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A Comprehensive Review of Knowledge Mapping Techniques

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Abstract— Knowledge mapping is one of the most popular techniques used to identify knowledge in organizations. Using knowledge mapping techniques; a large and complex set of knowledge resources can be acquired and navigated more easily. Knowledge mapping has attracted the senior managers' attention as an assessment tool in recent years and is expected to measure deep conceptual understanding and allow experts in organizations to characterize relationships between concepts within a domain visually. Here the very critical issue is how to identify and choose an appropriate knowledge mapping technique. This paper aims to explore the different types of knowledge mapping techniques and give a general idea of their target contexts to have the way for choosing the appropriate map. It attempts to illustrate which techniques are appropriate, why and where they can be applied, and how these mapping techniques can be managed. The paper is based on the comprehensive review of papers on knowledge mapping techniques. In addition, this paper attempts to further clarify the differences among these knowledge mapping techniques and the main purpose for using each. Eventually, it is recommended that experts must understand the purpose for which the map is being developed before proceeding to activities related to any knowledge management dimensions; in order to the appropriate knowledge mapping technique **.**

Keywords – knowledge map; knowledge management; knowledge structure mapping

1. INTRODUCTION

Nowadays, it is axiomatic for many organizations that knowledge management is a cornerstone for the success. Knowledge management can be summarized in the phrase “Know, Show, Grow!” Know is tacit “head knowledge”; Show means knowledge that is written down and documented (explicit knowledge), and Grow is considered as collaboration toward innovation and stimulates new knowledge [1]. Deep understanding of these concepts can radically develop the capability required to compete with other organizations [2]. According to the Organization for Economic Cooperation and Development (OECD), Knowledge can be classified as follows: Know-What, Know-Why, Know-How and Know-Who [3]. Wilke [4] highlighted that the most important responsibilities of knowledge management are to envisage knowledge for knowledge seekers. Knowledge mapping is one way that allows knowledge to be represented graphically through *nodes* to represent main ideas and *links* leading to representing the relationships between the ideas.

This paper is a comprehensive review of various types of available knowledge mapping techniques and gives a general idea of their purpose. It attempts to illustrate which techniques are appropriate and why, where they can be applied, and how these mapping techniques can be managed. Consequently, this paper clarifies the differences among these knowledge mapping techniques. The rest of the paper is structured as below: section two is reviewing some related works followed by definition of the knowledge map in section three. Section four is about using knowledge maps followed by the classification of knowledge maps is discussed in section five. Finally, the techniques of knowledge mapping are reviewed and concluded in section six.

2. RELATED WORKS

Numerous studies have attempted to set up a guideline to develop knowledge maps. For example, [5] focused on the application of knowledge mapping in open learning. They demonstrated how knowledge maps can help organize knowledge in several contexts such as: learning design, learning path planning and problem solving, on online learning, and distance education. Besides, [6] offers a basic map for knowledge classification pedestal on the tasks management of knowledge. These tasks consist of four steps: knowledge identification maps, knowledge creation and development, application and assessment maps. This categorization is not wide-ranging, multipurpose, and accurate enough to be used in knowledge management. However, [7] research on mind mapping; argument mapping and concept mapping demonstrated the differences in each of these mapping tools and outlined the various types of tools available as well as their advantages and disadvantages. [8] combined the use of the analytic hierarchy process (AHP) with social network analysis (SNA) to produce interval/ratio measures for using in an organization’s knowledge map. Moreover, [9] offered a technique to develop a knowledge map for an industrial organization via capturing and demonstrating organizational knowledge. Thus,

they stated that knowledge map is the best tool to represent knowledge in an organization. Finally, [10] presented a method using knowledge map to explain knowledge associations that enable users in an organization to see associations of knowledge and provide them the path to access the knowledge stored within a knowledge base. In addition, they presented ways of increasing efficiency of knowledge management with the use of knowledge maps

3. RESEARCH METHODS

This paper reviewed more than thirty papers to identify the existing knowledge mapping techniques. The review led us to fifteen types of knowledge mapping techniques and gave a general idea of their purpose and context. In addition, it is illustrated that what, why, where, and how these mapping techniques can be organized to help and guide the knowledge managers in any organization. Finally, the selected knowledge techniques are summarized and their relationships are shown to different knowledge types identified in our research as Know-what, Know how, Know-why.

4. KNOWLEDGE MAP

Knowledge map shows relations among procedures, concepts and competency and provides easy and effective access to knowledge sources [10]. According to [3], Knowledge map is defined as a method to retrieve the knowledge that is arranged via knowledge experts. Another description for the Knowledge map is the geographical view of knowledge inside an organization illustrating the owner, location, and value using method of organizational knowledge [3] [11]. According to [12], a knowledge map portrays the knowledge flow throughout the enterprise and helps to steer, both tacit and explicit knowledge. Knowledge maps do not provide, but indicate tools for knowledge [13] and as [14] stated:"Knowledge maps are guides, not repositories".

A. Using a Knowledge Map

Knowledge map gives a holistic overview of knowledge resources. Therefore, it determines and clarifies the needed knowledge to achieve strategic goals in a more simple and friendly manner. Information presented in the knowledge map helps directors to observe issues and discover risks. Constructing knowledge map assists directors to build up and enhance training and educational support systems to achieve successful team working and see knowledge relations within and across knowledge areas in organizations [15].

B. What objects are mapped?

Objects of knowledge can be text or hypertext to archive explicit knowledge. Thus, explicit knowledge exists generally in hypertexts on the Web or texts on the Intranet which we view them as documents [16]. The following table illustrates the most important objects that can be mapped [7];

TABLE 1: Objects that can be mapped

Type of Knowledge	Objects
Explicit knowledge	• Subject, purpose • Location • Format • Ownership • Users • Access right
Tacit knowledge	• Expertise, skill, experience • Location, accessibility, contact address • Relationships/networks
Tacit organizational process knowledge	• The people with the internal processing knowledge
Explicit organizational process knowledge	• Codified organizational process knowledge

5. KNOWLEDGE TYPES AND KNOWLEDGE MAP CLASSIFICATION

First of all, it is needed to clarify what is meant by knowledge in knowledge mapping. There are two knowledge types, explicit and tacit [17]. Explicit knowledge can be documented, illustrated and symbolized. On the other hand, tacit knowledge is in individuals' minds and hard to express or document. The other classification of knowledge consists of three categories [18]: (1) Descriptive knowledge (know-what), also referred to as declarative, provides a description of an object, situations and facts or methods [18]. (2) Procedural knowledge (know-how) specifies doing something, actions or manipulations. In general, it describes a method or behavior. (3) Strategic knowledge (know-why, know-when) is the category form which the decision process benefits the most. [18].

Knowledge map classification gives a general idea of the issues and helps to find the suitable problem solving method among the potential mapping techniques. Classification decreases the difficulty of determining the desired knowledge map design for the target context [6]. Moreover, classification clarifies similarities and differences of the knowledge mapping techniques [6]. Principles of classification adapted from [6] are the following questions:

- What is our purpose of creating a knowledge map? (“why” questions)
- Who is going to use the map, in what situation and which phase? (“When” and “To Whom” questions)
- Which domain of knowledge is the in the focus? (”what” questions)
- Which graphical method is preferred who is to construct it? (“how” questions)
- Where the firm’s knowledge is rooted and expected to produce? (“where” questions)

6. KNOWLEDGE MAPPING TECHNIQUES

As mentioned, there are several mapping techniques useful for learners or open sense making communities. Through these techniques, they can create knowledge maps to explore learning materials, solve activities, systematize ideas, construct and represent their argumentation, and organize and share additional references. The comprehensive literature review led us to identification of fifteen knowledge mapping techniques. Table 2 depicts these knowledge mapping tools and techniques. In this table, the techniques were examined based on the classification explained in the previous section.

TABLE 2: Knowledge Mapping Techniques:

Knowledge Technique	Description	Know what	Know how	Know why
1. Mind Maps	Mind mapping (or ‘‘idea’’ mapping) is a representation of ideas and the relation between them in a nonlinear visual manner. Mind maps consist of a network of concepts in relation with each other. Its main help is in memory retention and organize ideas in relation together [19].	Yes	Yes	Yes
2. Concept Maps	Developed by Prof. Joseph D. Novak around 1972, Concept map is a structured way to help groups to develop conceptual frameworks used in planning or evaluation [9]. Concept mapping is different with mind mapping and not to be confused thus it is more formal and structured. Starting from a question or phrase, in a ‘tree’ structured hierarchy ideas lay in layers (primary, secondary and tertiary ideas) [19].	Yes	Yes	Yes
3. Argument Maps	Invented by J.H. Wigmore around 2000, this map is considered relatively new to help in the analysis of legal arguments. This class of technique decomposes an argument into claims, reasons and objections. It is also used for preparing and presenting arguments and for developing critical thinking skills, both individually and collectively [5].	Yes	No	No
4. Causal Maps	Causal maps (cause maps or cognitive maps) represent the cause-effect relations between experts’ opinion in a directed	Yes	Yes	Yes

	graph [20]. There are many diagrams known as causal maps like Ishikawa (fishbone) diagrams or cause and effect diagrams that are used to help teachers or students [21].			
5. Knowledge Asset Map	As it comes from the name, it consists of mechanisms enabling organizations to identify their knowledge assets, their inter relations and needed knowledge to fulfill development plans [22]. Provides a framework that allows organizations to identify the critical knowledge areas of their company[23]	Yes	No	No
6. Social Network Analysis	SNA studies, measures and maps any knowledge processing element in a network of connected nodes (people, groups, organizations, computers, and est.) and captures the flow of knowledge among them [24]. SNA studies actors, how they blend or act in the overall network and relations, how the actions make a change in whole network.	Yes	No	No
7. Topic Map	Topic maps (TM) organizes knowledge describes the relations between knowledge domains and links to knowledge resource [25]. Topic Maps (TM) help to visualize information routing within organization [26].	Yes	Yes	Yes
8. Folksonomy	"A folksonomy is the collectively and/or collaboratively form of the tags that can emerge from user-generated metadata" [27] which is used instead of formal taxonomies for organizing resources. The word is a combination of the worlds 'folk' and 'taxonomy' to refer to an informal collection of related vocabulary [28]. A way of sorting content on the internet by social tagging; social classification generated by employees reflects the real situation of knowledge understanding.	Yes	No	No
9. Process Knowledge Mapping	Process knowledge mapping identifies current knowledge and needed knowledge in business process. Process knowledge mapping analyzes a business process or method to identify knowledge bottlenecks (where), knowledge requirements (what), and how to acquire them (or by who) [29]. Process mapping aids organizations in productivity, efficiency, error omitting, aim customer satisfaction and add to profit [17].	Yes	Yes	Yes
10. Functional knowledge mapping	It is sometimes mistaken with process knowledge mapping but functional knowledge map's main focus is on experts or people. This map illustrates each position in an organization, individual possessing that position, his skills, experiences and academic education, also depicts the social relation of all individuals and resources. Functional knowledge map provides an organizational directory of knowledge resources; inter relations of personal and their skills [30].	Yes	Yes	Yes
11. Competency Mapping	Competency Mapping represents organizational structure, with jobs description and personnel requirements; it does not reveal the real expertise and Individual's knowledge [17].	Yes	No	No
12. Information Flow Analysis	This type using complex programs, investigates formal and informal networks and processes in the enterprise and reports every knowledge resource is used by who, and how often [17].	Yes	Yes	Yes

13. Petri nets	A Petri net is a graph with place or transitions as nodes. They are two parted graphs with directed edges and have formal semantics. [31]. It is a well known tool for information processing system study. [32].	Yes	Yes	Yes
14. Semantic Map	As it comes from the name, this map tries to represent relation of documents and explain the data economically with semantics [33]. A semantic mapping technique aims to simplify implementation by building precise transforms from canonical message and document structures to 'flattened' formats where readily meaningful business names replace machine-orientated fixed attribute codes in deeply nested structures [34].	Yes	Yes	No
15. Cognitive map	This map tries to show how people see their environment and captures their comprehending, learning or keeping knowledge. [35]. This map facilitates mutual understanding by depicting several views in team members and helps to reach a solution based on an integrated understanding [36].	Yes	Yes	Yes

7. CONCLUSION

The present paper aimed to discuss various types of the current knowledge mapping techniques and give a summary of them. The paper attempted to overview knowledge mapping techniques with regard to "what, why and how" aspects. Moreover, this paper explained the differences among these techniques. Accordingly, it is suggested that understanding of knowledge mapping techniques is necessary and takes priority over the other activities in the knowledge management dimension Before taking any step in knowledge mapping, researchers must identify the main purpose of mapping, define whether they concentrate on "Who", "What" and "How" or two or three of them, and choose the appropriate technique for knowledge mapping in order to fulfill the purpose.

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