
ISSN:2382-6185

IJKE

International Journal of Knowledge Engineering

Vol.3, No.1 & No.2, 2017

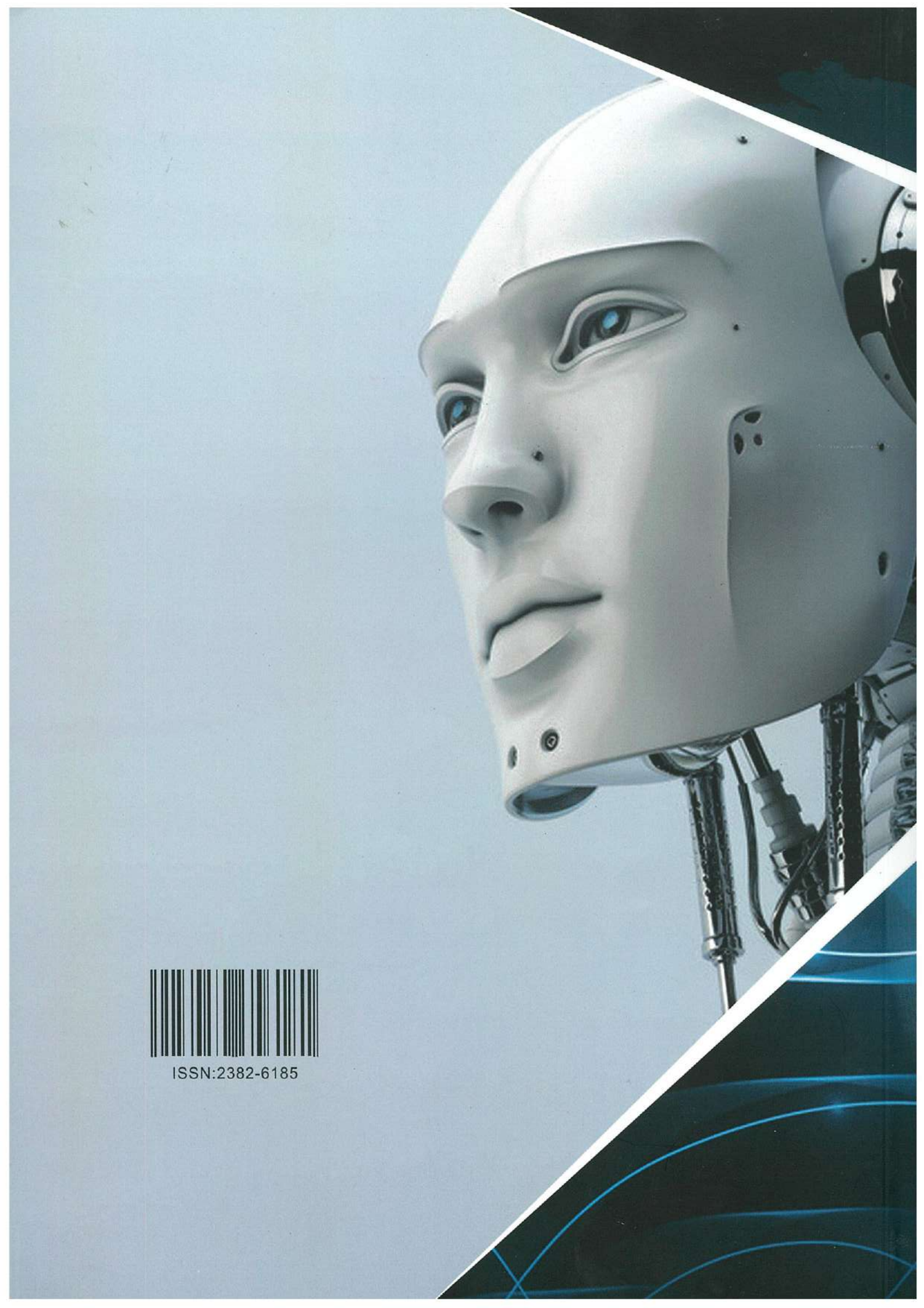
www.ijke.org

International Journal of Knowledge Engineering (IJKE)

Vol. 3, No. 1 & No. 2, 2017
ISSN: 2382-6185

International Journal of Knowledge Engineering

CONTENTS



ISSN:2382-6185

Knowledge Management Support for Enterprise Architecture Development

Adi Wibowo

***Abstract*—Knowledge Management (KM) has become an important part of organization's competitive strategy. KM in general has 3 processes, ie. create, classify, and retrieve. This three processes can be utilised to support EA Team in formulation of enterprise architecture. This paper suggests the use of knowledge chain, labels (tagging), and taxonomy to develop knowledge base that can helps EA Team in formulation process of enterprise architecture. To support the use of KM principles knowledge expert needs to become part of EA Team. Knowledge expert tasks are capture tacit knowledge into explicit knowledge, convert knowledge documents using standardized file format, specify documents' metadata, build knowledge chain and taxonomy for EA's knowledge base.**

***Index Terms*—Enterprise architecture, knowledge chain, knowledge management, taxonomy.**

I. Introduction

Knowledge Management (KM) is an important part of organization's survival and sustainable competitive strategy [1]. Knowledge management (KM) is defined as "the process by which an organization creates, captures, acquires and uses knowledge to support and improve the performance of the organization" [2]. Competitive strategy usually consists of several core competencies that can be used to produce better values than competitors. Knowledge that originate from internal organization is usually unique so it can be used to build competitive strategy.

Organization uses Enterprise Architecture to integrate information technology to support business processes. Enterprise Architecture (EA) is defined as understanding the elements of an organization and how the elements relate to each other. [3] These elements are strategy, business drivers, principles of organization, unit, location, budget, processes, services, information, communication, and information systems. J. Schekkerman state that organizations at 149 countries have implemented Enterprise Architecture. The most used enterprise architecture framework are Zachman Framework (23%), TOGAF (11%) dan FEAF (11%) [3].

Knowledge Management and Enterprise Architecture have the same goal of developing the competitive ability of the organization. Enterprise Architecture also requires a lot of knowledge that has been retained by organizations such as business models, business strategy, organization conditions (strengths, weaknesses, problems and opportunities). This paper suggests an approach that utilize the principles of knowledge management in the process of analysing and designing enterprise architecture. The aim is to provide enterprise architecture team with complete and logical knowledge base.

Manuscript received December 12, 2016; revised April 12, 2017.

The author is with Petra Christian University, Indonesia (e-mail: adiw@petra.ac.id).

II. Related Works

To understand the relationship between knowledge and enterprise Henderson and Venkatraman suggested that business and IT alignment can be understood using Strategic Alignment Model (SAM) [4]. Venkatraman argued that the difficulty to realize value from IT investments is caused by the lack of business and IT alignment. In SAM there are two aspects of enterprise, i.e. business domain, and IT domain, and two levels, i.e. strategy level, and infrastructure-and-processes level. Venkatraman suggested that Business Strategy will become the driver (design choices and logic) for both Organization infrastructure-and-processes, and IT infrastructure-and-processes. Exploitation of IT Strategy can also impact Organization infrastructure-and-processes, i.e. new products, or distintive competitiveness. IT Strategy can also assure the effectiveness of IT infrastructure and processes. Strategic Alignment Model is shown at Fig. 1.

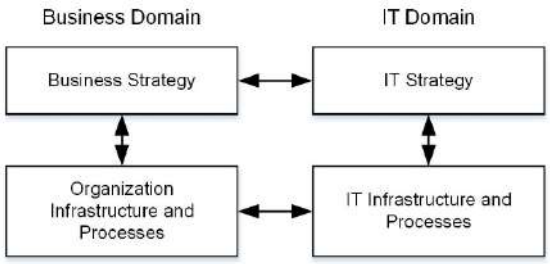


Fig. 1. Strategic alignment model.

Gudas and Brundzaite (2007) proposed inclusion of Knowledge Management Systems to store and process organizational memory to implement Knowledge-based Enterprise to realize SAM [5].

To implement knowledge management perspective to support enterprise architecture construction activities Choo proposed that each EA activities can falls into knowing cycles (sense making, decision making, and knowledge creation) [6]. At each EA activities organization needs to identify what kind of knowledges need to be constructed.

Approaches suggested by Henderson, and Gudas laid foundation to use knowledge management systems to support business and IT strategy. This paper proposes a practical approach to use knowledge base and knowledge management to support Enterprise Architecture development as suggested by Gudas and Brundzaite.

doi: 10.18178/ijke.2017.3.1.082

III. Proposed Approach

A. Knowledge Management as a Base

This approach utilizes three steps contained in Knowledge Management definition. Knowledge management (KM) is defined by Kinney as "the process by which an organization creates, captures, acquires and uses knowledge to support and improve the performance of the organization" [2]. KM is an approach taken to improve organizational learning processes and organizational outcomes by using the knowledge owned by the organization.

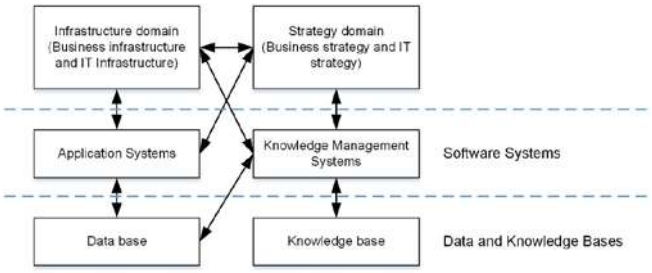


Fig. 2. Knowledge-based enterprise architecture.

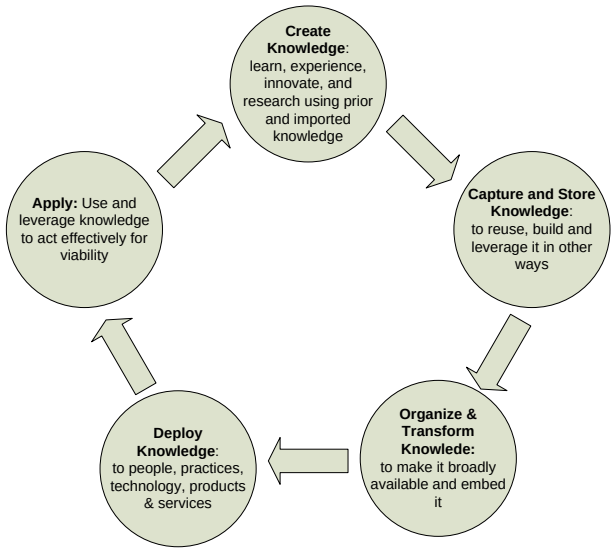


Fig. 3. Knowledge management processes.

There are two kinds of knowledge contained in an organization, i.e. tacit and explicit knowledge. Tacit knowledge is the understanding, concepts, or definitions that are in the mind of members of the organization. Tacit knowledge is usually associated with more complex things, such as the interpretation of the trend of sales, staff satisfaction tendency toward the organization, etc. Explicit knowledge is usually in the form of documentation, or models obtained from experiments or activities. Explicit knowledge then becomes part of the social explicit knowledge of the organization in the form of procedures, regulations, etc.

The initial step of knowledge management is to transform tacit knowledge into explicit knowledge. This conversion process is referred to as knowledge capture. The overall knowledge management process is depicted in Fig. 3 [2]. The process begins with the formation of tacit knowledge in the mind of every member of the organization. Tacit knowledge is gained from experience, analysis, learning process from every member of the organization. The source of the analysis is tacit knowledge from other members, or explicit knowledge from existing knowledge base. The second processes is to change tacit knowledge possessed by each member of the organization into explicit knowledge that can be stored in the knowledge base. The second process is called knowledge capture. Obtained explicit knowledge then stored in knowledge base. The third processes is usually performed when members of the organization access knowledge base through information portal, or knowledge retreival system. Third process is also called as knowledge application process, or the knowledge implementation on every process and activity within the organization. This process generates new tacit knowledge in the mind of every member of the organization.

Three big KM processes which are create, classify, and retrieve will be used as a base to support development of enterprise architecture in this proposed approach.

B. Enterprise Architecture Framework

Before knowledge can be used in the development process of enterprise architecture, it is important to first deal with the understanding of how enterprise architecture is developed. There are many frameworks that guide architects in designing EA, e.g. Zachman Framework, The Open Group Architecture Framework (TOGAF), Federal Enterprise Architecture Framework (FEAF), Enterprise Architecture Planning (EAP Spewak), and others. From those frameworks there are similar principles or steps in the development of enterprise architecture, i.e.:

1) Identification of business strategy. The first step starts from the analysis of the business model of the organization, which determines the nine pillars of the business model. The next step is to see the environmental conditions surrounding the organization, including competition, government regulations, challenges and opportunities of the organization, including the trend of technological support for the organization. When an organization plans to incorporate support of information technology in business strategy, then the information technology support plan are included in the organization's strategic planning. Information strategic planning is part of the organization's business strategy.
2) Identification the organization "as-is" condition. At this stage EA team begin to look for the weaknesses in the organization business strategies and processes. EA team needs to examine whether these weaknesses come from the poor support of information system (needs improvement of IS), or it can be addressed by developing new information systems (need a new development). This stage is performed by EA team together with each department management through interviews and document analysis.
3) Determine functions and data. Using prior information of data used by organization, EA Team determine data structure and classification for the organization. EA Team also divide business processes into activities and tasks.
4) Identification of information sub-systems. Using the matrix formed from functions and the data from step 3, EA team groups functions and data into information sub-systems. This process can use data affinity principle (Spewak) [7], consideration of EA team members

(Zachman) [8], or the process of classification (Melissa A. Cook) [9].

5) Identify appropriate types of application and technology architecture within each sub-system. A sub-system can consist of several types of smaller information systems. EA Team can also determine enterprise wide applications used across departments or divisions.
6) Create plan for proper implementation of EA. Implementation plan consists of several iterations of transition. Usually more than one iteration is needed for large-scale change.

All steps to develop Enterprise Architecture are depicted at Fig. 4.

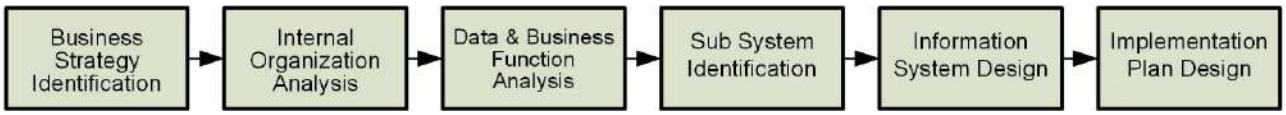


Fig. 4. Steps to develop enterprise architecture.

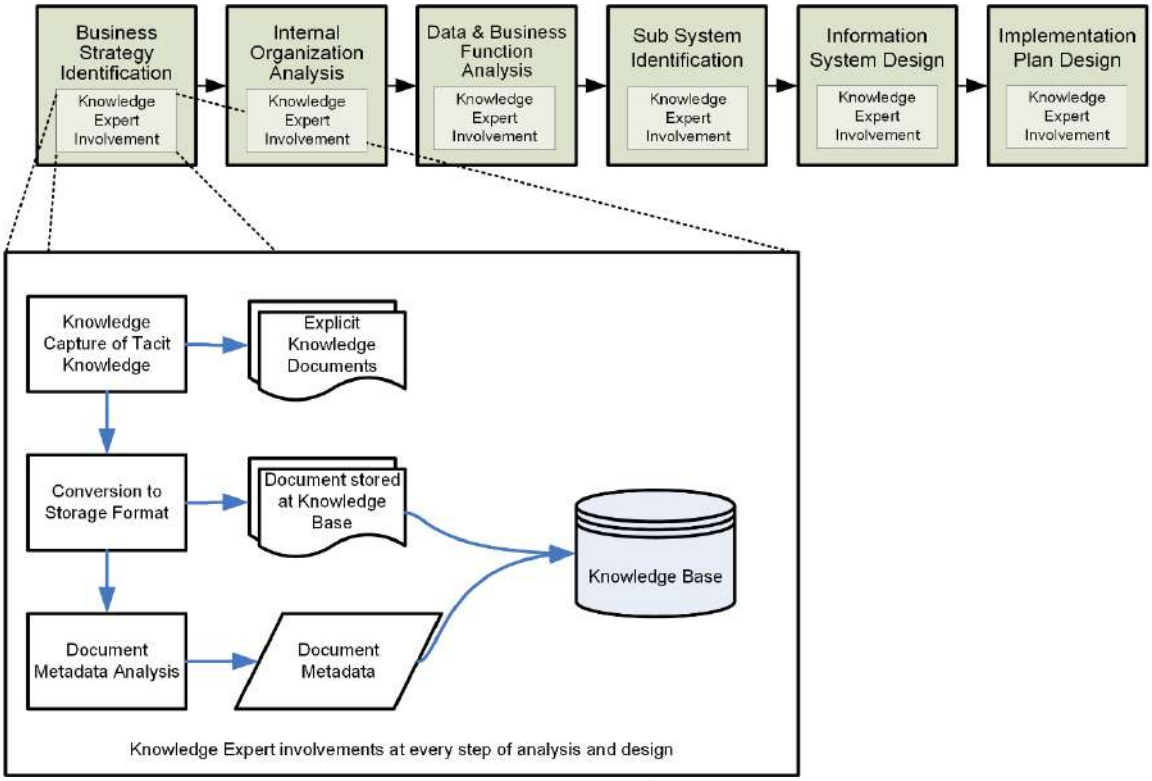


Fig. 5. Knowledge expert involvements in each step of enterprise architecture development.

C. Knowledge Expert Involvement in Explicit Knowledge Creation Process

In each step of the development process of enterprise architecture above, members of the team have interviews, collect data, assess which technology is widely used, model the processes, and finaly making decision. Usually EA team documents data obtained at each step using model of a specific notation, such as BPMN, DFD, or IDEF0. There is an opportunity to process obtained data as knowledges. To support this opportunity Knowledge Expert is involved as one of the members of the EA team. His job is to:

- Guide and help EA Team to achieve conclusions in any discussions by changing tacit knowledge contained in the mind of every member of the EA team, and the people involved in the interview, into explicit knowledge. Discussions are held both with EA team members, as well as with other executives at interviews. Explicit knowledge found by Knowledge Expert are the problems that arise within organization and expected solutions, best practices of technology, options of the available technologies, decisions taken when grouping of data - function, determining of the appropriate sub-system, the determining of the application needed, technology standards, technology platforms, etc. Explicit knowledges generated by Knowledge Expert are then stored in a knowledge base and become an input for the next iteration of the development of the EA. Explicit knowledge collected also serves as documentation of each stage results Enterprise Architecture.
- Determine the most appropriate format to store (organize) and retrieve documents obtained through process of knowledge capture above. Document format is chosen according to the purpose of storing, and available standard file formats. There are three purpose of storing documents [10], i.e.:

1) References. Reference is usually stored in organization's information portals or search engines. Reference aims to give the users an overview of information that they will access. For a textual document, reference can be in the form of image that displays the cover page and abstract. For audio documents, reference can be in the form of a 30-second audio clip.
2) Reproduction. The quality of reproduction of documents

depends on the desired method of reproduction. Document for reproduction should has similar quality with the original document.

3) Replacement. The original documents will be destroyed, or is not expected to have a long durability. Documents are stored for the purpose of trying to keep physical elements such as size, resolution, color of the original document.

In addition to the consideration of the purpose of storage, knowledge expert is also needs to consider several formats for de-facto standard in storing document. Standard becomes very important in the effort to store explicit knowledge documents into the database because:

1) Consideration for future development. The format should be able to survive long enough to minimize the effort reconversion into other formats.
2) Avoiding lock-up of a proprietary technology. If technology that is required to read and display the document is obsolete, then the document in the knowledge base is in danger of inaccessibility.

- Create knowledge representations by determining metadata standards. Representation of documents is needed because existing information retrieval technology is still not able to produce / deliver search results based on the context of the document perfectly. Context can be provided by the document's metadata. There are two kinds of metadata standards, i.e. descriptive and semantic. Descriptive metadata can only explain about the author, location, date, or physical description. Semantic metadata also provides a description of the context and content of the document. An expert knowledge can use both types of metadata standards to create a representation of the same document. Most popular metadata standards are MARC and the Dublin Core. MARC is a metadata standard used for printed documents [11], while Dublin Core is a metadata standard for electronic documents [12].

The overall involvement of expert knowledge in every step of formulation of enterprise architecture is depicted in Fig. 5.

D. Knowledge Classification

Knowledge Base that has been made by the EA team through the process of knowledge capture, either at the current iteration or the previous iteration, is used to help EA Team to identify the problems they faced, or to improve EA solutions. To access the knowledge contained in a knowledge base Knowledge Expert needs to classify information.

1) Knowledge Chain: In order to keep the context of captured knowledge intact, the knowledge stored in the knowledge base must form a chain of knowledge. Knowledge chain gives EA Team the opportunity to track the development of EA concepts. For example, to design the UI according to staff's ability level and functions, EA Team need to develop initial identification of the level and ability of staffs, options of UI design, and then user interface design based on application functionality. This process will continue until the end of user interface design (including security considerations). Knowledge chain could be branched to form a tree as depicted by Fig. 6.

Business strategy is an important knowledge for the development of enterprise architecture. Knowledge expert needs to capture business logic covering the proposed value, distribution channel and value chain. Subsequent knowledge is value chain consists of main functions of the organization. Value chain is then developed into business process required to perform these functions (along with the model), and organizational structure. The organizational structure is then developed to be the locations of the organization. Knowledge chain can be displayed visually to provide an overview of the context of the concept being discussed as depicted at Fig. 7.

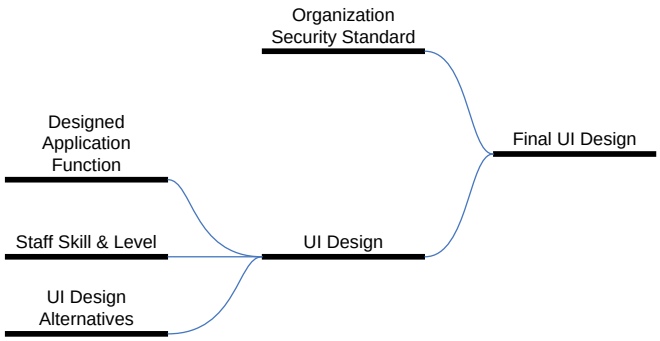


Fig. 6. Knowledge chain about user interface design.

Fig. 8 shows knowledge chain about business strategy after several iterations of development of enterprise architecture.

Knowledge chain can also be used as historical data when evaluation of a concept (knowledge) is needed in the future, for example, to evaluate the development of the business strategy of an organization within the last 5 years. From any business strategy document taken from knowledge base, EA Team will also find (as a result of knowledge chain) knowledge about strategic information plan, enterprise architecture design, implementation plan, and evaluation for each of the business strategy.

2) Labelling (Tagging) Each Document. Document labels should not be made freely, but should be taken from a controlled vocabulary. Controlled vocabulary is a set of terms (words or phrases) which are collected to illustrate concepts discussed during the formation of EA. Terms in the controlled vocabulary should not form a sequence, or convey relationship between concepts. This means that each term in the controlled vocabulary can stand alone. Controlled vocabulary is different from the taxonomy that the terms in it does not have to form a hierarchy. Most of the contents of the controlled vocabulary must be made prior to the formation of EA. Controlled vocabulary is necessary so that there are common terms (no two terms for similar definition) and the precise definition of terms among team members.

Examples of controlled vocabulary:
BUSINESS FUNCTION
DATA CLASSIFICATION
USER INTERFACE
SECURITY STANDARD
APPLICATION STANDARD
ARCHITECTURE PATTERN

Labels serves as an index that gives an overview of the knowledges inside knowledge base. A document can have as many labels as required. Labels are required to mark

document. Search engine used during the information retrieval process is usually not able to understand the contents of the document. Information Retreival (IR) usually able to locate documents most relevant to a query request, but does not guarantee that the content of the document context is always relevant to the query in question. Knowledge Expert with the help of subject expert can identify concepts inside documents correctly and apply apropriate labels to those documents. As an example: labels on the document "business process" are BUSINESS PROCESS, BPMN, MARKETING DIVISION.

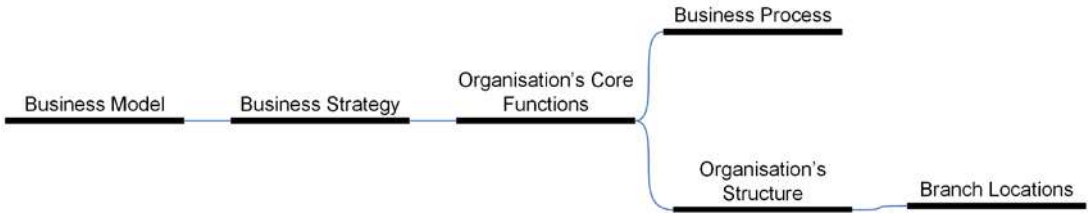


Fig. 7. Knowledge chain about business development strategy.

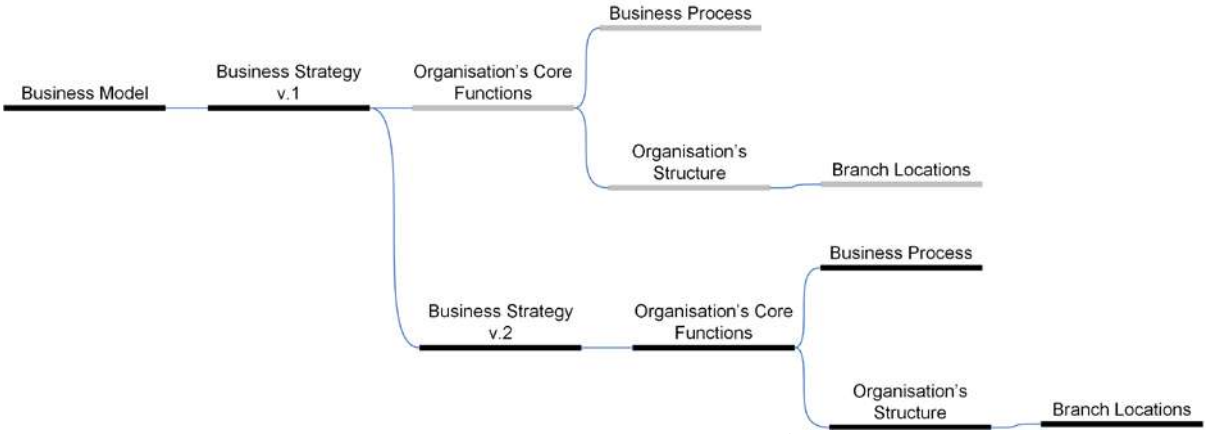


Fig. 8. Knowledge chain about business development strategy after several iterations.

Knowledge base that uses labels works by defining a set of keywords that represent a certain knowledge. Example: when EA team try to design a portal in accordance with the organization culture, EA team seek knowledge in the knowledge base by using keywords: culture, communication, security, etc. EA team can create a set of keywords for each purpose, for example to search documents related to knowledge portals, information systems, security, corporate culture, business strategy, etc. Sets of keywords for each of the purpose of EA team are then stored in a retrieval system belonging to the EA team to be used over and over again so that the EA team does not need to enter a new set of keywords anymore.

3) Taxonomy for EA Knowledge Base. Organizations need taxonomy. Knowledge has been created and circulated in an organization for years to form what is called a 'jungle' of information. There are too much information and if they are not classified they will confuse any staff who are trying to learn. Organization needs to establish taxonomy with the scope of the enterprise (enterprise-wide taxonomy) which covers all the knowledges that were exchanged within organization. This taxonomy is usually used to form the organization portal in knowledge management efforts. Organizations also need to create a second taxonomy made specifically for enterprise architecture innitiative. This second taxonomical classification is made to accommodate the concepts, models, technology, business strategy, methods and tools required by the formulation process of enterprise architecture. Organization usually needs more than one taxonomy because in order for taxonomy to be effective, the taxonomy must be made in accordance with a particular context. If taxonomy is created for a context that are too broad the result will contain too many hierarchical levels and horizontal variations. Taxonomy also need to be maintained or updated according to the development of knowledge and technology in an organization. There is a taxonomy created by Melvil Dewey [13] which is known as the Dewey Decimal Classification (DDC). DDC provides a broad classification scheme for the purpose of classifying the entire knowledge including language and literature, pure science to applied science, and psychology. DDC scheme becomes quite large and includes too broad scope for use in an organization. Organizations in the field of food manufacture would not require a classification that describes the field of linguistics and literature.

The first step to create taxonomy is idenfifying who the stakeholders of the organization are, what are the level of stakeholders, and then ask each stakeholder about description of the contents (context) of any existing documents [14]. The second step is to create taxonomy draft by construct taxonomic structure. Once the draft is completed, taxonomy is linked with documents of the organization and then submitted to all stakeholders for refiew. At this time of the hierarchy of taxonomy can be reevaluated. Once the entire process is completed, the resulting taxonomy can be used in the knowledge management process. The same process is used to form a taxonomy for enterprise architecture. The difference with organizational taxonomy is only in scope.

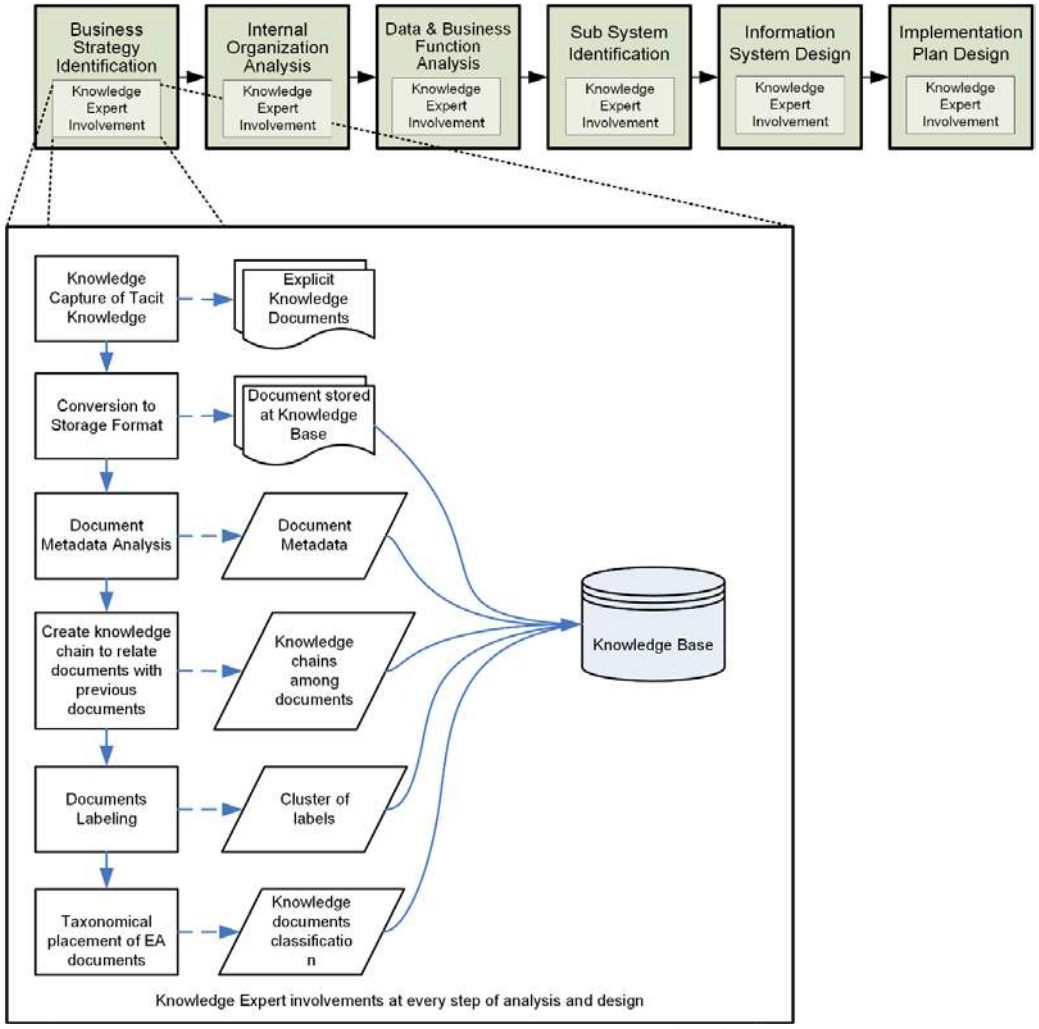


Fig. 9. Knowledge expert involvement at each step of EA framework.

E. Involvement of Knowledge Expert in Enterprise Architecture Development

Complete picture of the involvement of knowledge expert in each step of the designing enterprise architecture is shown in Fig. 9. Taxonomy for EA complements knowledge chain and labels. Taxonomy provides the structure of concepts learned during the creation of enterprise architecture. Knowledge chain forms particular knowledge into sequence, and also provide historical data for that knowledge. Labels give additional context to knowledge documents to increase the effectiveness of knowledge retrieval. Thus if a member of EA team intends to develop or revise a portion of the enterprise architecture, he can seek knowledge that have been made previously by using a specific label, and then tracked all related documents using knowledge chain. He could compare a chain knowledge with others using taxonomy.

IV. Conclusion

The principles of knowledge management (creation, classification, retrieval) can be used to assist or support each step of enterprise architecture (EA) development. In order to do this, knowledge expert should be part of EA team. Knowledge expert tasks are:

- Change the tacit knowledge inside of every team member, and members of other departments mind into explicit knowledge through a knowledge capture process.
- Store explicit knowledge documents into knowledge base by converting them into a standardized file format.
- Specify the document metadata.
- Determine knowledge chain for the documents, or create a new chain of knowledge for those documents.
- Determine labels of documents by using controlled vocabulary that was created earlier.
- Determine the location of document on the EA taxonomy, and organization's taxonomy.
- Store metadata, knowledge chain, labels, and the locations of the document in the taxonomy into knowledge base.

References

[1] A. Rahimli, "Knowledge management and competitive advantage," *Information and Knowledge Management*, vol. 2, no. 7, pp. 37-43, 2012.

[2] T. Kinney, "Knowledge management, intellectual capital and adult learning," *Adult Learning*, vol. 10, no. 2, pp. 2-5, 1998.

[3] J. Schekkerman, "Trends in enterprise architecture: How are organizations progressing?" A*mersfoort: Institute for Enterprise Architecture Developments*, 2005.

[4] J. Henderson and N. Venkatraman, "Strategic alignment: A model for organization transformation via information technology," *Massachusetts Institute of Technology*, 1990.

[5] S. Gudas and R. Brundzaite, "Approach to enterprise knowledge base development," ser. *Advances in Information Systems Development - New Methods and Practice for the Networked Society*, Springer, 2007, pp. 61-72.
[6] C. W. Choo, *The Knowing Organization*, 2nd ed. Oxford: Oxford University Press, 2006.
[7] S. H. Spewak and S. C. Hill, *Enterprise Architecture Planning: Developing a Blueprint for Data, Applications, and Technology*, A Wiley-QED Publication, 1993.
[8] J. P. Zachman. (2015). The Zachman framework evolution. [Online]. Available: https://www.zachman.com/ea-articles-reference/54-the-zachman-framework-evolution
[9] M. A. Cook, *Building Enterprise Information Architectures: Reengineering Information Systems*, Prentice Hall, 1996.
[10] J. M. Reilly and F. S. Frey, "Recommendations for the evaluation of digital images produced from photographic," *Microphotographics, and Various Paper Formats*, Rochester: Rochester Institute of Technology, 1996.
[11] *MARC 21 Format for Classification Data*, United States of America, Library of Conggress, 2014.
[12] *ISO 15836:2009 Information and documentation - The Dublin Core Metadata Element Set*, Technical Committee ISO/TC 46, The International Organization for Standardization. 2009.
[13] Online Computer Library Center. (2015). Dewey decimal classification summaries. [Online]. Available: https://www.oclc.org/dewey/features/summaries.en.html
[14] D. Bruno and H. Richmond, "The truth about taxonomies," *Information Management Journal*, vol. 37, p. 44, 2003.

Adi Wibowo is a lecturer at Informatics Department, Petra Christian University. He obtained the bachelor degree in electrical engineering from Petra Christian University, and the master degree in information system from Institut Teknologi Bandung. His research interests include knowledge management, enterprise architecture, and information retrieval.