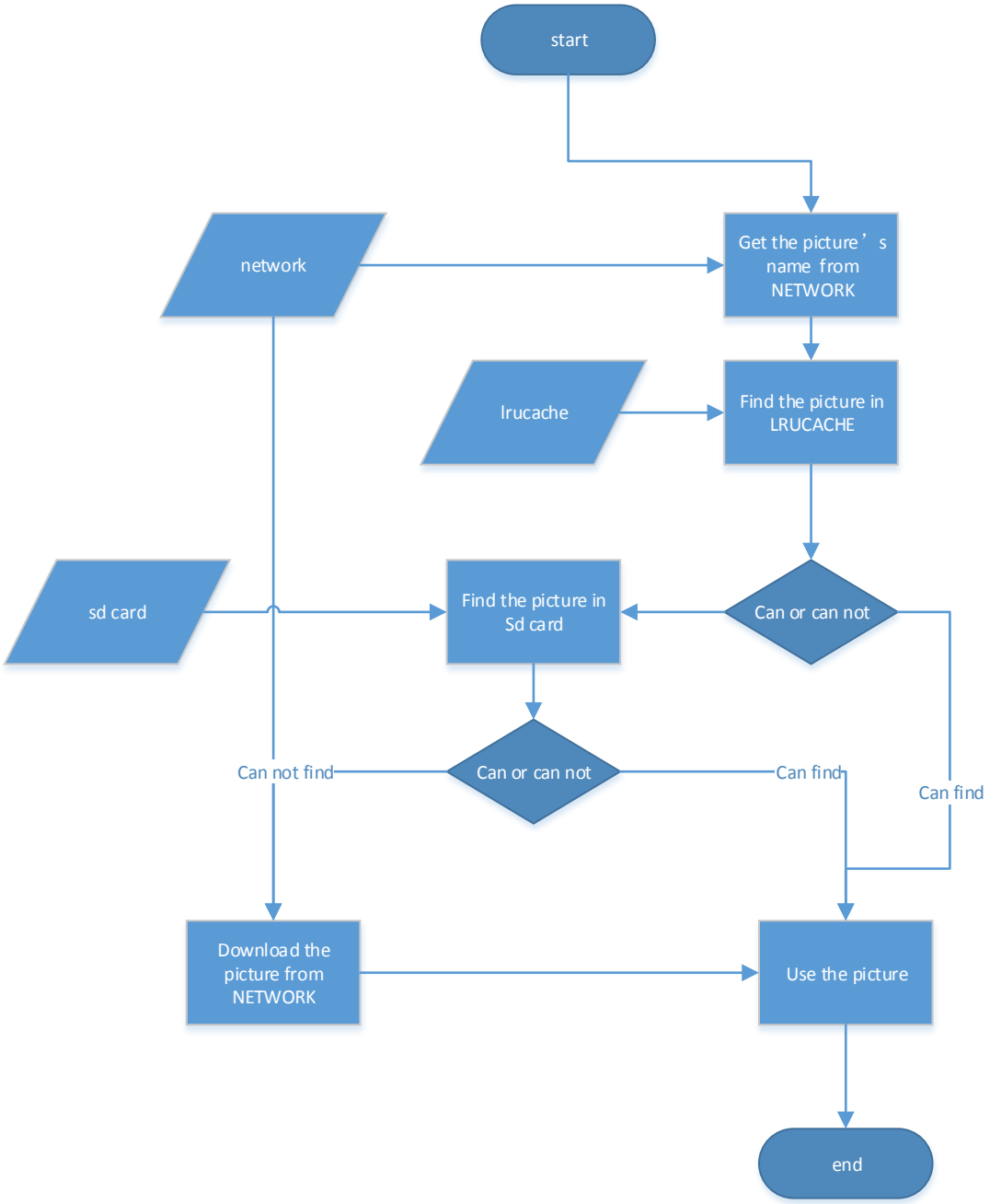


Figure 23 Three-level Cache Sequence Diagram

After getting the picture name, while an application requests a diagram, firstly, it will find the picture in the LruCache (First Level). If the application cannot find the target picture, it will search the picture in the SD card storage system (Second Level). Furthermore, if there is no object picture in the SD card, then the application will request the remote server and get the picture form network (Third Level).

# Chapter 5 Evaluation and Result

In order to analyze the necessity, advantages and disadvantages of the specific mobile business to adopt the cloud computing. The dissertation evaluates the two kinds of platforms (Traditional and Cloud) when they provide service for the Soosokan based on several criteria of the latency, reliability and cost saving.

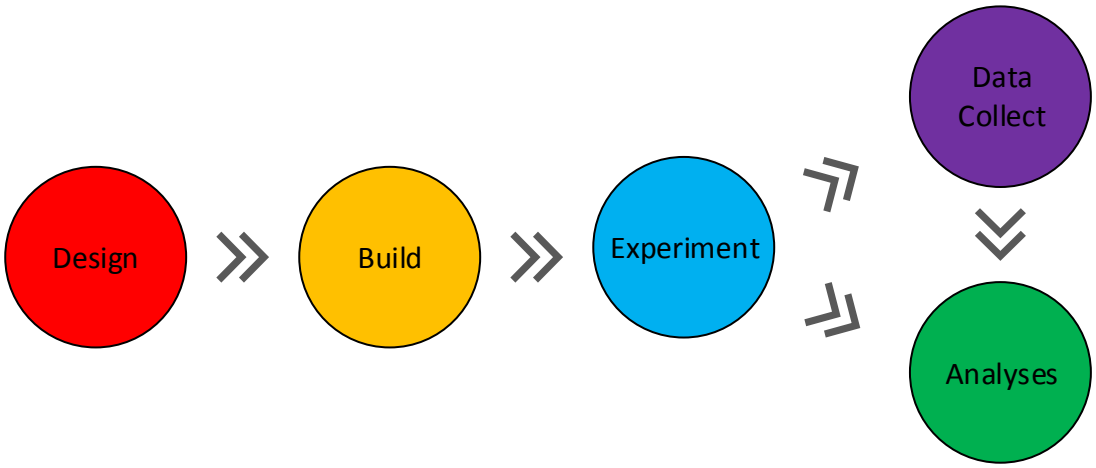


Figure 24 Experiment Sequence

The Figure 24 shows the sequence of the experiment, it includes the experiment design, experiment environment set up, details about the experiment data collection and analyses.

## 5.1 Experiment Design

First, In order to assess the two kinds of servers, this dissertation set up the two servers of Soosokan then uses the Android application to request them and record the response time of each server. In the same time it also tests the reliability of the two servers by using the method that applications send sustained requests until gets an unexpected result and record the correct response number.

Besides assess the two servers, the dissertation also evaluates the write and read efficiency of the local computer file system and the cloud storage. In order to achieve

this target, the applications will upload and download some files from the two storage system and record how much time the operation spend.

## 5.2 Environment set up

### 5.2.1 Traditional Server Set up

The dissertation uses a general personal laptop as a hardware device to build the servers. Servers are deployed in Ubuntu 14.04 operation system, and they are built by the lightweight web application Apache Tomcat 7.0.

### 5.2.2 Cloud Server Set up

This section will mainly describe how to deploy the server and storage system to the cloud. After Soosokan becomes the winner in the Dragon's Den which is mentioned in the last chapter, it got the help from the Microsoft. The company provides one year free membership in using their cloud service. So in this part, mainly talk about how to deploy relevant components to the Microsoft Azure Cloud.

- Deploy Server to Cloud Services

Azure not only support the .Net for the visual studio IDE it also has the plug in software of the Eclipse, so it is very easy to deploy the main server and picture server by using the Eclipse IDE.

In the Azure, there are two kinds of environments that can deploy service. Firstly we deploy the server to the staging environment which can help us to test the servers and make sure they can provide correct functions as we expect. Then we published the servers to the production environment so that they can be accessed by others through the Internet.

Before use the Azure cloud, it is necessary to prepare a publish setting key file which is generated and can download from the Microsoft. *"The file contains secure credentials and additional information about subscriptions that user can use in the development*

*environment. This file contains an encoded management certificate. It serves as credentials to administer the subscriptions and related services."[21]* Azure provides the GUI for users to manage their server and user can access by using a web browser.

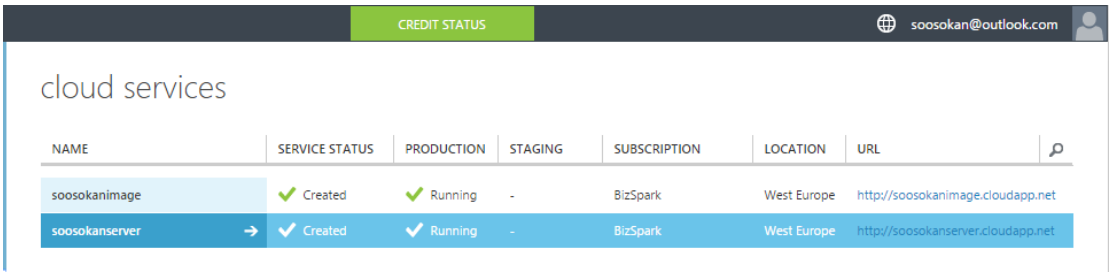


Figure 25 Azure Cloud Service GUI

Using the GUI, we can monitor the work CPU percentage and configure the server with a simple and clear way.

- Deploy File System to Cloud Storage

Azure storage used the solid-state drive in order to provide correct service with high frequency read and write operations.

One Azure Storage usually has several containers and in the container there are blobs, tables or queues.

The Figure 26 shows the architecture of the storage. We use Soosokan account to access the service.

The Soosokan system uses the Azure blob Storage as the file system to storage relevant image files. The blob is used to store unstructured data like the text or various files and can be accessed by using the HTTP or SHTTP protocol on the web. There are two kinds of storage modes of the blob storage: public storage, the data is exposed and can be accessed by everyone has the link; private storage, the data can only be accessed by authorized person. Soosokan stores the image files in the public blob storage.

Before use the blob to store relevant file, it is necessary to create a container. *"A container has a grouping of a set of blobs, and all blobs have to be in a container."[22]*

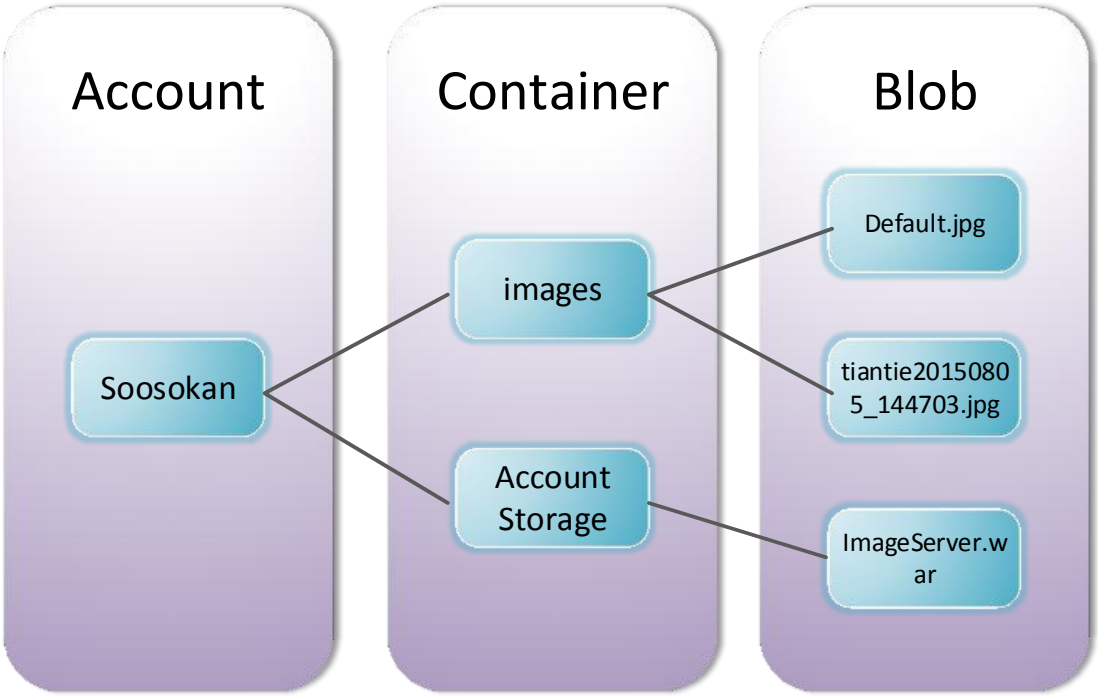


Figure 26 Architecture Diagram of Soosokan Azure Blob Storage

There is an AccountStorage container to stores the related documents which are generated during the operation. For example, when we deploy the Image Server to the cloud, the upload war file will be stored in this container. The images container is being built to store the image file, and all images which was generated during the operation will be saved in the container.

Azure provides a standardized API for the Java language so that users can connect the storage, then add, modify and delete data from the java project. In the mean time, we can also monitor and configure the Azure Storage by the web browser.

## 5.3 Service latency Test

The experiment is focus on collects and analyses of how much time the two servers spend when they receive several parallel requests until they send the correspond results.

- Request body: An android device installs the Soosokan application. The device sends several parallel requests (from 1 to 13) to the two servers and records the response time of those requests. In order to increase the reliability of the

experiment, it repeats the experiment and send same parallel requests for many times.

- Request content:

1. Verification request: Login request, an android device sends a username and password (encrypted by MD5). The servers check the identity and return the results.

2. Text request: General plain text request is to request the item information, users request product information. The servers return the results using the JSON text format.

- Experiment Results:

This dissertation records the response time of the two kinds of servers: traditional server (TS) and the cloud server (CS) then calculates the average response time and the draw diagrams (Figure 27 and Fig 28) to compare and contrast the results.

1. Verification Request Result

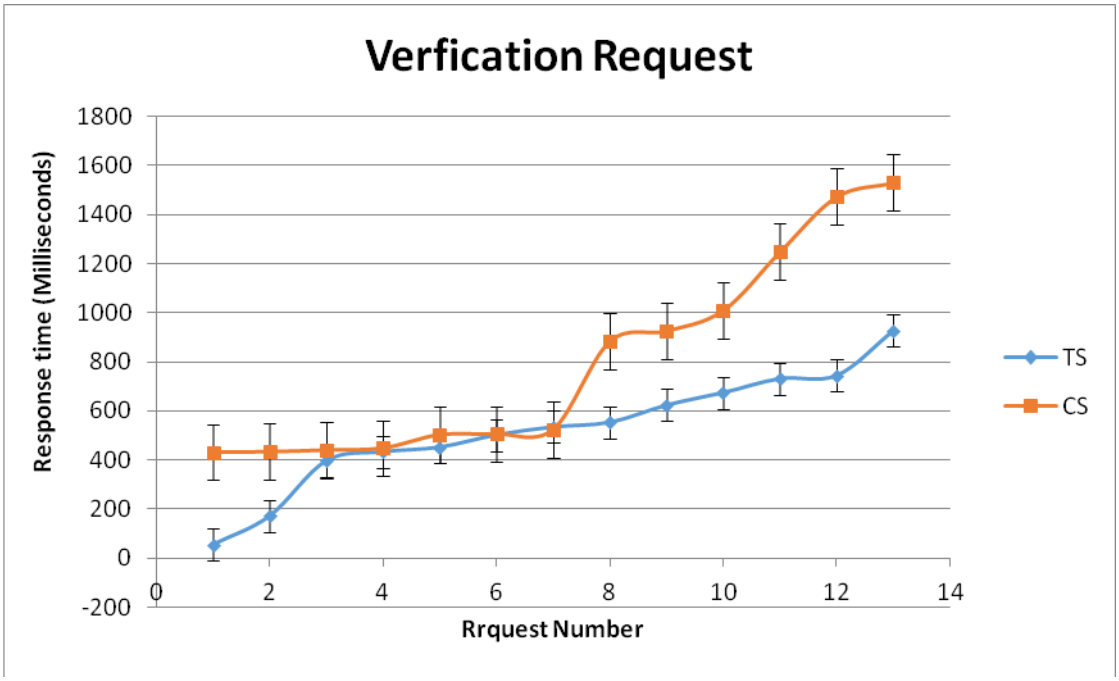


Figure 27 The verification response time of the two servers

This experiment does over 10 tests and the results are shown in the Figure 27. In terms of the experiment result, the TS's average response time of verification request is 561.3076923 milliseconds, as for the CS's average response time of the login request is 812.2307692 milliseconds.

From the experiment results, the service latency of traditional server is less than the cloud server. But the gap of the average response time is very small which less than half second.

2. Text Request Result

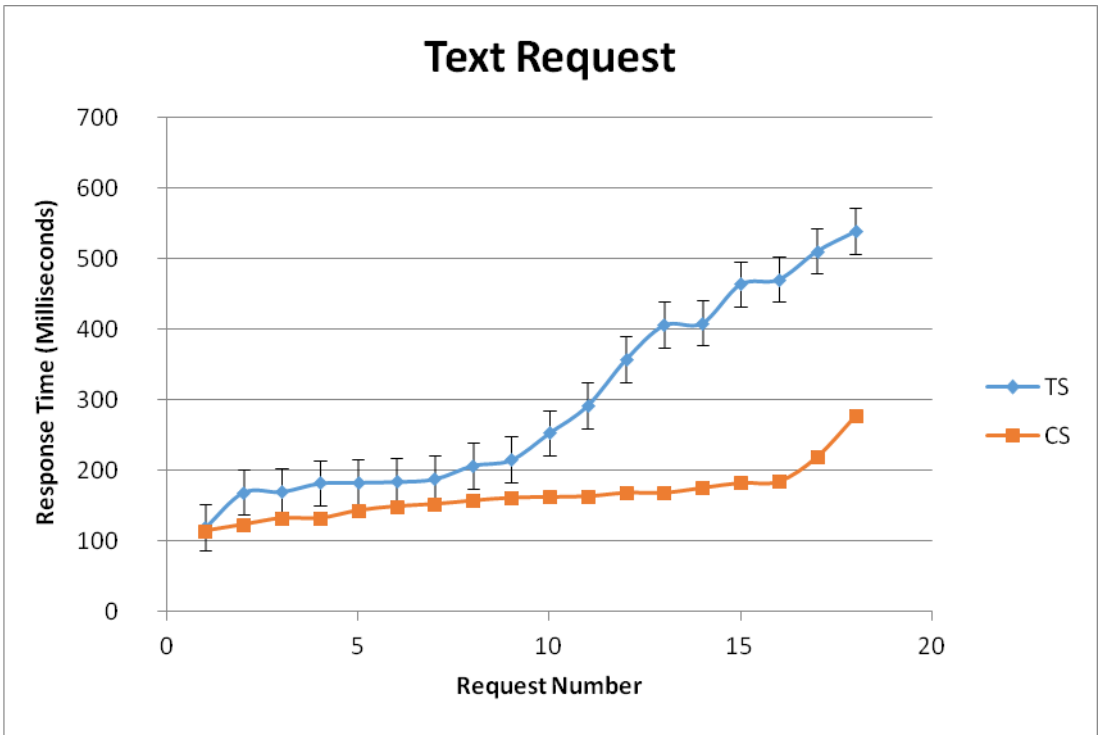


Figure 28 The text response time of the two servers

As the diagram shows that the response time of traditional server to process the plain text request is higher than the cloud server, and the cloud server is stable in some extend.

From those two experiments, the service latency of the two kinds of servers are similar. However the TS's login request response more efficient than the CS, but the CS' spent less time to process the plain text requests.

## 5.4 Storage Read and Write Test

This experiment aims to test read and write rate of the traditional storage system and cloud storage. In order to achieve this experiment will send requests to the two storage systems. They are Cloud Storage System (CSS) and Traditional Storage System (TSS).

File request: Users request a large file and the application records how long it takes to download the file from remote server. In this experiment, the application is requested for an image file and the image size is 44kb.

File and text upload: The android device uploads an image file to remote server. Then the server stores the image in the local file system and returns result to the front end user. The mobile also records how much time the request spends from start upload file to the upload finish.

1. File Request Result:


Figure 29 The file downloads time of the two servers

The time this experiment records that android device downloads file from the two server is basically same, but cloud server performance better than the traditional server.

2. File and Text Upload Result:


Figure 30 The file and text upload time of the two servers

The time which android device spends to upload an image file to the two servers is basically the same, but cloud server spent less time than the traditional server.

Compare to the TSS, the CSS has higher efficiency in terms of the files read and write rate, but there is not much difference between the two storage systems.

## 5.5 Server Reliability Test

In order to test the reliability of the two servers, the application continues sending parallel request until the two servers return an unexpected result (Server did not return the correct results). And the application also records how many number it will gets the unexpected result.

- Request Body: The dissertation use java programs which have several threads to request simultaneously then verification the return result, and keep requesting until it gets the unexpected results.
- Request Content: General text request.
- Experiment results:

| Thread Number | Average Request Number |
|---|---|
| 3 | 98144 |
| 4 | 97199 |
| 5 | 84506.5 |
| 6 | 76413.4 |
| 7 | 70967.9 |
| 8 | 57267.2 |
| 9 | 55474.3 |
| 10 | 46320.7 |
| 11 | 44196.7 |
| 12 | 42336 |
| 13 | 41964.7 |
| 14 | 41954.2 |
| 15 | 41754 |
| 16 | 41487.7 |
| 17 | 41386.3 |
| 18 | 41326.7 |

Tab 5.5 Cloud Server Reliability Test Result

And the Reliability of the server are shows below:

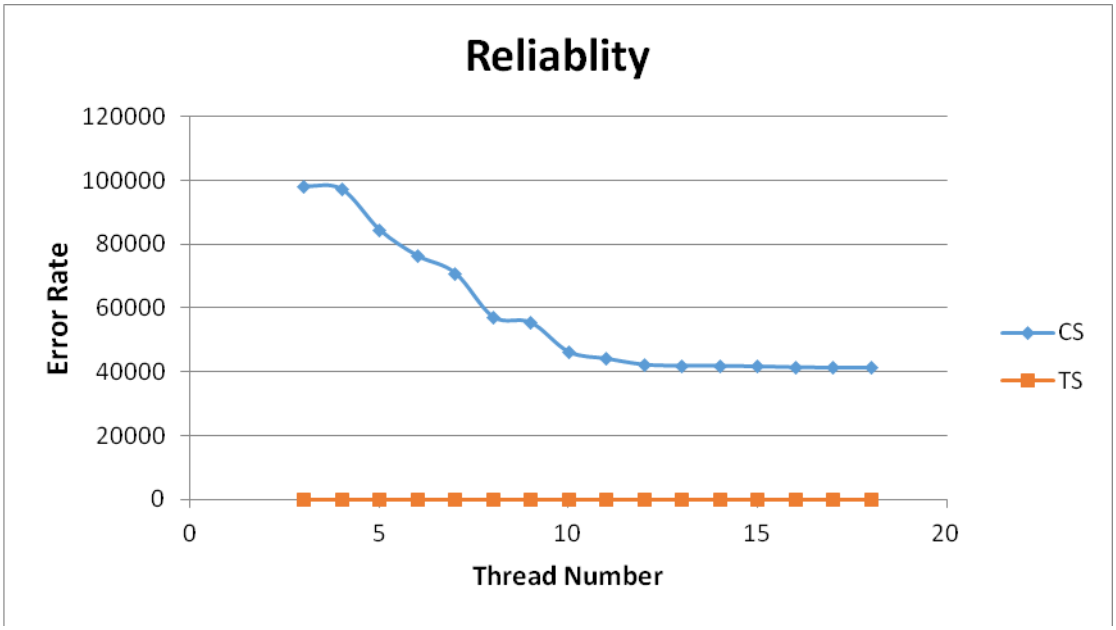

Figure 31 Reliability of Two Servers

Because of the limitation of time and capability, the experiment cannot get the relative data of traditional server, the server always returns the correct result in the experiment. So those two diagrams use the number 0 shows the server never encounters problems in the experiment.

- Analysis of experimental results:

As the experiment result show it is very obvious that the traditional server is much more reliable than the cloud server. And the percentage that the cloud server will return an unexpected result is 0.001956%. It means every 51106.20625 requests may encounter a problem.

## 5.6 Server Price Evaluation

### 5.6.1 Server Cost

- Cost of Cloud Server

In order to provide a clearly comparison, this dissertation divides the cloud server into several levels according to the service capability they provided, and the details are shown in the Tab5.5.1

| | Cores | RAM(GB) |
|---|---|---|
| Level 1 | 1 | 1.75--2 |
| Level 1.5 | 1 | 3.5--4 |
| Level 2 | 2 | 3.5--4 |
| Level 2.5 | 2 | 7--8 |
| Level 3 | 4 | 7--8 |
| Level 3.5 | 4 | 8+ |

Tab5.5.1. the classification of cloud server

This dissertation mainly considers three cloud computing platforms which are provided by the most popular IT companies. The three cloud servers are: Amazon Web Services, Google Cloud Computing and Microsoft Azure. It is common that, the service price of cloud platform is setting base on the capabilities of the CPU and the amount of the RMA.

And the Figure 23 shows the details price of the several server levels.

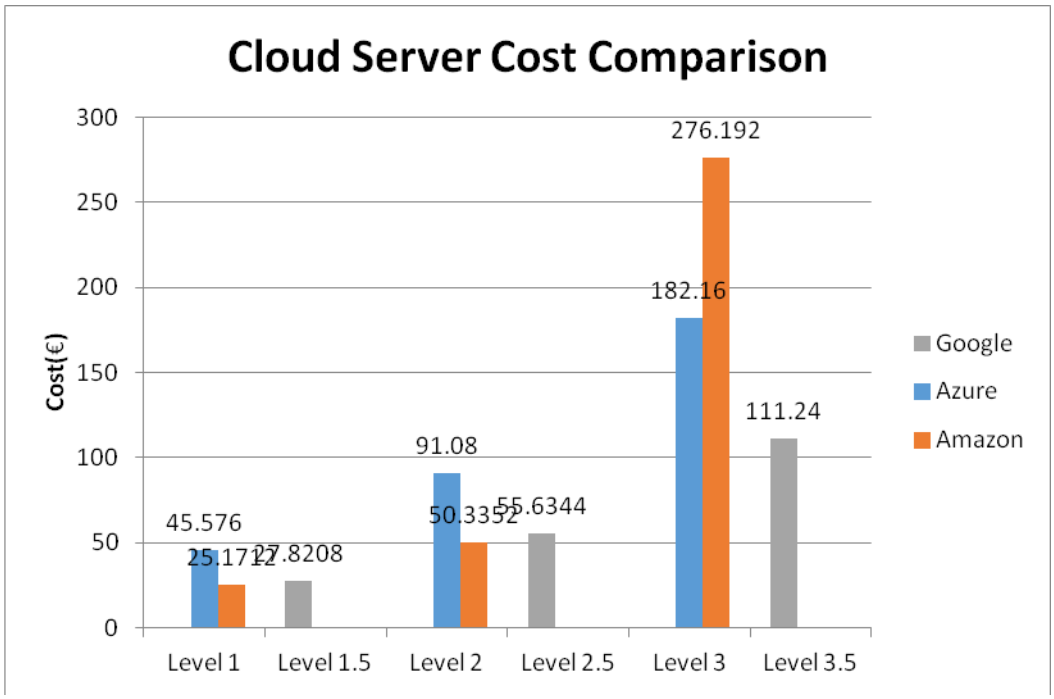


Figure 32 Cost Comparison of Different Cloud Servers

➢ Cloud Storage

The Fig5.5.1.2 shows the price of the storage and transfer cost of different cloud provider. It is obvious the Azure Storage is cheapest.

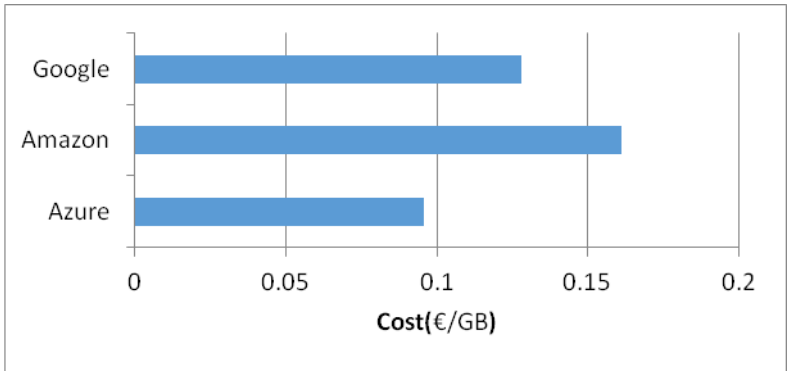

Figure 33 Cost Comparison of Different Cloud Storage

➢ Traditional Server Cost

If Soosokan plans to build a traditional server, we mainly consider rent a host to support relevant functions. In order to figure out the price this dissertation collects the price from the web and get the price table as Tab 5.5.1.2 shows.

| Core | RAM(GB) | Storage(GB) | Price(€) |
|---|---|---|---|
| 6 | 8 | 500 | 249 |
| 6 | 32 | 2000 | 395 |

Tab 5.5.1.2 Server Rent Price

## 5.6.2 Adoption Plan

In addition, this section will make a detailed plan of how Soosokan adopt the server base on the comparisons already down above.

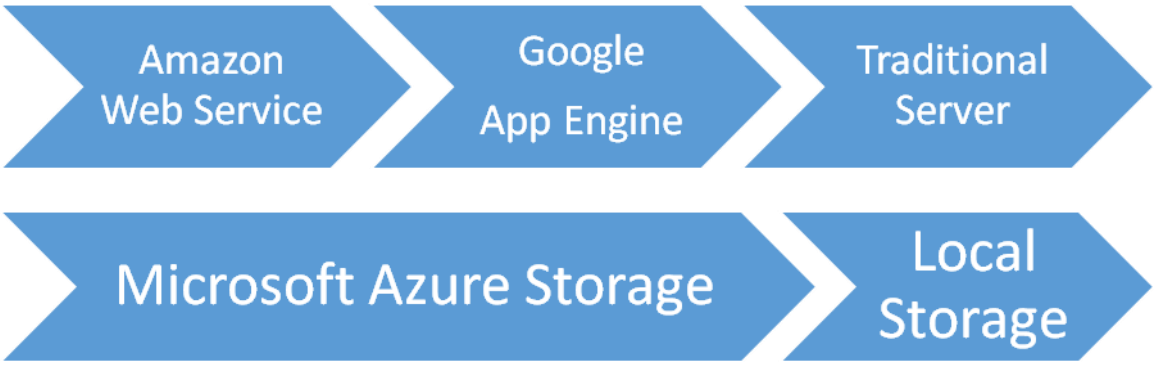


Figure 34 Service adopt plan

From the standpoint of cost, Amazon's Cloud service is relatively cheap in small-scale and so could be used when the business is first starting up, while Google Cloud is a good choice for a business when it has the potential to grow to a medium-size enterprise, as its performance is good and the cost is lower at medium-size scale. With regards to the traditional server, it is more suitable for a business that has grown to a

large-scale enterprise.

## 5.7 Summary

Service latency using the cloud server is similar to that of the traditional server, though the cloud server performs slightly better. However, the traditional server is more reliable than the cloud server.

Because of the limitation of time and resource, the experiment did not repeat many times, so the result of the experiment may not totally reliable. In addition those experiments based on only one cloud platform, the results have particularity, cannot represent all cloud computing platform.

# Chapter 6 Conclusions and Future Work

## 6.1 Conclusions

Soosokan is an idea about a geographical location-based information retrieving platform, which is an online to offline business model. The platform tries to help physical shop owner to increase interaction with their customer and help them to find potential customer. This dissertation in the context of the Soosokan it aims to analyses the necessity, advantages and disadvantages of Soosokan to adopts the cloud computing.

In order to achieve the goals, above all the dissertation investigates the architecture, technologies and services types cloud computing from the theory papers. In addition, it also reviews and investigates what are the factors which limit the Small and Middle Enterprise to adopt the cloud computing during their business. After research and analyses the dissertation discovers the cloud computing is an orderly, easy to manage, highly automated and efficient platform which can provide security and customized service for their users.

Then the dissertation states the development of the business idea and finds the market opportunity of Soosokan by identifying the target user and market position. In order to figure out the market demand trend, a set of surveys are carried out, it is about the intent of ordinary residents and interview the physical shop owner. The results of the two surveys show the Soosokan have prospects and potential to be a successful business. In order to formulate an appropriate and competitive promotion strategy of business, the dissertation compares Soosokan with the competitor and summarizes the features of competitors and figures out the sell points Soosokan.

In terms of the Soosokan application, there are details description in the dissertation which introduces the requirement and architecture and functions provide by the application. In addition, it also clarify that cloud is a core part of the system that

enables the two servers of Soosokan can provide correct functions to users. What's more the cloud also offers storage space so that Soosokan can store important data in the cloud.

Experiments of the dissertation evaluate the cloud service and the traditional server and find that the service latency of the cloud server is similar to a traditional server, and the cloud server performs even better to some extent. However, the traditional server is more reliable than the cloud server. And the cloud server is a better choice for the business which is at an early stage so that the server does not need many parallel requests. From the standpoint at cost, the Amazon Web Service and Google Cloud Computing are more suitable for building the cloud server and the Azure Storage is much cheaper than those two providers.

## 6.2 Future Work

- Experiment Part

  Because of the limitation of time and resource, the experiment did not repeat many times, so the result of the experiment may not totally reliable. In the Future, the experiment in this area should repeat more times so that can get a more reliable result.

- Application Function part

  In the future, we will extend the functions of Soosokan in order to provide a better user experience. The new development directions Soosokan as following:

  - Navigation: We plan to implement the navigation function to the Soosokan applications so that it can help users to find the path to the specific shop.

  - New search model: Soosokan now focus on fixed location search. In the future, above all, Soosokan plan to develop the new function that enables the user to provide a specific point then search items rather

than search based on the current position. For example, user can search the shops which sells bread near the office when they at home.

Beside this function, Soosokan also plan to implement the searching along a specific path. For example, users could search which shop is selling milk near the path which from office to home.

- Other channels and Internet of Things: Now the main channel Soosokan used to provide the services is the android smart phone, we plan to build two applications for the IOS and Windows Phone system. In addition, we also plan to enable the service be applied to the Internet of Things. For example, we plan to attach Soosokan to the Vehicular Navigation System, so that it can help drivers to find the nearest petrol station.

➢ Cloud Server part

First of all, we only have one year free membership to use the Microsoft Azure, so in the further we need to move our cloud server to the other cloud platform. According to the conclusion above, the Amazon Elastic Compute Cloud is the best choice. So we need to familiar with the skills to deploy the server to Amazon EC2.

Secondly, Azure Storage is the cheapest cloud storage, so we will keep using the cloud Storage for a long time. However, how to dock the two cloud services might be a problem that we need to solve it in the future.

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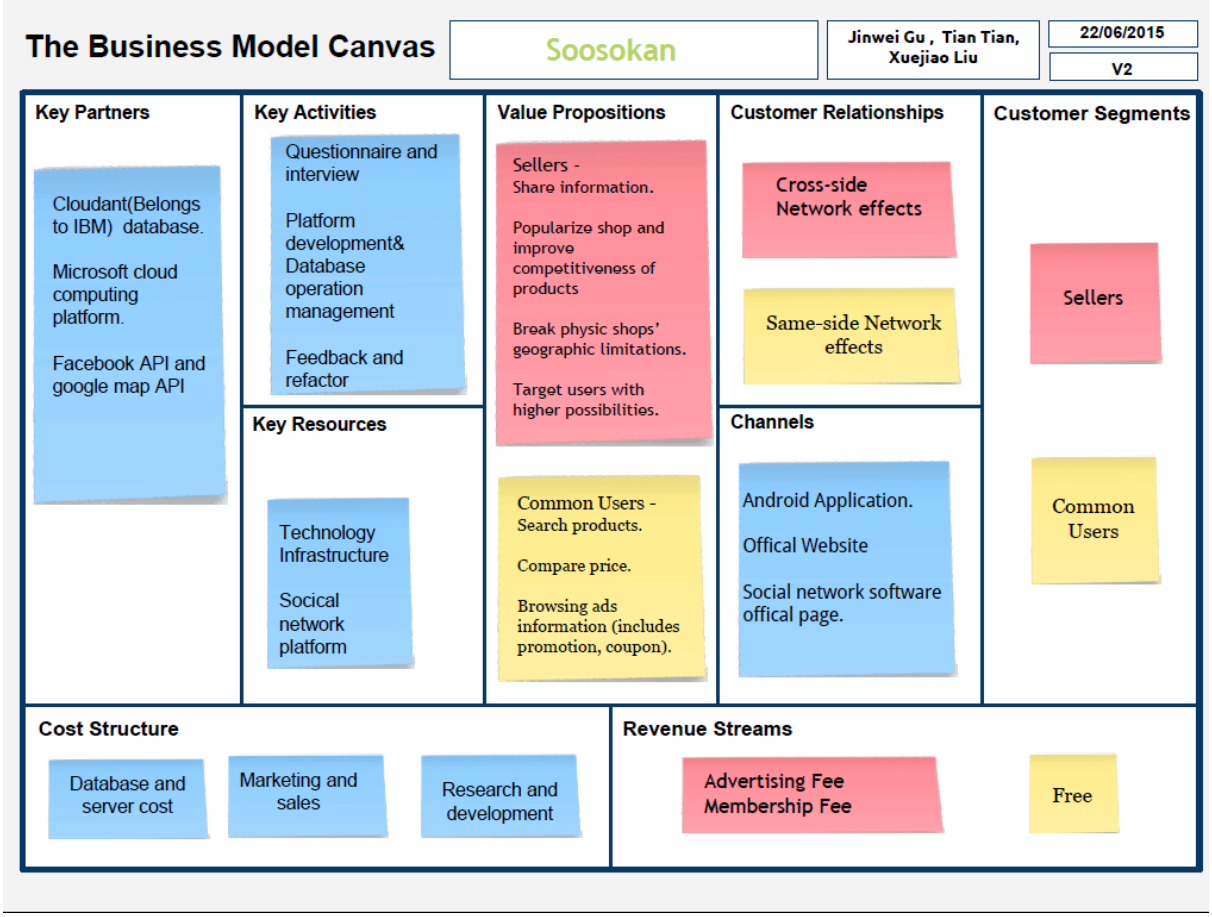
# Appendix

## The business Model Canvas



# Azure Cloud Usage Statement

| Billing Period | Meter Category | Meter Name | Meter Region | Unit | Consumed Quantity |
|---|---|---|---|---|---|
| 201508(7/3/2015 - 8/2/2015) | "Networking" | "Data Transfer In (GB)" | "Zone 1" | "GB" | 1.518772 |
| 201508(7/3/2015 - 8/2/2015) | "Networking" | "Data Transfer Out (GB)" | "Zone 1" | "GB" | 1.416934 |
| 201508(7/3/2015 - 8/2/2015) | "Data Management" | "Storage Transactions (in 10,000s)" | | "10,000s" | 2.42 |
| 201508(7/3/2015 - 8/2/2015) | "Azure App Service" | "Free App Service" | | "Apps" | 0.999936 |
| 201508(7/3/2015 - 8/2/2015) | "Azure App Service" | "Shared App Service Hours" | | "Hours" | 742 |
| 201508(7/3/2015 - 8/2/2015) | "Storage" | "Standard IO - Block Blob (GB)" | | "GB" | 0.09119 |
| 201508(7/3/2015 - 8/2/2015) | "Cloud Services" | "Compute Hours" | "EU West" | "Hours" | 321.083395 |
| 201508(7/3/2015 - 8/2/2015) | "Cloud Services" | "Compute Hours" | "EU North" | "Hours" | 466.266692 |
| 201508(7/3/2015 - 8/2/2015) | "Virtual Machines" | "Compute Hours" | | "Hours" | 0.083335 |