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**Knowledge Management in Collaborative
Environment and Service Oriented Organizations**

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Abstract

In this research, we propose a knowledge management architecture in a collaborative environment and service oriented organization. The architecture contains five components, including partners, knowledge bases, portals, pipes, and cloud. Each segment of knowledge which is created in partners' portals will be displayed in the cloud. The cloud contains knowledge from portals. Portals and the cloud will be linked by a specific type of connections (pipes), which presents the knowledge to the cloud without copying them.

We implement the proposed architecture online to prove its validity. The prototype that we examine has three partners including finance, insurance, and transportation. Each partner creates knowledge by using its portal and saving it in its own knowledge base (KB). Likewise, each partner has an access to other partners' portals to ask questions or perform inquiries. The answered questions are saved in the KBs and displayed in the cloud. For implementation, we use Joomla as CMS portals, K2 as KB in each portal, Yahoo Pipes as connections between the portals and the cloud. Finally, the cloud is a webpage that displays knowledge from different portals.

We demonstrate that the proposed architecture facilitates sharing knowledge among the partners in the VO, and prevents knowledge duplications in different KBs. Moreover, we could move the stored knowledge from KB to another by using backup feature the CMS portal if any partner want to leave or the VO decides to terminate.

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List of Abbreviations

CMS: Contents Management System

CN: Collaborative Networks

CNO: Collaborative Networked Organization

DS: Design Science

DSR: Design Science Research

DSRM: Design Science Research Methodology

EKC: Enterprise Knowledge Cloud

IaaS: Infrastructure as a Service

ICT: Information and Communication Technology

IS: Information System

IT: Information Technology

KaaS: Knowledge as a Service

KARe: Knowledge Agent for Recommendations

KB: Knowledge Base

KM: Knowledge Management

KMaaS: Knowledge Management as a Service

KMS: Knowledge Management System

MVNO: Mobile Virtual Network Operator

PaaS: Platform as a Service

RSS: Rich Site Summary

SaaS: Software as a Service

SECI: Socialization, Externalization, Combination, and Internalization

SME: Small and Medium Enterprise

SOA: Service Oriented Architecture

SOVO: Service Oriented Virtual Organization

TMS: Transactive Memory System

VC: Virtual Communities

VE: Virtual Enterprise

VL: Virtual Laboratories

VO: Virtual Organization

WCMS: Web Contents Management System

Chapter 1: Introduction

The involving of information technology (IT) in organizations has made their internal and external processes easier and faster. However, the IT-based applications generate a large amount of data in organizations which need to be managed. Moreover, with an ongoing trend in today's fast paced IT-based businesses, it will be more efficient and effective for small and medium enterprises (SMEs) to work in alliances, and form a collaborative network known as virtual organization (VO). The purpose of VO is achieving the goals within the required time, costs, and quality. The knowledge enablers in organizations might be human, organizations or technologies, or each of these entities, which usually include knowledge, skills, mechanisms and tools (Kim et al., 2005; Por & Molloy, 2000). Management of virtual organization consists of observing, controlling and coordinating activities and resources. In virtual organization, the data and information are especially required to be managed to store and share them in right time with the right person.

Virtual organizations have temporary and distributed behaviors. Lifecycle of the virtual organization vary from days to years (Loss, Pereira-klen, & Rabelo, 2005). Loss et al. (2005) define four basic difficulties that make VO knowledge management complex:

- The amount of knowledge of VO uses naturally is large.
- It is difficult in VO to choose which relevant information and lessons are successful or not.

- It is difficult to choose which and how information and lessons are used for decision-making.
- Knowledge in VO is usually shared among the VOs' partners, because each partner knows its own company knowledge, but rarely knows other partners' knowledge.

1.1 Research Problem

Due to the amount of knowledge that is being generated and shared within organizations and among partners in a virtual organization, if they are not managed properly, some might be lost, and some might be repeated. Moreover, it is an inefficient use of time and resources to repeat the same information or processes to perform the same activities. To illustrate, if the partner "A" asks partner "B" a question and B answers, the question and answer should be stored, managed, and accessed for future use again. Without a proper management of knowledge, the virtual organization cannot utilize this valuable asset in an efficient and timely manner.

1.2 Research Questions

In this research we attempt to answer the following questions:

1. How can knowledge be managed in a Service Oriented Virtual Organization (SOVO) as a collaborative environment? For example, how to store and share knowledge in SOVO?
2. What are the challenges of centralized vs. distributed knowledge management (storage) in SOVO?
3. How can the partner's private and competitive advantage be kept confidential while sharing certain public knowledge with its partners?

1.3 Research Problem Framing

Table 1 Framing Research Problem

Observation	<ul style="list-style-type: none"> • Knowledge of VO uses naturally is huge. • Difficult to choose which relevant information and lessons are successful or not. • How the information and lessons used for decision-making.
Thesis	VO knowledge is difficult and challenging to be collected because knowledge is distributed among partners, however by effective distributed knowledge management, it will be organized and useful.
Enthymeme	The KM in SOVO requires an infrastructure that can facilitate the collaboration among partners that assure the association and partnership. Also, assure the privacy within each partner.
Problem Statement	Design and implement an architecture for knowledge management in SOVO that manage the collaboration among partners, and maximize the cooperation publicly and maximize the privacy internally in each partner processes.
Objectives	Manage the knowledge in SOVO to reduce time, efforts, duplication and repeating of information, and maximize efficiency and effectiveness.
Research Questions	<ol style="list-style-type: none"> 1. How to manage knowledge in Service Oriented Virtual Organization (SOVO) as a collaborative environment? i.e. how to create, store, retrieve and share knowledge in SOVO? 2. What are the challenges of centralized vs. distributed knowledge management (storage) in SOVO? 3. How to keep the partner's private and competitive advantage confidential while sharing its public knowledge with its partners?

1.4 Research Objectives

We want to emphasize knowledge sharing and knowledge management in the virtual organization. The objective of this research is to design a suitable architecture, processes and interface to make knowledge sharing among partners in (SOVO) more manageable.

This architecture aims to be able to manage the knowledge that is transferred among partners in the virtual organization to be useful during the VO life. The management of knowledge includes creating, storing, transferring, applying, and retrieving.

The objectives:

1. Manage the knowledge that is transferred.
2. Reduce duplication and the repeating of information.
3. Maximize the benefits of using knowledge bases.

1.5 Methodology

1.5.1 Design Science Research Methodology (DSRM)

DSRM includes principles, practices, and procedures to achieve the objectives in information system (IS) research (Peffer, Tuunanen, Rothenberger, & Chatterjee, 2007). DSR “combines a focus on the IT artifact and a high priority on relevance in the application domain” (Hevner & Chatterjee, 2010). IS researchers started to introduce DS research in the early 1990s to the IS community and it is still evolving (Peffer et al., 2007).

There are two different paradigms in information systems research. These are behavioral science and design science (Hevner & Chatterjee, 2010). *Behavioral science* materialized from natural science that develops and justifies theories, while *design science* emerged from engineering and it is a problem-solving paradigm. Design science defines ideas, practices, and products through analysis, design, and implementation. There is a complimentary interaction between those two types of paradigms: design science provides utility to behavioral science while behavioral science provide theories to design science (Hevner & Chatterjee, 2010).

There are seven guidelines for DS in IS research developed in 2004 (Hevner, March, Park, & Ram, 2004). The main contribution of (Hevner et al., 2004) was how to conduct, evaluate, and present DS research to IS researchers (Hevner & Chatterjee, 2010). The guidelines are presented in Figure 1.

Guideline	Description
Guideline 1: Design as an Artifact	Design science research must produce a viable artifact in the form of a construct, a model, a method, or an instantiation
Guideline 2: Problem relevance	The objective of design science research is to develop technology-based solutions to important and relevant business problems
Guideline 3: Design evaluation	The utility, quality, and efficacy of a design artifact must be rigorously demonstrated via well-executed evaluation methods
Guideline 4: Research contributions	Effective design science research must provide clear and verifiable contributions in the areas of the design artifact, design foundations, and/or design methodologies
Guideline 5: Research rigor	Design science research relies upon the application of rigorous methods in both the construction and evaluation of the design artifact
Guideline 6: Design as a search process	The search for an effective artifact requires utilizing available means to reach desired ends while satisfying laws in the problem environment
Guideline 7: Communication of research	Design science research must be presented effectively to both technology-oriented and management-oriented audiences

Figure 1 DSR Guidelines (Hevner & Chatterjee, 2010)

1.5.2 Design Science Research Cycles

There are three design science research cycles that we have to identify and understand in any research design as shown in figure 2 (Hevner & Chatterjee, 2010).

These cycles are relevance cycle, rigor cycle, and design cycle.

Relevance Cycle: The output from DSR must be returned to the environment to see the effect of DSR on environment improvement. In this research we have SOVO project as a collaborative environment which is used for testing the architecture.

Rigor Cycle: The past knowledge must be involved to ensure the research innovation. In this research we use the past knowledge to design our architecture and share the results with others.

Design Cycle: This is the heart of DSR because it must be repeated rapidly between constructions, evaluation, and feedback. In this cycle, we implement our architecture and evaluate it in the context of a scenario.

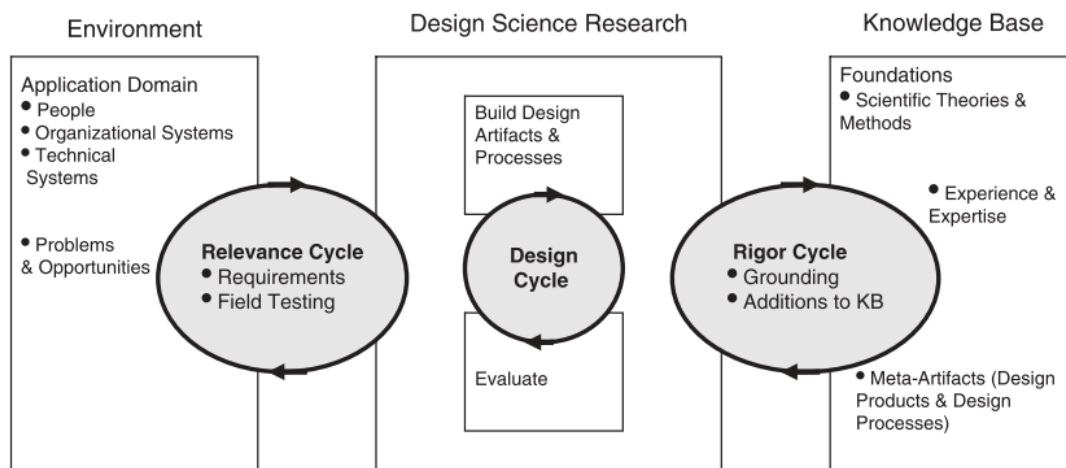


Fig. 2.2 Design science research cycles

Figure 2 DSR Cycle (Hevner & Chatterjee, 2010)

1.5.3 Research Activities

The DS research includes six activities or steps which are: problem identification, definition of the objectives, design, demonstration, evaluation, and communication (Peffer et al., 2007). The activities that follow in this research are:

1. **Problem identification.** We identify the problem of knowledge management in SOVO, and we justify the value of the solution that helps readers to follow the solution and accept the results easily.
2. **Definition of the objectives.** We infer the objectives that we want to get from identifying the problem and the solution. We describe in SOVO how the new solution supports the problem.

3. **Design.** We create an artifact that is construction and method to manage the knowledge in SOVO. This artifact includes infrastructure and procedure for knowledge management in SOVO. In this step we design architecture to manage knowledge in SOVO.
4. **Demonstration.** We use the artifact to solve one ore more cases from the problem in SOVO. In this step we implement the architecture and get the results.
5. **Evaluation.** We observe the collaboration among partners in the artifact that we designed and we compare it with other solutions. In this step we evaluate the architecture by testing a scenario. According to Hevner et al. (2004), there are five evaluation methods; one of them is descriptive method that includes scenario evaluation, which construct step-by-step scenario to demonstrate the architecture utility.
6. **Communication.** We share the results with others by publishing in conferences and journals.

In this research we follow the problem-centered approach that starts with activity number one. We modify the figure in (Peffer et al., 2007) and replaces its activities with ours in this research as shown in figure 3.

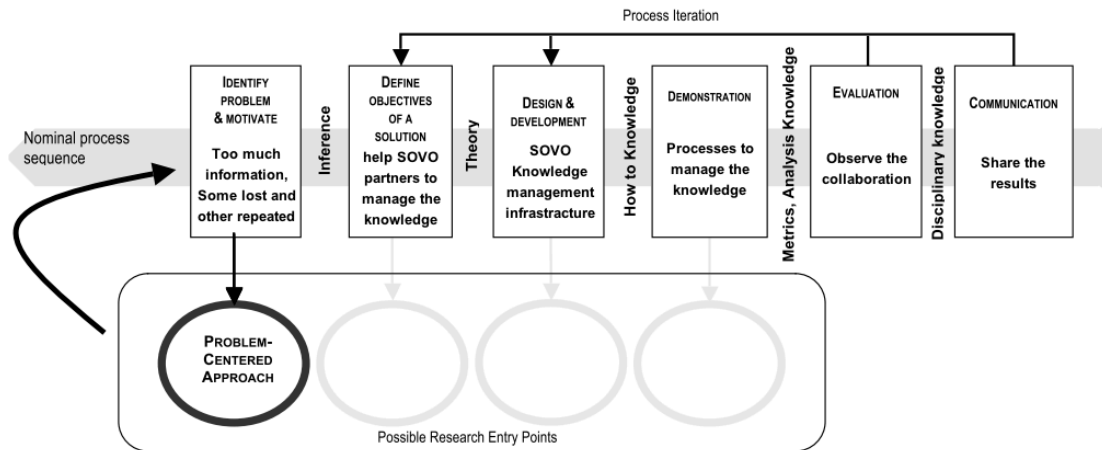


Figure 3 DSR Activities (Peffer et al., 2007)

1.6 Research Model

The main objective is building an architecture that manages the knowledge sharing in SOVO. Achieving this goal by improving an infrastructure that determines the tasks for each partner to publish the knowledge, use, store, retrieve, update, and modify it. The solution involves the management of knowledge inside the partner, among partners, and within SOVO.



In the conceptual framework shown in figure 4 we examine the factors that we have in our research and combine them to achieve the main goal. The factors include KM as a concept, Network as an environment, Knowledge Base as a tool, Partners as enablers, and SOA as a method of collaboration.

People appoint public knowledge using knowledge base, and it positively affects the internal knowledge within each partner and collaboration among partners.

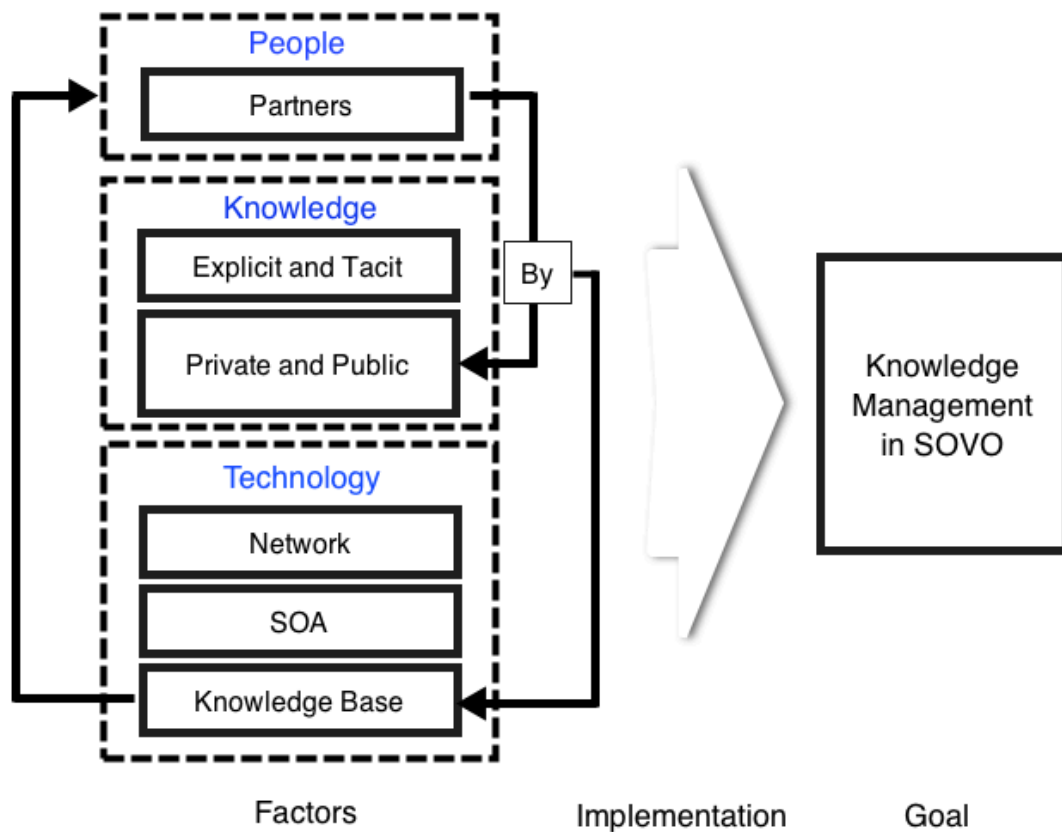


Figure 4 Conceptual Framework

1.7 Thesis Contribution

- In this research we propose an architecture that utilize the benefits while avoid the drawbacks of centralized knowledge base and distributed knowledge base.
- We use cloud concept to share the knowledge without copying it.
- We employ web 2.0 technologies to manage the knowledge in a collaboration environment.
- We use Mashups and Pipe to grab the knowledge from its source to virtual hub.

1.8 Thesis Structure

This research is organized in 5 chapters. In chapter 2, we review the literature by looking in depth at each term. We define CNOs and its associated types and we

discuss the VO and its lifecycle with its four phases. As well, we present the basic definition of SOA and its architecture. Then we move to SOVO definition that is our environment in this research and we follow its concept. In addition, we introduce the knowledge as a term, and then we discuss its origin and types and how it comes. Furthermore, we present the tacit and explicit knowledge and the relationship between them to create new knowledge, which is the spiral evolution of knowledge conversion. Also, we specify the knowledge management and KM in VO with its ecosystem. Afterwards, we present TMS and its components and sources as a basic idea of knowledge management. Moreover, we review KMS and its framework to give an initial idea about CMS. Also, we explain enterprise 2.0 from its web 2.0 origin, and its technologies and relationship with knowledge management. Next, we introduce CMS as a tool for knowledge management in organization and communities. Then we define the KM portal as a collaboration interface among partners. Finally, we define the knowledge base as a repository for information.

In chapter 3, we introduce a high level framework for knowledge management in collaborative environment; then, we present our proposed architecture for knowledge management. This architecture includes five components, which are partners, KBs, portals, connections, and the cloud. We present the architecture and define each component in more details. We compare between centralized KB and distributed KBs in terms of advantages and disadvantages. We then introduce Mashups as an application for knowledge management. Cloud computing also has been defined in this research because it has relationships with KM and Knowledge as a Service. Also, we demonstrate a scenario of the architecture processes and how the does the architecture works. In the end of this chapter we provide a solution in terms of changing partners or VO dissolution.

In chapter 4, we present a prototype implementation of the propose architecture and examine the architecture by testing a scenario. By displaying how we host our portals and cloud; also, how the portal works and how the knowledge that created in the portal display immediately in the cloud without copying it. We explain in details how we link the portals to the cloud by Pipes and how a partner asks a question to another partner to create new knowledge. In addition, we show the contents of the cloud webpage. In the end of this chapter, we demonstrate how we can take a backup from any portal and reinstall again in a new website.

In chapter 5, we conclude our research by providing a summary and contributions of the research. Afterwards, we present the publication the resulted from this research and limitations beside of future works.

Chapter 2: Literature Review

2.1 Collaborative Networked Organizations

Nowadays, working in alliances is one of the sources of power in the market. Collaborative networks (CN) is combining different entities such as people and organizations that are independent, physically distributed, and varied in operating environments (Camarinha-Matos & Afsarmanesh, 2005). CN exists in many types of forms, including collaborative networked organizations (CNOs), VO, virtual enterprises (VE), virtual communities (VC), and virtual laboratories (VL). The relationships of CNs are illustrated in Figure 5.

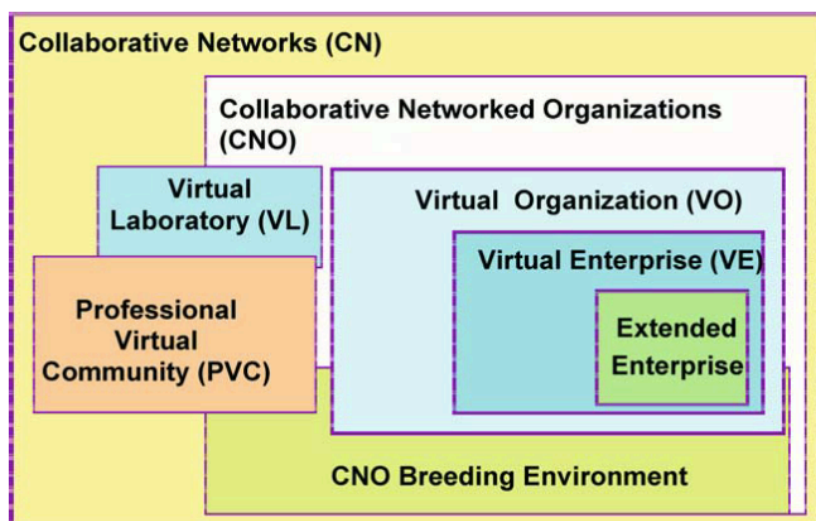


Figure 5 CNs Relationships (Camarinha-Matos & Afsarmanesh, 2005)

CNO is an alliance of organizations working in a collaborative network to reach common goals by identifying the roles and governance rules (Camarinha-Matos & Afsarmanesh, 2008).

VO is one form of CN and it is a temporary network containing people and/or organizations using information and communication technology (ICT) tools to achieve common goals (Jägers, Jansen, & Steenbakkens, 1998). There are four

versions of VOs: telecommuting, hot-desk environment, hoteling and virtual teams (J. Wang & Liu, 2011). VOs naturally have temporary and distributed behaviors and logically end after reaching its goals (Loss et al., 2005). VOs exist for a limited time and because of this fact they have a lifecycle that consists of four phases, which are foundation or creation, operation, evolution, and dissolution (Kim et al., 2005; KIT, 2007) as shown in Figure 6.

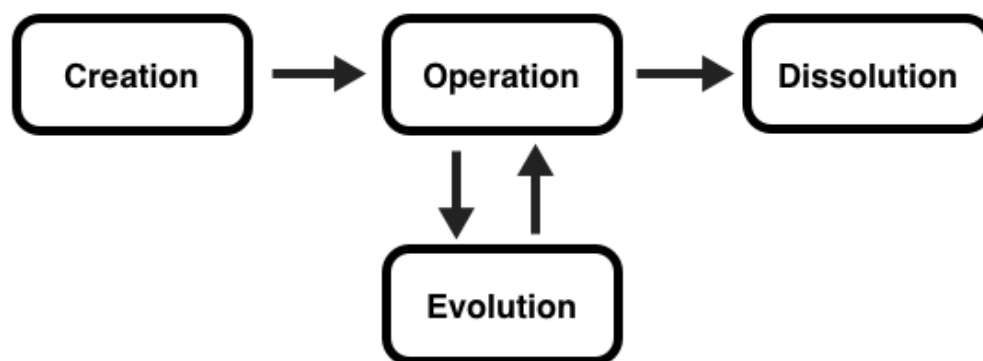


Figure 6 Virtual Organization Life Cycle (Kim et al., 2005)

Each phase of the VO lifecycle has many activities which are defined in the following paragraphs (Panken, Zoetekouw, Bokhove, & Hulsebosch, 2011):

Creation Phase:

Creation phase or “formation phase” is the first step to building a virtual organization. In this phase, the base for the VO is established. Moreover, members or partners who are involved in VO will be chosen, and each one of them will have a role or list of roles. After that, services that will be delivered and received will be identified, as well as their sources. At the end of this phase, each member or group has to have the right of access to certain services.

Operation Phase and Evolution Phase:

In some research, this stage is referred to as the operational and maintenance phase. In these two phases the tasks for each partner are given. Also, the use of services will begin, and during these two phases, which are the heart of VO, there are many changes in groups, partners, roles, tasks, services, and access rights.

Dissolution Phase:

Dissolution phase or “closure phase” is the stage in which VO is disbanded. The cause of the dissolution is because the target of the VO is achieved “or might be not” and the life of VO has ended. There are no activities in this phase other than some resources that have are shared among the partners for them to read, and this depends on the VO administrator.

2.2 Service Oriented Virtual Organization

Before we go through Service Oriented Virtual Organization (SOVO), we need to define one of the basic terms which is SOA that SOVO based on. Service Oriented Architecture (SOA) is an architectural style in systems, which contains service providers and service users (Bianco, Kotermanski, & Paulo Merson, 2007). The main components in SOA are a service provider, a service user, and the service itself as in Figure 7 (Haas, 2003). To illustrate, the provider of the service has to publish the service in the directory “or broker” to be available for users “or customer” to find it. Once the user has found the service, an interaction will be made between user and provider of the service.

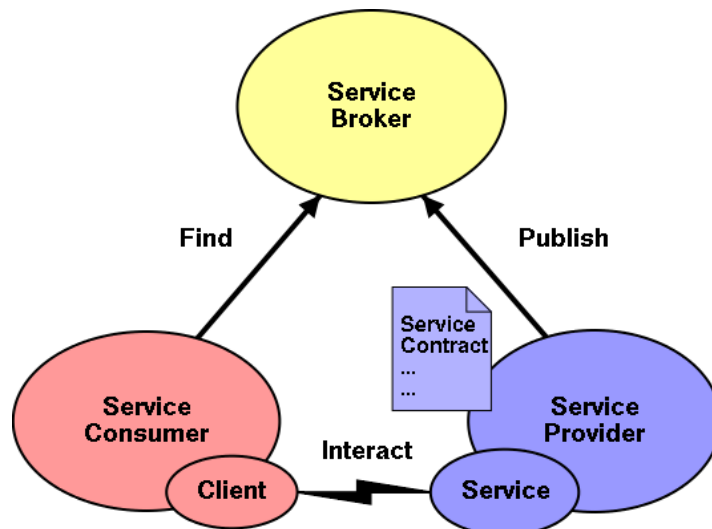


Figure 7 Service Oriented Architecture (Haas, 2003)

There are many business benefits of using SOA, such as agility, costs reduction, risk reduction, and global sourcing (Zimmerli, 2009). Also, instead of duplicating or building the same service or process in different departments within one organization or different organizations, the services could be built once and stored in a place, then used by many users that require the same processes and outcomes (InfoWorld, 2007)

One of the main benefits of SOA is agility as mentioned earlier. And because VOs are in a very dynamic environment, they need computer networks and information systems to accelerate the collaboration amongst partners (M. H. Danesh, Raahemi, & Kamali, 2011).

SOVO stands for Service Oriented Virtual Organization and “the focus in it is on sharing services between organizations and building collaborative processes on top of the organizational services” (Kamali, Richards, Danesh, & Raahemi, 2012). SOVO framework is built upon the best practices to ensure an effective service oriented process design as shown in Figure 8 (M. H. Danesh et al., 2011).

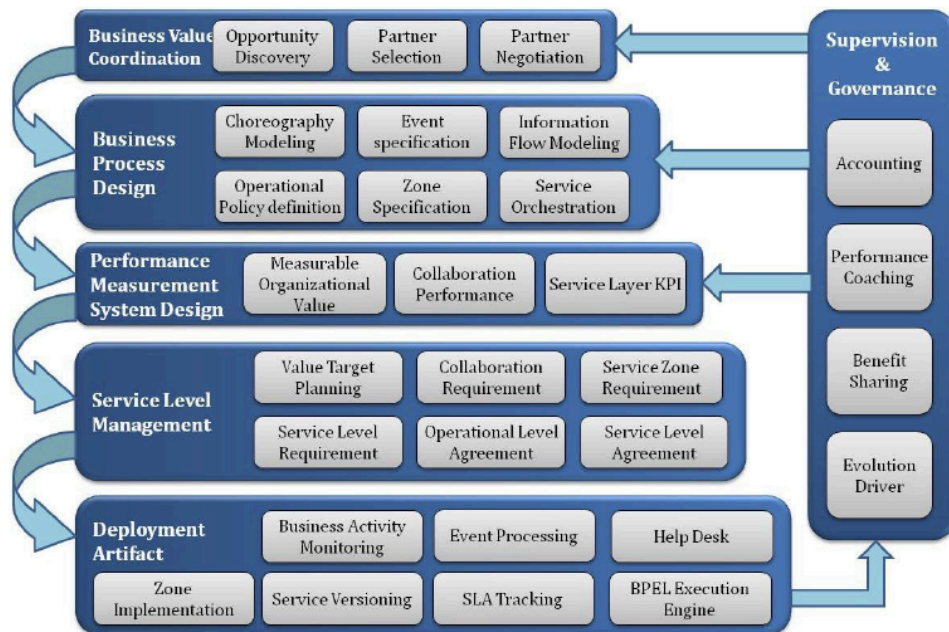


Figure 8 SOVO Process Management Frameworks (M. H. Danesh et al., 2011)

This framework depends on distributed management of the VO. Service zones within the organization shown in Figure 9 ensure that the services and processes of each partner are completely independent. “The service zone lets organizations share their cooperative services under rules and policies defined by VO business processes” (M. H. Danesh et al., 2011).

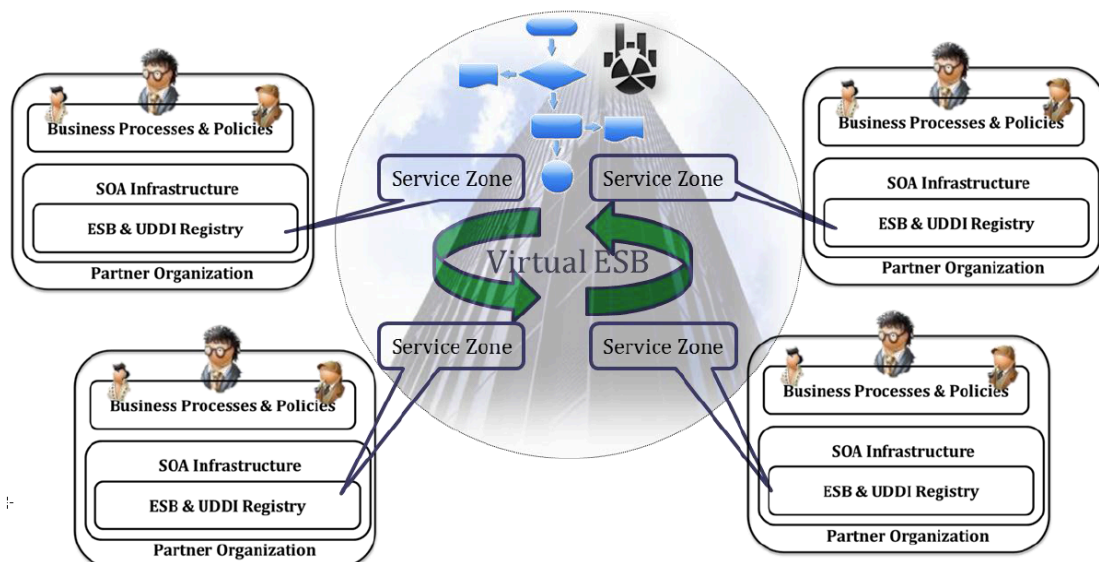


Figure 9 Virtual ESB Facilitating a Distributed SOA Infrastructure (M. H. Danesh et al., 2011)

2.3 Knowledge

Knowledge is defined as “facts, information, and skills acquired through experience or education” (Oxford Dictionary). To be more specific, knowledge is information with more meaning and power because it contains connections, comparisons, identifying consequences and understanding from experiences, studies, and collaborations (Servin & Brun, 2005). Knowledge is information and experiences that combined with context, interpretation, values, expert insight and reflection (Davenport, Long, & Beers, 1998; Davenport & Prusak, 2005). Davenport et al. (1998) added that knowledge is high value of information that is ready to apply in action. Knowledge is valuable because it is close to actions than information and can be used for decision making (Davenport & Prusak, 2005). Knowledge can be viewed from different perspective: a) a state of mind. b) an object. c) a process d) access to information. e) capability (Alavi & Leidner, 2001). Knowledge contains “tacit experiences, ideas, insights, values and judgments of individuals” (Taylor, Lacy, & MacFarlane, 2007). Information can be easy to store and retrieve when it is stored electronically, while knowledge is stored in the minds of people and is difficult to retrieve unless we ask the person who has the knowledge directly (Jackson & Klobas, 2007).

Knowledge is a factor of the wisdom hierarchy or DIKW hierarchy -knowledge pyramid-, which contains Data, Information, Knowledge, and Wisdom as shown in Figure 10 (Rowley, 2007). The DIKW hierarchy is used to describe the processes and transformation between its entities. The taxonomy of the DIKW hierarchy is defined by (Zeleny, 1987) as follows:

- Data: Know-Nothing
- Information: Know-What

- Knowledge: Know-How
- Wisdom: Know-Why



Figure 10 DIKW Hierarchy (Rowley, 2007)

Understanding moves up the hierarchy from Data to Wisdom (Taylor et al., 2007) as shown in Figure 11, and other research says that value also progresses up from Data to Wisdom (Rowley, 2007).

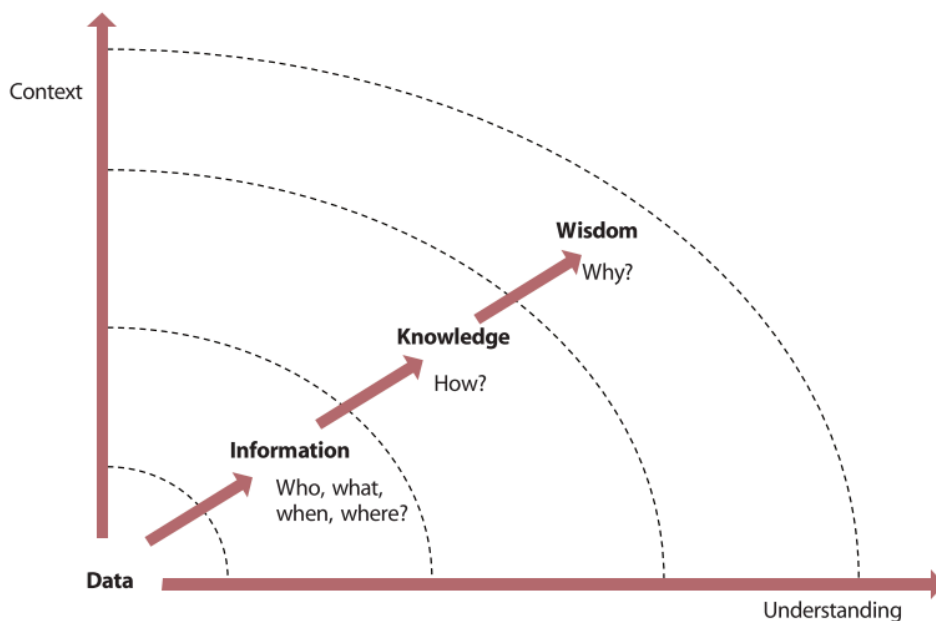


Figure 11 Flow from Data to Wisdom (Taylor et al., 2007)

2.3.1 Explicit Knowledge and Tacit Knowledge

Explicit knowledge is knowledge that can be captured and stored in documents such as procedures, best practices, and lessons learned, while Tacit knowledge is the knowledge that is captured in people’s minds and not easy to store in documents

(Servin & Brun, 2005). For instance, some employees refuse to share or transfer their knowledge because they received the knowledge from their experiences and they were able to land their job because they are experts (Jackson & Klobas, 2007).

There is an interaction between tacit and explicit knowledge that creates new knowledge. This is known as the SECI model, which stands for Socialization, Externalization, Combination, and Internalization (Nonaka & Konno, 1998; Nonaka & Takeuchi, 1995). All the conversion modes have processes and definitions, and are listed briefly in Table 2 and the Spiral Evolution in Knowledge Conversion in Figure 12.

Table 2 Knowledge Modes (Nonaka, 1991, 1994)

Mode	Process	Definition
Socialization	Tacit knowledge to Tacit knowledge	Sharing tacit knowledge between individuals.
Externalization	Tacit knowledge to Explicit knowledge	Translate tacit knowledge to be understood by others.
Combination	Explicit knowledge to Explicit knowledge	Integrate or link different knowledge to produce new knowledge.
Internalization	Explicit knowledge to Tacit knowledge	Individuals convert explicit knowledge into the organization's tacit knowledge.

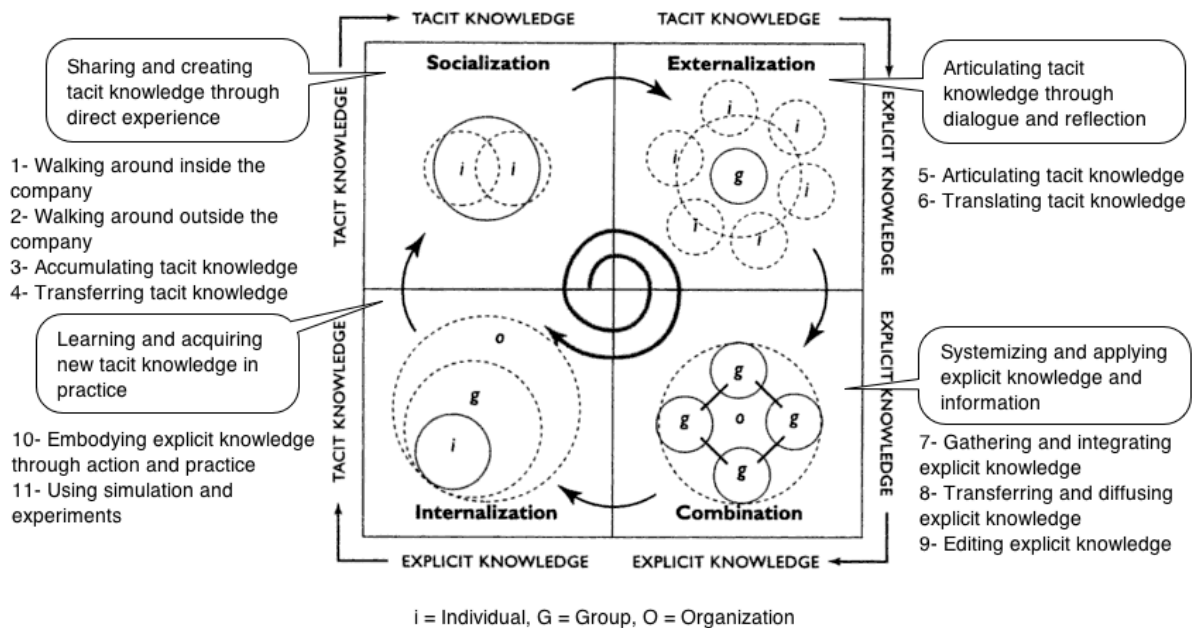


Figure 12 Knowledge Conversion (Nonaka & Konno, 1998; Nonaka & Takeuchi, 1995)

2.4 Knowledge Management

Knowledge Management “comprises a range of strategies and practices used in an organization to identify, create, represent, distribute, and enable adoption of insights and experiences” (Reza & Soheila, 2011). Also, it is defined as “the explicit and systematic management of knowledge and its associated processes of creating, gathering, organizing, diffusion, use and exploitation” (Anand & Singh, 2011). KM is applying knowledge in an organization to achieve goals, and to ensure that people have what they require when and where they need it –the right knowledge in the right place at the right time (Servin & Brun, 2005). However, the organizations have to consider that they should not transfer any vital knowledge that would create new competitors or give their competitors more advantages and power over them (Hamid & Salim, 2010). Knowledge management has four basic processes which are creating, storing / retrieving, transferring and applying (Alavi & Leidner, 2001).

Knowledge management incorporates several activities including data entry, database organization, and database consumption (Bojan, 2011). On the other hand, other researchers put KM into eight activities divided into three groups (Bibikas, Paraskakis, Vasconcelos, & Psychogios, 2009), which are:

- Knowledge development
 - o Knowledge creation
 - o Knowledge acquisition
 - o Knowledge capture
- Knowledge recombination
 - o Knowledge assembly
 - o Knowledge sharing
 - o Knowledge integration
- Knowledge use
 - o Knowledge leverage
 - o Knowledge exploitation

In (Yip, Hou, Ng, & Din, 2012), the authors define KM activities in yet another way, putting them in a cycle that consists of knowledge identification, acquisition, application, sharing, development, creation, presentation, and measurement.

In terms of the challenges and difficulties of KM, there is one challenge called “one-size-fits-all”. This happens usually in KM solutions (Fontaine & Lesser, 2002), which means if a solution is discovered, others want to copy it and apply it in a different situation. As an illustration, if we apply one solution without understanding the needs of the different partners, we will lose time and money because we are going to make changes on the solution to fit in another situation with another partner.

Knowledge management objectives defined by Davenport et al. (1998) as follows:

- 1- Create knowledge repository.
 - Some organization creates centralized storage; while others create distributed.
- 2- Improve knowledge access.
 - Facilitate knowledge transfer among individuals.
- 3- Enhance knowledge environment.
 - Improve awareness of knowledge management.
- 4- Manage knowledge as asset.
 - Treating knowledge like any other assets to profit from it.

In another research the knowledge management objectives are listed as follows (Taylor et al., 2007):

- Improve quality of service, increase satisfaction, and reduce costs.
- Ensure that, staffs have understanding about their services.
- Ensure that, accuracy of information at given time and location about the services.

2.5 Knowledge Management in Virtual Organization

Partners in a virtual organization could share expenses, processes and skills with each partner contributing its specialization (Pollalis & Dimitriou, 2008). Also, partners could share data, information, and knowledge to reach VO goals. “Virtual organizations are highly in need of controlled knowledge sharing among them” (Khoshnevis & Rabeifar, 2012). Any VO that strives to pursue knowledge management should follow these general knowledge management initiatives (Pollalis & Dimitriou, 2008):

- Create knowledge teams.
- Share the best practices.
- Develop a knowledge database.
- Create a knowledge center.
- Select and use of collaborative technologies.
- Create an intellectual capital team.

The value of KM in VO comes from a knowledge ecosystem that is comprised of people, knowledge and technology (Por & Molloy, 2000). The three components generate business and social value as shown in Figure 13.

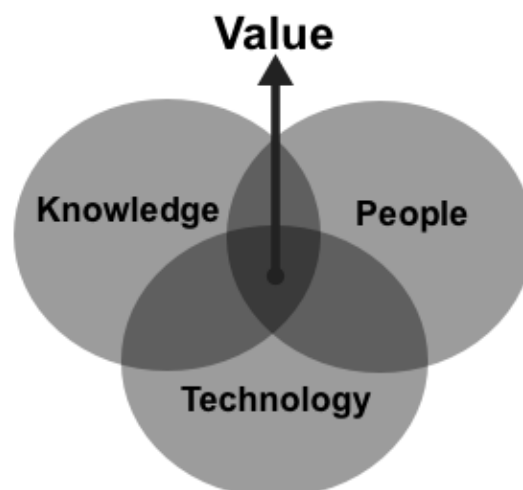


Figure 13 Knowledge Ecosystem (Por & Molloy, 2000)

In some cases, the knowledge ecosystem components are distributed. For example, people in different locations produce knowledge using different technologies. “Remote staffs” are one example of a distributed environment. Remote staffs in some organizations work out of sight, and they are less likely to receive information. As well, they are less likely to transfer information to others when they need it. In addition, they may have difficulty accessing information in the head office from their external location (Jackson & Klobas, 2007). In this research, the partners in SOVO

work as remote staffs, and we want them to work in a collaborative environment where they transfer and retrieve knowledge.

Knowledge management shifted the strategies in traditional business to new world of e-business (J. Wang & Liu, 2011). Wang and Liu (2011) add that there are three success factors about knowledge management 1) KM technologies deliver the right information to the right person at the right time, 2) KM technologies can store human experiences, and 3) KM technologies can distribute these experiences. The main goal of managing VO knowledge is that possibility to consult what happened in the past for similar cases (Loss et al., 2005).

In some VOs that make products, there are two types of data that need to be managed, business data and products data (Yoo & Kim, 2002). Yoo & Kim (2002) add that there are three types of knowledge as follows:

- Metadata: standards to describe data resources in application domain.
- Ontology: terms describing the domains.
- Mapping: methods for translating products data in different formats.

2.6 Transactive Memory System

TMS is a system to store and retrieve information and communications in a group (Hamid & Salim, 2010; Jackson & Klobas, 2007; Oguntebi, 2009; Wegner, Giuliano, & Hertel, 1985). Transactive memory can be defined as organized knowledge in group members' memories and a process that happened among the members (Wegner et al., 1985). In TMS, group members work together and each of them becomes familiar with who knows what. Furthermore, group members can get what they need whenever they need (Oguntebi, 2009). TMS comes from knowledge management

outcomes, which consists of creation, transfer, and retention the knowledge as in Figure 14 (Oguntebi, 2009).

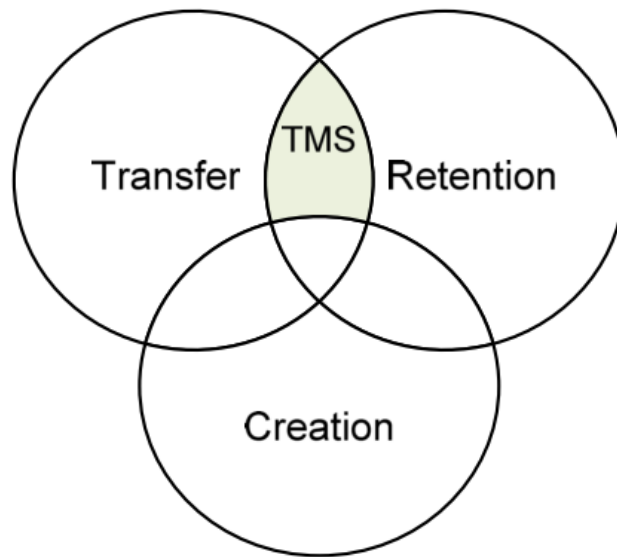


Figure 14 TMS Components (Oguntebi, 2009)

Working virtually has many difficulties and TMS can help to reduce these issues, along with reducing the extent of distributed information among the partners. Usually, working virtually places a lot of pressure upon the partners because they are demanding time. Fortunately, TMS helps to save time (Riedl, Gallenkamp, Picot, & Welp, 2012). In TMS there are three sources of knowledge which are classified as knowledge, collaboration knowledge, and tacit knowledge as in Figure 15 (Yong Liu & Zhong, 2011).

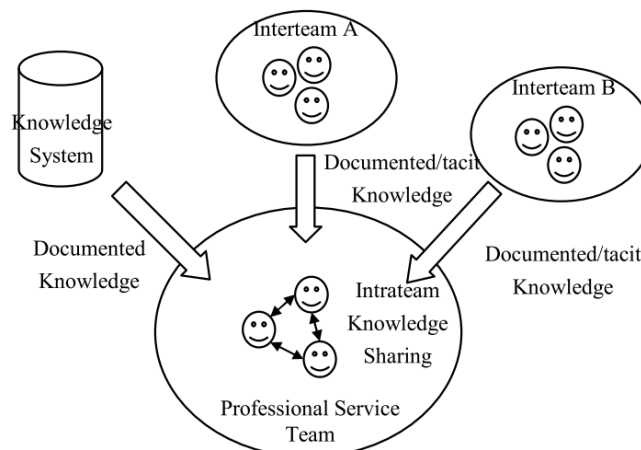


Figure 15 Knowledge Sources in TMS (Yong Liu & Zhong, 2011)

2.7 Knowledge Management System

KMS is a system which helps a community find the best practices in knowledge services to achieve the goal (Abdullah, Eri, & Talib, 2011). Specifically, KMS is a system that helps an organization to create, store, share, locate and retrieve knowledge to improve collaboration and knowledge processes (Frost, 2010). KMS is IT-based systems support the processes in organization for knowledge management processes (Alavi & Leidner, 2001). KMS maintains the knowledge base to distribute knowledge among employees within an organization (Faris, Totaro, & Corallo, 2011). There are three common applications that manage organization knowledge, which are sharing best practices. Creating knowledge directory, and creating knowledge network (Alavi & Leidner, 2001). Faris et al. (2001) introduce a framework for KMS as shown in Figure 16 that improves the collaboration among workers to save time and effort by making the knowledge available wherever and whenever it is required.

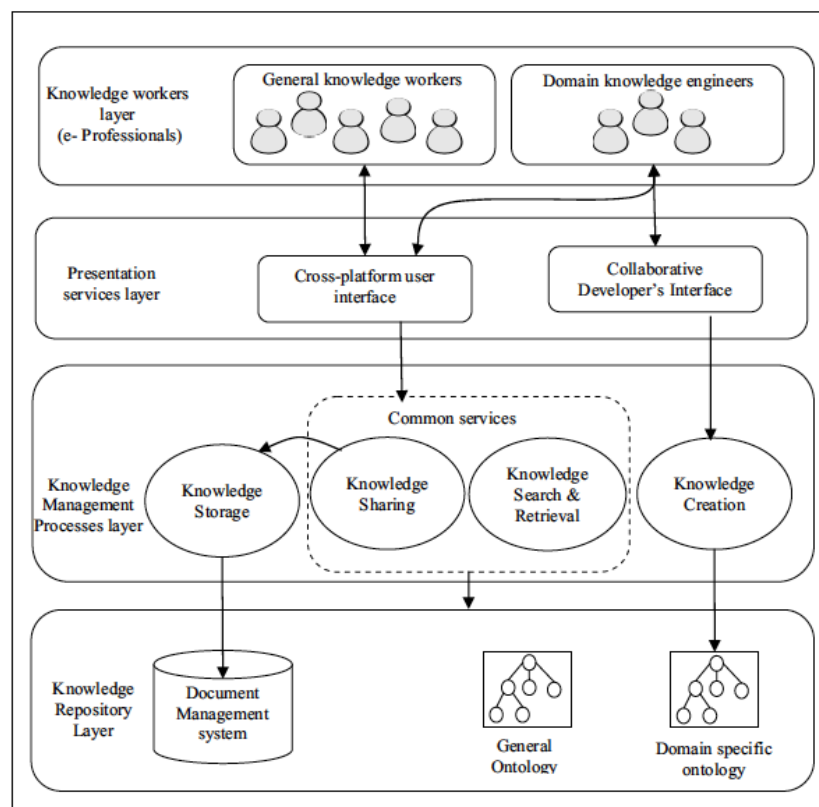


Figure 16 KMS Framework (Faris et al., 2011)

For services organizations, KMS helps reduce the costs of managing the services by increasing the efficiency and reducing the risks (Taylor et al., 2007). Taylor et al. (2007) add that service provider most establish KMS to be shared, updated and used by workers, partners and customers. Figure 17 shows an architecture of service KMS.

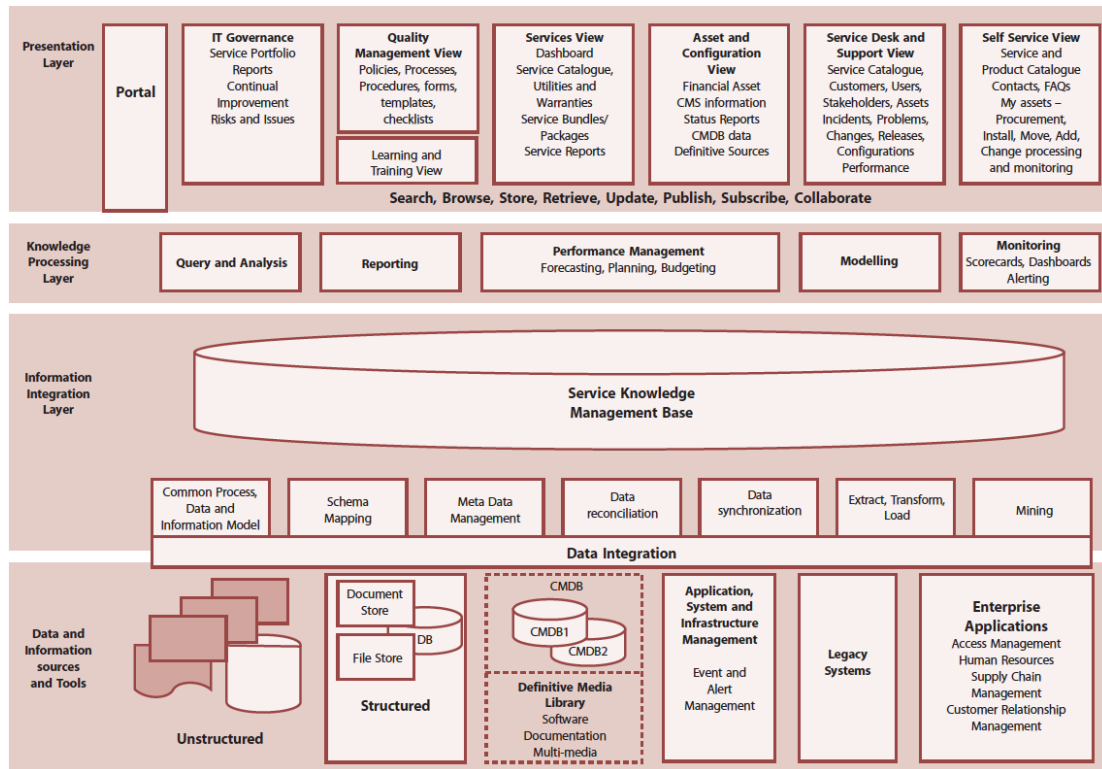


Figure 17 Service KMS (Taylor et al., 2007)

For explicit knowledge, IT is powerful tools to creating, sharing, application, validation and distribution; however, sometimes the same tools will be not able to deal with tacit knowledge (Tiwana, 1999). Tiwana (1999) add that KMS is not enabler of knowledge and it should be related with the organization that wants to apply it. KMS has four main components, namely, repositories, collaborative platforms, networks, and culture. According to Tiwana (1999), KMS architecture provides guideline to choose technology components that share knowledge in distributed environment effectively. KMS archicticrue has seven layers as shown in figure 18.

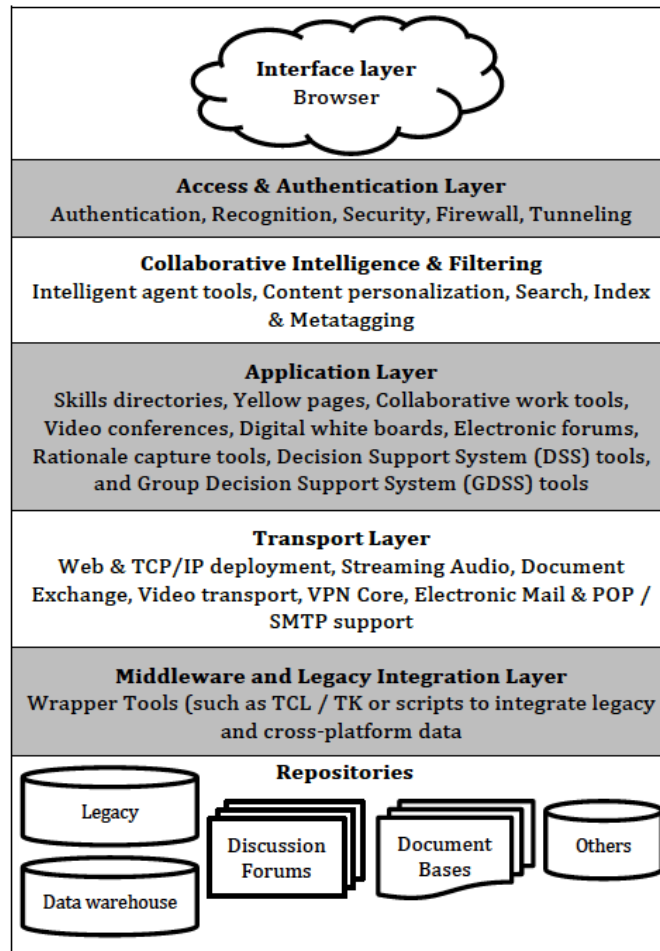


Figure 18 The seven layers in the knowledge management system architecture
(Tiwana, 1999)

According to Lindvall et al. (2003), different types of technologies should support knowledge management for creating, storing, indexing, classifying, and retrieving information; and collaborating and applying knowledge. Figure 19 shows different layers that contain technologies as KMS architecture.

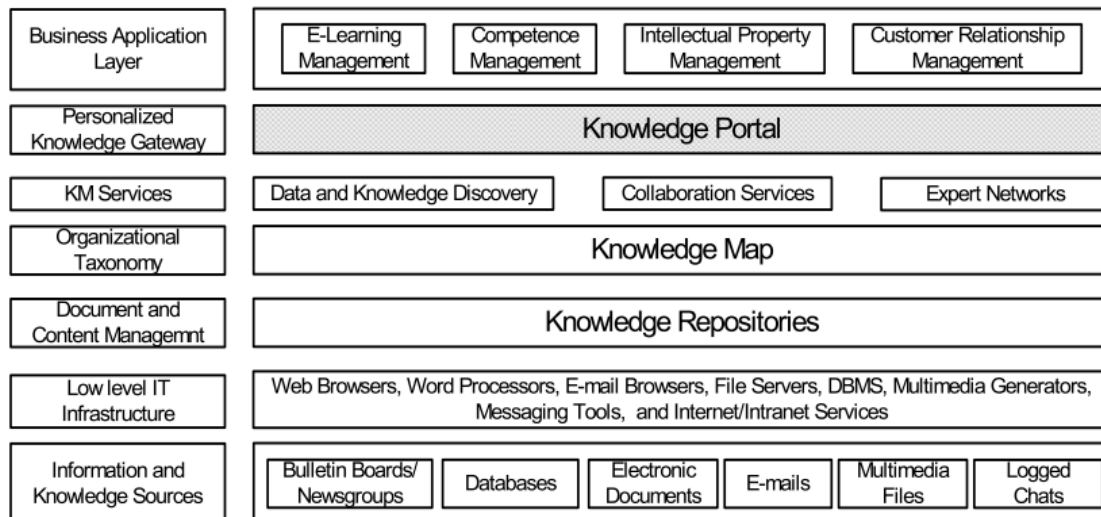


Figure 19 KM Architecture Model (Lindvall, Rus, & Sinha, 2003)

Chua (2004) developed a three-tiered KMS architecture that identifies three services supported by KM technologies as shown in figure 20. The architecture contains infrastructure, knowledge, and presentation services.

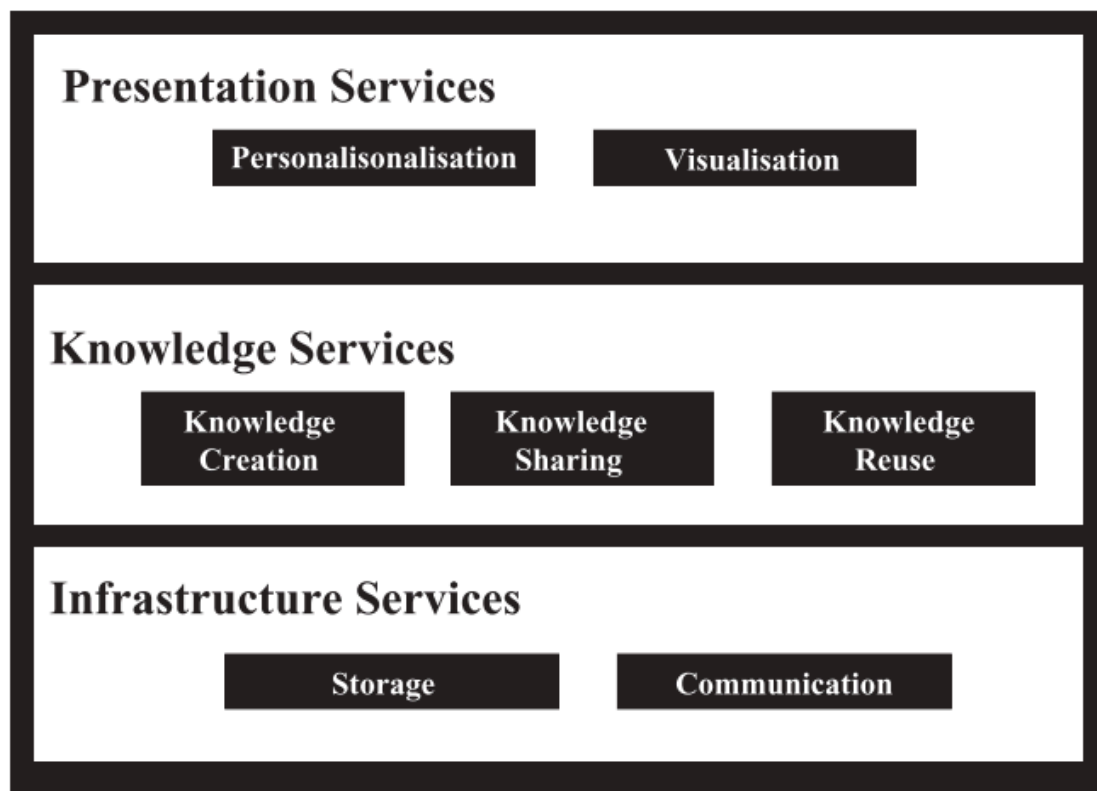


Figure 20 KMS architecture (Chua, 2004)

2.8 Enterprise 2.0

Enterprise 2.0 uses social software platforms within organizations or between organizations, customers and partners (Mcafee, 2006). “Enterprise 2.0 means a broad base of workers becomes engaged, adding a strong bottom-up component to management” (Valayer, 2010). Enterprise 2.0 uses Web 2.0 technologies to simplify processes within a company, improve collaboration, and connect people by using social media (Velev & Zlateva, 2012a). One survey pertaining to enterprise 2.0 produced several definitions of Enterprise 2.0 (Aiim, 2008), and some of the definitions are as follows:

- The application of Web 2.0 technologies in the enterprise.
- The next generation of Enterprise Content Management Technology that enables people to collaborate and/or form online communities.
- The use of emergent social software platforms within companies, or between companies and their partners or customers.

Enterprise 2.0 facilitates the applications of Web 2.0, enables people in the organization to communicate, enables partners outside of the organization to communicate, manages the internal information system, offers new methods of knowledge management, enables business agility, facilitates transparency, and enables the customization of sources (Balasubramanian, 2012; Velev & Zlateva, 2012a). Enterprise 2.0 helps businesses to solve the challenges because business has become a network, improves business performance, innovates the business, and mitigates the risks; also, to improve collaboration, knowledge sharing, search and discovery (Mcafee, 2006; Valayer, 2010). “Enterprise 2.0 aims to help employees, customers and suppliers collaborate, share, and organize information” (Balasubramanian, 2012).

2.8.1 Enterprise 2.0 knowledge management

In any VO, communication and collaboration are mandatory, and these activities produce information that has to be captured, stored, and shared. By using enterprise 2.0 to manage the knowledge within, any organization will be able to connect employees, connect employees to knowledge assets, and connect those who know the knowledge to those who need it (Velev & Zlateva, 2012a).

“Enterprise 2.0 is the perfect environment where KMS can run smoothly” (Velev & Zlateva, 2012a). “The emergence of the Web 2.0 and social networks provide a great opportunity for knowledge acquisition, sharing, learning, and eventually leading to enterprise intelligence” (Khoshnevis & Rabeifar, 2012). There are different technologies that are used to manage knowledge, such as wikis, collaboration portals, blogs, cloud computing applications, shared spaces, mashups, and knowledge bases. We explain some of these technologies in details in the next sections.

2.8.2 Knowledge Management Mashups

Mashups (sometimes called Web Application Hybrid) is “a Web application, in which the user can autonomously combine Web services, data and further content” (Bitzer, Ramroth, & Schumann, 2009). Mashups are applications that reuse and combine data and services available on the web (Grammel & Storey, 2008). Essentially, Mashups are a way to extract data and information from different sources, such as websites, and combine them into a single webpage.

Using Mashups to manage knowledge within an organization has been used for a few years. Some researchers introduce framework or infrastructure for using Mashups in knowledge management. For instance, (Zhu & Meza, 2010) create enterprise Mashups to combine reports from the Lab and Intranet People Finder into one single web page. This combination helps users to follow up on the latest reports and

developments in the lab. Another example, (Bianchini, Antonellis, & Melchiori, 2009) present a technique to help with searching Mashups components and their composition. This technique selects components from the web and defines event operations association with mapping.

To employ Mashups, information from different sources on the web could be retrieved by Pipes, RSS, and other ways to build one single website that combines diverse sets of knowledge. Pipes is “a free online service that lets you remix popular feed types and create data Mashups using a visual editor” (Yahoo, n.d.). Pipes could be used to run web projects, or publish and share web services without ever having to write a line of code (Yahoo, n.d.). The architecture of Pipe is produced by (Yan Liu, Liang, Xu, Staples, & Zhu, 2011) as shown in Figure 21, retrieving information is done by using filters with Pipes. There are many tasks for filters such as assorting data, joining records, forking, or removing unnecessary data.

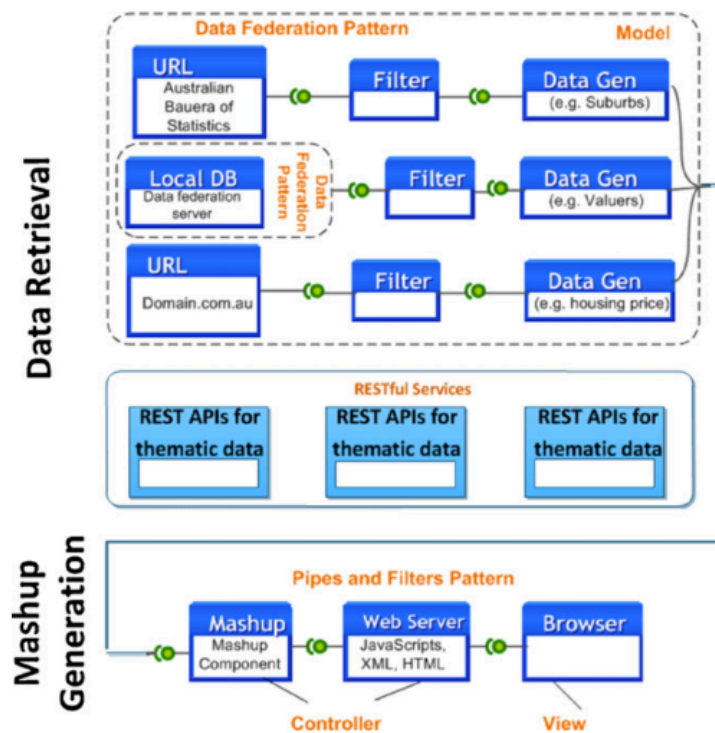


Figure 21 Mashups Pipes and Filters (Yan Liu et al., 2011)

Because of the similarities between Mashups and KMS, Bitzer et al. (2009) suggest integration between Mashups components (Figure 22) and KMS architecture to improve knowledge activities as shown in Figure 23.

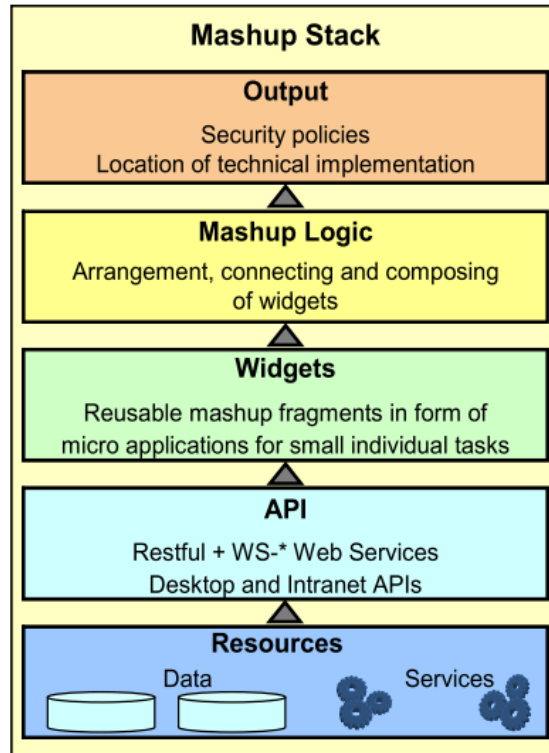


Figure 22 Mashups Stack (Bitzer et al., 2009)

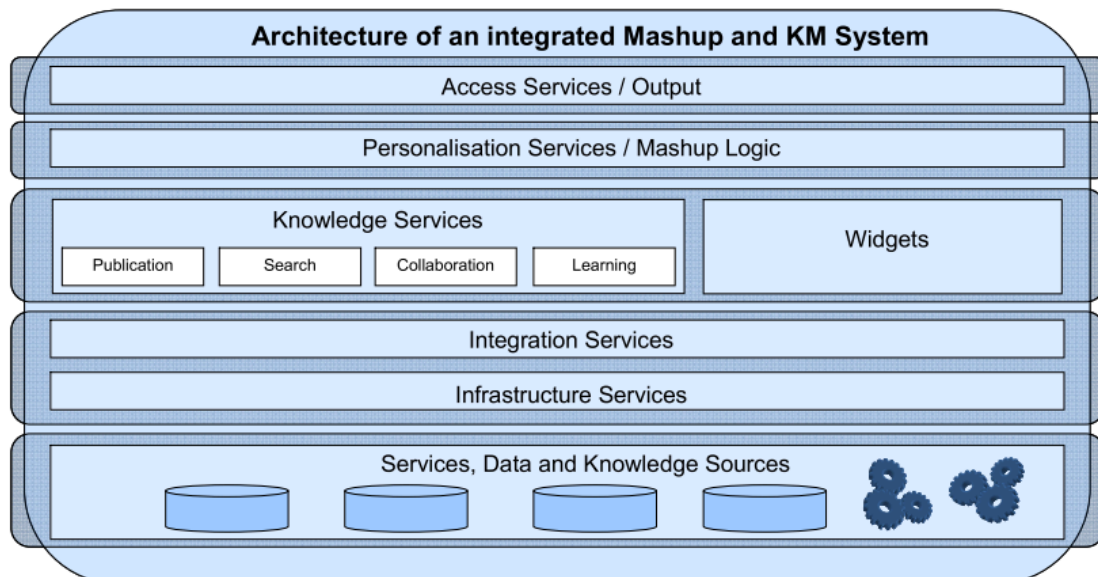


Figure 23 Mashups and KMS frameworks Integration (Bitzer et al., 2009)

Furthermore, using RSS is very valuable for knowledge management. RSS keeps workers up to date, because it pushes data to the subscribers (Dunay, 2006). In

(Dunay, 2006), the author divides the RSS subscriptions into two ways: inside the enterprise where the workers can read and comment within the organization among groups, the other way is RSS subscription from outside the enterprise such as a subscription to shipment delivery information

2.9 Content Management System

CMS is a system that allows to users to collaborate, interact, and control content through an interface (Johnston, 2011), such as Joomla, Drupal and WordPress. Joomla is a free open source CMS that enables users to build their own websites and customize the look to resemble a corporate portal, online reservation, government application, or community-based portal, among others (Joomla, n.d.). Drupal is “a free software package that allows you to easily organize, manage and publish your content, with an endless variety of customization” (Drupal, n.d.). CMS software enables organizations or individuals to build their websites in many different environments to create and share information. CMS is not only for building large websites, but also it collect, manage, and publish information in websites (Boiko, 2002).

Since the web has become the chosen way to share the contents, CMS should be called Web CMS or WCMS (Browning & Lowndes, 2001). WCMS is a web application that enables users to collaborate to organize the contents of different departments within an organization, and the contents could be text and multimedia (Hong Kong Government, 2008). CMS has four categories as shown in Figure 24, which are (Browning & Lowndes, 2001):

1. Authoring: Create web contents within authorizing environment.
2. Workflow: Manage the steps from authoring to publishing.

3. Storage: Store the contents.
4. Publishing: Deliver the contents.

There are different types of CMS, which depend on the nature of the contents (Rockley, 2003). The types are:

1. WCMS: Creating of web contents.
2. TCMS: Managing e-commerce transactions.
3. IDMS: Managing integrated enterprise documents and contents.
4. PDMS: Managing organization publications.
5. LCMS: Managing web-based learning contents.
6. ECMS: Managing enterprise contents and publication or managing contents and their transactions.

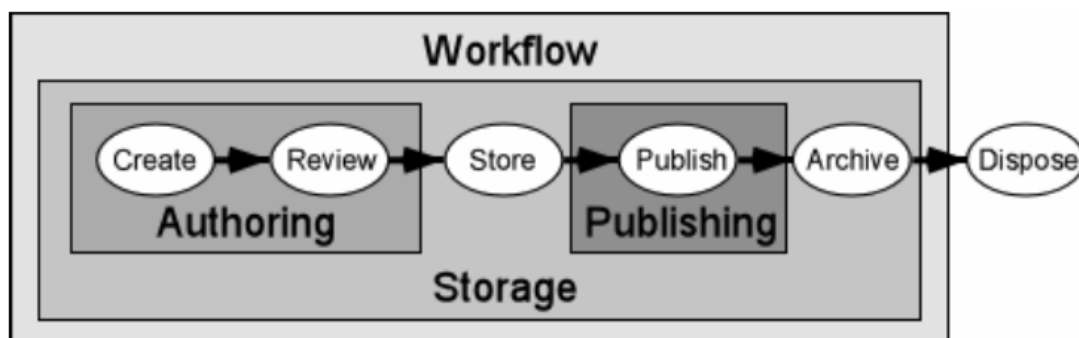


Figure 24 CMS Categories (Browning & Lowndes, 2001)

2.10 Cloud Computing

Cloud computing is the delivery of computing resources such as applications or data over the Internet (IBM Cloud, 2013). Also, can be defined as a “model for enabling convenient, on-demand access to a shared pool of configurable computing resources” (Khoshnevis & Rabeifar, 2012). Cloud computing is divided into three services which are Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS). In addition, it includes different models in terms of privacy, such as public cloud, private cloud, and hybrid cloud which contains the first two models

(IBM Cloud, 2013), however, (Khoshnevis & Rabeifar, 2012; Sriram & Khajeh-Hosseini, 2010) add one more model which is community cloud and the hybrid cloud contains all three types public, private, and community cloud as shown in Figure 25. There are five key characteristics of cloud computing: on demand service, accessibility, pooling, elasticity, and measure the service (Mell & Grance, 2011).

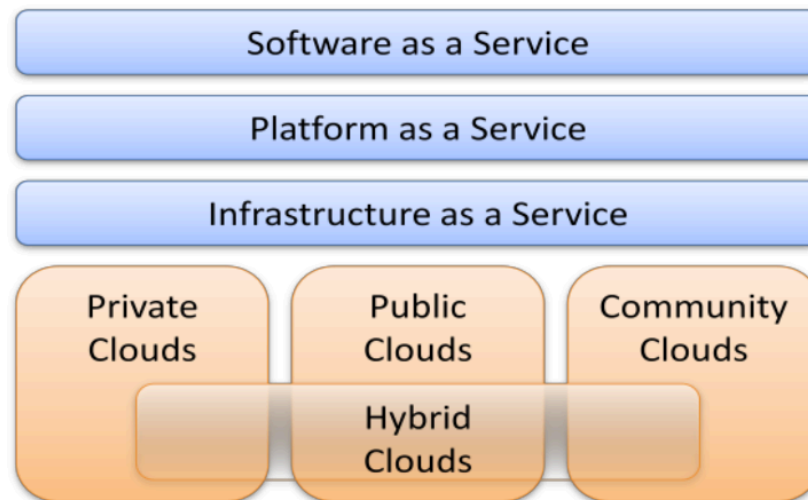


Figure 25 Cloud Computing Models (Khoshnevis & Rabeifar, 2012)

2.10.1 Cloud-Based Knowledge Management

The main feature for cloud computing is that services that includes software or information that can be accessed from any device connected to the network. This meets the demand of knowledge management especially for employees who are not in one location (Velev & Zlateva, 2012a). In some organization, the knowledge has to be available from outside the boundaries for such as partners, customers, or market. The cloud KM helps the organization to store the tacit knowledge, such as experiences and lessons learned, so that it is available for employees (Khoshnevis & Rabeifar, 2012).

One of the features of cloud KM is that it has a built-in redundancy, which means if one of the services or servers suffers an outage, it will not cause the whole network to go down (Velev & Zlateva, 2012b). In (Delic & Riley, 2009), authors describe the cloud KM as Enterprise Knowledge Cloud (EKC), which is “a collaborative,

cooperating, competing mega-structure providing computing, networking and storage and producers services to various ‘knowledge procedures and consumers’ – being devices, people and applications”.

Many researchers have introduced knowledge in a cloud recently. Kloud is one of the research outcomes that is contributed by (Sathyadevan, 2012). Kloud is a system that gathers information assets and centralizes them in organized way with respect to consumers’ needs. Kloud has three main components which are Central Content Directory Management Cloud, Central Content Scavenger and Aggregator Platform, and Content Aggregator and Broadcast Agent. (H. Wang, Zhao, & Kong, 2010) propose cloud library knowledge sharing based on cloud computing, which lets users build knowledge about papers, books and documents and share them together. The cloud will combine many users from different libraries from colleges and universities.

2.10.2 Knowledge as a Service

Knowledge retrieval in organizations may happen between knowledge seeker and the partner who has the knowledge or it may be retrieved from directories (Jackson & Klobas, 2007). There are many platforms that offer online collaboration among organization workers. One of these technologies is Microsoft SharePoint which is “a new ways to share work and work with others, organize projects and teams and discover people and information” (SharePoint, 2013). The aim of cloud computing is to deliver everything as a service, even knowledge as a service KaaS and knowledge management as a service KMaaS (Khoshnevis & Rabeifar, 2012). KaaS “integrates knowledge management, knowledge organization, and knowledge markets” (Abdullah et al., 2011). Also, Abdullah et al. added, “KaaS is programs as a system that provide content-based (data, information, knowledge) as organizational outputs (e.g., advice, answers, facilitation), to meet person or external user wants or needs.”

KaaS paradigm contains three types of participants, which are data owners, a service provider, and knowledge consumers (Xu & Zhang, 2005) as shown in Figure 26.

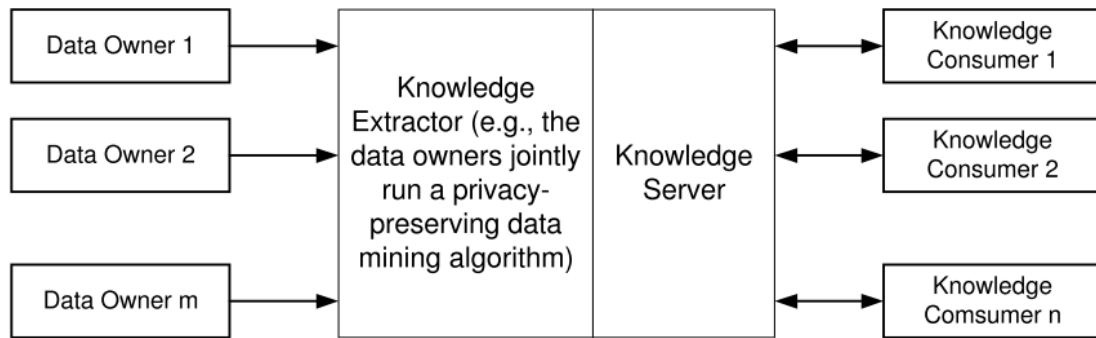


Figure 26 KaaS Participants (Xu & Zhang, 2005)

KaaS is SaaS but provided by a knowledge service provider (Khoshnevis & Rabeifar, 2012). Also, in (Khoshnevis & Rabeifar, 2012), the authors add that KMaaS that provides knowledge management services to consumers, and KaaS is part of KMaaS. There are many services have to be provided by KMaaS as shown in Figure 27. KaaS in a cloud is not just storage space to store information, it should also be able to provide more than just a search engine and information repository (Tsui, Cheong, & Sabetzadeh, 2011). Also, they add that KaaS should advise the users about the relevant information to meet their needs and provide expert opinions about the information searched.

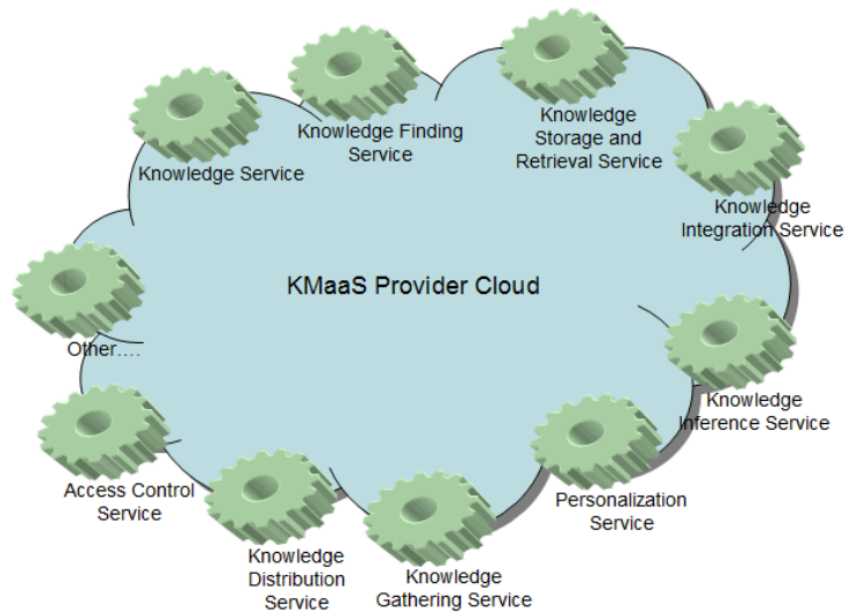


Figure 27 KMaaS Services (Khoshnevis & Rabeifar, 2012)

2.11 Knowledge Management Portal

Knowledge management portal is a significant factor in many organizations that is based on experiences and lessons learned. The workers in those organizations need to access a portal to learn and collaborate, and this portal can be in a cloud (Velev & Zlateva, 2012a). A portal is a website that provides access to all types of information on specific interests and needs in single place (Natarajan, 2008). The portal links many KM repositories inside the organization or outside in a logical way in a single source to simplify the decision and policy-making. In (Natarajan, 2008), the author divides the portals into two types which are horizontal portals and vertical portals. The horizontal portal is a general portal that contains information and services from different sources. On the other hand, the vertical portal, “also know as Vortal,” contains information in a specific area in the industry. Knowledge portal is also defined as knowledge exchange protocol, which is provides wide access to corporate knowledge and encourages inter-organizational collaboration (Pollalis & Dimitriou, 2008).

Knowledge management requires acquisition, synthesis, and knowledge creation, and portals to support storage, distribution, and usage processes (Benbya, Passiante, & Aissa Belbaly, 2004). The typical components of the knowledge management portal as follows (Rajan, 2011):

- Accessible to the employees based on standard authentication options.
- Load contents in various standard formats.
- Validate the content and approve the content to be usable for a large audience.
- Searches could be allowed based on document title or internally generated numbers.
- Advanced social networking features like sharing, tagging.

K-station is one of the solutions that solves knowledge management issues in organization. K-station is a portal to link people together in virtual places to access things they need (Lotus, 2000). Workers in K-station can locate, share, and transfer knowledge in a collaboration environment within the organization or across their boundaries.

2.12 Knowledgebase

KnowledgeBase (KB) is a collection of rules, facts, documents and experiences related to real life within an organization and with other organizations (Adnan, Islam, & Hossain, 2011; Navarro & López, 2009). A knowledgebase or a repository helps workers to share experiences with each other (Guimaraes, 2009). KB is a centralized repository for information used to enhance information collection and retrieval (Rouse, 2007). KB has information that can be useful for users, help desk analysts, and management teams (Brown, 2012). That means KB works as a database, however

for knowledge management it contains information with value (finalized) that is ready to be shared with others.

Chapter 3: Proposed Knowledge Management Architecture

In this chapter we propose a framework for knowledge management in a collaborative environment; also, we propose architecture for knowledge management in SOVO. The framework is a high level architecture for KM in collaborative environment. The architecture depends on the main concept of VO that working in a distributed environment. Moreover, it includes the concept of KaaS which depends on cloud computing. Furthermore, we combine the idea of centralized KB and distributed KBs by using KB in each partner's organization and using a cloud between partners to share knowledge. Also, we use a tool to push the knowledge from the partner's KB to the cloud without copying it, which helps us to keep the original knowledge in its source. In addition, this tool helps us to avoid the duplication and repeating of knowledge.

3.1 Knowledge Management System Framework

In this section we introduce a general framework to manage knowledge in organizations that working in a collaborative environment. This framework is based on different KMSs described in section 2.7.

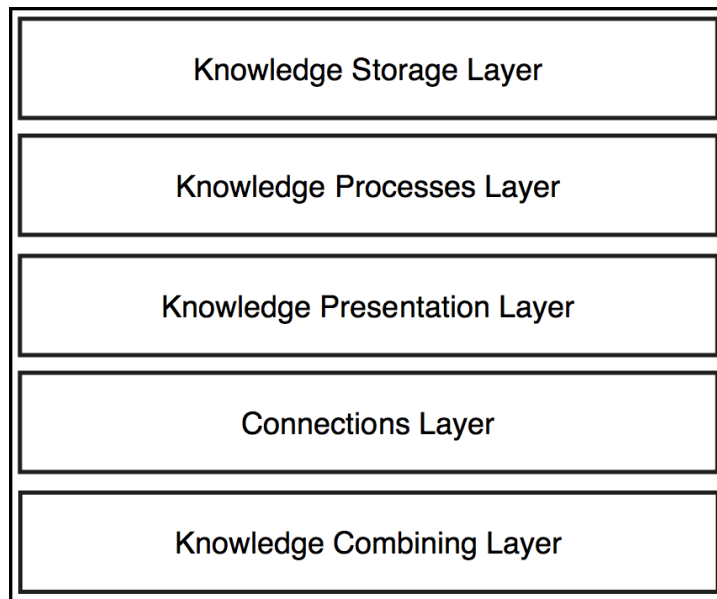


Figure 28 Knowledge Management System Framework

This framework has five layers that have technologies to manage knowledge in a collaborative environment. To give more clarity, we explain each layer:

1- Knowledge Storage Layer

This layer works as knowledge repository to store knowledge in each organization in the VO. Storages could be knowledge bases or data bases to store multimedia, documents, files, experiences, knowledge, and directories.

2- Knowledge Processes Layer

The second layer in this framework is for performing processes on knowledge such as sharing, publishing, and modifying.

3- Knowledge Presentation Layer

This layer includes technologies to present knowledge; also, this layer could have an interface to perform collaboration processes. Users could do some knowledge activities such as browsing, searching, retrieving, subscribing, and asking questions.

4- Connections Layer

To send knowledge from interfaces to combining layer, we have to link it to be

displayed. RSS, web services, web applications, XML, and APIs could link the interface with the next layer.

5- Knowledge Combining Layer

The last layer is combining layer that for collect all knowledge from different partners and display them to read and use. The knowledge could be displayed by using Mashups, KaaS, and PaaS.

3.2 An Example Scenario

In this section we investigate a small scale of collaboration in a VO. In this scenario we understand the importance of knowledge management in VO. As shown in Figure 29 we have a Wireless Service Virtual Organization that offers one package of services which includes cell phone, wireless services and data plans. This company is Mobile Virtual Network Operator (MVNO), which is a company provides mobile phone services, but does not have an infrastructure or licensed frequency allocation of the radio spectrum (MVNO Dynamics, n.d.). The VO in this scenario has a contract with cell phones vendor (i.g. Apple) to sell their products to customers. Also, it has a contract with a wireless company (i.g. Rogers) to sell their services. The most important thing in this VO is that customers should get a cell phone and service plan together.

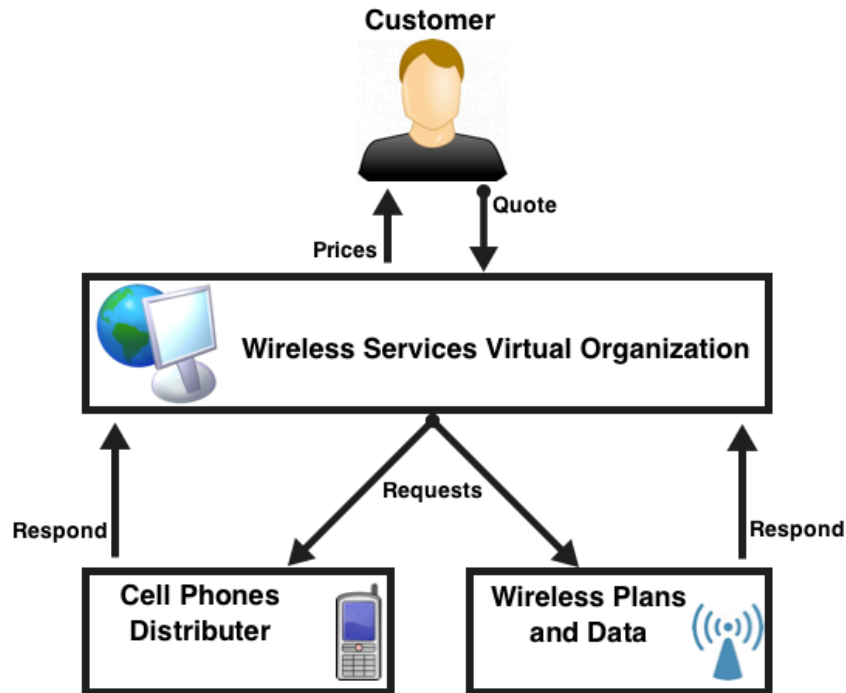


Figure 29 The Example Scenario of Wireless Service Virtual Organization

The steps of the scenario:

1. Customer go to the MVNO website and pick a suitable cell phone and choose a service plan.
2. Once the customer chooses them, he/she could submit the order (quote).
3. The website agent (machine or human) sends inquiry to the two companies which are Apple and Rogers and ask them to get last prices and specifications.
4. Once the agent gets the answer, it will give the customer the prices.

If another customer picks the same product and service that were chosen by previous customers, will the website agent send requests to Apple and Rogers? Because one of the main advantages in KM and service oriented in VO is saving time. It should save the responds from Apple and Rogers for every quote and use them to answer the same customers' orders in the future.

3.3 Components of Architecture

Based on our KM framework, we build this architecture to manage knowledge. This architecture has five components, which are:

1. Partners
2. Knowledge Bases
3. Portals
4. Pipes
5. The cloud

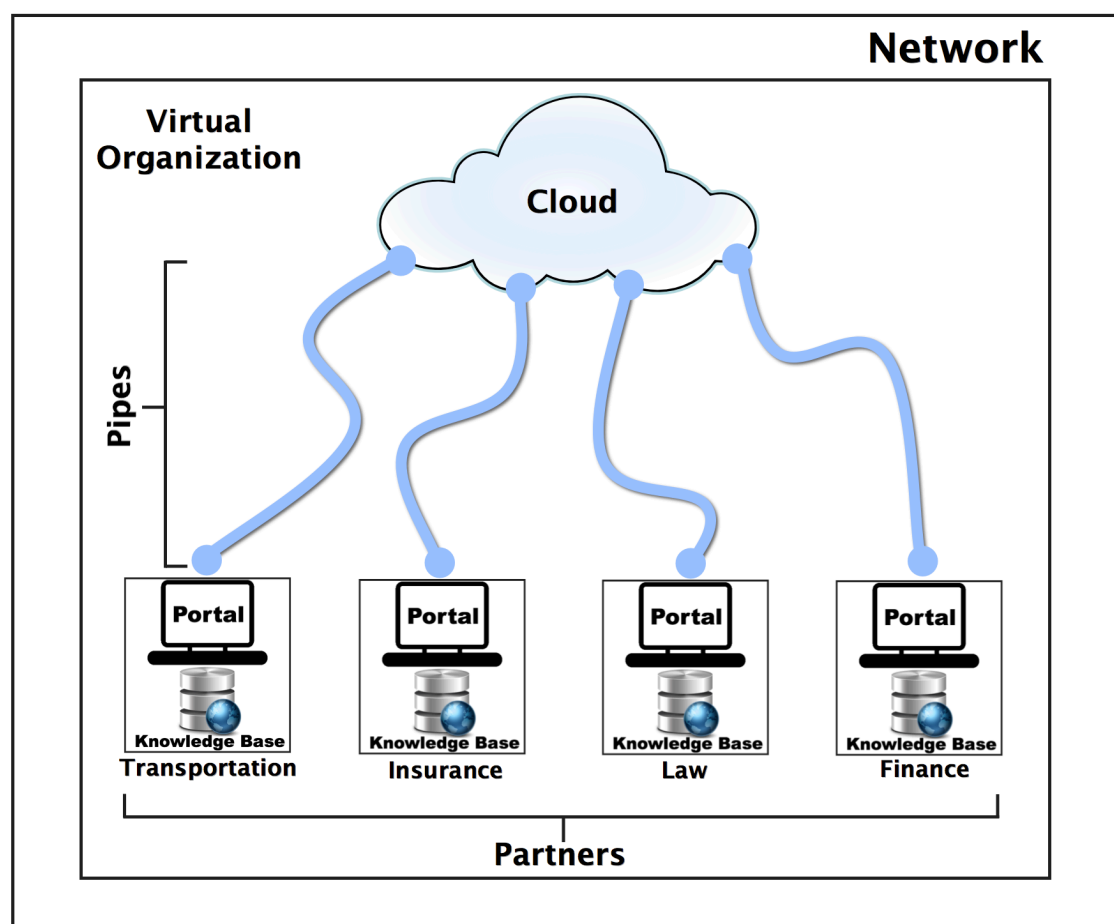


Figure 30 The Proposed Knowledge Management Architecture

3.3.1 Partners

In this research we have 4 partners that are collaborating within a VO. Each partner has specific roles and functions to perform services to the customers. The main

facility in this VO is that offer a full package of services as one service in single access that include finance, insure and ship any shipment among different countries supported by law. So, we have Transportation company, Law firm, Finance corporation, and Insurance company (M. H. A. Danesh, 2012). Danesh (2012) implemented the VO and called it “VOTranspo” as shown in figure 31. Each organization exists somewhere in the world. However, the customer will be able to access to single webpage and get all the services from different partners in one access. The website of the VO is not our focus; our efforts in this study is managing the collaboration among these four partners.

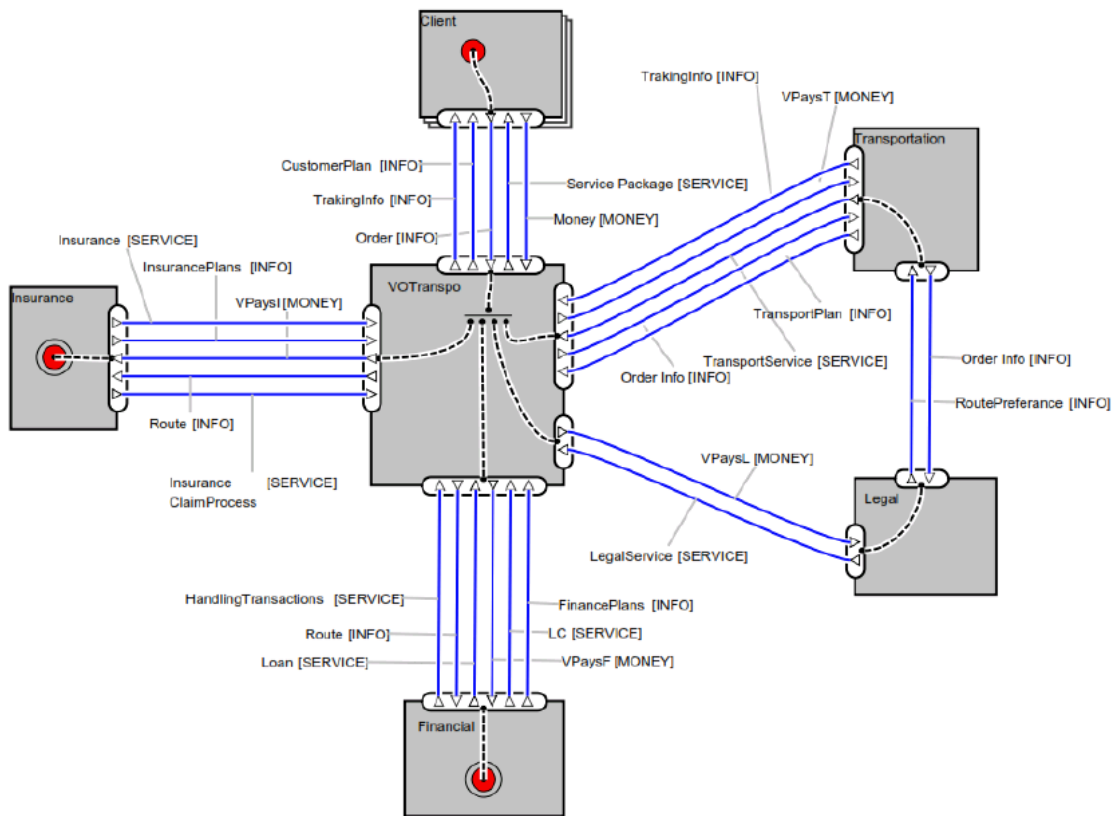


Figure 31 VOTranspo Model (M. H. A. Danesh, 2012)

3.3.2 Knowledge Bases

3.3.2.1 Public and Private Knowledge

Each partner in the VO has a knowledge repository that contain public knowledge and private knowledge. Public knowledge is available to be shared to operate the VO, such as shipment prices, distances, and insurance costs. Private knowledge is for internal processes and it is not shared with others, such as pricing, and competitive data. Workers should feed Private Knowledge by adding new knowledge and updating existing knowledge to support internal processes.

3.3.2.2 Knowledge Base as a Tool

There are many ways to store information in organizations and retrieve them. However, in this research, there will be a large amount of information, because partners in this VO have knowledge in their side that should be transferred among them when someone needs it. Obviously, each partner has private knowledge that related to internal processes and they do not want to disclose it. On the other hand, there is public knowledge that needed to be shared to operate the VO. To handle those two types of knowledge, we need an application that deals with such a type; so, KB is a useful tool because it organizes knowledge to be easy to use such as questions and answers, articles, and multimedia. We employ KB in this VO to manage knowledge; yet, how we save and share the knowledge? Could we apply centralized KB or distributed KBs?

3.3.2.3 Centralized Knowledge Base or Distributed Knowledge Bases

Do we need to install one KB in this VO or several KBs in each partner? There are benefits and weaknesses in each solution, and we briefly point them here:

Centralized Knowledge Base:

Install one KB in the middle of the VO and use it by all partners to store, update and reuse the public knowledge as shown in figure 32. If any partner wants to retrieve knowledge, it should be retrieved from the central KB that all partners share it in the middle.

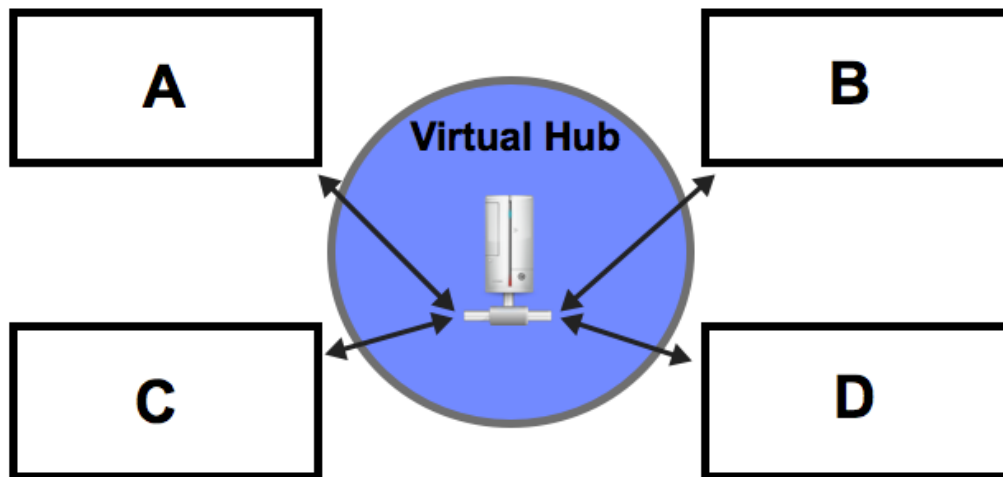


Figure 32 Centralized Knowledge Base

Advantages:

- Categorize and store knowledge depend on common meaning among partners (Bonifacio, Cuel, Mameli, & Nori, 2002).
- One knowledge portal could be useful for accessing enterprise knowledge and retrieve it (Bonifacio et al., 2002).
- No need for a high level of trust among partners.
- Centralized database for knowledge.
- Reduce cost for building, hosting, implementation, operation, and maintenance.
- No duplication in data and knowledge.
- One piece of knowledge could be shared among all partners.

Disadvantages:

- Who is the owner of knowledge in the KB?
- How to manage the data for a partner if it wants to leave?
- How to store the data after dissolution?
- There is no private knowledge will be shared in the KB.

Distributed Knowledge Bases:

Install KB in each partner and use it to send and receive knowledge such as question and answer. Each partner has to use a KB to store and share knowledge in the VO, and this KB should be accessible by all other partners.

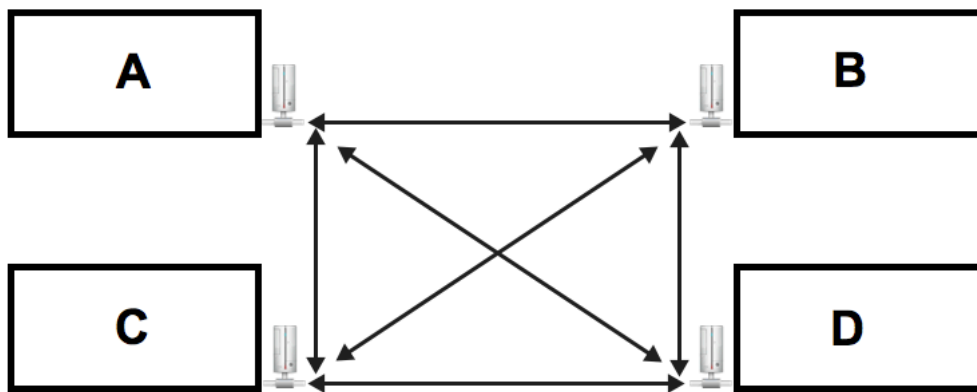


Figure 33 Distributed Knowledge Bases (Peer-to-Peer Network)

Advantages:

- Each partner has a possibility and right to represent the knowledge according to its goals and criteria (Bonifacio et al., 2002).
- Set protocols and mechanisms to communicate in an informal way (Bonifacio et al., 2002).
- Each partner passes questions to the other partner who considered as responder.
- Partner could share its public knowledge and keep the private.
- Also, could share some private knowledge with trusted partners only.
- No need to worry about ownership of knowledge during the operation.

- No need to worry about storing the knowledge after dissolution.

Disadvantages:

- There is need for a high level of trust among partners.
- If partner A trust B, and partner B trust C, this does not mean A trust C (Kim et al., 2005).
- High cost because each partner has to build its own knowledge base.
- High cost because we need to build peer-to-peer network.
- There will be duplication in some knowledge in different KBs.

We could build a star network as shown in figure 34, however, we still need to install KB in each partner. Also, it needs a central hub to connect all partners together. Moreover, a failure of the central hub will disconnect the network between partners.

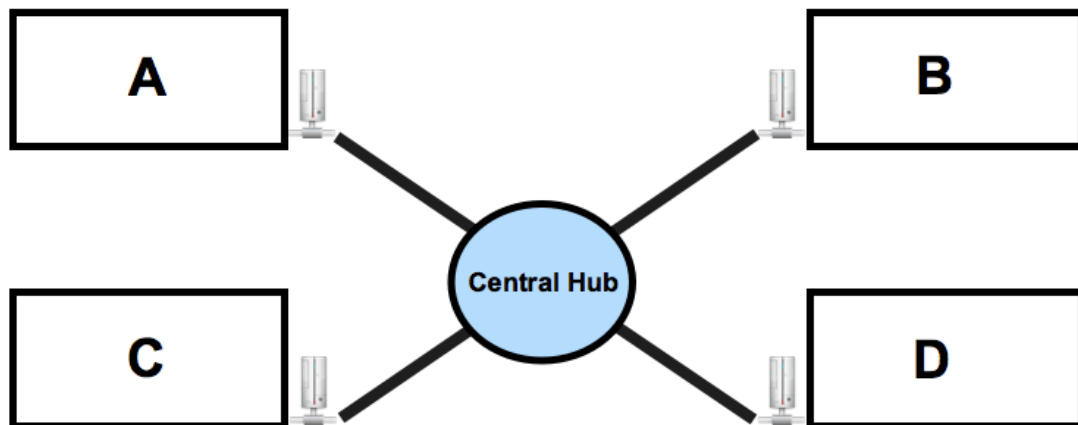


Figure 34 Distributed Knowledge Bases (Star Network)

3.3.2.4 Duplication in Knowledge Bases

One of the challenges in virtual organization management is that distributed operations between partners (M. Danesh, Raahemi, Kamali, & Richards, 2012). Managers in large organizations suffering sometimes from solving the same problem from scratch many times (Davenport & Prusak, 2005). VO is dynamic because of the agility and it needs a very quick act and responses among partners to catch-up the changes. The operations and transactions among partners in VO have a huge amount

of knowledge (Loss et al., 2005), some of them are questions and answers and other are experiences from problems and solutions. We need to manage the knowledge that is shared among partners, and we have issues to consider.

The main issue in KM in VO is the distributed knowledge, and each partner will be involved somehow in each piece of knowledge. Centralized KB is a suitable solution, but it will oppose the main concept of VO in a distributed environment. Therefore, we need to go with “distribution solution” that ensures knowledge will be shared among partners. However, there are two questions, which are:

1. Does knowledge have to be duplicated “same version” with each partner? How to “synchronize” update it?
2. How partners share knowledge? Does knowledge have to be partitioned with each partner?

There is one solution for these two questions, which is applying KB in each partner, and each of them has to do knowledge activities internally and export the results externally to other partners. Thus, we want to maximize the benefits and reduce the weaknesses by integrating centralized and distributed concepts.

As mentioned earlier, partners came to the VO with their own knowledge, which produced by their processes before VO creation; and they will produce new knowledge which will be created from the collaboration in the VO.

In our case, each partner will publish knowledge in its KB and make it available to other organizations in a place that could be reached by all other partners. The place could be a virtual hub between partners. This will be in line with the main concept of VO in collaborative environment and service oriented organization. However, the main two issues we will face here is that who is the owner of the virtual hub? And where we can keep the knowledge after the VO dissolution? And this will send us

back to square one. Therefore, we come up with a beneficial solution that is push the VO knowledge in a cloud instead of virtual hub. This cloud owned by all partners and all of them create the knowledge in it. Furthermore, the knowledge in the cloud will be published and stored in partners' KBs not the cloud database. We implement that by allowing each partner to display their knowledge in the cloud by using Mashups.

3.3.3 Portal

Each partner has to have a portal or interface that used for collaboration and posting knowledge. This portal will be the link between the partner and other partners. It will be available also to the partner's employees and other employees from the VO to log in and perform knowledge activities. Partner's public knowledge is posted in its portal and they are accessible from outside the organization. Any new knowledge will be posted in it to be displayed immediately in the cloud.

3.3.3.1 Encapsulation and Information Hiding

To make sure the confidentiality and privacy for each partner knowledge; we utilize a software engineering concepts. Two Software Engineering principles are information hiding and encapsulation (Tekinerdo, n.d.). These two principles are useful and helpful to our scope in this research. Encapsulation is "a grouping of data and the operations that manipulate that data into an aggregate data structure" (Structures, n.d.). Information hiding is a separation of the user interface from the structure of the system (Structures, n.d.).

We employ these two principles from Object-Oriented Design concepts in software engineering in VO knowledge management. The aim from using encapsulation and information hiding is to protect the partner's private knowledge from distribution

among other partners. As shown in Figure 35 the partner is going to offer final service or a final product without disclosing its private processes.

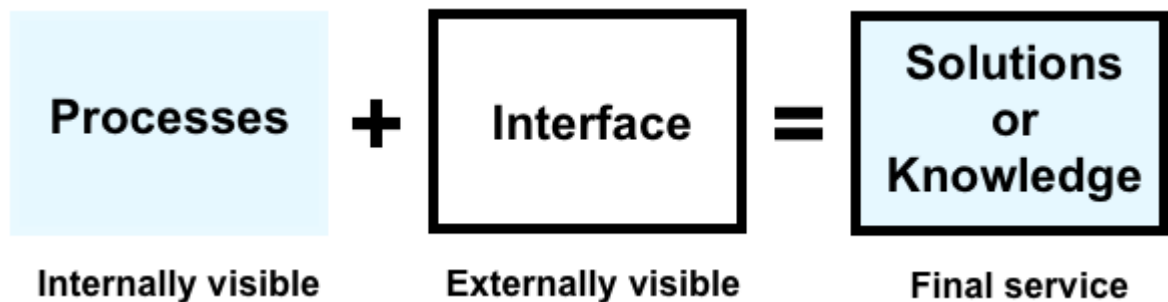


Figure 35 Information Hiding

3.3.4 Pipes

This architecture helps us to manage the collaboration in a distributed environment. In order to set the connections between partners and the cloud we need to find a type of link or communication tool. There are several tools to make the connections; however, some of them intelligent (i.e. agent) and others not (i.e. Mashups).

3.3.4.1 Knowledge Agent for Recommendations

To manage knowledge in VO, we have to find a process to share the right knowledge to the right partner in right time within the right channel (Velev & Zlateva, 2012a). One of the researches suggests that adopt an agent in VO to achieve the purpose of knowledge sharing among partners (P. Liu, Raahemi, & Benyoucef, 2011). Each partner has an agent which is communicating with other partners agents. Another research suggests a same concept to share knowledge, asking and answering question, and transfer experiences. Knowledge Agent for Recommendations (KARe) is a solution for this problem which is considered as a multi-agent technique, where agents collaborate to establish and share knowledge pieces on behalf of their users, cooperating in a peer-to-peer network (Guizzardi, Ludermir, & Sona, 2006). As we

see in Figure 36 this is a peer-to-peer network and the agent works as sender and receiver of questions and answers. In the same Figure scenario (1) a health insurance user asks a question by their agent, and the agent passes the question to a peer who is considered as a responder based on the question pattern and attributes. If the health insurance agent gets the answer, it will keep it as an experience for the future. In the scenario (2) the health insurance could answer the same question it had asked before if another partner asked it, because it already has the experience.

In this research we employ this concept but with some modifications. The agent does not pass questions or answer; however, it passes the knowledge to the cloud to be readable for others.

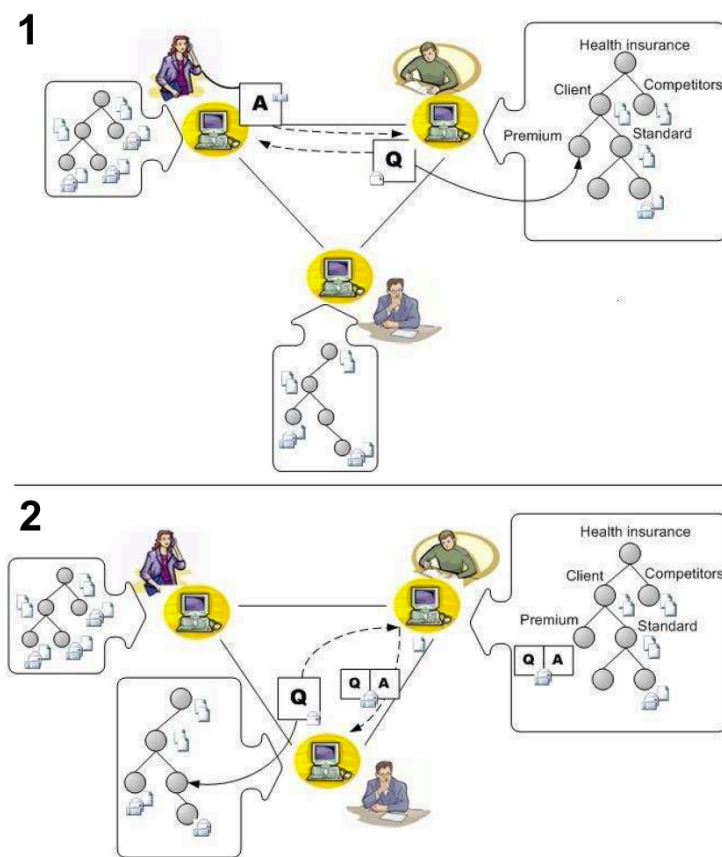


Figure 36 KARE Scenarios (Guizzardi et al., 2006)

3.3.4.2 Mashups

Mashups will be a very useful tool in our work. As mentioned earlier; we want to build a service one time and use it in different organizations, and this service could be information or knowledge. For example, if one organization posts a new article in their KB, it will be available “displayed” in the cloud and other organizations may use it. Once the partner updates the knowledge, it will be updated in the cloud. There are many ways to use Mashups in our work, but we preferred Pipes service to implement it.

By using Pipes we link each partner’s KB with the cloud. Any knowledge wanted to be displayed in the cloud, should be posted in Partner’s KB only. For instance, if a partner has new knowledge (problem and solution, question and answer, or experience) and posts it in its KB, it will be available for others in the cloud. The knowledge will be pushed from the KB to the cloud.

Also, each partner could keep its private knowledge in its own KB if they do not want to share it with others. This idea is endorsing our view that each partner has public knowledge that eligible to be shared and private knowledge that for internal processes.

3.3.5 The Cloud

The cloud in this architecture works as a collaboration area between the partners. All knowledge that produced in each partner’s KB will be pushed into the cloud to be available for all partners. Knowledge will be displayed “not copied” in the cloud by using Mashups. We use a cloud because of few reasons:

- The VO exists for limited time as mentioned earlier.
- Reduce costs
- Avoiding duplication

- It is erasable

The cloud has single webpage that has all the knowledge from partners. If any partner updates any piece of knowledge, it will be updated immediately in the cloud. Also, this function happens when a partner move or delete knowledge.

3.4 An Example Scenario of Knowledge Management

Processes

The main benefit for SOA is that building a service in one place and allows others to use it anywhere over a network to maximize the availability and reduce cost. We need the same concept in Knowledge Sharing in VO to build a knowledge in one place and allows others to use it, copy it, or learn from it. Also, this idea meets our needs and our concept in SOVO, as mentioned earlier, which is the Service Zone that found in the middle and let partners collaborate.

The aim from this architecture is to build Distributed Knowledge Management. Each partner has a full KB with its interface, which is available to partner's employees and other employees from the VO. The VO is connected with a cloud that contains a webpage that has all knowledge from different partners. The cloud is available for access from all partners. Any partner could log in any other KB directly through its interface to read solutions or write questions.

To understand how this architecture works, we follow the sequence in this example. As shown in figure 37, the Finance partner wants to get knowledge from Transportation partner, and the steps as follows:

1. Finance worker should search the knowledge they want in the cloud by using the search engine.
2. If it is found, they could use it.

3. If it is not found, they have to log in Transportation Portal and ask a question.
4. The Transportation worker answers the question supported by private knowledge, and posts it in Transportation Portal.
5. The knowledge will be saved in the public KB.
6. The knowledge will be displayed in the cloud.

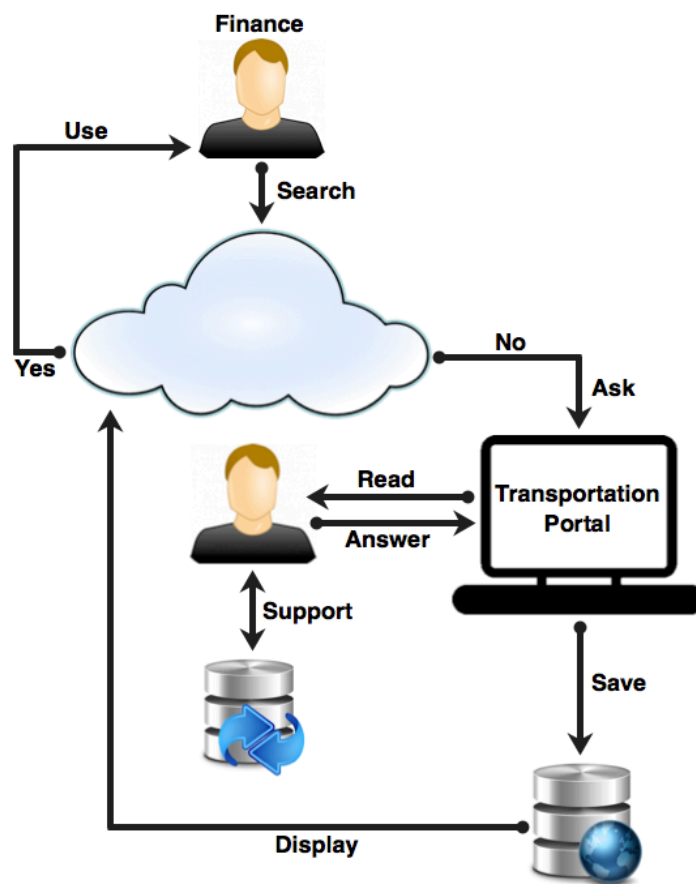


Figure 37 An Example Scenario of Knowledge Management Process

3.5 Changing Partners and dissolution

3.5.1 Changing Partners

Partners in the VO are exposed to be changed or leave. Therefore, it is essential to facilitate it for VO flow. There are many changes could happen such as partner

replacing, partner leaving, and new partner joining. In terms of service and process change, in (Obidallah, Raahemi, Kamali, & Danesh, 2013), authors propose a framework for change management that facilitate and improve change processes between partners in SOVO. However, our concern is how to keep the partner's knowledge after the change. We investigate this issue and come up with an idea that making a copy from the partner's KB which is going to be changed and send it to other partners. The new or existing partner could use the copy of the KB. We observe the procedure of backing up and restoring and we give more details in the next chapter.

3.5.2 Dissolution

We had a concern about where and how to keep the knowledge and who is the owner of the knowledge after dissolution. As we mentioned earlier, all knowledge in the VO is posted in their sources and displayed in the cloud. If all partners leave the VO, the cloud will be empty and each partner will be responsible of its own KB. However, each partner could have a copy of others public knowledge by using the same method of backing up and restoring that mentioned in the previous section.

Chapter 4: Implementation

In this chapter we investigate the architecture through implementation. We combine all factors that contained in the architecture and test them to get results. We use web 2.0 technologies to evaluate the architecture by a scenario. The technologies we use are CMS, Pipes, RSS, and Mashups. We build three websites that represent three partners which are Finance, Insurance, and Transportation. We use CMS for building the websites. Also, we install KB in each website to manage articles that displayed in the cloud. As well, we set a form for questions and answers in each website to make sure each partner has a space to collaborate in other websites. Each partner has access to other partners' websites to be able to read articles and ask questions. We link the three websites with a cloud to push all knowledge that related to the VO. The connections between websites and the cloud are Pipes. The cloud is very basic webpage that combines all knowledge that collected from KBs by Pipes. Also, the cloud has a search engine to allow any partner to search in all portals.

To evaluate our idea and architecture, we build the websites and the cloud in one of our own domain, which is (www.fahads.com), however, we build them in different sections. We create three folders in the main domain to install the portals. Each section "Folder" represents one partner as shown in figure 38. The URLs of websites as follows:

Finance: www.fahads.com/Knowledgebase1

Insurance: www.fahads.com/Knowledgebase2

Transportation: www.fahads.com/Knowledgebase3



Figure 38 Partners Folders

The cloud is hosted in the same domain but in different folder. We called its folder “kb” as shown in figure 39 and the URL is www.fahads.com/kb

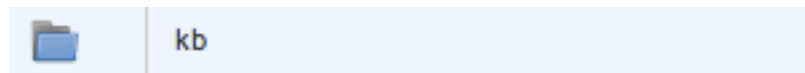


Figure 39 Cloud Folder

4.1 Portal

CMSs are the most efficient systems to manage the contents that could be information, knowledge, articles, multimedia, or documents. We use Joomla as a CMS to build our websites because it meets our needs in this research. In real life, the partners in the VO could use any type of portal or CMS to post and share their knowledge; however, there are certain specifications that needed to make sure the connections work properly. The specifications are, ability to create different sections, RSS, ability to install KB component, ability to set Q&A form, and ability to backup the portal. All the websites that we installed have all the specifications. In figure 40 we show one of the websites, which is Finance Portal.

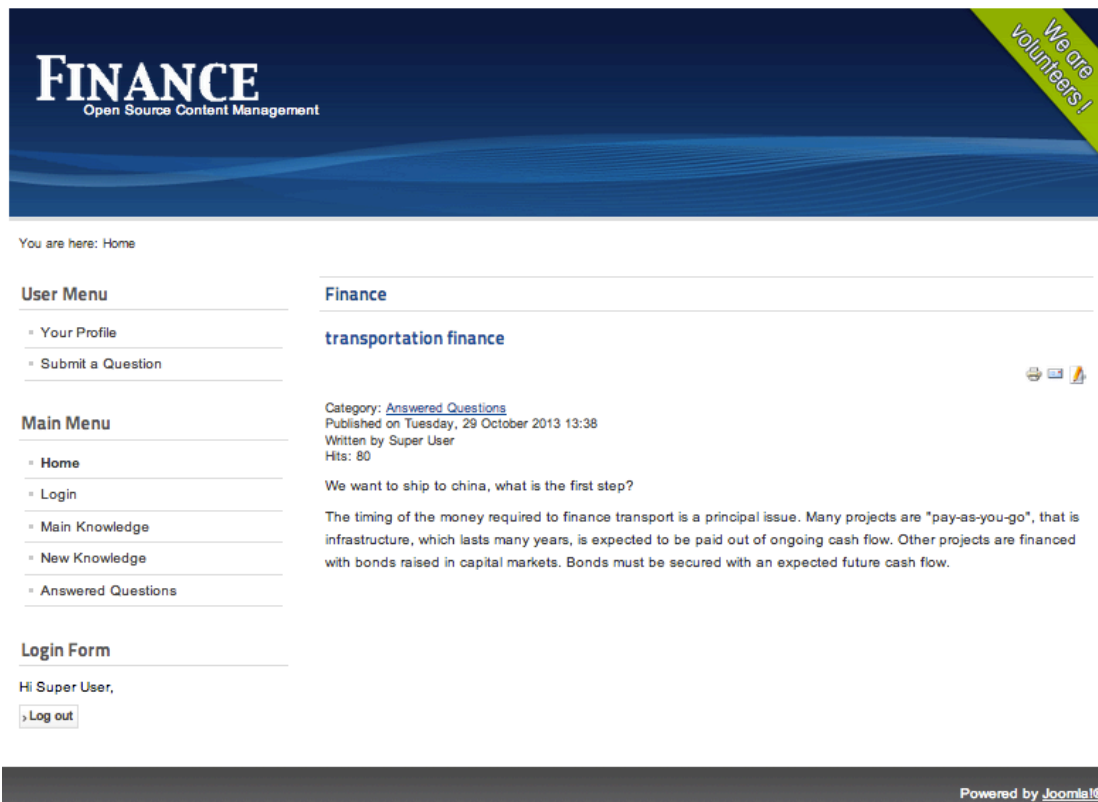




Figure 40 Finance Portal

On the left side of the Portal there are two menus, which are user menu and main menu. User menu has two links, user profile and link to submit a new question. Other partners are allowed to ask questions to Finance Company by “Submit a Question” form. Main menu has three sections which are Main Knowledge, New Knowledge, and Answered Question.

- Main Knowledge: The knowledge produced before the VO creation, and they are needed to operate the VO.
- New Knowledge: The knowledge that related to the VO and produced for its processes.
- Answered Questions: Knowledge that produced by the VO collaboration.

Each section has many articles that contain knowledge. The knowledge could be text, photos, videos, or mixed of them. As well, each section should have RSS feed to link it by Pipes to the cloud as shown in figure 41.


Main Knowledge (3)


Monday, 30 September 2013 17:15

Operation

Written by [Super User](#)

[\[edit\]](#)

Private transport is only subject to the owner of the vehicle, who operates the vehicle themselves. For public transport and freight transport, operations are done through [private enterprise](#) or by [governments](#). The infrastructure and vehicles may be owned and operated by the same company, or they may be operated by different entities. Traditionally, many countries have had a [national airline](#) and [national railway](#). Since the 1980s, many of these have been [privatized](#). International shipping remains a highly competitive industry with little regulation,^[14] but ports can be public owned.^[15]



[Incheon International Airport](#),
South Korea

Published in [Main Knowledge](#)

[Be the first to comment!](#) | [Read more...](#)

Monday, 30 September 2013 17:15

Vehicles

Written by [Super User](#)

A vehicle is any non-living device that is used to move people and goods. Unlike the infrastructure, the vehicle moves along with the cargo and riders. Unless being pulled by a cable or muscle-power, the vehicle must provide its own propulsion; this is most commonly done through a [steam engine](#), [combustion engine](#), [electric motor](#), [jet engine](#) or a [rocket](#), though



Figure 41 Portal Section

Due to using RSS feed, if the partner update, change, or delete any article, it will take action immediately on the cloud, and this solves the problem of duplication that mentioned earlier. As shown in figure 42, RSS feed for Main knowledge section in Finance Portal is produced automatically. We use its URL which is “www.fahads.com/Knowledgebase1/index.php/main?format=feed&type=rss” to link it and push knowledge to the cloud.

```

<?xml version="1.0" encoding="utf-8"?>
<!-- generator="Joomla! - Open Source Content Management" -->
<?xml-stylesheet href="/Knowledgebase1/media/system/css/modal.css" type="text/css"?>
<rss version="2.0" xmlns:atom="http://www.w3.org/2005/Atom">
  <channel>
    <title>Main Knowledge</title>
    <description><![CDATA[]]></description>
    <link>http://fahads.com</link>
    <lastBuildDate>Mon, 24 Feb 2014 23:24:25 +0000</lastBuildDate>
    <generator>Joomla! - Open Source Content Management</generator>
    <atom:link rel="self" type="application/rss+xml" href="http://fahads.com/Knowledgebase1/index.php/main?format=feed&type=rss"/>
    <language>en-gb</language>
  </channel>
  <item>
    <title>Experimental finance</title>
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<span id="Experimental_finance" class="mw-headline">Experimental finance</span><span class="mw-editsection" style="-webkit-user-select: none; font-size: small; font-weight: normal; margin-left: 1em; vertical-align: baseline; line-height: 1em; display: inline-block; white-space: nowrap; padding-right: 0.25em; unicode-bidi: -webkit-isolate;"><span class="mw-editsection-bracket"></span><a href="https://en.wikipedia.org/w/index.php?title=Finance&action=edit&section=10" title="Edit section: Experimental finance" style="color: #0b0080; background-image: none;">edit</a><span class="mw-editsection-bracket"></span></div></h3>
<div class="relink_relatrice_mainarticle" style="font-style: italic; padding-left: 1.6em; margin-bottom: 0.5em; color: #000000; font-family: sans-serif; font-size: 13px; line-height: 19.200000762939453px;">Main article: <a href="https://en.wikipedia.org/wiki/Experimental_finance" title="Experimental finance" style="color: #0b0080; background-image: none;">Experimental finance</a></div>
<p style="margin: 0.4em 0px 0.5em; line-height: 19.200000762939453px; color: #000000; font-family: sans-serif; font-size: 13px;"><a href="https://en.wikipedia.org/wiki/Experimental_finance" title="Experimental finance" style="color: #0b0080; background-image: none;">Experimental finance</a> aims to establish different market settings and environments to observe experimentally and provide a lens through which science can analyze agents' behavior and the resulting characteristics of trading flows, information diffusion and aggregation, price setting mechanisms, and returns processes. Researchers in experimental finance can study to what extent existing financial economics theory makes valid predictions, and attempt to discover new principles on which such theory can be extended. Research may proceed by conducting trading simulations or by establishing and studying the behavior of people in artificial competitive market-like settings.</p></div>]]></description>
    <author>fahad@fahads.com (Super User)</author>
    <category>Main Knowledge</category>
    <pubDate>Sun, 23 Feb 2014 23:17:17 +0000</pubDate>
  </item>
  <item>
    <title>Financial mathematics</title>

```

Figure 42 RSS Feed

In terms of facilities in the website, each portal has a search engine that allows other partners to do search in all sections and categories as shown in figure 43.

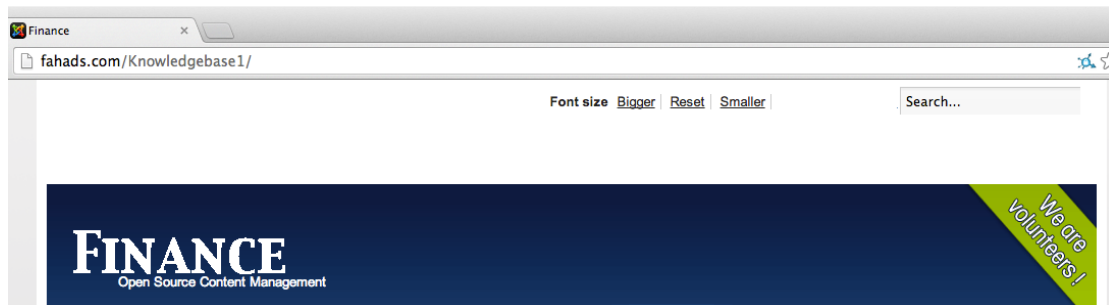


Figure 43 Search Engine

4.2 Knowledge Base

All knowledge in each partner's website should be stored in a KB. However, Joomla as a CMS does not have KB component, and the regular article system that comes with Joomla does not meet our needs in this implementation. For that, we install a component in each website which called K2. There are more than 7500 extensions for Joomla in its official website, and they are needed to customize Joomla for different usages. KS is one of the extensions which help to manage website contents. K2 manages multimedia, users, permissions, groups, and more.

Once we install K2 in Joomla, the back-end will be transformed into KB with more features than regular Joomla. As shown in figure 44 the back-end of the website transformed from normal menu to professional menu which is K2. The administrators deal with the new menu to manage all articles and multimedia in Joomla. Also, they can move all the articles that posted before installing K2 into K2 to manage them easily. This feature is useful and helpful for the existing website that has knowledge.

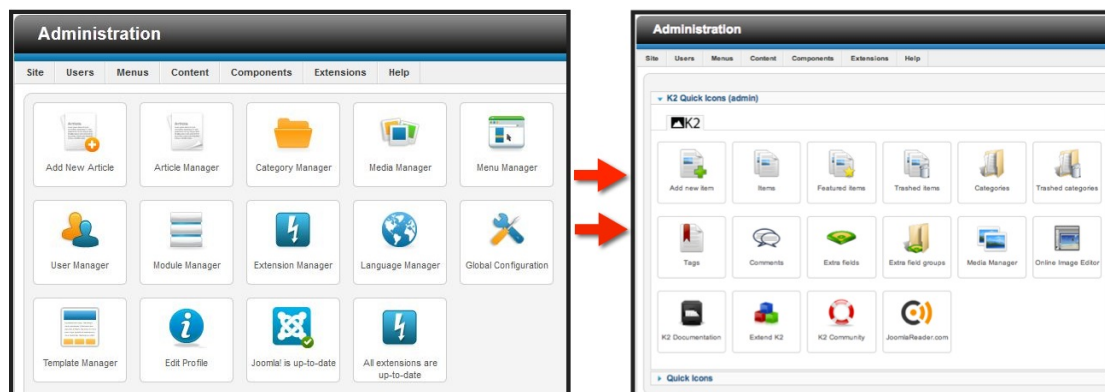


Figure 44 K2 Installation

4.3 Questions Form

We set this form to let other partner ask questions about something they do not locate it in the cloud or KBs. As mentioned earlier, the question form will be in User Menu that does not show up to visitors or unregistered users. The user should be registered to be able to use this form. As shown in figure 45, question form allows other partners to write their question or inquiry and save it to be presented in the back-end of the website. The question will not be posted in the website until the administrator process it and answer it.

Editor

Title *

Alias

B *I* U ~~ABC~~ | | Styles Paragraph

| | HTML

— |

Path: p

Figure 45 Question Form

With this form there is a configuration for posting as shown in figure 46. The question will be posted in the Questions category that is not published on the website. Questions category is shown only for administrators in the back-end. Any question should be reviewed and answered before it posted in Answered Questions section that is accessible in Main Menu.

Publishing

Category *

Author's Alias

Status

Featured

Start Publishing

Finish Publishing

Access

Ordering:
New articles default to the first position in the Category. The ordering can be changed in backend.

Figure 46 Question Configuration

To test this form, we log in as Insurance user in Finance portal, and ask a question by using Question Form as shown in figure 47. There are two fields need to be filled, Title and the question.

The image shows two parts of a web form. The top part is titled 'Editor' and contains a 'Title' field with the text 'Shipping mortgage' and an empty 'Alias' field. There are 'Save' and 'Cancel' buttons. Below this is a rich text editor toolbar with various icons for bold, italic, underline, and other text formatting. The main text area contains the question: 'What charges, lens or securities could take the priority over a mortgage?'. Below the text area, it shows the path 'Path: p » strong' and several buttons: 'Article', 'Image', 'Page Break', 'Read More', and 'Toggle editor'. The bottom part is titled 'Publishing' and contains several dropdown menus and text fields: 'Category' (set to '- Questions'), 'Author's Alias' (empty), 'Status' (set to 'Published'), 'Featured' (set to 'No'), 'Start Publishing' (empty), 'Finish Publishing' (empty), and 'Access' (set to 'Registered'). At the bottom of this section, there is a note: 'Ordering: New articles default to the first position in the Category. The ordering can be changed in backend.'

Figure 47 Asking Question

In the back-end of Finance website, the question waiting to be answered and posted in Answered Questions section. Figure 48 shows the administrator form to answer the question in Finance back-end. After answering the question, administrator has to change the category from Question to Answered Question and save it again to be displayed in Answered Questions section.

Edit Article

Title *

Alias

Category * ←

Status

Access

Permissions

Featured

Language

ID 74

Article Text

What charges, liens or securities could take the priority over a mortgage?

The Shipping Act, 1998 lists the order of priority of maritime liens and only the liens associated with claims for wages and master's disbursements take priority over the claims of a registered mortgagee.

Path: p.style7

Article Image Page Break Read More Toggle editor

Figure 48 Answers Form

When administrator answers the question and change its category, it will be posted in Answered Questions section as shown in figure 49. Afterward, it is ready to be displayed on the cloud, and it will be presented automatically there by using Pipes.

Title	Author	Hits
Shipping mortgage	Written by Insurance	0
transportation finance	Written by Super User	80
Insurance fund	Written by Super User	72

Figure 49 Answered Questions Section

4.4 Pipes

All three sections in any partner's portal have RSS feed URL, and by using them we connect the sections to the cloud. Yahoo Pipes needs RSS feed URL to get the articles from any section. As shown in figure 50, we use "Fetch Feed Module" from "Sources Modules" in Yahoo Pipes to get the feeds. We use Finance Answered Questions RSS

URL which is “www.fahads.com/Knowledgebase1/index.php/answered-questions?format=feed&type=rss” to get the feeds, and as we see in the figure 50, the Pipe output is listed as same as Finance Answered Questions section in figure 49.

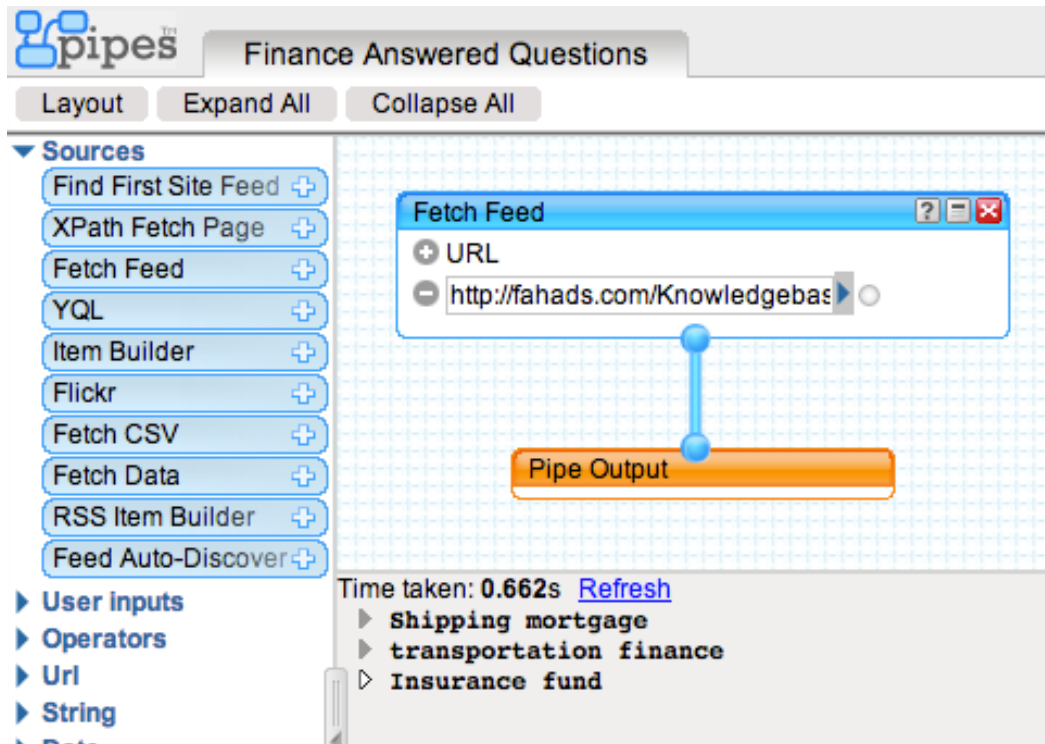


Figure 50 Finance Answered Questions Yahoo Pipes

We use Fetch Feed Module for all sections' RSS that we have which are Main Knowledge, New Knowledge, and Answered Questions; moreover, we do it with all three websites. That means we have nine sections for three partners as shown in figure 51.

- Insurance (New) ★**
 Sources: fahads.com
 0 clones
- Finance (New) ★**
 Sources: fahads.com
 0 clones
- Transportation (New) ★**
 Sources: fahads.com
 0 clones
- Insurance (Main) ★**
 Sources: fahads.com
 0 clones
- Finance (Main) ★**
 Sources: fahads.com
 0 clones
- Transportation (Main) ★**
 1 clones
- Insurance Answered Questions ★**
 Sources: fahads.com
 0 clones
- Transportation Answered Questions ★**
 Sources: fahads.com
 0 clones
- Finance Answered Questions ★**
 0 clones

Figure 51 List of Nine Sections' Pipes in Yahoo Pipes

Each Pipe has URL and badge that produced automatically by Yahoo to allow users to embed it in any webpage. For example, Finance Answered Questions badge is:

```
<script
src="http://l.yimg.com/a/i/us/ppp/listbadge_1.6.js">{"pipe_id":"c790dc28daafc757f1
1d1be11e54e891", "_btype":"list"}</script>.
```

We copy this badge and embed it in a simple webpage as shown in figure 52.

Finance Answered Questions

Shipping mortgage
 What charges, liens or securities could take the priority over a mortgage? The Shipping Act, 1998 lists the order of priority of maritime liens and only the liens associated with claims for wages and master's disbursements take priority over the claims of a registered mortgagee.

transportation finance
 We want to ship to china, what is the first step? The timing of the money required to finance transport is a principal issue. Many projects are "pay-as-you-go", that is infrastructure, which lasts many years, is expected to be paid out of ongoing cash flow. Other projects are financed with bonds raised in capital markets. Bonds must be secured with an expected future cash flow.

Insurance fund

Powered by Y! Pipes™

Figure 52 Finance Answered Questions Badge

We do last step –copy badges and embed them- with all sections and place them in a simple webpage as shown in figure 53. Each section in this webpage has a title, and it is easy to track the knowledge that wanted.

<p>Finance Answered Questions</p> <p>transportation finance We want to ship to china, what is the first step? The timing of the money required to finance transport is a principal issue. Many projects are "pay-as-you-go", that is infrastructure, which lasts many years, is expected to be paid out of ongoing cash flow. Other projects are financed with bonds raised in capital markets. Bonds must be secured with an expected future cash flow.</p> <p>Insurance fund How much you insure? The aim of the research programme is dedicated to making an original contribution to the progress of insurance through different initiatives in the field of insurance finance. It engages in: highlighting issues of key importance, promoting studies of the function of finance in insurance, discussing the relevance of financial concepts and instruments to the industry, detecting new and promising theoretical developments, and diffusing knowledge and the results of research worldwide.</p> <p>Powered by Y! Pipes™</p>	<p>Transportation Answered Questions</p> <p>Are you virtual? Where is your offices? We do not have any offices</p> <p>Do you have air shipment and how? Do you have air shipment and how? Yes. Air cargo numbers have the format 123-12345678 We use the first 3 digits to automatically send the request to the correct airline If the airline is not supported or you want to select a specific airline you can do this manually after tracking If you know of any airlines offering tracking that is not included please contact us!</p> <p>Powered by Y! Pipes™</p>	<p>Insurance Answered Questions</p> <p>test question are you still working? Yes from 8 to 8</p> <p>What types of vehicles? What types of vehicles you have? We have 30 types of vehicles and all of them are insured.</p> <p>How many countries? How many countries you are dealing with? We are dealing with 15 different</p> <p>Powered by Y! Pipes™</p>
---	---	--



<p>Finance (New)</p> <p>Corporate finance Corporate finance [edit] Main article: Corporate finance Corporate finance is the area of finance dealing with the sources of funding and the capital structure of corporations and the actions that managers take to increase the value of the firm to the shareholders, as well as the tools and analysis used to allocate financial resources. Although it is in principle different from managerial finance which studies the financial management of all firms, rather than corporations alone, the main concepts...</p> <p>Personal finance Personal finance [edit] Main article: Personal finance Questions in personal finance revolve around Protection against unforeseen personal events as well as events in the wider economy</p> <p>Powered by Y! Pipes™</p>	<p>Transportation (New)</p> <p>generates air. A gyroplane is both fixed-wing and rotary-wing. Fixed-wing aircraft range from small trainers and recreational aircraft to large airliners...</p> <p>What is transportation Transport or transportation is the movement of people, animals and goods from one location to another. Modes of transport include air, rail, road, water, cable, pipeline and space. The field can be divided into infrastructure, vehicles and operations. Transport is important since it enables trade between people, which in turn establishes civilizations. Transport infrastructure consists of the fixed installations necessary for transport, including roads, ...</p> <p>Powered by Y! Pipes™</p>	<p>Insurance (New)</p> <p>New: Property Insurance Property insurance provides protection against risks to property, such as fire, theft or weather damage. This may include specialized forms of insurance such as fire insurance, flood insurance, earthquake insurance, home insurance, inland marine insurance or boiler insurance. The term property insurance may, like casualty insurance, be used as a broad category of various subtypes of insurance, some of which are listed below: US Airways Flight 1549 was written off after...</p> <p>New: Auto Insurance ...</p> <p>Powered by Y! Pipes™</p>
--	---	---



<p>Finance (Main)</p> <p>Experimental finance Experimental finance [edit] Main article: Experimental finance Experimental finance aims to establish different market settings and environments to observe experimentally and provide a lens through which science can analyze agents' behavior and the resulting characteristics of trading flows, information diffusion and aggregation, price setting mechanisms, and returns processes. Researchers in experimental finance can study to what extent existing financial economics theory makes valid...</p> <p>Financial mathematics Financial mathematics [edit] Main article: Financial mathematics Financial mathematics is a field of applied mathematics concerned with financial markets. The subject</p> <p>Powered by Y! Pipes™</p>	<p>Transportation (Main)</p> <p>Operation [edit] Incheon International Airport, South Korea Private transport is only subject to the owner of the vehicle, who operates the vehicle themselves. For public transport and freight transport, operations are done through private enterprise or by governments. The infrastructure and vehicles may be owned and operated by the same company, or they may be operated by different entities. Traditionally, many countries have had a national airline and national railway. Since the 1980s, many...</p> <p>Vehicles ...</p> <p>Powered by Y! Pipes™</p>	<p>Insurance (Main)</p> <p>Liability insurance Liability insurance is a very broad superset that covers legal claims against the insured. Many types of insurance include an aspect of liability coverage. For example, a homeowner's insurance policy will normally include liability coverage which protects the insured in the event of a claim brought by someone who slips and falls on the property; automobile insurance also includes an aspect of liability insurance that indemnifies against the harm that a crashing car can cause to others' lives,...</p> <p>Claims ...</p> <p>Powered by Y! Pipes™</p>
--	---	---

Figure 53 Sections Badges

4.5 The Cloud

In the cloud webpage we redesign the badges (figure 53) to be easy to read and browse as shown in figure 54. VO Knowledge Cloud is hosted in this folder www.fahads.com/kb, and we build it as HTML webpage. The menu on the left side has three sections as same as partners' portals, and each section has all knowledge from the same section in the three portals. For example, New Knowledge section in the cloud webpage has all new knowledge from Finance, Insurance, and Transportation portals. Also, it has a search engine that powered by Google search in all partners' portals.

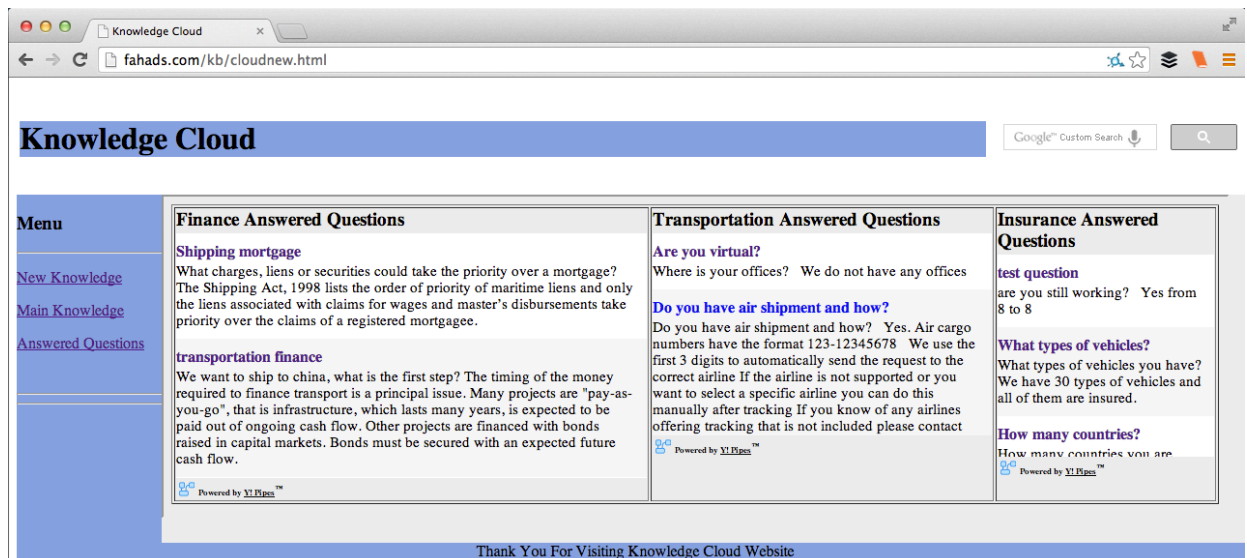


Figure 54 SOVO Knowledge Cloud Website

4.6 Knowledge-Base Back-up

4.6.1 Backup

As stated in section 3.5, if we want to change a partner, partner want to leave, or the VO comes to dissolute, we have to keep all knowledge in a place to be retrieved in the future. To solve this issue, we take a full backup from Finance website and install it again in a new folder. There are many tools to backup databases and reuse them

again, and we use one that fit with our portals. Akeeba Backup is one of Joomla components as shown in figure 55 that backups full website in one click. Akeeba tool backups all website's files, database, and portal into one single file that available for download. Akeeba works only in the back-end of websites.

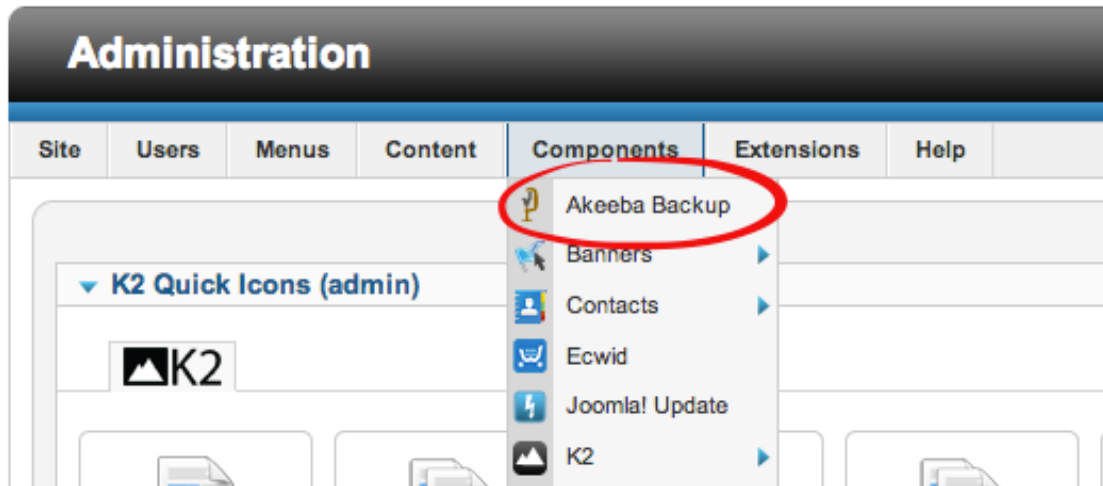


Figure 55 Akeeba Backup Component

In one of the three portals that we have, we install Akeeba tool (figure 55) to take a full copy. The tool is very useful, as shown in figure 56 it is ready to backup the website.

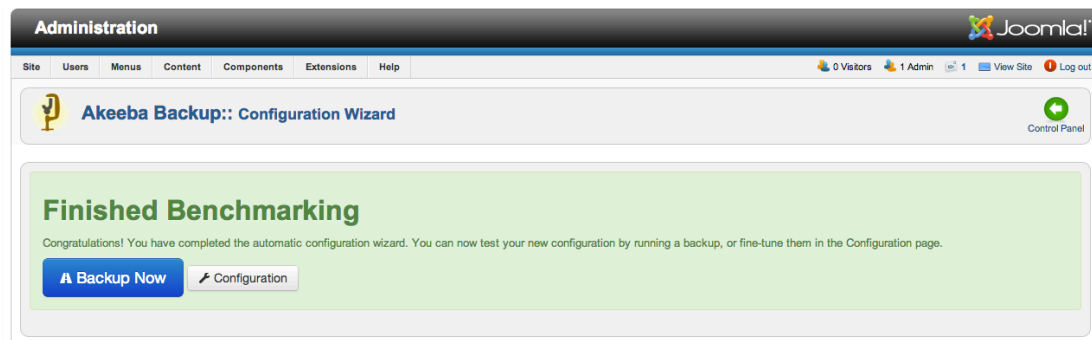


Figure 56 Backup Button

When we click on Backup Now, the tool will start working automatically. After it completing the processes, the backup file will be available to download as shown in figure 57. We download the backup file and save it to use it in restoring the website in the next step.

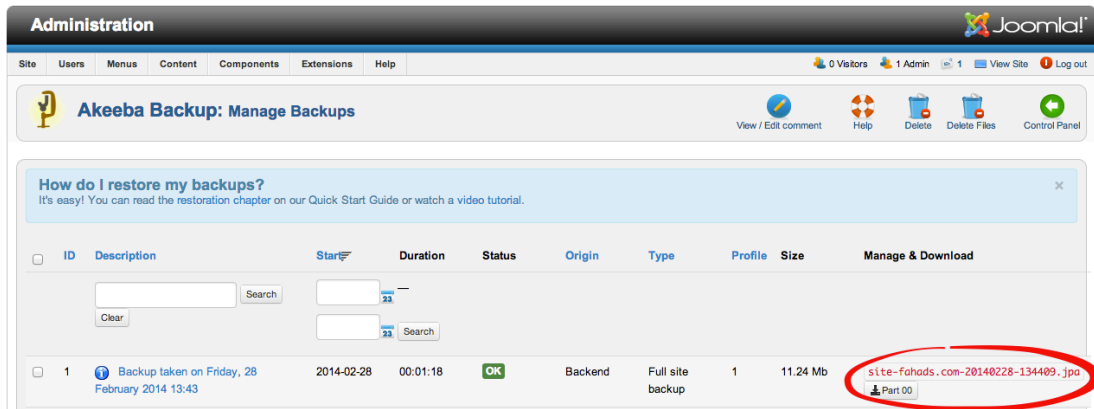


Figure 57 Backup File

4.6.2 Restore

Akeeba Backup does not restore the file that it produces. We need another tool to restore the backup or install it in another folder. There is a tool called Akeeba Kickstart that helps to restore Joomla backup. To examine this tool we create a new empty folder in our main domain and name it “KnowledgebaseBackup” and its URL is “www.fahads.com/KnowledgebaseBackup”. We upload Akeeba Kickstart files in that folder and the backup file that we downloaded earlier. With Akeeba Kickstart files that we upload them to the new folder, there is a file called kickstrt.php, and this file is responsible of extract the backup file. When we run it in the browser, Akeeba Kickstart starts working but needs some configurations as shown in figure 58.

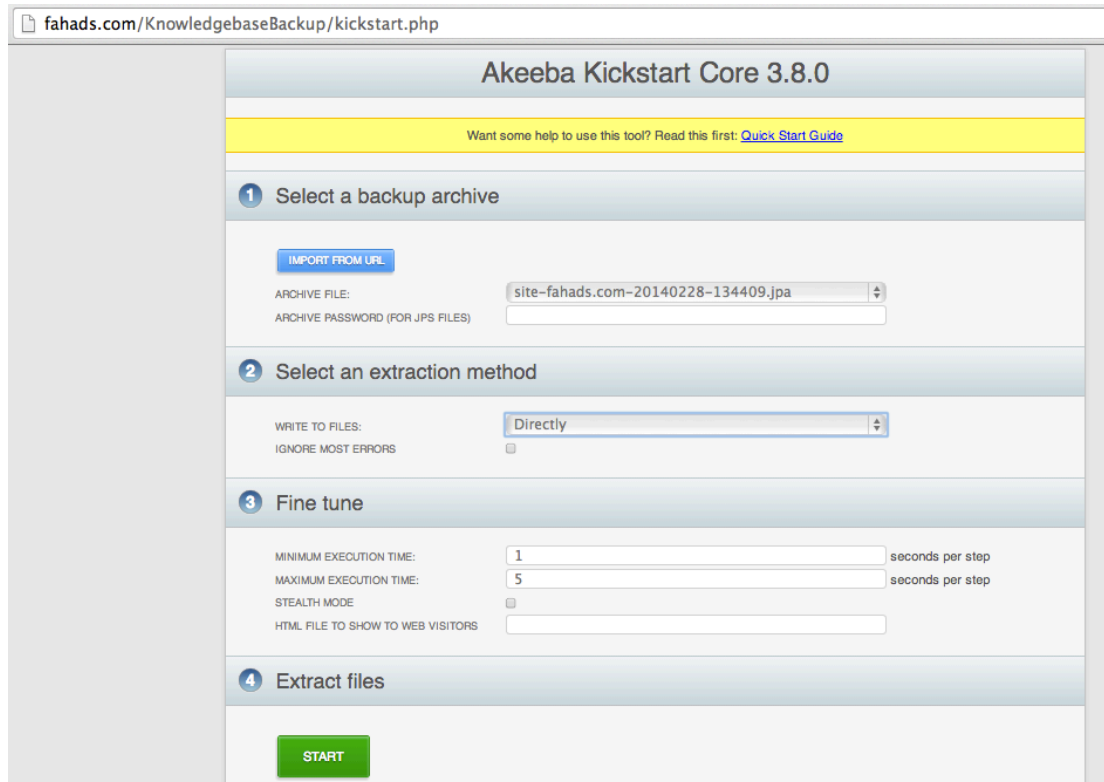


Figure 58 Kickstart

After we choose what we need in tool form, we click on START, and the tool will extract the file as shown in figure 59.

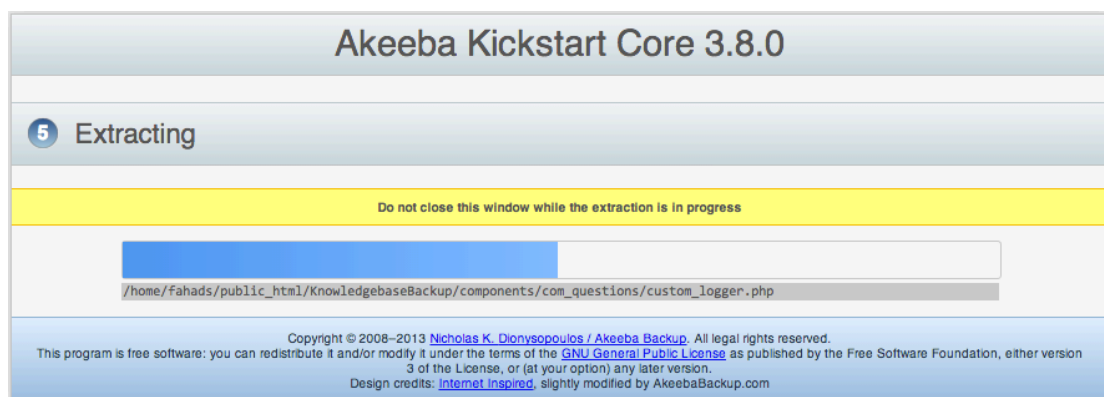


Figure 59 Kickstart Extracting

Afterward, Kickstart extracted the backup file and ready to install it in the new folder. We go to the installer in Akeeba Kickstart by clicking on RUN THE INSTALLER as shown in figure 60.

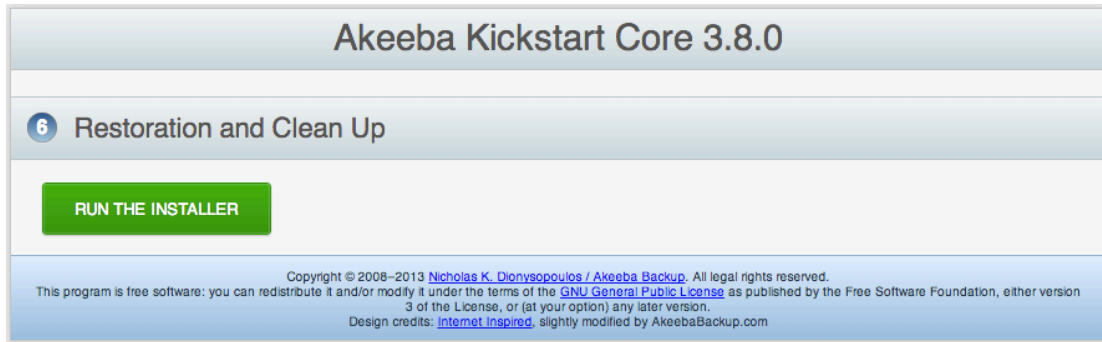


Figure 60 Kickstart Run Installer

It is crucial to check all setting before the installation in installer page as in figure 61. Then click Next to start installation.

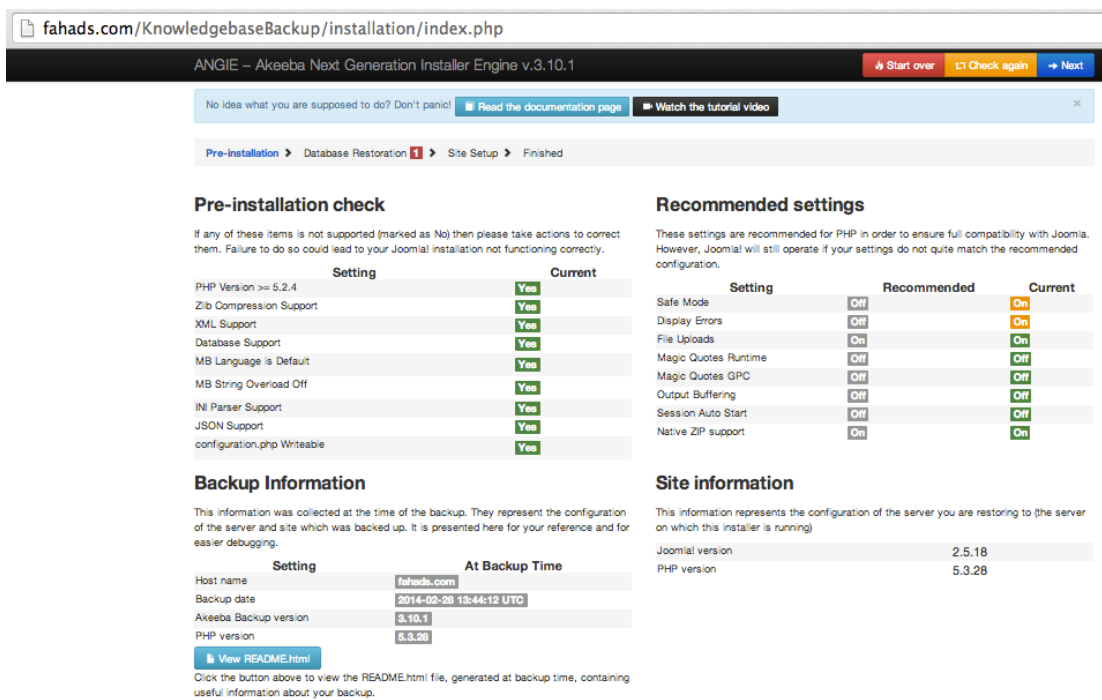


Figure 61 Kickstart Installer

Once the installation finish, kickstrt.php file will show again and provide two options, visiting the website or visiting the administration page as shown in figure 62.



Figure 62 Kickstart Last Step

And in figure 63 the new website that restored in this folder www.fahads.com/KnowledgebaseBackup is ready to use.

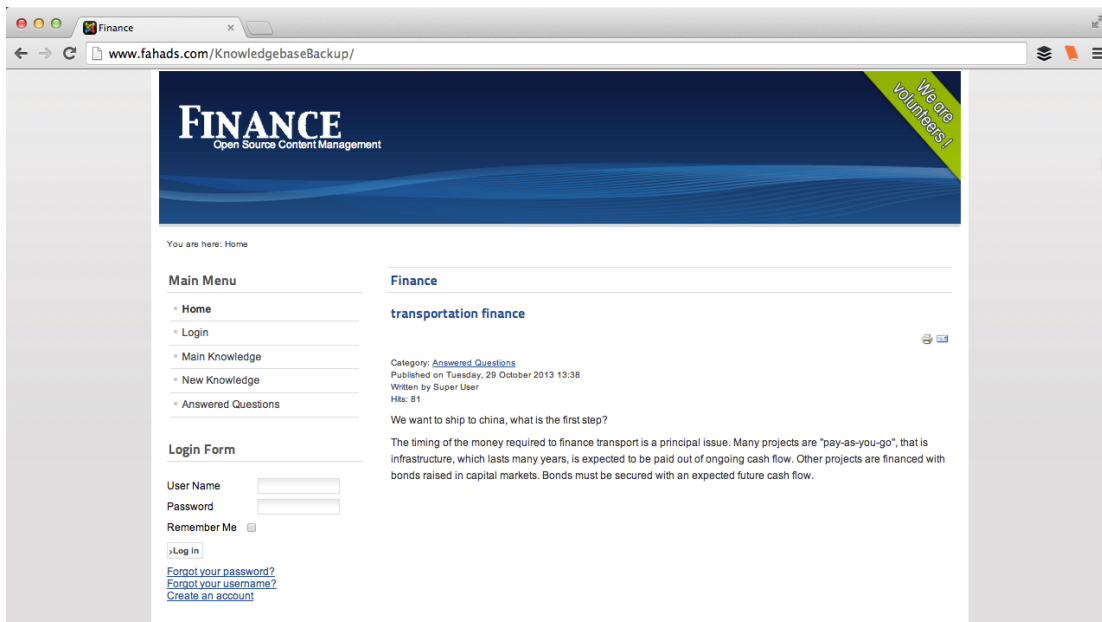


Figure 63 Restored Website

Chapter 5: Conclusion

5.1 Summary of the Research

Virtual organizations need to be managed, which includes observing, controlling, and coordinating the Virtual Organization (VO) activities that contain data and information. If the VO contains more than one organization, the partners need to share expenses, skills, and processes to reach common goals. Also, they need to share their knowledge in a collaborative environment. Knowledge could be text, multimedia, or mix of them; moreover, it might be from one source or many sources (collaborative knowledge). Knowledge could be shared in many ways; however, there are few ways that share knowledge in a safe environment. The privacy and trust issues have high priority in designing any architecture for knowledge management.

We described and compared two solutions to share knowledge in the VO, a centralized Knowledge Base (KB) and distributed Knowledge Base. Each one has its own advantages and disadvantages. We integrated their concepts into one solution, based on distributed KBs and using Mashups to link them with a cloud. The proposed solution addresses the duplication and inconsistency in distributed KBs and discussed the trust and privacy issues in centralized KB.

We adopted the idea of dividing each partner's KB into two sections, which are *public knowledge* that can be shared and *private knowledge* that used for internal processes and cannot be shared. The knowledge that linked with the cloud is the public knowledge only. Each partner has a portal to post and present public knowledge to be accessed by other partners to read, search and ask questions.

In case of partners changing or leaving the VO, to ensure that the VO knowledge archived, we apply a solution that backups the public knowledge for certain KB, and installs it in a new website.

Finally, in this research we met all the objectives that we stated in chapter 1. We used knowledge bases to store knowledge, and used RSS, Mashups and cloud to share knowledge and reduce the duplication and repeating.

5.2 Contribution of the Research

We contributed to the VO knowledge management by facilitating the processes of sharing knowledge in a collaborative environment by combining the benefits of centralized knowledge base and distributed knowledge bases and employing web 2.0. We apply knowledge bases to manage the knowledge in each partner's organization and a portal to present the knowledge. We performed cloud computing to display the knowledge that pushed from each knowledge base. We linked the KBs with the cloud by using Mashups and Pipes. We implemented the architecture and evaluated it by performing a scenario.

In summary, we list our contributions as follows:

- 1- Combining the benefits of centralized knowledge base and distributed knowledge bases.
- 2- Developing an architecture and associated processes to share and save the knowledge.
- 3- Employing web 2.0 technologies to manage knowledge in a collaborative environment.
 - a. Using portals to post and present the knowledge in each knowledge base.

- b. Using cloud computing to collect all knowledge from all partners' portals.
- c. Using Mashups to push the knowledge from partners' portals to the cloud.
- d. Using RSS to link the portals to the cloud by Yahoo Pipes.

5.3 Publication Resulted from this Research

- Fahad Alaieri, Bijan Raahemi "Knowledge Management in Collaborative Environment and Service Oriented Organizations", 7th edition of the Engineering and Computer Science Poster Competition 2014.
- Fahad Alaieri, Bijan Raahemi, Waeal Obidallah "Knowledge Management in Collaborative Environment and Service Oriented Organizations," The International Conference on Management of computational and collective Intelligence in Digital EcoSystems (MEDES'14), 2014 The 6th International Conference on Management of Emergent Digital EcoSystems, 15-17 September 2014 (Submitted)

5.4 Research Limitations

Through the implementation, the proposed architecture has some limitation. The search engine in the cloud -that powered by Google- some times doesn't crawl into all portals in order to get all results we need. K2 dose not offer Q&A forms, and we used the regular article form for Joomla instead.

Regarding the costs and performance, we did not compare the solutions based on them because we focus on sharing knowledge and how to reduce the duplication and maximize the synchronization.

The validation in a real world need to be performed; however, The architecture will face some difficulties if we want to apply it with existing organizations, because some organizations already have their own websites that have a lot of knowledge. Some organizations have a huge amount of knowledge in their website and they might disapprove to install new CMS, portal, or KB to manage their heritage.

5.5 Future Works

Knowledge management in a collaborative environment and service-oriented organization is a very active area to continue the search. Furthermore, the framework needs improvement to apply it in different environments. Regarding technologies, will be useful in this architecture to design RSS feed widget to push knowledge from the KBs and display it in the cloud. This solution will solve the privacy issue in this architecture; also will solve the shutdown issues that happening from third party services. In addition, will be a valuable solution to design a search engine and install it in the cloud webpage instead of Google search engine.

References

- Abdullah, R., Eri, Z. D., & Talib, A. M. (2011). A Model of Knowledge Management System for Facilitating Knowledge as a Service (KaaS) in Cloud Computing Environment. In *IEEE Research and Innovation in Information Systems (ICRIIS)* (pp. 1–4). Malaysia.
- Adnan, M. N., Islam, M. R., & Hossain, S. (2011). Clustering software systems to identify subsystem structures using knowledgebase. In *5th Malaysian Conference in Software Engineering* (pp. 445–450). Malaysia: Ieee. doi:10.1109/MySEC.2011.6140714
- Aiim. (2008). *Enterprise 2.0: Agile, Emergent & Integrated*. Silver Spring.
- Alavi, M., & Leidner, D. (2001). Review: Knowledge management and knowledge management systems: Conceptual foundations and research issues. *MIS Quarterly*, 25(1), 107–136.
- Anand, A., & Singh, M. D. (2011). Understanding Knowledge Management : a literature review. *International Journal of Engineering Science and Technology (IJEST)*, 3(2), 926–939.
- Balasubramanian. (2012). Enterprise 2.0 - Information Technology Management with a Purpose. Retrieved January 19, 2014, from <http://itknowledgeexchange.techtarget.com/information-technology-management/enterprise-20/>
- Benbya, H., Passiante, G., & Aissa Belbaly, N. (2004). Corporate portal: a tool for knowledge management synchronization. *International Journal of Information Management*, 24(3), 201–220. doi:10.1016/j.ijinfomgt.2003.12.012
- Bianchini, D., Antonellis, V. De, & Melchiori, M. (2009). Collaborative enterprise knowledge mashup. *Third Interop-Vlab*, 5–9.
- Bianco, P., Kotermanski, R., & Paulo Merson. (2007). *Evaluating a Service-Oriented Architecture*. Software Engineering Institute.
- Bibikas, D., Paraskakis, I., Vasconcelos, A. C., & Psychogios, A. G. (2009). Enterprise 2.0: The “New Knowledge Management” Or Just Another Buzzword?
- Bitzer, S., Ramroth, S., & Schumann, M. (2009). Mashups as an Architecture for Knowledge Management Systems. In *42nd Hawaii International Conference on System Sciences* (pp. 1–10). USA.
- Boiko, B. (2002). Understanding Content Management A CM Domain White Paper By Bob Boiko Table of Contents. In *Content Management Bible*. Metatorial Services Inc. & HungryMinds Inc.

- Bojan. (2011). How knowledge management can cut costs in your company. Retrieved January 19, 2014, from <http://alphaefficiency.com/how-knowledge-management-can-cut-costs-in-your-company/>
- Bonifacio, M., Cuel, R., Mameli, G., & Nori, M. (2002). A Peer-to-Peer Architecture for Distributed Knowledge Management.
- Brown, W. (2012). What is a Knowledge Base? | Help Desk Helps. Retrieved January 29, 2014, from <http://helpdeskhelps.com/education/what-is-a-knowledge-base/>
- Browning, P., & Lowndes, M. (2001). *JISC TechWatch Report : Content Management Systems List of Figures* (pp. 1–25).
- Camarinha-Matos, L., & Afsarmanesh, H. (2005). Collaborative networks: a new scientific discipline. *Journal of Intelligent Manufacturing*, 439–452.
- Camarinha-Matos, L., & Afsarmanesh, H. (2008). Classes of collaborative networks. *Encyclopedia of Networked and Virtual Organizations*, 193–198.
- Chua, A. (2004). Knowledge management system architecture: a bridge between KM consultants and technologists. *International Journal of Information Management*, 24(1), 87–98. doi:10.1016/j.ijinfomgt.2003.10.003
- Danesh, M. H. A. (2012). *Design and Implementation of a Framework for Process Management in Service Oriented Virtual Organizations Using Service Zones*. University of Ottawa Ottawa,.
- Danesh, M. H., Raahemi, B., & Kamali, M. a. (2011). A framework for process management in service oriented virtual organizations. In *IEEE 7th International Conference on Next Generation Web Services Practices* (pp. 12–17). Spain: Ieee. doi:10.1109/NWeSP.2011.6088146
- Danesh, M., Raahemi, B., Kamali, S. M. A., & Richards, G. (2012). A Distributed Service Oriented Infrastructure for Business Process Management in Virtual Organizations. *Electrical & Computer Engineering (CCECE)*.
- Davenport, T. H., Long, D. W. De, & Beers, M. C. (1998). Successful Knowledge Management Projects. *Sloan Management Review*, 39(2), 43–57.
- Davenport, T. H., & Prusak, L. (2005). Working Knowledge: How Organizations Manage What They Know. *ACM: Ubiquity*, 1–15.
- Delic, K. a., & Riley, J. a. (2009). Enterprise Knowledge Clouds: Next Generation KM Systems? In *International Conference on Information, Process, and Knowledge Management* (pp. 49–53). Mexico: Ieee. doi:10.1109/eKNOW.2009.28

- Drupal. (n.d.). About Drupal | Drupal.org. Retrieved January 22, 2014, from <https://drupal.org/about>
- Dunay, P. (2006). Using RSS for Knowledge Management | Marketing Darwinism. *Marketing Darwinism*. Retrieved January 24, 2014, from <http://pauldunay.com/using-rss-for-knowledge-management/>
- Faris, H., Totaro, S., & Corallo, A. (2011). Framework and Implementation of a Knowledge Management System for Aerospace Collaborative Working Environments. In *IEEE 12th International Conference on Mobile Data Management* (pp. 92–97). Sweden: Ieee. doi:10.1109/MDM.2011.22
- Fontaine, M., & Lesser, E. (2002). *Challenges in managing organizational knowledge*. IBM Institute for Knowledge-Based Organizations. Somers, NY 10589 U.S.A.
- Frost, A. (2010). Knowledge Management Systems. Retrieved January 21, 2014, from <http://www.knowledge-management-tools.net/knowledge-management-systems.html>
- Grammel, L., & Storey, M. (2008). *An end user perspective on mashup makers. ... of Victoria Technical Report DCS-324-IR*.
- Guimaraes, T. (2009). Enabling the Virtual Organization with Agent Technology. *Connectivity and Knowledge Management in Virtual Organizations: Networking and Developing Interactive Communications*, 321–338.
- Guizzardi, R., Ludermir, P., & Sona, D. (2006). A Recommender Agent to Support Knowledge Sharing in Virtual Enterprises. *Agent and Web Service Technologies in Virtual Enterprises*, Idea Group Publishing.
- Haas, H. (2003). Designing the architecture for Web services - slide “Service-Oriented Architecture.” W3. Retrieved December 16, 2012, from <http://www.w3.org/2003/Talks/0521-hh-wsa/slide5-0.html>
- Hamid, N. A. A., & Salim, J. (2010). Exploring the role of transactive memory system (TMS) for knowledge transfer processes in Malaysia E-government IT outsourcing. In *International Conference on Information Retrieval & Knowledge Management (CAMP)* (pp. 303–309). Malaysia: Ieee. doi:10.1109/INFRKM.2010.5466896
- Hevner, A., & Chatterjee, S. (2010). Design Research in Information Systems. In *Chatterjee, Design Research in Information Systems, Integrated Series in Information Systems* (Vol. 22, pp. 9–23). Boston, MA: Springer US. doi:10.1007/978-1-4419-5653-8
- Hevner, A., March, S., Park, J., & Ram, S. (2004). Design Science in Information Systems Research. *MIS Quarterly*, 28(1), 75–105.

- Hong Kong Government. (2008). *Web content management system. The Government of the Hong Kong Special Administrative Region.*
- IBM Cloud. (2013, November 26). IBM Cloud Computing: What is cloud computing? - Canada. IBM Corporation. Retrieved January 20, 2014, from <http://www.ibm.com/cloud-computing/ca/en/what-is-cloud-computing.html>
- InfoWorld. (2007). *InfoClipz: Service-Oriented Architecture*. Retrieved from <https://www.youtube.com/watch?v=-9zgeS9B2NE>
- Jackson, P., & Klobas, J. (2007). The Organization as a Transactive Memory System. In P. Jackson & J. Klobas (Eds.), *Becoming Virtual, Knowledge Management and Transformation of the Distributed Organization* (pp. 111–133). doi:10.1016/j.dss.2007.05.001.
- Jägers, H. P. M., Jansen, W., & Steenbakkens, G. C. A. (1998). Characteristics of virtual organizations. *Universiteit van Amsterdam PrimaVera Working Paper Series*, (February), 98–02.
- Johnston, M. (2011). CMS or WCM - Which is Which? Retrieved January 20, 2014, from <http://www.cmscritic.com/cms-or-wcm-which-is-which/#.Ut3BAGQo7-Y>
- Joomla. (n.d.). What is Joomla? Retrieved January 21, 2014, from <http://www.joomla.org/about-joomla.html>
- Kamali, S. M. A., Richards, G., Danesh, M. H., & Raahemi, B. (2012). A Framework For Performance Measurement In Service Oriented Virtual Organizations A Value Network Approach to Collaborative Performance Measurement. In *7th International Conference on e-Business*. Italy.
- Khoshnevis, S., & Rabeifar, F. (2012). Toward Knowledge Management as a Service in Cloud-Based Environments. *Austrian E-Journals of Universal Scientific Organization*, 2(4), 88–110.
- Kim, E., Vtt, J., Biba, J. E., Eschenbaecher, J., Jansson, K., Karvonen, I., ... Negretto, U. (2005). *Challenges in Virtual Organisations Management Report on methods for distributed business process management* (p. 36).
- KIT. (2007). Collaboration & Interoperability for Networked Enterprises. COIN.
- Lindvall, M., Rus, I., & Sinha, S. (2003). Software systems support for knowledge management. *Journal of Knowledge Management*, 7(5), 137–150. doi:10.1108/13673270310505449
- Liu, P., Raahemi, B., & Benyoucef, M. (2011). Knowledge sharing in dynamic virtual enterprises: A socio-technological perspective. *Elsevier Knowledge-Based Systems*, 24(3), 427–443. doi:10.1016/j.knosys.2010.12.004

- Liu, Y., Liang, X., Xu, L., Staples, M., & Zhu, L. (2011). Composing enterprise mashup components and services using architecture integration patterns. *Journal of Systems and Software*, 84(9), 1436–1446. doi:10.1016/j.jss.2011.01.030
- Liu, Y., & Zhong, R. (2011). Research On Transactive Memory System, Knowledge Reuse And Team Efficacy In Professional Service Teams. In *IEEE Management and Service Science (MASS), International Conference* (pp. 1–4). China.
- Loss, L., Pereira-klen, A. A., & Rabelo, R. J. (2005). Knowledge management based approach for virtual organization inheritance. *Federal University of Santa Catarina, Department of Automation and Systems GSIGMA – Intelligent Manufacturing Systems Group*, 1–10.
- Lotus. (2000). *Knowledge Management Portal Solutions*. Lotus Development Corporation.
- Mcafee, A. (2006). *Enterprise 2.0: The State of an Art*.
- Mell, P., & Grance, T. (2011). *The NIST Definition of Cloud Computing*. U.S. Department of Commerce Rebecca.
- MVNO Dynamics. (n.d.). Definition: Mobile Virtual Network Operator (MVNO). Retrieved February 08, 2014, from <http://www.mvnodynamics.com/mvno/>
- Natarajan, M. (2008). Portal as A Tool For Knowledge Management Synchronization. In *International Conference on Knowledge for All: Role of libraries and Information centres*. India.
- Navarro, M. B., & López, A. V. (2009). Knowledge Integration Through Inter-Organizational Virtual Organizations. *Connectivity and Knowledge Management in Virtual Organizations: Networking and Developing Interactive Communications*, 61–72.
- Nonaka, I. (1991). The knowledge-creating company. *Harvard Business Review*, 96–104.
- Nonaka, I. (1994). A Dynamic Theory of Organizational Knowledge Creation Ikujiro Nonaka. *Organization Science*, 5(1), 14–37.
- Nonaka, I., & Konno, N. (1998). The concept of “ba”: building a foundation for knowledge creation. *California Management Review*, 40, 40–55. doi:10.1016/j.otrs.2010.03.008
- Nonaka, I., & Takeuchi, H. (1995). *The knowledge creating company: how Japanese companies create the dynamics of innovation* (XII., p. 284). New York: Oxford University Press.

- Obidallah, W., Raahemi, B., Kamali, S. A., & Danesh, M. (2013). Service oriented virtual organizations: A service change management perspective. In *26th IEEE Canadian Conference on Electrical & Computer Engineering (CCECE)* (pp. 0–5). Canada: IEEE.
- Oguntebi, J. (2009). *Creating Effective Global Virtual Teams: A Transactive Memory Perspective*. University of Michigan.
- Panken, F., Zoetekouw, B., Bokhove, W., & Hulsebosch, B. (2011). *Virtual Organisations : Lifecycle*. GigaPort3.
- Peffer, K., Tuunanen, T., Rothenberger, M. a., & Chatterjee, S. (2007). A Design Science Research Methodology for Information Systems Research. *Management Information Systems*, 24(3), 45–77. doi:10.2753/MIS0742-122240302
- Pollalis, Y. a., & Dimitriou, N. K. (2008). Knowledge management in virtual enterprises: A systemic multi-methodology towards the strategic use of information. *International Journal of Information Management*, 28(4), 305–321. doi:10.1016/j.ijinfomgt.2008.02.005
- Por, G., & Molloy, J. (2000). Nurturing Systemic Wisdom Through Knowledge Ecology. *PEGASUS COMMUNICATIONS THE SYSTEMS THINKER*, 11(8), 1–5.
- Rajan, S. (2011). Cloud Computing: Knowledge Management as a Service | Cloud Computing Journal. *cloud computing journal*. Retrieved January 20, 2014, from <http://cloudcomputing.sys-con.com/node/2088734>
- Reza, D., & Soheila, E. (2011). The Impact Of Knowledge Management On The Workplace. In *INTERNATIONAL CONFERENCE ON MANAGEMENT (ICM 2011)* (pp. 472–479). Malaysia.
- Riedl, B. C., Gallenkamp, J. V., Picot, A., & Welp, I. M. (2012). Antecedents of Transactive Memory Systems in Virtual Teams--The Role of Communication, Culture, and Team Size. In *45th Hawaii International Conference on System Sciences* (pp. 465–474). USA: Ieee. doi:10.1109/HICSS.2012.655
- Rockley, G. (2003). *Managing Enterprise Content : A Unified Content*. The Rockley Group Inc.
- Rouse, M. (2007). knowledge base. Retrieved January 29, 2014, from <http://searchcrm.techtarget.com/definition/knowledge-base>
- Rowley, J. (2007). The wisdom hierarchy: representations of the DIKW hierarchy. *Journal of Information Science*, 33(2), 163–180. doi:10.1177/0165551506070706
- Sathyadevan, S. (2012). Kloud – A Virtual Elastic Knowledge Cloud. In *Technology Enhanced Education (ICTEE), 2012 IEEE International Conference*. India.

- Servin, G., & Brun, C. De. (2005). ABC of knowledge management. *NHS National Library for Health: Specialist Library*, (July).
- SharePoint. (2013). SharePoint 2013 overview – collaboration software features. Retrieved January 20, 2014, from <https://office.microsoft.com/en-ca/sharepoint/sharepoint-2013-overview-collaboration-software-features-FX103789323.aspx>
- Sriram, I., & Khajeh-Hosseini, A. (2010). Research agenda in cloud technologies. In *1st ACM Symposium on Cloud Computing*. USA.
- Structures, D. (n.d.). Algorithms and Data Structures using C++. *Algorithms and Data Structures Using C++*.
- Taylor, S., Lacy, S., & MacFarlane, I. (2007). *ITIL Service Transition*. Published by TSO (The Stationery Office) for the London.
- Tekinerdo, B. (n.d.). Separating Software Engineering Concerns. University of Twente Department of Computer Science Enschede, The Netherlands.
- Tiwana, A. (1999). *The Knowledge Management Toolkit* (First Edit., p. 640). Prentice Hall PTR.
- Tsui, E., Cheong, R. K. F., & Sabetzadeh, F. (2011). Cloud-Based Personal Knowledge Management as a service (PKMaaS). In *Computer Science and Service System (CSSS), International Conference, IEEE* (pp. 2152–2155). China.
- Valayer, C. (2010). *Enterprise 2.0 What can the Web 2.0 do for your business?* *Trasys* (pp. 1–5).
- Velev, D., & Zlateva, P. (2012a). Current State of Enterprise 2.0 Knowledge Management. *International Journal of Trade, Economics and Finance*, 3(4), 245–250. doi:10.7763/IJTEF.2012.V3.208
- Velev, D., & Zlateva, P. (2012b). Enterprise 2.0 Knowledge Management Development Trends. In *International Conference on Economics, Business Innovation* (Vol. 38, pp. 83–87). Malaysia.
- Wang, H., Zhao, D., & Kong, J. (2010). Library knowledge sharing based on Cloud computing. In *2nd International Conference on Software Technology and Engineering* (pp. 424–427). USA: Ieee. doi:10.1109/ICSTE.2010.5608879
- Wang, J., & Liu, F. (2011). Knowledge management for a virtual organization. In *2nd International Conference on Artificial Intelligence, Management Science and Electronic Commerce (AIMSEC)* (pp. 2171–2174). China: Ieee. doi:10.1109/AIMSEC.2011.6010954

- Wegner, D. M., Giuliano, T., & Hertel, P. T. (1985). Cognitive interdependence in close relationships. *Compatible and Incompatible Relationships*, 253–276.
- Xu, S., & Zhang, W. (2005). Knowledge as a service and knowledge breaching. In *IEEE International Conference on Services Computing (SCC'05)* (Vol. 1, pp. 87–94). USA: Ieee. doi:10.1109/SCC.2005.60
- Yahoo. (n.d.). Pipes Overview. *Yahoo*. Retrieved February 04, 2014, from <http://pipes.yahoo.com/pipes/docs?doc=overview>
- Yip, M. W., Hou, A., Ng, H., & Din, S. (2012). Knowledge Management Activities in Small and Medium Enterprises / Industries : A Conceptual Framework. In *International Conference on Innovation and Information Management* (Vol. 36, pp. 16–19). China.
- Yoo, S. B., & Kim, Y. (2002). Web-based knowledge management for sharing product data in virtual enterprises. *International Journal of Production Economics 2002 Elsevier Science*, 75, 173–183.
- Zeleny, M. (1987). Management support systems: Towards integrated knowledge management. *Human Systems Management*, 7(1), 59–70.
- Zhu, Q., & Meza, J. (2010). Knowledge Organization with Mashups: A Mashup Experiment in an Enterprise Environment. In *Ubiquitous Developments in Knowledge Management: Integrations and Trends* (pp. 127–140). doi:10.4018/978-1-60566-954-0.ch008
- Zimmerli, B. (2009). Business Benefits of SOA. *University of Applied Science of Northwestern Switzerland*.