KNOWLEDGE-BASED REQUIREMENTS MANAGEMENT SYSTEM FOR MOBILE APPLICATION DEVELOPMENT

by

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A project report submitted in partial fulfilment of the requirements for the award of Master of Information System

Faculty of Engineering and Science

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Jun, 2014

DECLARATION

I hereby declare that this project report is based on my original work except for citations and quotations which have been duly acknowledged. I also declare that it has not been previously and concurrently submitted for any other degree or award at UTAR or other institutions.

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APPROVAL FOR SUBMISSION

I certify that this project report entitled **"KNOWLEDGE-BASED REQUIREMENTS MANAGEMENT SYSTEM FOR MOBILE APPLICATION DEVELOPMENT"** was prepared by **KEK MING CHYUAN** has met the required standard for submission in partial fulfilment of the requirements for the award of Master of Information System at Universiti Tunku Abdul Rahman.

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ABSTRACT

Smartphones and mobile software known as application, or “app” among smartphone users have become the new trend. To take advantage of this new market opportunity, many of the mobile application development companies aim to provide better quality and effective services to entrepreneurs, businesses and consumers through mobile applications. Client’s requirements for the mobile project always have to take into consideration the supported devices’ specification compatibility and mobile operation system limitation. However, not many domain experts understand and are experienced to manage the fast changes in the mobile industry. The accepted requirements need to transform into the requirements knowledge for future reuse and sharing. A pre-defined requirements form with different device limitation conditions generated from the knowledge-based requirements management system has to be created in order to improve the mobile requirements engineering. The purpose of this project is to develop a knowledge-based requirements management system to support mobile application requirements engineering for capturing requirements, and formalizing and managing requirements knowledge.

This system has been built with the web client-server development tools, and then evaluated by project managers. The conclusion of this evaluation shows that, using this system helps many junior project managers’ easy entry into the mobile technology knowledge, and prevents any misunderstanding or communication problems during the requirements engineering process. Most of the project managers are looking forward to the system for future enhancement, in order to support the full cycle of the project development that is not only limited to requirements capturing.

1. INTRODUCTION

1.1 Growth of Smartphones and Mobile Devices

Worldwide shipments of smartphones are expected to see a significant growth every year helped along by a constant drop in prices. According to the IT Business Edge news, in the year 2013, both Google Play Store and Apple App Store attracted over 50 billion downloads, and the momentum is continuing (IT Business Edge, 2014, p. 1).

A few key researches on the latest mobile growth statistics for 2013 did by Super Monitoring, which is a website monitoring service that was granted the Best Web Tool Award from Web Hosting Search, show where the mobile market trend is now:

- 91% of people have a mobile phone
- 56% of people own a smartphone
- 50% of mobile phone users use mobile to access the Internet for daily use
- 80% of the time on mobile is spent on the apps
- 72% of tablet users purchase online each week (Super Monitoring 2013, p. 1).

According to Cisco's 2013 global mobile data forecast, "The number of smartphone devices will exceed the number of people on earth by the end of 2014. There will be over 10 billion smartphone devices by 2018, and will be exceeding the world's population at that time." (7.6billion) (Cisco, 2013, p. 1).

1.2 Problem Statement

The growths of smartphones or mobile devices have given rise to significant growth in mobile apps usage. Mobile "apps" refer to software applications running on smartphones or mobile devices. Mobile applications have greatly transformed the daily lives of people where they assist individuals and businesses in managing their day-to-day operations (Holler, 2006, p. 17). The market for mobile applications is continuously expanding and gaining importance nowadays together with the growth of smartphones and mobile devices.

To take advantage of this new market opportunity, many mobile application development companies aim to provide better quality and effective services to customers of entrepreneurs and businesses through development of mobile applications. A business client's requirements for the mobile applications always have to take into consideration supported devices' specification compatibility and mobile device operating system limitations.

However, there are not many domain experts who have the understanding and experience to manage the fast changing mobile industry to ensure an effective and efficient requirements engineering process in mobile application development projects. In many cases, these projects have become more complex and challenging due to lack of knowledge or experience in the latest mobile technologies, problems integrating device hardware and operating system platforms, problems of incompatible sizes for different user interfaces, and other problems.

In many respects, the process of developing mobile applications is similar to personal computer software development. There are common issues including project management issues, performance, and storage limitations, but there are other issues as well not found with the traditional software application, such as:

1) Project Managers are not familiar with latest mobile technologies and operating system (OS) platforms – Most of the code is custom built for current devices, but unfortunately new mobile devices and new versions of OS are released very frequently. As a result there is no guarantee that the built application can support the new devices or OS version.
2) It is not easy to support multiple user interfaces and different device models – The mobile app developer cannot easily control all aspects of the user experience with a custom-built application, if the requirements does not specify clearly which specific device models and resolution size is to be used.

Knowledge of mobile application requirements of past projects could enable better process of application development. Many organizations do not realise the importance of keeping records of the finalised and accepted requirements of completed mobile application development projects and transforming them into requirements knowledge for future reuse and sharing.

So in order to improve the mobile application requirements engineering process, there is a need for mobile development application companies to develop a requirements knowledge repository from requirements of past projects. This knowledge repository could be reused through the development of a pre-defined

requirements capture form for the requirements of a typical mobile application for different industries and with different device limitation conditions from past projects that is retrieved on demand.

1.3 Research Question and Objective

The research questions for this project is: **How can the knowledge available in the field of mobile technology and the knowledge gathered from projects be combined by project managers for future projects?**

The purpose of this project is to investigate and develop a knowledge-based requirements management system to support capturing mobile application requirements and formalizing knowledge of mobile application requirements, and then to be reused for future projects. The system will break into 2 (two) main parts:

- To support the requirements engineering process for current mobile applications development projects by reusing requirements knowledge, and
- To transform accepted requirements for completed mobile applications development projects into requirements knowledge for reuse in current projects.

1.4 Significance of the Project

The development of this requirements knowledge management and requirements management system will enable greater sharing of knowledge in order to ensure that knowledge gained from previous projects are not lost and to optimize the development process of future projects. This system would be especially useful for junior project managers who are leading in the mobile application development projects because it will make the requirements engineering process more efficient and effective.

2. LITERATURE REVIEW

2.1 Introduction

It was not long ago that the mobile phone was just a device for talking and texting only but now with smartphones, people can have easy access to the world's information and perform their daily work by running applications on the phone's operating system. Mobile applications are rapidly becoming popular and people are looking to have their own applications to present their company profile, improve daily activities, and even as use it as a money-earning tool.

However there are various types of mobile device models and operating systems in the market. The requirement capturing for mobile application development projects always have to take into consideration supported device specification compatibility and mobile operating system limitations. A mobile application requirements knowledge management system should able to help junior or less-experienced project managers to smoothen the process of capturing requirements and avoid making mistakes due to limited knowledge of mobile technologies.

Requirements represent the quality, functionality or performance demanded of a person according to a certain regulations. Institute of Electrical and Electronic Engineers (IEEE) defines the requirement as a statement of what the system should do, how the system process, and what is the system development constraints must be satisfy [Clements P, Northrop L, 2006]. The engineering process is the set of activities to discover the purpose of the system being developed, identify the stakeholders' needs, and document these decisions.

Managing knowledge is the process of accessing, organizing, refining, sharing, and disseminating knowledge among the project team or organization. Requirements knowledge management can be kind of knowledge management, but emerges during requirement engineering phase, and is requirements-related.

This chapter reviews the literature on smartphones, requirements engineering, knowledge management, and requirements knowledge management.

2.2 Smartphone

There is no official definition of “smartphone”. The term started to appear after year 1997 when Ericsson defined its GS 88 “Penelope” phone as a “Smartphone” (Ericsson GS88 Preview", 2011-12-15, p. 1). The most significant difference between a smartphone and a feature phone is the “Application Programming Interfaces” (APIs) on the “smartphone” that allow third-party applications to run and integrate with the phone’s operating system (OS) and hardware.

The combined functionality of the smartphone and personal digital assistant (PDA) and the flexibility that allow third-party applications to run on it has rapidly brought the world into a new digital era. Smartphones have completely changed the way we communicate and use the Internet. People are looking for apps across all sectors to improve their everyday lives and activities.

Now most of the smartphones are flagships to larger screen size (like 5 inch and 6 inch) and faster performance. In order to become more competitive

among the smartphone manufactures, unique of features been highlighted and not limit as below:

- 2K Display – With the trend towards higher screen resolutions (e.g. 2560 x 1440 pixel screen), the era of 2K smartphone has arrived.
- Light Apps – Not all app required downloading onto the smartphone device. Users previewing the apps through cloud computing work is similar to Firefox OS's adaptive search.
- Personal Cloud – As cloud computing grows, many enterprises are moving their business and content to be stored in the cloud, so they have easy access via smartphone, web or PC anytime.
- Flexible Components – The flexible display, flexible battery, self-healing cover, and self-healing plastics, will be combined with softness in smartphone design.
- Fingerprinting Identification – With the touch ID fingerprint sensor, accessing the phone is faster and easier.
- Flagship Mini Versions – Smaller screen handsets that can be operated with one hand, longer standby time, and cheaper.
- More Sensors – Expected to have more unusual sensors (like mood-detecting sensor) in the smartphones
- 64-Bit System - The 64-bit processors can support larger amount of memory that help with more complex and graphical heavy applications.

2.3 Requirements Engineering

Requirements engineering (RE) refers to the process of formulating, documenting and maintaining the project requirements (Sommerville, 2011, p. 1). In the waterfall model software development method, requirements engineering is presented as the first phase but currently it "is usually performed in an iterative process with conceptual / preliminary design activities" (H-P de Koning, 2012, p. 1). The requirements engineering process varies widely depending on the application domain, the people involved and the system used for capturing requirements. However there are four common activities in the RE process:

1. Requirements elicitation, which is also called requirements discovery, is to find out who are the stakeholders involved, to understand the application domain area, what type of services should be provided and constraints if any on the development project. It is the process of gathering information from the customers and interacting with them to understand their expectations or domain requirements.
2. Requirements analysis is the process of refining the users' needs and constraints.
3. Requirements validation is the process of identification and assignment of verification and validation approaches.
4. Requirements management is to manage requirements and handle any changes or new requirements that emerge during the requirements engineering process and system development.

There are three important roles playing in this RE process: the customer (who will provide the requirements, and expectation of the system), the project

manager (who will document the requirements), and the knowledge expert (who know the domain knowledge well, and ensure the accuracy of the requirements). The quality of the requirements study is important, in order to smoothen the following development, testing, and maintenance process.

2.4 DIKT – Data, Information, Knowledge, Technology

It is too easy to confuse people what is data, information, knowledge, and technology (DIKT). Let's begin to understood connection and the transitional process between DIKT.

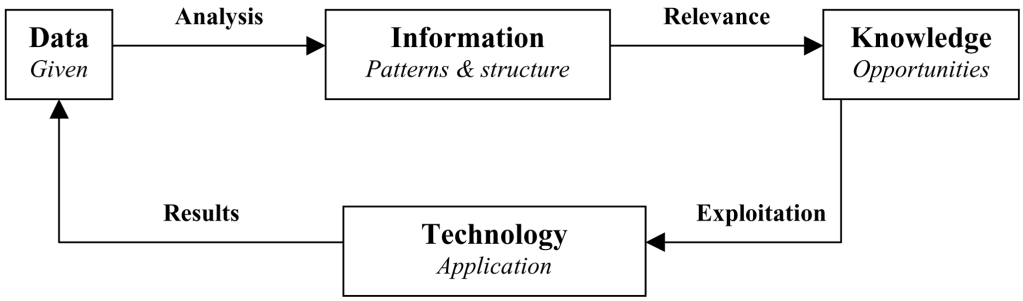


Figure 2.1: DIKT diagram

1. From data to information

   Data is just a raw, and unorganized facts that need to be processed. Example questions like "What is available". Data themselves are fairly useless unless it been processed, organized, structured and presented in a given content to make it useful, called Information. Example questions like "What do they mean". Another words, data is our computer language, and the translated language is information.

2. From information to knowledge

   The transition from information to knowledge is to understand of the past subjects or information and with a style of thinking about future process to identifies the opportunity for creating a new market values. Example question like “what can be done”.

3. From knowledge to technology

   The final stage is exploitation of knowledge as an opportunity within the form of application or system technology. It involves the organization to develop a stable process and culture to overcome a series of crises though utilizes the technology to deliver the products that create new expectation in the market. Example question like “ How can the new opportunity be consistently exploited”. Over a period of time, the technology introduces the new standard and form of knowledge to manage the process of learning.

2.5 Knowledge Management

“Knowledge Management (KM) is the process of capturing, developing, sharing, and effectively using organizational knowledge.” (Davenport, Thomas H, 1994, p. 119). Many organizations are realizing that the most valuable intellectual assets of a company is the knowledge of their staff. With the right approach to KM, the benefits to a company are improved performance, higher productivity, and increased revenue.

Specific domain information needs are to be to extracted and analysed by experts and stored as knowledge to produce a useful knowledge repository for sharing or reference. The goal of the knowledge management systems is to allow experts to create and manage a knowledge repository and for authorized users to search and locate the relevant content in the knowledge repository. There are four processes in knowledge management that can be applied to any KM Project:

1. Gathering – the activities such as sourcing from any similarity projects from knowledge repository, new data entry and revision.
2. Organizing – the activities such as cataloging, indexing, filtering, and linking.
3. Refining – the activities such as contextualizing, collaborating, compacting, projecting, and mining.
4. Disseminating – the activities such as flow, sharing, email / SMS notification. (*Information Week*, Angus and Patel, 1998)

In the software development process, people are making the technical or managerial decision based on personal knowledge, informal information or experience. There is the possibility that, this may cause the project failure if the person is not familiar on the domain knowledge or experience. Organizations are constantly looking for KM to reduce the development cost and time, learning or re-use from the past project by repeating the previous successful process, knowledge and experiences.

The emergence of new technologies makes work more effective, but at the same time can become the software provider's, or technology manager's worst nightmare. It is difficult for project managers to be proficient with new

technologies and understand the impact when using it. Hence organizations must quickly acquire the knowledge about new technologies, master it, and then spread it throughout the team. Knowledge sharing culture should be encouraged; a formal knowledge management process is an important aspect, to ensure that team members can access and re-use the past successful knowledge for future projects.

2.6 Requirements Knowledge Management

Requirements engineering, managing, and implementation are complex stage in the software project management. Different stakeholders with different background, experience and knowledge have different expectation of the outcome. Constant changes or new request always taking place in the software engineering, especially work with the stakeholders extremely dynamic. Thus, a systematic way of managing requirement knowledge and changes, in order to help organization leverage the knowledge they possess for future reference.

Acquiring knowledge about new technology is part of the root of requirements knowledge management, it not only affect the design of the system but also the output or goal of the system. New technologies often changes the behavior of the users, just like the smartphone technology is become the personal computing device that used for daily work, entertainment and new way of communication.

Knowing the latest technology knowledge, and mastering the mobile domain knowledge is once of the way of distinction to other competitors. Many developers often reuse open-source frameworks with complex functionality that developed by numerous stakeholders, in order to speed up the domain knowledge learning.

Capturing requirements using the defined process or reuse the past requirements knowledge, allows to shortening the deliver time and cost to development the system and for sure will increase the quality of the system [W. Maalej and A.K. Thurimella, p 10].

In general, the requirements knowledge managements brings several benefits with not limit to the following:

- Improve the understanding of the requirements knowledge, and reduce the mistake when capturing requirements.
- Identifying the new requirements by providing the rationales helpful information for future reference or uses.
- Speeding up the requirement process or decision making by reuse the previous relevant projects and knowledge.

2.7 Summary

Not long ago, mobile applications started dominating the traditional web and desktop software-development worlds. Developers were forced to change their attention to mobile application development that not only focused on system functionality. Managing the requirements knowledge includes two main activities are accessing and sharing knowledge with involves the tasks, methods, and tools. A good requirements knowledge management tools are required for addressing the need of the company or the project environment. The challenge is to select or build the software tools that fits the overall mobile requirements plan and are able to share or reuse the knowledge.

Therefore this research is conducted to develop a knowledge-based requirements management system to support mobile application requirements engineering for capturing requirements, and formalizing and managing requirements knowledge. A pre-defined requirements form with different device limitation conditions generated from the knowledge-based requirements management system has to be created in order to improve the mobile requirements engineering.

3. METHODOLOGY AND EXPERIMENTS

This chapter provides a short explanation of the project methodology used. First the Software Development Life-Cycle method is described. Next personal project management experience in the mobile development industry is presented and finally the overall steps in the project process are described.

3.1 Software Development Life-Cycle (SDLC) method

The method that has been used in this project to develop the requirements knowledge-base system is called System Development Life Cycle (SDLC). The SDLC is the conceptual model normally used in the software project management, from the requirements study until the project implementation and maintenance.

Several SDLC models have been developed to guide the process such as waterfall model, rapid application development (RAD), joint application development (JAD), spiral model and etc. Some of the methods work better for specific type of projects, but in general the SDLC process adopts the following steps:

- System Planning – Identifies the problem and deficiencies are defined. In the previous chapters, I have described the problem, objective and the significance of this system. A few literature studies and requirements analysis were conducted.
- System analysis – Analyses the information gathered during the planning phase, and then creates the uses-case of the system, plus the entity relationship diagram that could handle all of the information needs. This will be described further in chapter 4 that follows.

- System design – Designs the user interface and identifies the input, output and process that are needed to create this system. This is the most challenging part to make sure the program can make the user interface easy to navigate and handle all the information correctly. More explanation related to this will be provided in the following chapter 4.
- System Implementation – Involves developing the system and showing to my superior for review and comment. Revision and adjustment of this system must be made in this stage. Ensures the system has been tested successfully and is ready to be used. This is described in detail in chapter 5.
- System Maintenance – Once the system is up and running, users of the system have to keep up-to-date knowledge and follow the procedures. Exhaustive evaluation and feedback from the users are needed, which is then kept up the maintenance or modifications of the system if necessary.

3.2 Analysis of Projects Requirements based on past experience

I have been involved in the software development industry for more than 10 years and I have specifically more than 5 years working experience in the mobile application development companies and more than 200 mobile applications project have been developed such as iProperty, Kurnia Insurance, Stadium Astro, HLeBroking, Maxis BPL and etc.

I have interviewed or trained many project mangers during the past few

years, and I have realised that not many projects managers are able to catch-up with the fast-changing, emerging mobile technologies nor understand their limitations or performance when using it. This is the most serious challenge faced by project managers during the initial requirements stage. It may cause project failure due to the lack of latest mobile knowledge and experience in using it.

Due to my past experience, I realise there is a need to develop a knowledge-based requirements management system for mobile application development, in order to help all the project managers / companies succeed in their mobile projects.

3.3 Project Methodology

The overall steps used in this project are as follows:

- A review of the literature is conducted
- A review of the system analysis and design
- A review of the use-case diagram
- A review of the entity-relationship diagram
- A review of database validation
- A user acceptance test of the system is conducted
- Project mangers are invited to evaluate the system, Further description related to this is given in chapter 6.

4. ANALYSIS AND DESIGN

This chapter describes the analysis and design of this system, specifically to explain how the system activities process flows and the database handles all the information needs. The system users interface is designed to show how easily users can input and display the output and the process to manage the knowledge correctly.

4.1 Users and Requirements

The method to outline the roles of the knowledge-based requirements management system is through a series of use cases as shown in Figure 4.1. A Use Case is the set of transactions between the system and users, and describes the interactions between the system and users (Garcia, Carretero, Perez, Garcia, and Filgueira, 2005, p. 1).

There are five actors or roles for this system:

1. Project Manager, who leads the project team in the development of the mobile application.
2. Customer, who provides the high-level business domain knowledge, defines the operational requirements as well as provides useful feedback through out the development effort.
3. Knowledge Expert, who has the important role to manage quality of the requirements knowledge in the requirements knowledge repository and validate the usefulness of the captured information.

The expert also has knowledge on latest mobile technologies, their specifications and limitations.

4. System Administrator, who administers the knowledge-based requirements management system.
5. Sale Executive, who to the doing the customer relationship and manage the customer profile.

The functionalities that are related to each role are:

1. Project Manager:
    a. Initiates a new project.
    b. Collects requirements and information from customers.
    c. Analyzes the collected information.
    d. Archives the requirements into the requirements knowledge repository upon approval from knowledge expert, once the project is closed.
2. Customer:
    a. Provides the initial requirements and the expectations to project manager.
    b. Goes through the requirements study again, provides the feedback and revises when necessary.
    c. Ensures all the requirements have been captured correctly.
3. Knowledge Expert:
    a. Inputs the new technologies information to the knowledge-base system, for future reference and use.

b. Approve requirements information been archived by the project manager to transform into requirements knowledge in knowledge repository.

c. Ensures the requirements information has been stored in the knowledge base system is the useful knowledge.

4. System Administrator:

a. Assigns and manages the user access

5. Sale Executive:

a. Manages the customers' profile

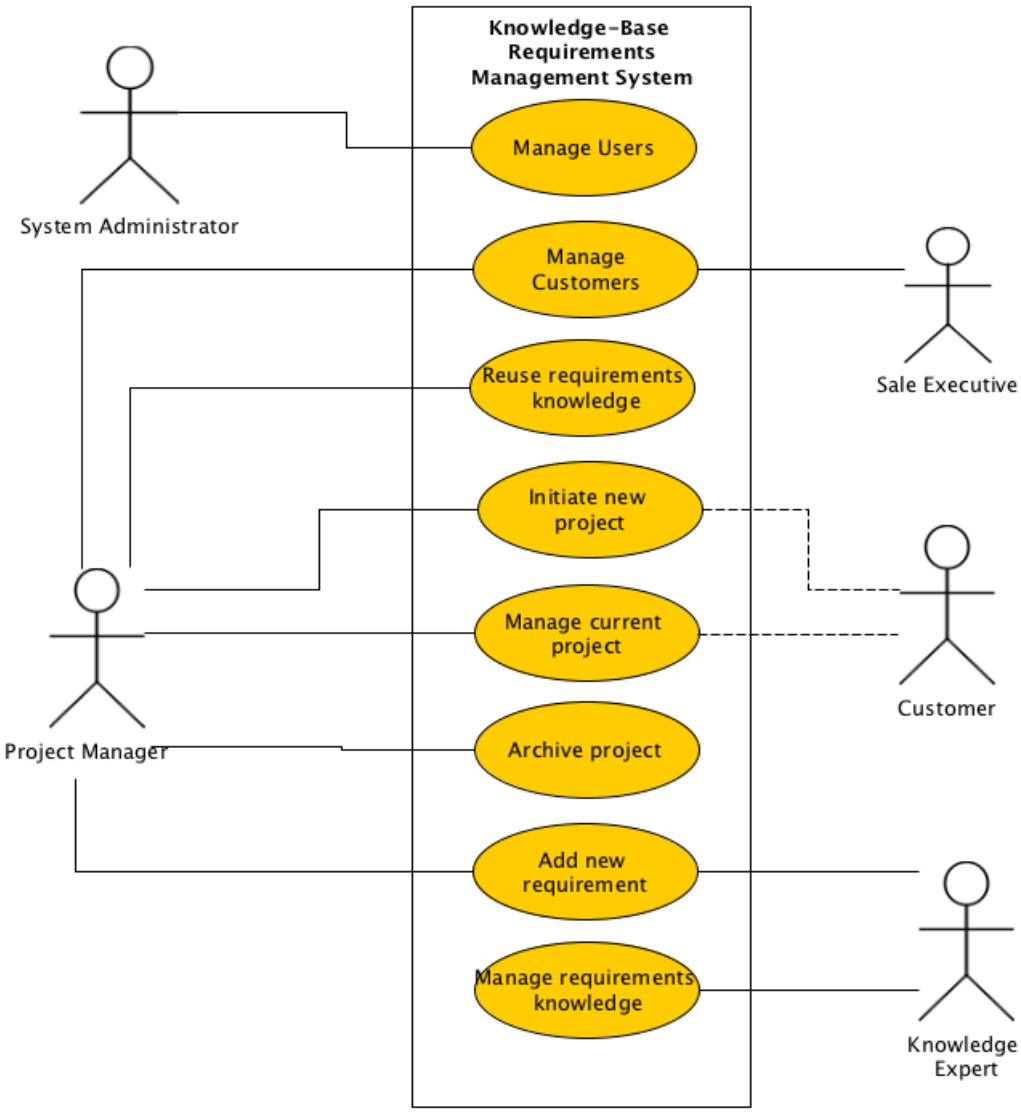


Figure 4.1: Use case for the system

Each of the use cases are described in detail in the use case description in the Tables 4.1 to 4.7:

Table 4.1: Initiates new project use case	
Use Case Name	Initiates new project
Use Case Description	This use case allows Project Manager to initiate a new project and collects the requirements about the project from customers.
Actor	Project Manager Customer (secondary actor)
Flow of events	1. Project Manager initiates a new project. 2. Using the pre-defined requirements capture form, Project Manager collects the requirements from the customer. 3. Project Manager analyses the collected requirements to check whether they are do-able or not.

Table 4.2: Manage current project use case	
Use Case Name	Manage current project
Use Case Description	This use case allows Project Manager to manage current projects.
Actor	Project Manager Customer (secondary actor)
Flow of events	1. Project Manager manages project revisions and revises the requirements according to Customer's requests for changes. 2. System manages versioning in order to keep the past records for reference purpose.

Table 4.3: Archive project use csae	
Use Case Name	Archive project
Use Case Description	This use case transforms requirements of closed projects into knowledge that is stored in the requirements knowledge repository for future reference or reuse.
Actor	Project Manager
Flow of events	1. Project Manager updates the project status to "Closed" once the project has been completed. 2. Project Manager archive the project and this project requirements will be stored in the knowledge repository for future reference or reuse.

Table 4.4: Add new requirement use case	
Use Case Name	Add new requirement
Use Case Description	This use case allows the addition of latest mobile technologies information into system as new requirements that will be approved as the domain knowledge for future reference.
Actor	Project Manager Knowledge Expert
Flow of events	1. Project Manager enters new requirements that are not in the knowledge repository. 2. Knowledge Expert review and approves the new requirements. 3. System stores the information in the knowledge repository for future reference.

Table 4.5: Manage requirements knowledge use case	
Use Case Name	Manage requirements knowledge
Use Case Description	This use case allows Knowledge Expert to

	manage the requirements knowledge repository.
Actor	Knowledge Expert
Flow of events	1. Knowledge Expert manages the requirements knowledge in the knowledge repository to ensure it is the correct information..

Table 4.6: Reuse requirements knowledge use case	
Use Case Name	Reuse requirements knowledge
Use Case Description	This use case allows Project Manager to search and reuse requirements knowledge in the knowledge repository
Actor	Project Manager
Flow of events	1. Project Manager search for the past projects requirements that can be reused or referenced. 2. Project manager applies requirements found for the current project.

Table 4.7: Manage users use case	
Use Case Name	Manage users
Use Case Description	This use case allows Sale Executive to manage customers' profile
Actor	Sale Executive
Flow of events	1. Sale Executive creates and manages customers' profile via the system

Table 4.8: Manage customers use case	
Use Case Name	Manage customers
Use Case Description	This use case allows System Administrator to manage system users and their authorisation.
Actor	System Administrator
Flow of events	1. System Administrator creates and manages users who can access the system 2. System Administrator manages authorization for users to perform tasks.

4.2. Database Design

The database for the system contains two major types of data as below:

1) The requirements information for current projects: This contains the collected domain-related information and relationships in a structured and machine-interpretable format.

2) The requirements knowledge repository for completed projects: This contains the approved domain-related information and relationships in a structured and machine-interpretable format. The system allows indexing, searching and reusing of these knowledge assets, based on concepts and relationships of the domain knowledge.

Knowledge has an expiration date, especially in the mobile industry and may become obsolete over time as new techniques are discovered or technology is developed. Technology is changing everyday, and old knowledge will be replaced by new knowledge. Knowledge Expert is playing an important role in this system to update the latest knowledge and manage the expired knowledge.

The design for the data stored in the database of the system is shown in the Entity-Relationship Diagram (ERD) shown in Figure 4.2.

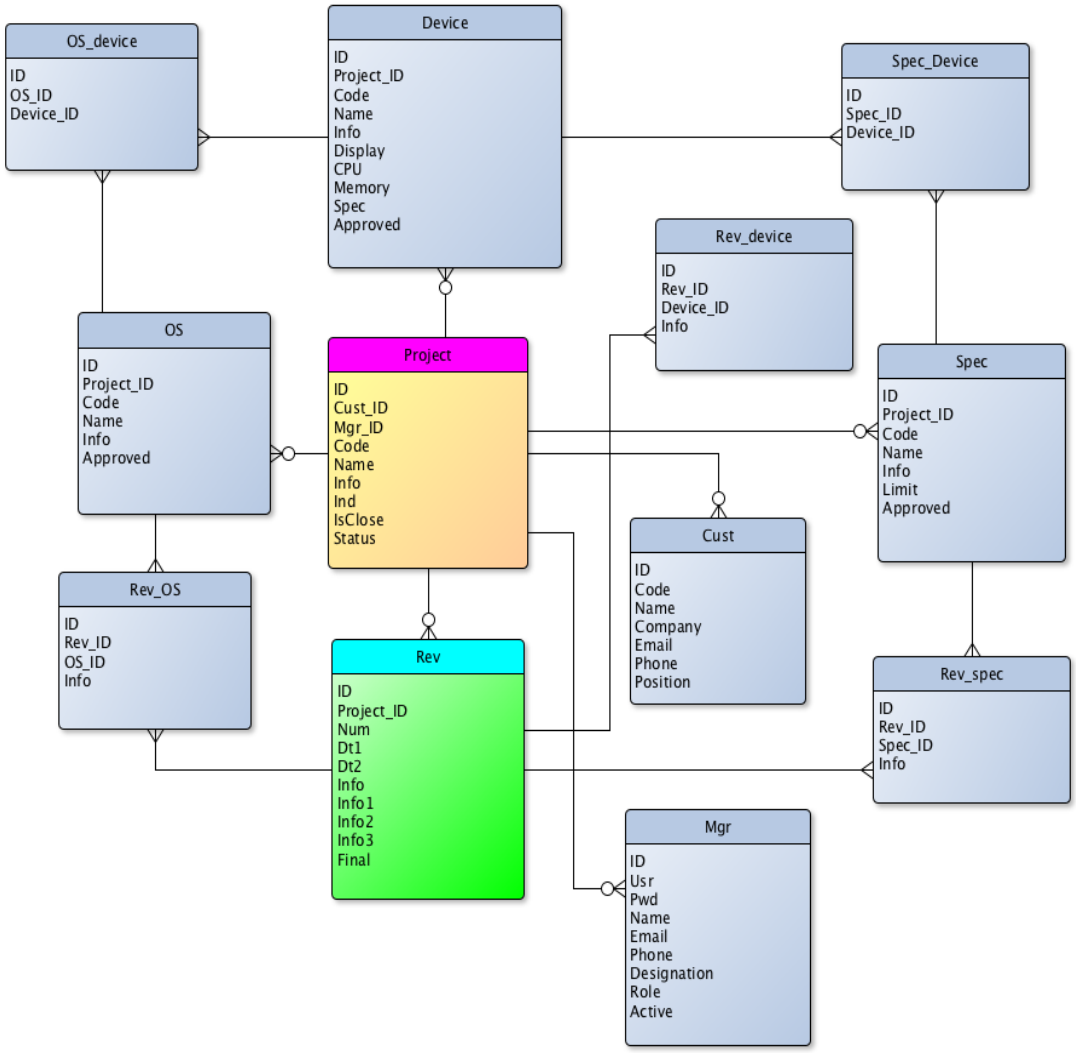


Figure 4.2: Entity-Relationship Diagram for database design

The detailed descriptions of each of the tables in the database design are shown in the Table 4.9 to 4.20:

Table 4.9: Project table		
Table Name	Project	
Field Name	**Description**	**Data Type**
ID	Primary key	Integer

Cust_ID	Foreign key to *cust* table	Integer
Mgr_ID	Foreign key to *mgr* table	Integer
Code	Project code (system auto generate)	String
Name	Name of the project	String
Info	Description of the project	String
Ind	Project under which industry. The standard industry listings are pre-defined based as below: • Agriculture • Apparel • Automobiles & Motorcycles • Business Services • Chemicals • Computer Hardware & Software • Construction & Real Estate • Consumer Electronics • Education • Food & Beverage • Furniture & Furnishings • Health & Medical • Home & Garden • Manufacturing & Processing... • Minerals & Metallurgy • Office & School Supplies • Packaging & Paper	String
IsClose	Archive the project, and no allow for further edit (1= YES; 0=NO).	Integer
Status	Status of the project. The standard project status are pre-defined adapted from the PMP four major project status as below: • Initiating: The project has been initiated • Planning: The project requirements are being collected and analysed • Executing: The project is in the developing or executing stage. • Closed: The project is closed	String

Table 4.10: Rev table		
Table Name	Rev	
Field Name	**Description**	**Data Type**
ID	Primary key	Integer
Project_ID	Foreign key to *project* table	Integer
Num	Version number of the project detail. System will auto increase the version number for every new revision of the project	Integer
Dt1	Targeted go-live date of the project	Date
Dt2	Last modified date of this revision	Date
Info	General remarks for this new revision	String
Info1	General remarks for the OS requirements	String
Info2	General remarks for the device requirements	String
Info3	General remarks for the features/spec requirements	String
Final	Finalized this revision, and not allow for further edit (1= YES; 0=NO).	Integer

Table 4.11: Mgr table		
Table Name	Mgr	
Field Name	**Description**	**Data Type**
ID	Primary key	Integer
Usr	User name use for login to system	String
Pwd	User password use for login to system	String
Name	Name of the user	String
Email	Email of the user. System will validate the valid email address.	String

Phone	Telephone number of the user.	String
Designation	Designation of the user. Example like project manger, sale executive, or knowledge expert	String
Role	Pre-defined the role of the user: • Admin • Project Manager • Sales Executive • Knowledge Expert	String
Active	Active the user (1=YES; 0=NO)	Integer

Table 4.12: Cust table

Table Name	Cust	
Field Name	**Description**	**Data Type**
ID	Primary key	Integer
Code	Customer code	String
Name	Name of the person-in-charge	String
Company	Company name of the customer	String
Email	Email of the person-in-charge. System will validate a valid email address	String
Phone	Tel. no. of the person-in-charge	String
Position	Position of the person-in-charge	String

Table 4.13: Rev_OS table

Table Name	Rev_OS	
Field Name	**Description**	**Data Type**
ID	Primary key	Integer
Rev_ID	Foreign key for *rev* table	Integer
OS_ID	Foreign key for *os* table	Integer

Info	Remarks of each items been selected	String

Table 4.14: OS table		
Table Name	OS	
Field Name	**Description**	**Data Type**
ID	Primary key	Integer
Project_ID	Foreign key for *project* table	Integer
Code	Operating system code (system auto generate)	String
Name	Name of the operating system	String
Info	Description of the Operating System	String
Approved	Has this information been validated and approved (1=YES; 0=NO)	Integer

Table 4.15: OS_device table		
Table Name	OS_device	
Field Name	**Description**	**Data Type**
ID	Primary key	Integer
OS_ID	Foreign key for *os* table	Integer
Device_ID	Foreign key for *device* table	Integer

Table 4.16: Device table		
Table Name	Device	
Field Name	**Description**	**Data Type**
ID	Primary key	Integer
Project_ID	Foreign key for *project* table	Integer
Code	Device specification code (system auto	String

	generate)	
Name	Name of the device	String
Info	Description of the device or operation version	String
Display	The display resolution of the device	String
CPU	The CPU specification of the device	String
Memory	The memory specification of the device	String
Spec	Any features or special specification need to be highlighted	String
Approved	Has this information been validated and approved (1= YES; 0=NO)	Integer

Table 4.17: Spec_device table

Table Name	Spec_device	
Field Name	**Description**	**Data Type**
ID	Primary key	Integer
Spec_ID	Foreign key for *spec* table	Integer
Device_ID	Foreign key for *device* table	Integer

Table 4.18: Spec table

Table Name	Spec	
Field Name	**Description**	**Data Type**
ID	Primary key	Integer
Project_ID	Foreign key for *project* table	Integer
Code	Project features code (system auto genereate)	String
Name	Name of the mobile feature	String
Info	Description of the mobile feature	String

Limit	Limitation of the mobile feature	String
Approved	Has this information been validated and approved (1=YES; 0=NO)	Integer

Table 4.19: Rev_device table

Table Name	Rev_device	
Field Name	**Description**	**Data Type**
ID	Primary key	Integer
Rev_ID	Foreign key for *rev* table	Integer
Device_ID	Foreign key for *device* table	Integer
Info	Remark for each item been selected	String

Table 4.20: Rev_spec table

Table Name	Rev_spec	
Field Name	**Description**	**Data Type**
ID	Primary key	Integer
Rev_ID	Foreign key for *rev* table	Integer
Spec_ID	Foreign key for *spec* table	Integer
Info	Remark for each item been selected	String

5. PROJECT DEVELOPMENT AND VALIDATION

In this project, I choose HTML to create useful and well-formatted web pages. With the addition of PHP as programming language and MySQL as the database to collect data from uses, it creates specific content on the fly and performs other things that HTML alone cannot be done.

5.1 Database Validation

To have better understanding on the process flow of the ERD, giving an example and validating the database design, from tables 5.1 to 5.7 :

1. To start a new project: The mobile applications requirements information from customers will be into following Tables:

Table 5.1: Project details sample

#	Fields	Data Entry
1	Customer	KFC Brunei Berhad – Mr. Danny Wong
2	Name	KFC Brunei Mobile Application
3	Description	Introducing the mobile app for KFC in Brunei: tTo find the nearest KFC outlet s, enquire about our delivery and catering services and stay up to date on our latest products or promotions.
4	Industry	Food & Beverage
5	Manager	Sharon Lee
6	Status	Initiating

If the customer not in the listing, project manager can add in the customer information into the system as below:

Table 5.2: Customer details sample

#	Fields	Data Entry
1	Company	KFC Brunei Berhad

2	Name	Mr. Danny Wong
3	Email	danny.wong@kfc.com.bn
4	Phone	+673-2430806
5	Position	Brunei Country Director

The project manager who is the system login person's name will be recorded to this system. The access authorization been created by the Admin as below:

Table 5.3: Project manager details sample

#	Fields	Data Entry
1	Username	sharon
2	Manager Name	Sharon Lee
3	Designatio	Project Manager
4	Email	sharon.lee@mobileapp.com
5	Tel	+6012-3289865
6	Job Role	Project Manager

After created the project header, and then continue to gather the project requirements by revision control.

Table 5.4: Revision details sample

#	Fields	Data Entry
1	Go live Date	31-07-2014
2	Revision	1
3	Revision Description	First requirements study
4	OS	Android & iOS
5	Remarks for OS	Have to support the old OS version
6	Devices	HTC One (M8), Samsung Galaxy S5, Google Nexus 5, iPhone 5S, Sony Xperia Z1 Compact
7	Remarks for devices	At least have to support the current latest top 5 devices
8	Features	About Us, Products, Videos, Photos, Contact, Facebook
9	Remarks for Features	Phase 1

Project manager can view the listed OS / devices / features detail by click on the *view* button. However if the requirements for OS / device / feature

not in the listing, project manager can add in the information into system as below:

Table 5.5: Operating system details sample		
#	Fields	Data Entry
1	Name	Android
2	Description	Android operating system

Table 5.6: Device details sample		
#	Fields	Data Entry
1	Name	Apple iPhone 4
2	OS	iOS
3	OS Version	iOS 4, and above
4	Display	640 x 960 pixels, 3.5 inches (~330 ppi pixel density)
5	CPU	1 GHz Cortex-A8
6	Memory	8/16/32 GB storage, 512 MB RAM
7	Specs	Refer to http://www.gsmarena.com/apple_iphone_4s-4212.php
8	Features	All, except NFC feature

Some mobile application features have the device capability limitation like the NFC feature. The device specification and supported features been clearly defined in the system. The project manager should have basic mobile technology knowledge to aware, and highlight the limitation to the stakeholders during the requirements capturing stage, in order to avoid any future argument.

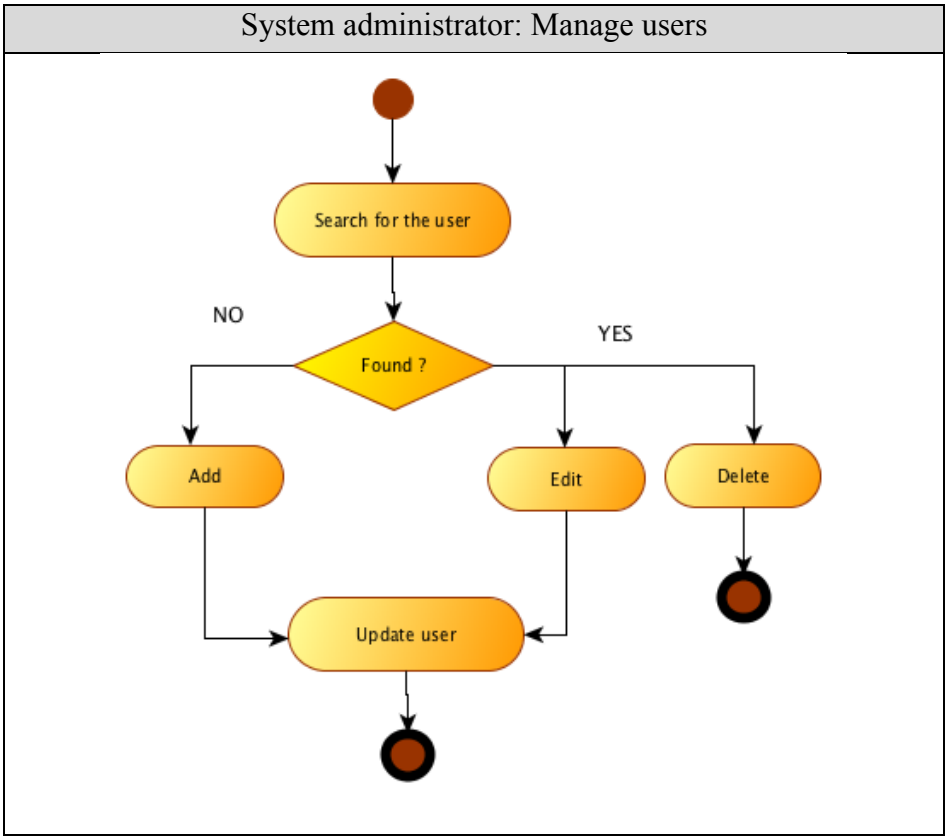
Table 5.7: Mobile feature details sample		
#	Fields	Data Entry
1	Name	News
2	Description	Display the list of news and view the detail
3	Limitation	

Repeat the same step as above for the next revision update.

2. Especially for junior project manager, always be advised to learn from the past project requirements knowledge to be re-use or as the reference. Project Manager can search the knowledge by the past project name, what type of industry, who is the customers, who is the project manager and etc. To reuse the past project knowledge, system will create a new project code with duplicating the past requirements, so that the project manager can continue to update requirements.

5.2 Process Flow and User Interface design

The system process flow and the user interface design for the 4 (four) different roles of users are present as below Figure 5.1 to Figure 5.7:



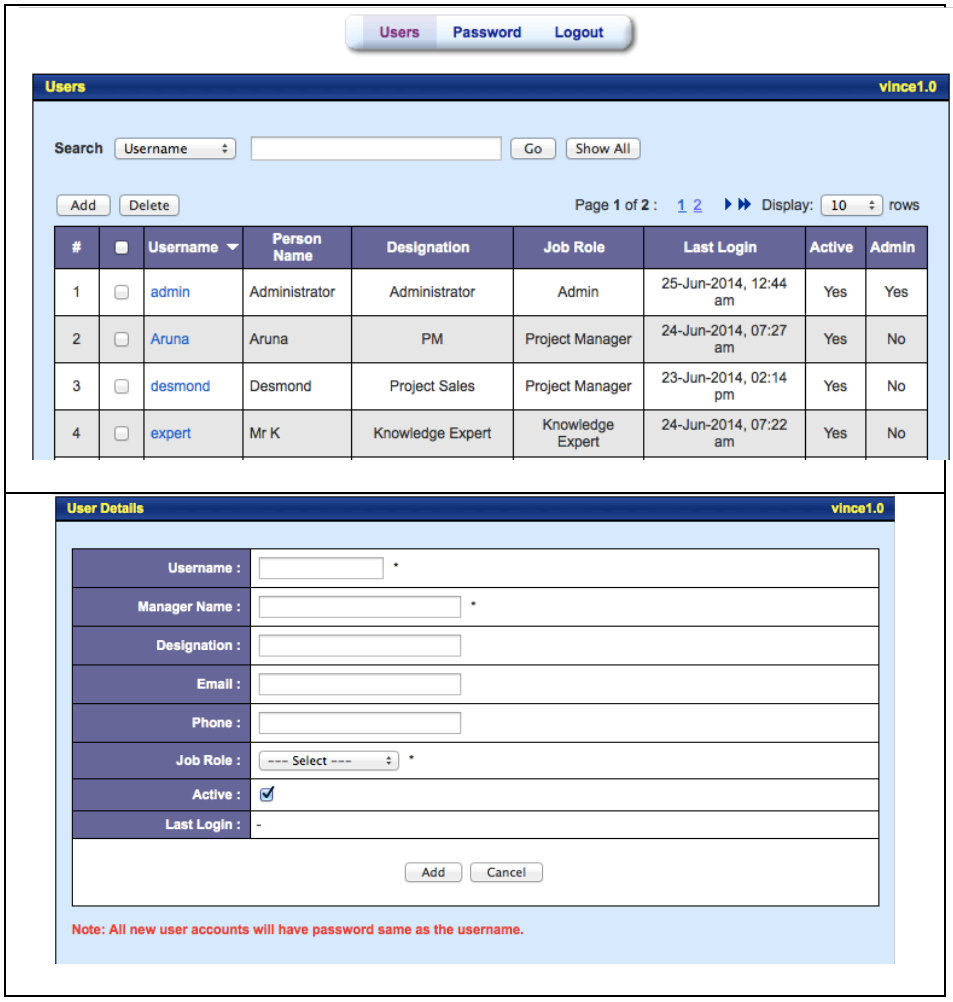
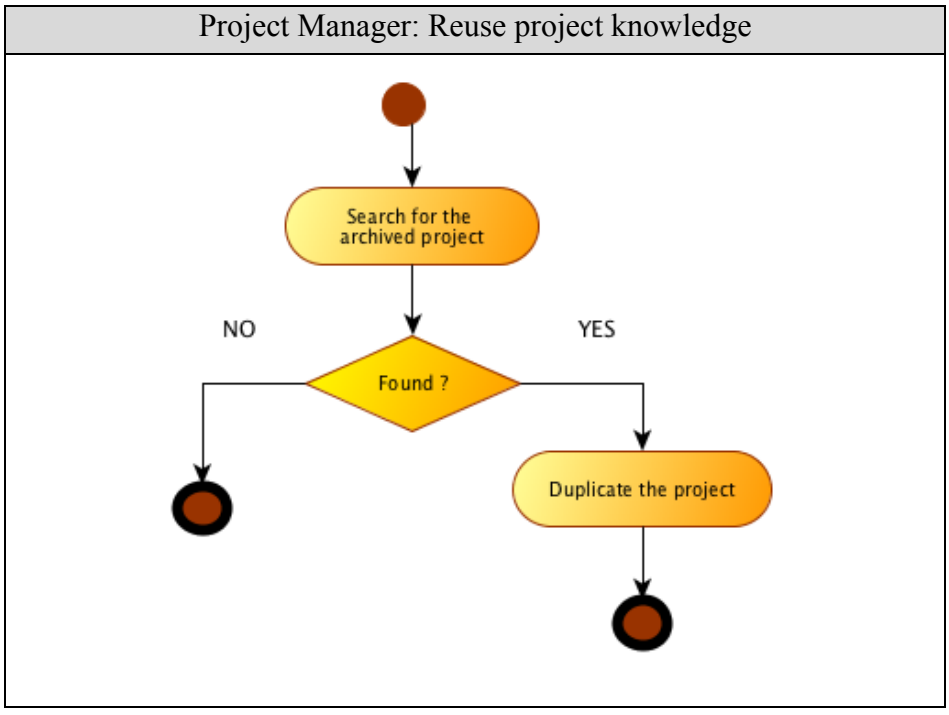


Figure 5.1: Manage users



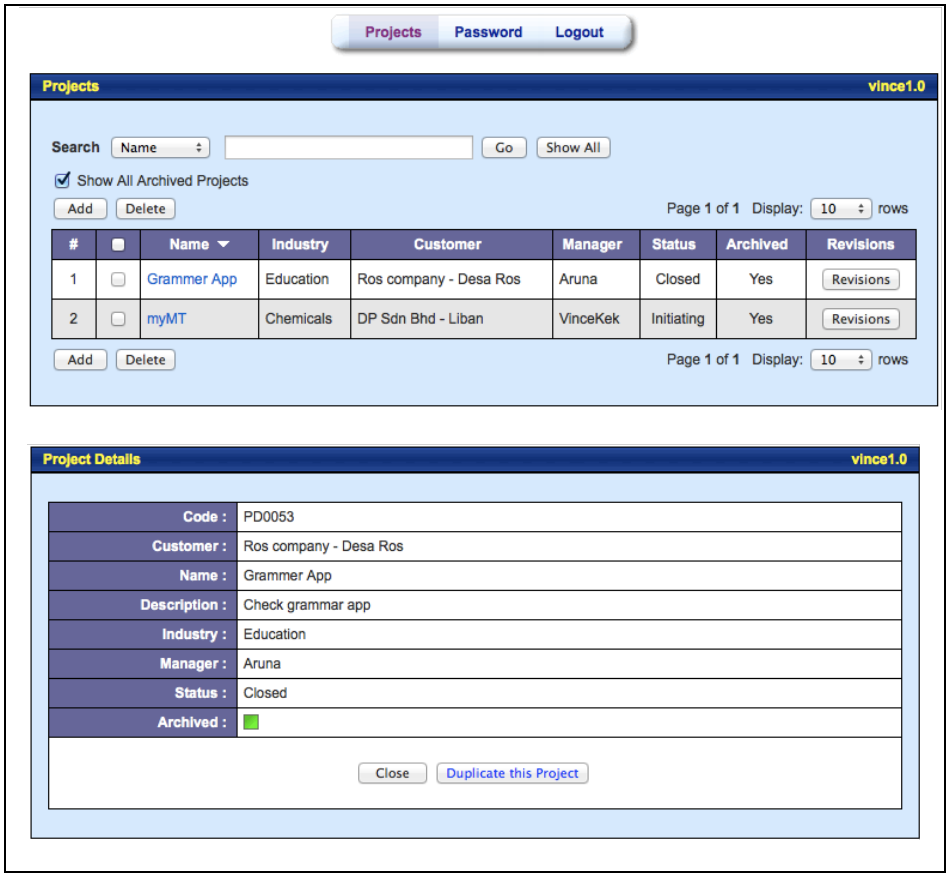
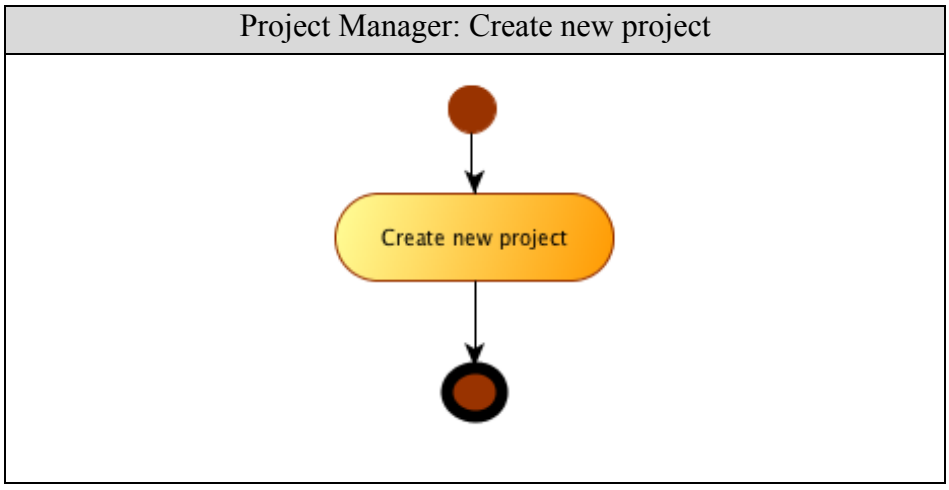


Figure 5.2: Reuse project knowledge



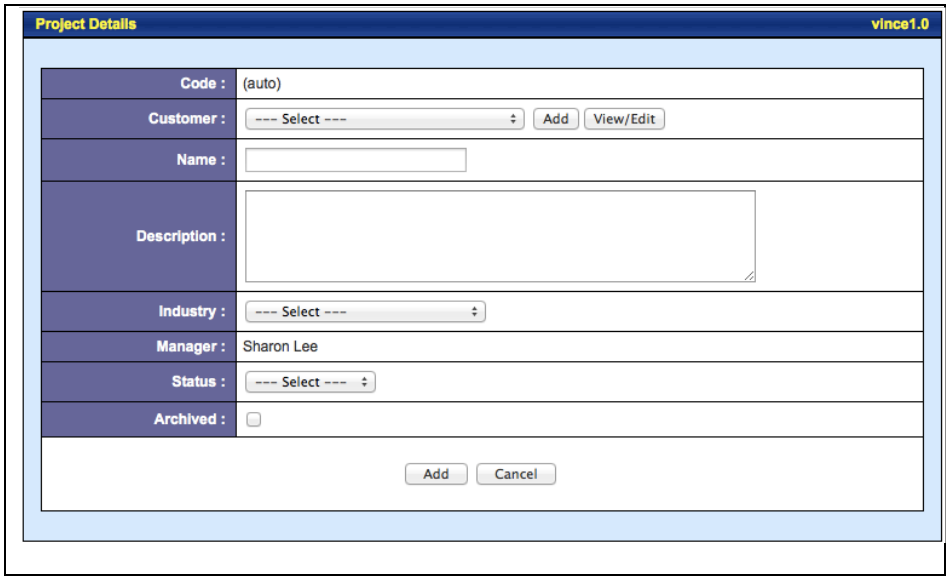
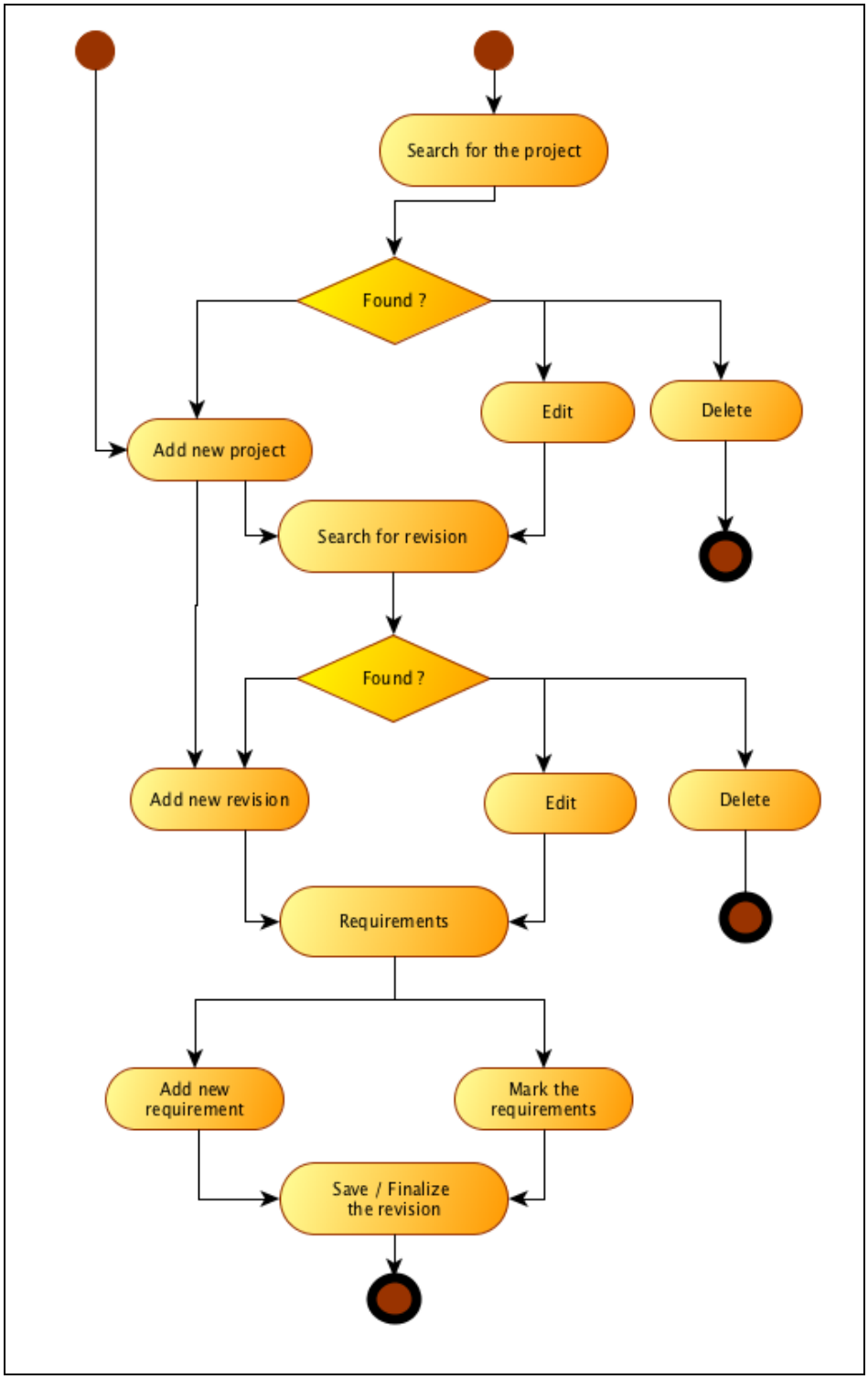
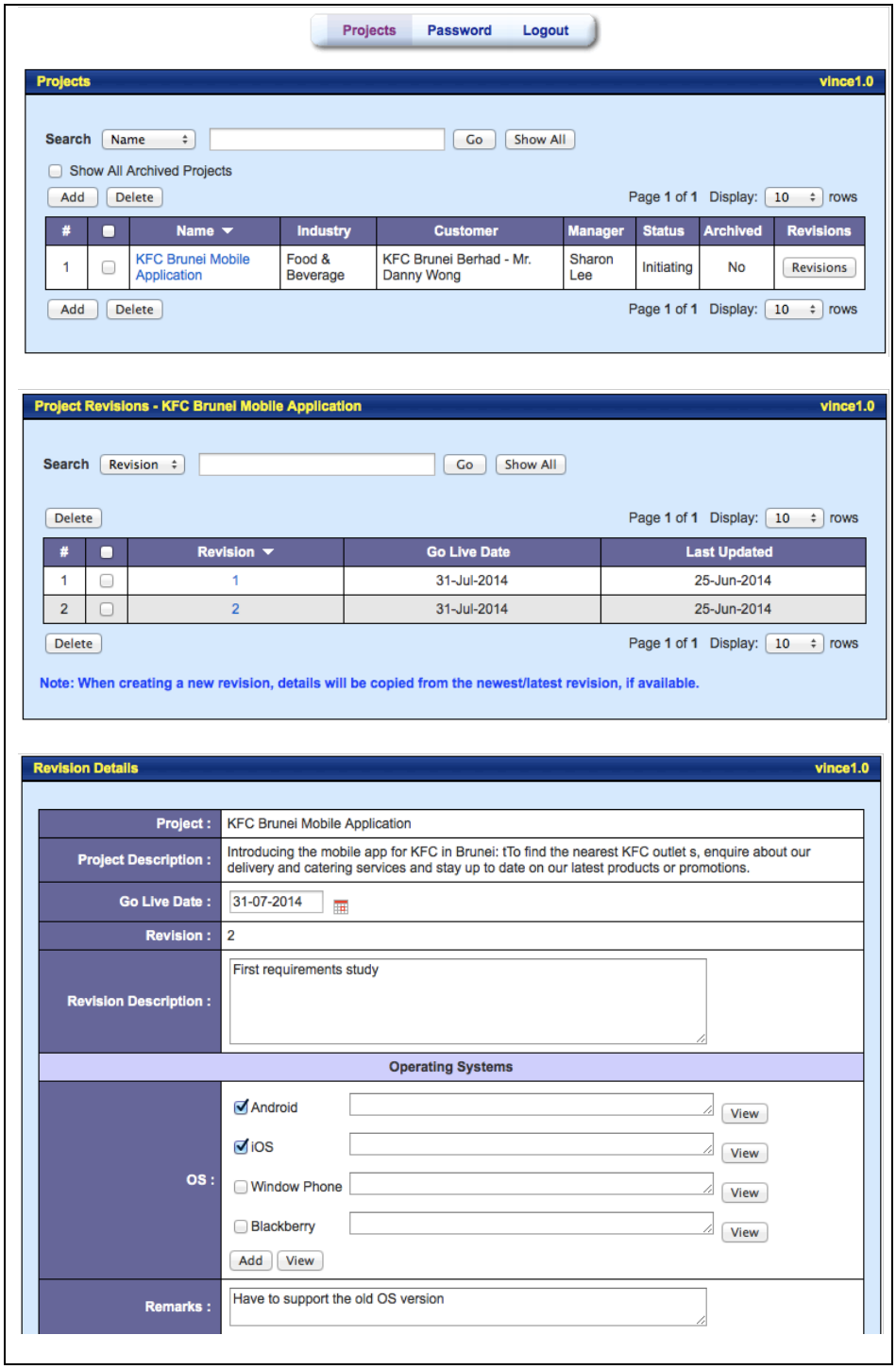
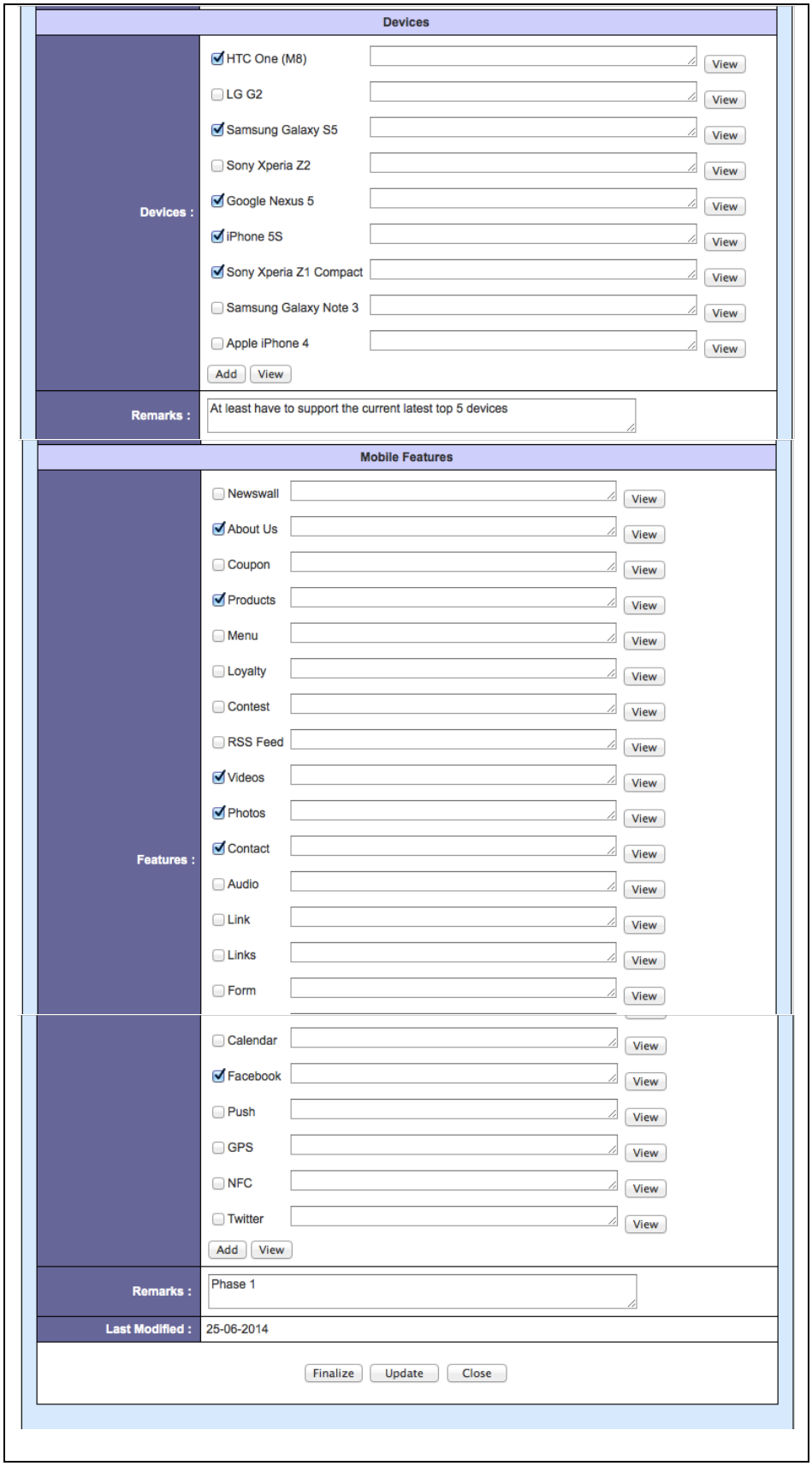


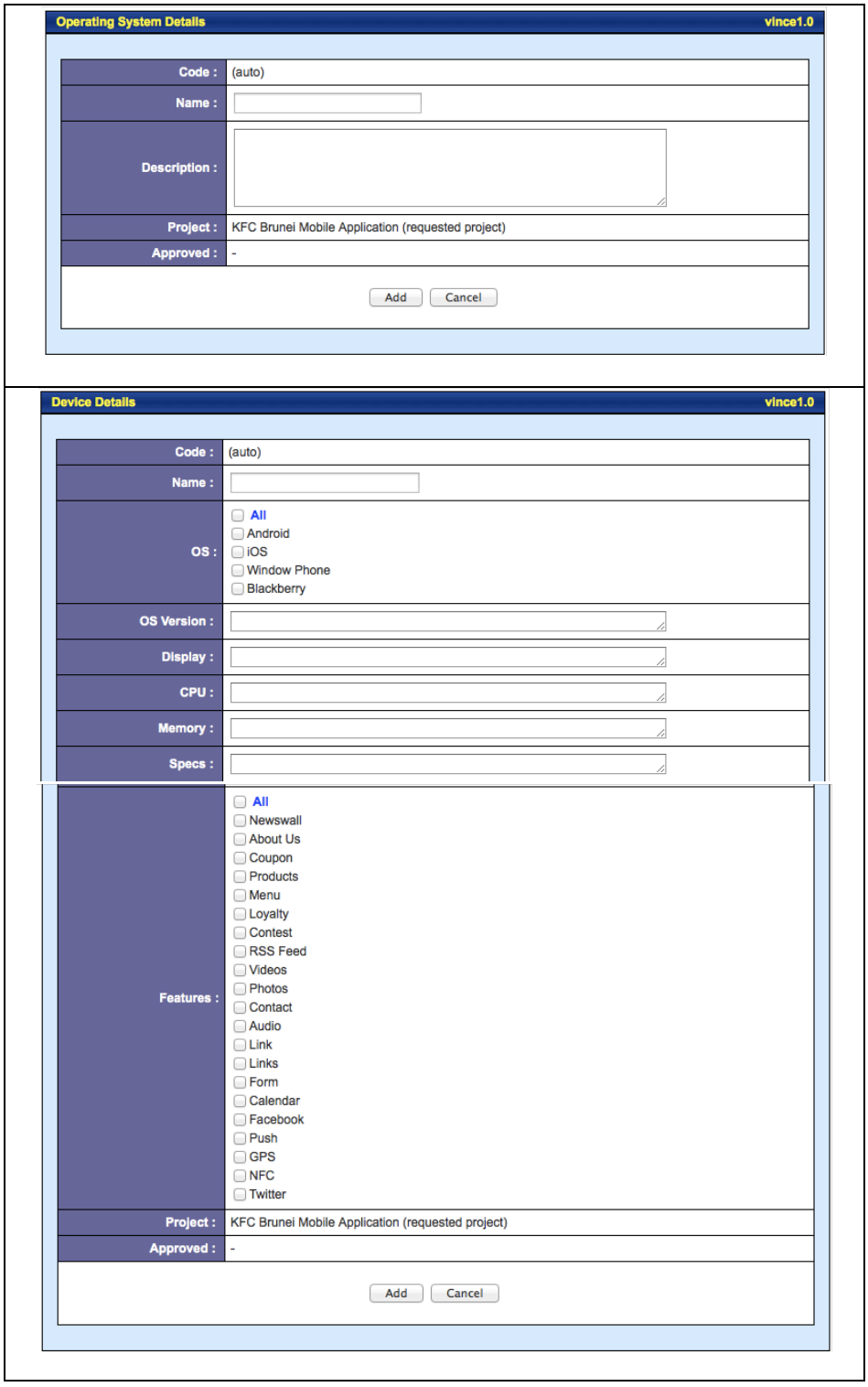
Figure 5.3: Create new project

Project Manager: Manage current project


Search for the project
Found ?
Edit
Delete
Add new project
Search for revision
Found ?
Add new revision
Edit
Delete
Requirements
Add new requirement
Mark the requirements
Save / Finalize the revision


Projects
Password
Logout
Projects
vince1.0
Search
Name
Go
Show All
Show All Archived Projects
Add
Delete
Page 1 of 1
Display:
10
rows
#
Name
Industry
Customer
Manager
Status
Archived
Revisions
1
KFC Brunei Mobile Application
Food & Beverage
KFC Brunei Berhad - Mr. Danny Wong
Sharon Lee
Initiating
No
Revisions
Project Revisions - KFC Brunei Mobile Application
vince1.0
Revision
Delete
Go Live Date
Last Updated
2
31-Jul-2014
25-Jun-2014
Note: When creating a new revision, details will be copied from the newest/latest revision, if available.
Revision Details
Project :
KFC Brunei Mobile Application
Project Description :
Introducing the mobile app for KFC in Brunei: tTo find the nearest KFC outlet s, enquire about our delivery and catering services and stay up to date on our latest products or promotions.
Go Live Date :
31-07-2014
Revision :
Revision Description :
First requirements study
Operating Systems
OS :
Android
iOS
Window Phone
Blackberry
View
Remarks :
Have to support the old OS version


Devices
Devices :
HTC One (M8)
LG G2
Samsung Galaxy S5
Sony Xperia Z2
Google Nexus 5
iPhone 5S
Sony Xperia Z1 Compact
Samsung Galaxy Note 3
Apple iPhone 4
View
Add
View
Remarks :
At least have to support the current latest top 5 devices
Mobile Features
Features :
Newswall
About Us
Coupon
Products
Menu
Loyalty
Contest
RSS Feed
Videos
Photos
Contact
Audio
Link
Links
Form
Calendar
Facebook
Push
GPS
NFC
Twitter
Add
View
Remarks :
Phase 1
Last Modified :
25-06-2014
Finalize
Update
Close


Operating System Details
vince1.0
Code :
(auto)
Name :
Description :
Project :
KFC Brunei Mobile Application (requested project)
Approved :
-
Add
Cancel
Device Details
vince1.0
Code :
(auto)
Name :
OS :
All
Android
iOS
Window Phone
Blackberry
OS Version :
Display :
CPU :
Memory :
Specs :
Features :
All
Newswall
About Us
Coupon
Products
Menu
Loyalty
Contest
RSS Feed
Videos
Photos
Contact
Audio
Link
Links
Form
Calendar
Facebook
Push
GPS
NFC
Twitter
Project :
KFC Brunei Mobile Application (requested project)
Approved :
-
Add
Cancel

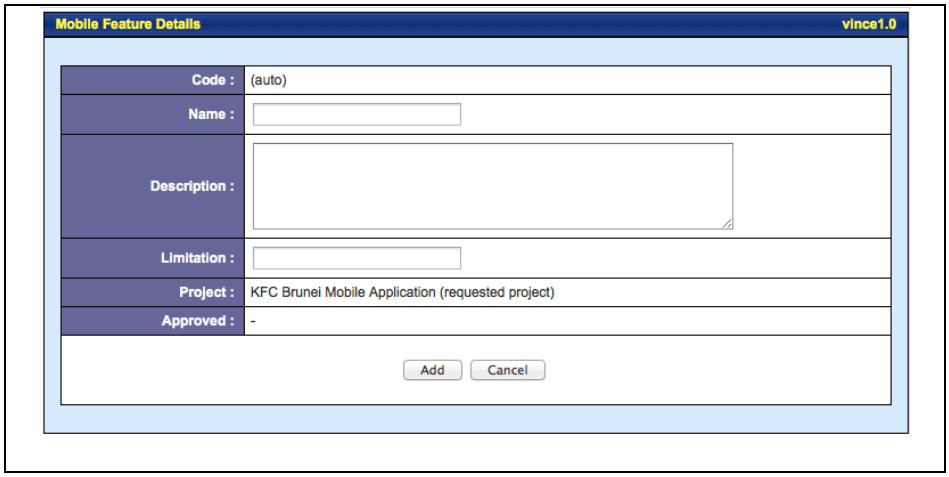


Figure 5.4: Manage current project

Project Manager: Archive requirements knowledge

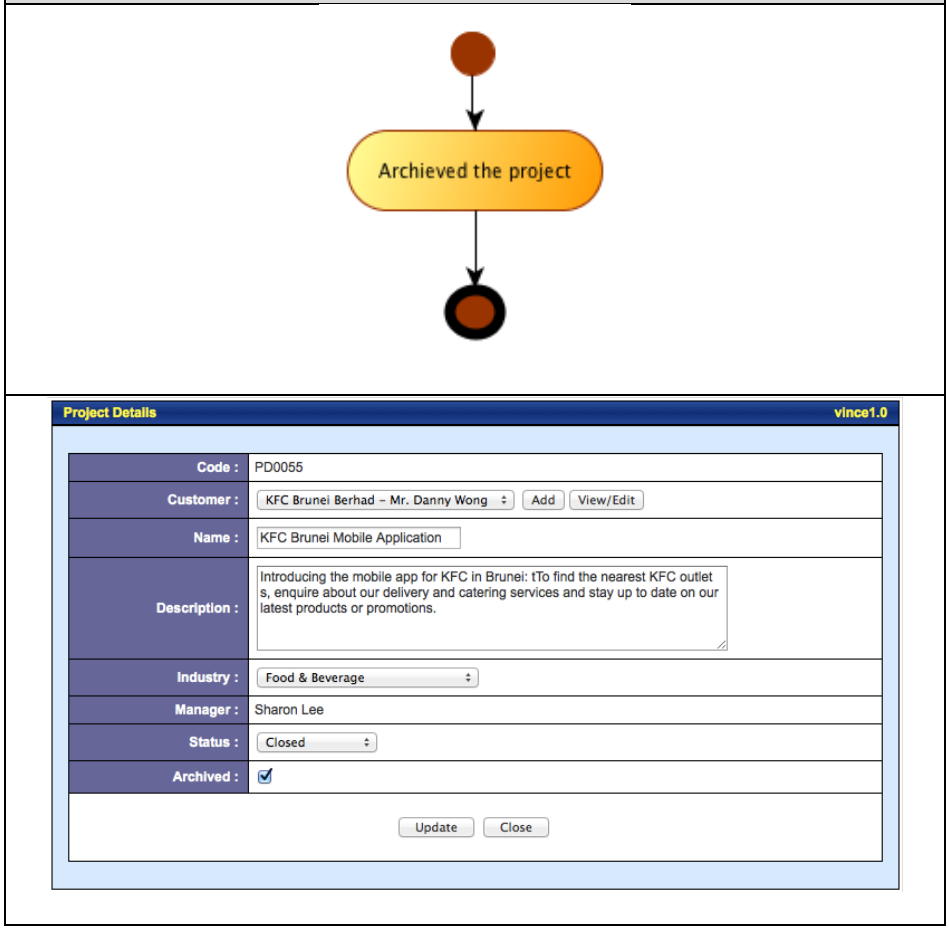
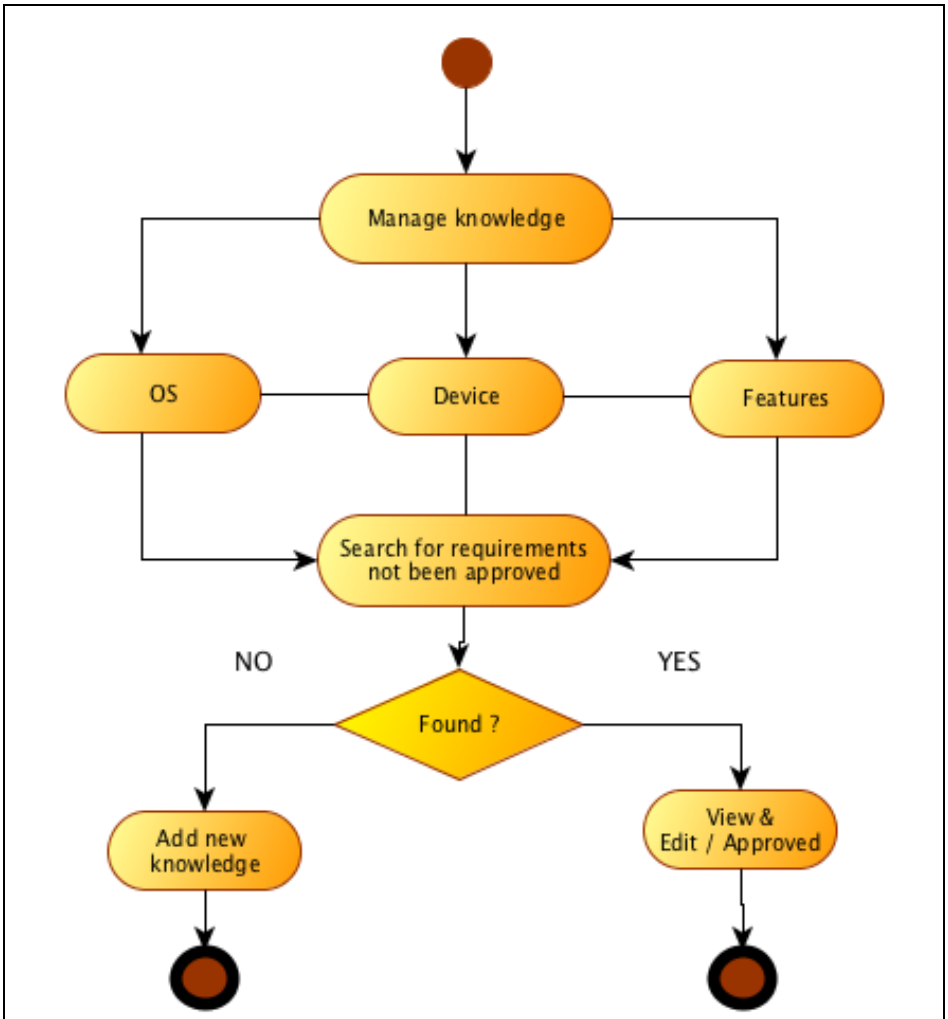


Figure 5.5: Archived requirement knowledge

Knowledge Expert: Manage requirements knowledge


Manage knowledge
OS
Device
Features
Search for requirements not been approved
NO
YES
Found ?
Add new knowledge
View & Edit / Approved

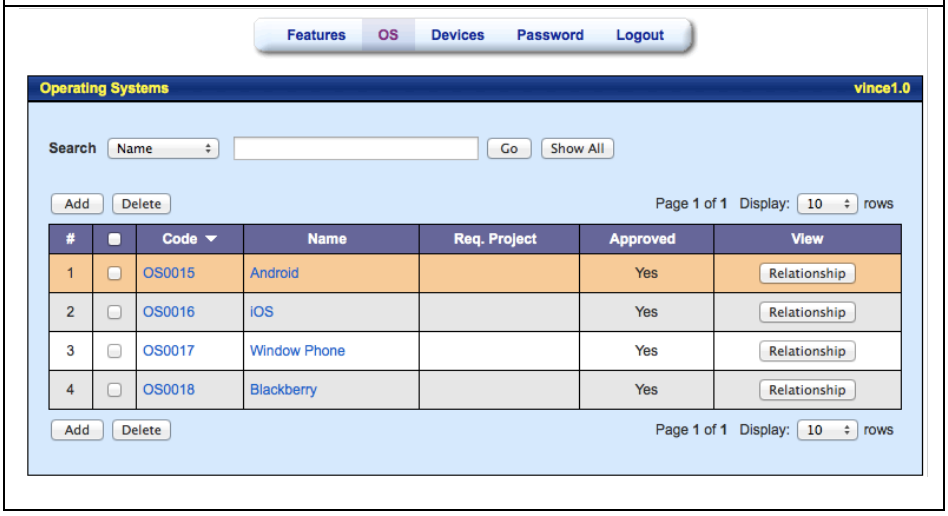

Features
OS
Devices
Password
Logout
Operating Systems
vince1.0
Search
Name
Go
Show All
Add
Delete
Page 1 of 1
Display:
10
rows
| Code | Name | Req. Project | Approved | View
1 | OS0015 | Android | | Yes | Relationship
2 | OS0016 | iOS | | Yes | Relationship
3 | OS0017 | Window Phone | | Yes | Relationship
4 | OS0018 | Blackberry | | Yes | Relationship

Figure 5.6: Manage requirement knowledge

Sale executive: Manage customers

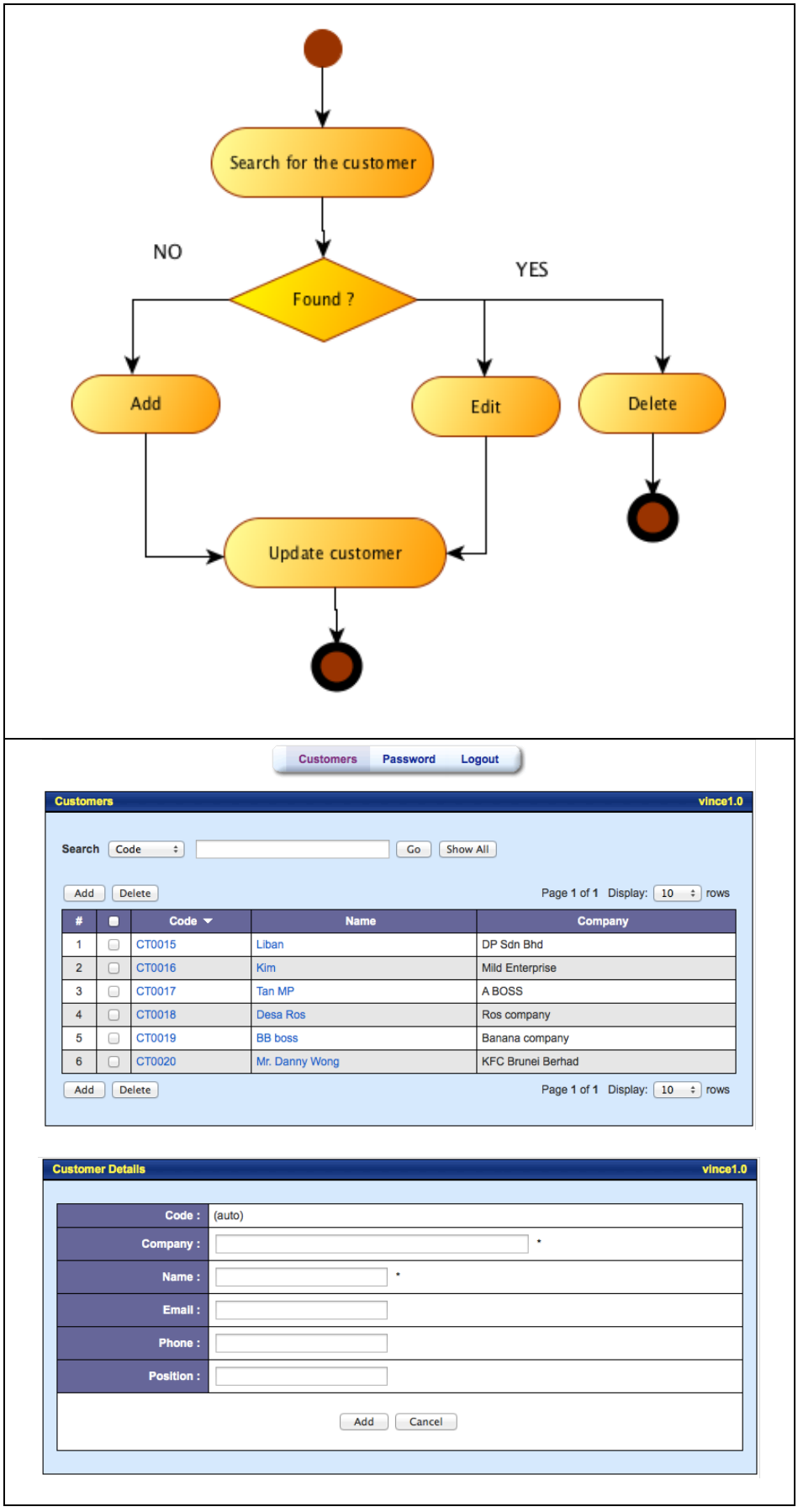

Search for the customer
NO
Found ?
YES
Add
Edit
Delete
Update customer
Customers
Password
Logout
Customers
vince1.0
Search
Code
Go
Show All
Add
Delete
Page 1 of 1
Display:
10
rows
| Code | Name | Company
1 | CT0015 | Liban | DP Sdn Bhd
2 | CT0016 | Kim | Mild Enterprise
3 | CT0017 | Tan MP | A BOSS
4 | CT0018 | Desa Ros | Ros company
5 | CT0019 | BB boss | Banana company
6 | CT0020 | Mr. Danny Wong | KFC Brunei Berhad
Customer Details
vince1.0
Code :
(auto)
Company :
Name :
Email :
Phone :
Position :
Add
Cancel

Figure 5.7: Manage customers

5.3 System Integration Testing (SIT)

The prototype knowledge-base system has been developed and tested with the following test scripts:

System URL : http://master.ping2w.com
Username : admin
Password : admin
Objective : The objective of this test case is to test the system logic and process
follow the initial structure analysis and design that has been discussed as above.

Version 1.0				
#	**Module**	**Action**	**Test Step**	**Remarks**
1	Users	Add	1. Add new user 2. Set active or inactive 3. Assign roles	
		Edit	1. Select from the existing users 2. Update the name and etc	
		Delete	1. Select from the existing users 2. Press the delete button to delete the user	
		Search	1. Search with different type: a. Username b. Person Name c. Designation d. Active e. Admin	
		Login	1. Login with new created user	Password is same as username
2	Customer	Add	1. Add new customer	System will auto generate the running code no
		Edit	1. Select the existing customer 2. Update the name and etc	
		Delete	1. Select from the existing customers 2. Press the delete button to delete the customer	
		Search	1. Search with different type: a. Code b. Name c. Company	
3	Project	Add	1. Add new project 2. Key in the project name, and description 3. Select the customer 4. Select the industry	System will auto generate the running code no

			5. Select the project status	
		Edit	1. Select from the existing projects 2. Update the name and etc	
		Delete	3. Select from the existing projects 4. Press the delete button to delete the project	Archived projects not able be delete
		Search	1. Search with different type: a. Name b. Industry c. Customer d. Manager e. Status f. Archived	
		Revisions	1. Add new revision 2. Enter the revision description 3. Select the OS and key in remarks for each item or general 4. Select the devices by OS and key in remarks for each item or general. 5. Select the feature and key in remarks for each item or general 6. Key in the overall remarks for this revision 7. Press update or finalize button to save the revision	Once the revision been finalized, not allow to edit but able to create another new revision version
4	Features	Add	1. Add new features 2. Key in the feature name, description, and limitation 3. Approved the feature (only knowledge experts have authority to approve)	System will auto generate the running code no
		Edit	1. Select from the existing features 2. Update the name and etc	
		Delete	1. Select from the existing feature 2. Press the delete button to delete the feature	
		Search	1. Search with different type: a. Name b. Req. Project c. Approved	
5	OS	Add	1. Add new operating system 2. Key in the operating system name, and description 3. Approved the OS (only knowledge experts have authority to approve)	System will auto generate the running code no
		Edit	1. Select from the existing OSs 2. Update the name and etc	
		Delete	1. Select from the existing OSs 2. Press the delete button to delete the OS	
		Search	1. Search with different type: a. Name b. Req. Project c. Approved	
6	Devices	Add	1. Add new device 2. Key in the device name, specs and etc 3. Select the supporting operating	System will auto generate the running code no

			system 4. Select the supporting features 5. Approved the devices (only knowledge experts have authority to approve	
		Edit	1. Select from the existing devices 2. Update the name and etc	
		Delete	1. Select from the existing devices 2. Press the delete button to delete the device	
		Search	1. Search with different type: a. Name b. Req. Project c. Approved	
7	Password	Update	1. Key in the current password, new password, and reconfirm the new password 2. Update the new password	
		Login	1. Login with the new password	
8	Logout	-	1. Press logout button back to login screen	

5.4 Evaluation

In order to evaluate the prototype system that is developed, few mobile project managers who are leading mobile application development projects will be selected and be used to improve the qualitative effectiveness of the study conducted.

The focus groups were selected from four mobile technology companies-which focused on building the SME mobile applications. The four companies were selected such as: ***One Ping Sdn Bhd***, ***QR Solution Malaysia Sdn Bhd***, ***Nexstream Sdn Bhd***, and ***Infindo Technology Sdn Bhd.*** They have been chosen because there are many junior project managers who face challenges during mobile application requirements process and in catching up with the latest emerging mobile technology.

Although the number of participants were relatively small compared to the

overall project manager population in the all-mobile application development companies, but they are focusing on the features and interface elements of the mobile application. The low percentage of participants, in this case, should still provide a sufficient sense of the overall mobile application project managers' opinions.

The project manager will use this knowledge-based mobile application requirements gathering form to capture the requirements from their customers, and it can be revised time-to-time by increasing the version during the development period. The estimated participating time on each requirements study is around 30 minutes, because the requirements engineering process is by using the question and answer method between the project managers and customers.

The outline of the focus group session is as below:

1. Project mangers use the system to capture the new mobile application project requirements.
2. Project managers answer the questionnaire by asking the customers for their feedback, and records down any specific requirements or limitation of the project.

The evaluation of the system will be gathered based on the feedback from the project managers on how efficiency of this system can help them improve the requirements capturing process and ensure accuracy until the end result.

The evaluation survey form used is given below or can refer to https://docs.google.com/forms/d/1Ty4Yr8XA3mcZ5e2eZw-QnEdWkZIr2sZYznu2y9LKkls/viewform:

Dear Valued Project Manager,

I would like to thank you for giving me the opportunity to do this survey with you. To help with my continued efforts for improvement of this system, please take a couple of minutes to complete this survey form. I appreciate and value your feedback, as it will help me to improve the system quality.

1. Strongly Disagree
2. Disagree
3. Neutral
4. Agree
5. Strongly Agree

Ref	Questions	Score				
		1	2	3	4	5
1	It is easy to start using this system (e.g. not requiring system setup or configuration).					
User Interface						
2	The interface is pleasant to view.					
3	The web pages have a consistent layout.					
4	The function buttons are easy to interpret.					
5	It is easy to navigate though the system.					
Requirements Capturing Function						
6	This system will help me capture the requirements for mobile application project.					
7	This system will help me capture all the requirements that you expect.					
8	This system will help me reduce my time in requirements gathering?					
Requirements Knowledge Management						
9	This system will help a junior project manager easy to manage the mobile application project.					
10	This system will help a project manager gain or learn the latest technologies knowledge and application domain knowledge faster.					
11	This system will help Knowledge Expert to manage and					

	approve the inserted information into knowledge repository for future reference.					
Overall						
12	I would like to use this system for my future projects.					
13	I will recommend this system to others.					
Feedback or areas to improve:						
Name:						
Position:						
Company:						
Years of experience in mobile app industry:						

6.CONCLUSION

6.1 Evaluation of questionnaire result

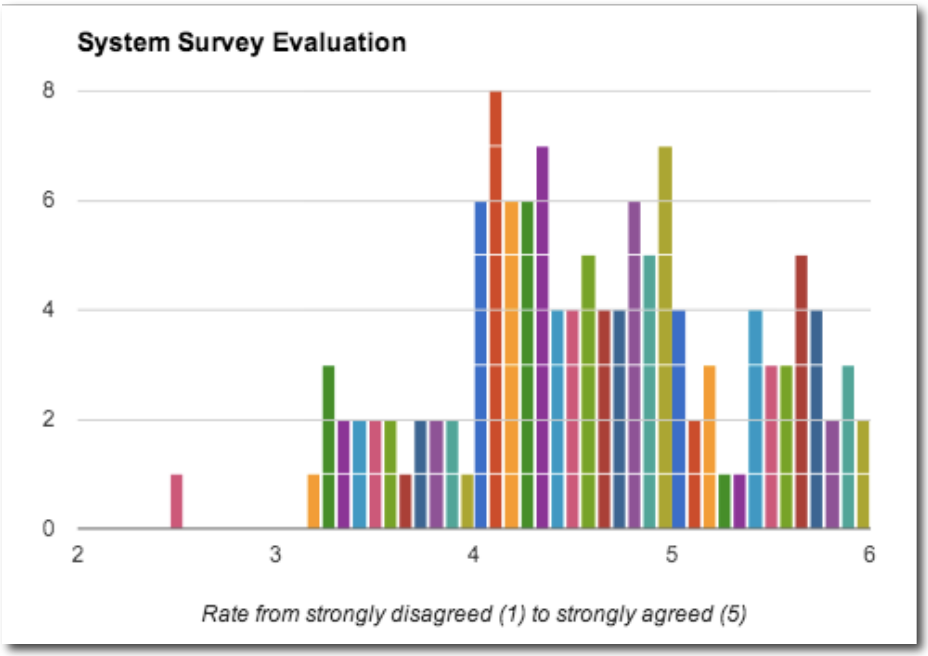


Figure 6.1: Evaluation of the system

As the above survey results show the majority of participants were very satisfied with the system. Still, participants did make some comments, which were mostly relating to time and organisational issues, such as possibly needing too many presentations, not enough time for dialogue, and lack of punctuality.

A detailed analysis of the graph show that 80% of the users enjoyed the system interface. A 70% of the users found it easy to navigate the system and hence they answered they would recommend this system to others. A 60% of the participants who answered the questionnaires *agreed* that the system was user friendly, had consistent layout, and was easy to interpret. Another 60% of the respondents *agreed* that this system would help knowledge experts to manage and

approve the inserted information into knowledge repository for future reference. A 50% of the users of this system *strongly agreed* that this system would help them to reduce the time of requirement gathering. Another 50% of the users *agreed* that this system will help them capture all the requirements that they expected.

6.2 Limitation and future improvement of this system

Some of the limitations of this system that needs improvement is: It is only limited to mobile application development projects. Most of the project managers were of the opinions that this system would have been more effective if it could support normal software development projects as well.

Another shortcoming of this project is that this system is limited to requirement study area only. Further studies should focus on the full project life-cycle processes, such as development, testing, and implementation.

At present the knowledge available in this system is limited. In order to have more effective and useful knowledge management system, this system must be made available to the public. In that cases, new project managers who use the system can store their research findings into the existing knowledge repository. People in that case can easily use the available knowledge for their future reference with regard to mobile application development projects.

Now a days, technology is changing very fast, so we need to get more domain experts who can input new knowledge into the knowledge-based management system. Future success lies in making the system more flexible in order to cover all kinds of industries such as education, small medium enterprises (SMEs), manufacturing, medical, and entertainment fields.

6.3 Conclusion

Overall this study is very promising and it may help many project managers especially the junior ones who are new in this field to learn and re-use the knowledge from the past projects. If the system can accommodate the very fast changing mobile technology, the number of people who will take to the system for its user friendliness and ease in handling it would no doubt continue to increase greatly. Therefore this study will be an eye opener as to how the available mobile technology and the knowledge gathered from such projects done by various people can be reused for future advancements in the field of mobile application technology.

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BIOGRAPHY

Kek Ming Chyuan is the pioneer graduand from UTAR (2005, Degree in Computer Science), and I am currently the CEO and founder of the *One Ping Sdn Bhd*, a mobile application solutions company, with clients such as Maxis, Beyond Gift, Penerbitan Multimedia Sdn Bhd, and etc. I was worked as the project manager in *Infindo Technology Sdn Bhd* in year 2009, focusing on developing the latest in mobile technologies. Throughout the years, *Infindo* has developed hundreds of innovative applications for various mobile platforms to different partners and clients' worldwide encompassing Apple iOS, Android, Window mobile and Blackberry.

In the year 2012, I was transferred and promoted as the Vice President of the new setup company named *Nexstream Sdn Bhd* that was founded by the same owners of Infindo. *Nexstream* continues to identify emerging mobile and cloud technologies to create dynamic solutions that bring the virtual communities together for their clients. My role as head of the Project Management Office (PMO)is taking care of all the projects' quality, and taking care the profit and loss of each projects.

In the early part of this year 2014, I decided to form my own Mobile Application Development Company named as "One Ping Sdn Bhd", and is continuing to provide the service with my knowledge expertise on mobile solutions and technologies. During my long duration of experience in the mobile industries, I have realised that the capturing of the mobile requirements study is very important at the initial stage, and the accuracy of the information been collected will impact the whole development and testing stages.