What is knowledge and how it can be evaluated?

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Abstract

In this paper, we present a conceptual model for knowledge evaluation. After a literature review, over various definitions on knowledge, we first extracted the main plausible features of knowledge both its nature and meaning. The main features are amount of information, verification of information and retrieval ability of information. We then developed a three dimensional model to evaluate knowledge. The surrounded volume amount these components can represent the knowledge value. To see how powerful our model is, we have considered a case study. It has been shown that the model can evaluate customer knowledge. We extracted different aspects of knowledge value from the literature and showed that they can be also acknowledged by the proposed model. The model provides a general framework for knowledge valuation and can be used to evaluate human and artificial knowledge.

Keywords: knowledge management, knowledge value.

1. Introduction

Knowledge and innovation have played an important role in the development of society throughout history. The transformation from agrarian to industrial and now to the information and knowledge society has largely brought about the accumulation of knowledge as an intangible asset in organizations.

Managing knowledge however, may be a problem to organizations, because they should manage an intangible, undefined thing which cannot be measured and evaluated easily (hashemian and Afrazeh, 2007). Most businesses even have not defined what knowledge is and they don't know how to measure it (Green, 2007).

Effective knowledge management needs to evaluate knowledge as a resource and as a product (Li et al., 2006). Although there are few methods to evaluate knowledge assets (Choy et al., 2006), but one major trend in knowledge management is measuring the knowledge value because of importance of it (Cupta et al., 2000).

In this paper, we present a three dimensional model for knowledge evaluation. This model can evaluate different types of knowledge, and it can help knowledge management.

The rest of the paper is organized as follow: Section 2 discusses knowledge definitions. In Section 3 we discuss knowledge evaluation methods. We present our three-dimensional model for knowledge evaluation in section 4. In Section 5 we discuss the advantages of our model and show how the model can be verified by other aspects of knowledge value in the literature. In section 6 we apply our model in a case study, and we conclude the paper in section 7 by summarizing our research contributions.

2. Knowledge Definitions

There are many concepts of knowledge (Schneider, 2007) and the lack of agreement about the concept is really a problem (Firestone, 2008).

In this paper we present a model for knowledge evaluation. We review some definitions of knowledge first, because evaluating something that we do not know what it really means, is very difficult. Some of them are as follow:

Plato (1953) first defined the concept of knowledge as "justified true belief". Plato believed that we learn in this life by remembering knowledge originally acquired in a previous life, and that the soul already has all knowledge, and we learn by recollecting what in fact the soul already knows (Kakabadse and Kouzmin, 2003).

Plato's concept was debated by Aristotle (1982), a student of Plato. He revised the origin of knowledge and considered the environmental information for knowledge creation that interacts with the human knowledge base to create new knowledge. He defined the important law of association. Based on his opinion, knowledge is acquired through empirical evidence obtained through experience, observation, and induction of principles from observation (Gordon, 2000).

Nonaka and Takeuchi (1995) defined Knowledge as true justified beliefs and bodily acquired skills.

Davenport and Prosuk (1998) defined Knowledge as a fluid mix of framed experience, contextual information, values, and expert insight that includes a

number of things that we have within us, such as experiences, beliefs, values, how we feel, motivation, and information.

One approach to define knowledge is to use the concept of a value chain or hierarchical structure among data, information, and knowledge. The value increases from data to knowledge (Tuomi, 1999). Data are facts and observations, which in a particular context become information. Information gets value to become knowledge. Many authors have argued this hierarchy in literature. Some of them are as follow:

Churchman (1971) defined knowledge as a collection of information. Once information is processed through the user's brain, it becomes the user's knowledge.

Information consists of facts and data that are organized to describe a particular situation or condition; whereas, knowledge consists of truths and beliefs, perspectives and concepts, judgments and expectations, methodologies and know-how (Wiig, 1993).

Bohn (1994) suggests that knowledge is something that prescribes what to do, information is organized or structured data, and data is raw material (Bohn, 1994).

Harris's definition (1996) states that data is known fact, information is analyzed data, and knowledge is a combination of information, context, and experience.

Vance (1997) suggested that knowledge is authenticated information and information is interpreted data.

According to Sveiby (1997) information is meaningless, but becomes meaningful knowledge when it is interpreted.

Van der Spek, and Spijkervet(1997) defined data as symbols which have not yet been interpreted, information as data with meaning, and knowledge as what enables people to assign meaning and thereby generate information.

According to Davenport (1997) data is simple observations of states of the world, information is data endowed with relevance and purpose, and knowledge is valuable information.

Greenwood (1998) suggested that information is raw material, and knowledge is information which is valuable for a specific organization.

Kock & McQueen (1998) regard data as carrier of information and knowledge, information as relating to descriptive and historical fact, and knowledge as new or modified insight or predictive understanding.

Dretske (1999) regards knowledge as a production that is made from information as raw material.

Zack (1999) defined data as observation or facts, information as data in a meaningful context, and knowledge as meaningfully- organized accumulation of information.

Based on Luen and Al-Hawamdeh knowledge is active information that one can act upon or manipulate in order to generate value.

Several authors, including Vanderspek and Spijkervet(1999) agreed on adding action and application to information to get knowledge.

Knowledge includes the set of facts and rules of thumb that experts may have acquired over many years of experience (Liebowitz, 2001).

Buckley and Carter (2000) defined knowledge as structure information and as a catalyst for action.

McGinnis and Huang (2007) focused on understanding and applying information. According to them Knowledge is information plus the causal links that help to make sense of this information.

Tobin (1996) added the level of wisdom over knowledge and defined knowledge as information + application.

Finally, Beckman (1997) proposed a five- level knowledge hierarchy. He added two levels over knowledge and called them expertise and capability. In his model, knowledge is the result of adding reasoning, abstraction, relationship and application to information.

However, within the value chain, there are different views on the status of knowledge made from information. The common factor of those definitions is that knowledge is over information and added value can change information to knowledge (Liebowitz, 1999).

As different concept of knowledge lead to different perspectives of knowledge management (Rezgui, 2007), it is better to aggregate definitions.

In all definitions based on knowledge hierarchy the origin of knowledge is *information,* but the added value which can transform information into knowledge differs. In our definition we accept the information as an origin of knowledge which can affect knowledge value.

The added value which transforms information into knowledge differs in different definitions. Combination, processing, interpretation, structuring and selection are some added values which transform information into knowledge.

Our perception about the added value is close to Plato and Vance idea. The last stage of information processing which can transform it into knowledge is verification. For example, after interpretation if the information would not be verified, it may goes down in knowledge hierarchy and becomes data. Verification as the last stage may need selection, processing, structuring, interpretation and organizing. In our definition, we have considered information as the origin of knowledge. It becomes knowledge after verification. Verification is the added value to information and can transform it into knowledge.

We have considered another characteristic to describe knowledge, and it is the ability of retrieving. The existence of a set of verified information without retrieving ability is equal to the lack of knowledge. The verified, retrieved information can be considered as knowledge and can be used for doing something.

We define knowledge as *verified information which can be retrieved.*

A good definition should cover different types of knowledge. The most famous classifications are tacit and explicit knowledge. Explicit knowledge can be expressed in formal and systematic language and shared in the form of data, scientific formulae, specifications, manuals and the like (Takeuchi and Nonaka, 2004). It can be processed, transmitted and stored relatively easily. In contrast, tacit knowledge is highly personal and hard to formalize. Subjective insights, intuitions, rules of thumb, and hunches fall into this category of knowledge. Tacit knowledge is deeply rooted in a person's actions, procedures, routines, behavior, ideals, values and emotions (Hashemian and Afrazeh, 2006).

Our definition can cover both types of knowledge. For tacit knowledge, experiences can verify the information and transform it into tacit knowledge (Hashemian and Afrazeh, 2006). The information of how to do something can be applied in practice. After that the verified information can be transformed into the knowledge of how to do it. If some information was not verified it is not information any more and transform into data. Sometimes the information is verified by some true cases, and it creates verified information in the forms of rules of thumbs, subjective insights and intuitions and tacit knowledge.

For explicit knowledge, the process of transforming of information into knowledge may contain abstraction, analysis, deduction, etc. that can verify the information and transform it into knowledge.

3. Knowledge Evaluation

Measuring knowledge value is necessary for successful knowledge management (Wilkins et al., 1997, Liebowits and Wright, 1999), but it is not really clear whether knowledge can be measured or not (Liebowits and Wright, 1999). Despite the various researchers trying to develop metrics and models to measure knowledge (Roos, 1997), people think that knowledge measurement is one of the most difficult part of the knowledge management activities(Ruggles, 1998). Other researchers even argue that knowledge cannot be measured, but the activities or outcomes associated with applying knowledge can be measured (Davenport and Prusak, 1998).

As the value is perceptual, it is important to define the context of the perception (Ford and Staples, 2006). In term of knowledge within organizational context, perceived value can be from three different perspectives. First the organization may value the employees' knowledge in terms of its influence on the employees' abilities to perform their jobs and for the organization to achieve its goals.

Second, congruent with the marketing literature that examines consumer value. It is possible to evaluate knowledge from the perspective of the knowledge seeker. In other word, the more valuable knowledge causes the more willing to seek out the knowledge.

Third is the perspective of the knowledge owner/ potential share.

The KP3 methodology enables to assess the contribution of each individual's different knowledge to business performance(Ahn and Chang, 2002). The KP3 methodology establishes logical links between knowledge and business performance through product and process, and suggest various application areas for improving business performance. A number of linkage matrices were introduced for that purpose. With the help of those linkage matrices, contribution of knowledge to business performance can be assessed. The basic building blocks of the KP_3 methodology consist of four components: Knowledge, Process, Product, and Performance. Knowledge is further classified into two: Product-related knowledge and Process related knowledge.

Many knowledge management evaluations are no more than the assessment of information management (and its systems), a fact which has contributed to the general confusion surrounding this topic (Yates and Bowden, 2001). There have been numerous attempts to devise methodologies for rationally valuing information and knowledge, ranging from simple qualitative value judgments, through assessment of added value and 'scorecards', 'monitors', 'benchmarks' and similar ways of dealing with intangible assets, to complex mathematical methods.

Rodger (2003) categorized knowledge based assets as market- based, economic- based, hybrid- based and sub- corporate knowledge valuation techniques. The market- based methods include comparable market value. The economic- based methods encompass brand contribution, net cash flow earning and royalty technique. The hybrid- based methods include net book value approach and premium price/earnings for a firm. The sub- corporate knowledge valuation techniques provide an objective measure of knowledge assets performed by analyzing the relationship between earning of knowledge asset and cost of knowledge asset.

alisbury (2001) described 4 phases for knowledge creation: needs analysis, design process, development process and performance environment phase. In each phase, knowledge evaluation is necessary for gap analysis.

There are several approaches to measure the value of knowledge assets. There is distinction between global approaches, trying to measure the overall value of the knowledge in an organization, and local or micro approaches, which set out to measure the value of separate knowledge assets. The first approach is best represented by the work of Edvinsson and Malone and Sveiby. The concept of intangible assets attempts to capture the value of human capital, competencies, customer relationships, employee collaboration or diversity in

an organization. On the basis of these concepts, several tools such as the Skandia navigator have been created to serve as strategic and monitoring devices (Edvinsson and Malone, 1997).

Although the macro approach is quite useful, it is of less help when dealing with knowledge assets at a level lower than the organization as a whole. For this, micro approaches are better suited (Dekker and Hoog, 2000). In micro approaches knowledge value will be measured through evaluation of knowledge projects and their impacts on other parameters in organizations. Tools and techniques of measuring and evaluating knowledge value are: Fuzzy Modeling, Analytical Hierarchy Process (AHP), System Dynamics (SD), Linear Programming (LP), Cobb-Douglas Equation (CD), Balanced Score Card (BSC), Human Resource Accounting (HRA), Economic Value Added (EVA), and Intellectual Capital (IC) (Fatahi and Afrazeh, 2005).

The macro methods cannot help knowledge evaluation in many cases that a manager encounters. Some micro approaches, are not applicable for different cases.

In the next section we will present the three dimensional model which can provide general framework for knowledge evaluation.

4. The Three- dimensional Model

In this paper after a literature review, we defined knowledge as *verified information which can be retrieved*. The Information, the Verification, and the Ability of retrieving can be seen in the definition.

We suggest a three-dimensional model and three components for knowledge evaluation. The surrounded volume amount three components represent the value of knowledge (Fig. 1).

The first component, refer to information and called *Amount*. Only relevance and so useful information adds the value of knowledge. The *Amount* depends on two parameters: the volume of information and the degree of information. The degree shows the rate of relevance or usefulness of information.

$$Amount = \sum Volume \times Degree. \quad (1)$$

For example, the increase of irrelevant verified information cannot increase knowledge value, because the degree decreases by irrelevancy. As the repetitive information is not useful, the degree decreases by tautology.

The increase of (degree × volume) can increase the *Amount* and the value of verified information.

The other component is *Verification*. Verification depends on two parameters too. One is the rate of verification and the other is the validation of the verifier. If the validation of verifier or the rate of verification increases, the verified information gets more value.

$$Verification = Rate\ of\ verification \times Validity\ of\ verifier \quad (2)$$

The last component is the ability of *Retrieving*. A knowledge base with a good access is more valuable than a knowledge base with difficult access.

If one component comes down to zero, the value of knowledge will become zero and the increase of other components cannot increase the value of knowledge. If each component becomes less than accepted threshold, it should be considered zero. If the verification rate is not accepted, the increase of amount or retrieving ability cannot add the value of knowledge. A book in unknown language has not the accepted retrieving ability. So, it has not value for the reader, even if the two other components increase.

The retrieving ability should be measured by the end user of knowledge base. This component can be improved by the user too. By a face to face communication the retrieving ability of a tacit knowledge increases and the tacit knowledge becomes more valuable.

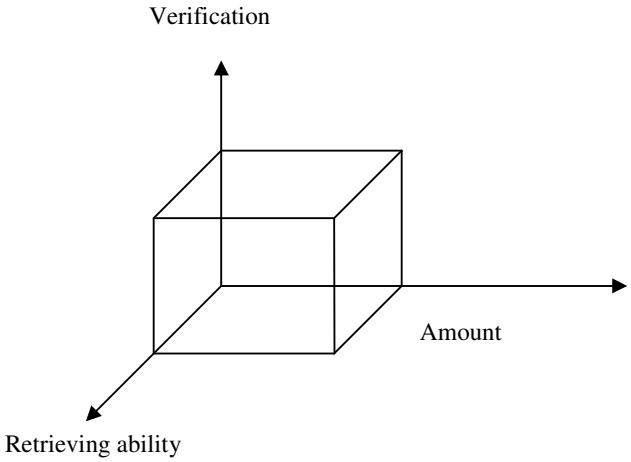

Fig. 1: The three dimensional model

The knowledge maps in organizations can provide better access to necessary knowledge and increase organizational knowledge value. Translation a book can increase the retrieving ability and can increase the value of stored knowledge in the book.

Enberg and et al. (2006) pointed to the importance of meeting for better knowledge sharing. In meetings the retrieving ability of tacit knowledge increases and tacit knowledge value can be increased too. People construct knowledge as they interact in a social context (Hemetsberger, 2006). In team works people can share knowledge and the knowledge value increases because of more retrieving ability.

5. Verification and Advantages of the Model

There are other aspects of knowledge value in the literature which can be acknowledged by the proposed model. The most important aspects of knowledge value are quality and quantity of knowledge (Drucker, 1999, Liebowitz, 1999, Ramirez and Nembhard, 2004, Rao et al., 2007).

The quality has some dimensions (Rao et al., 2007). One dimension is the newness (Ramirez, 2004). In the proposed model, we can see it in the degree of knowledge and in the *Amount* component. The old verified information gets less degree and less value.

The other quality dimensions are accessibility, availability, reuse and sharing (Rao et al., 2007). These four dimensions can be seen in the *Retrieving ability* component. A good access to a knowledge base or increase of its availability can increase the *Retrieving ability* component and so the value of knowledge. Providing a good knowledge reuse or knowledge sharing increase the knowledge value and can be seen in the *Retrieving ability* component.

Other dimensions are accuracy, consistency, credibility and correctness. These four dimensions can be seen in the *verification* component. Increasing of them increases the knowledge value and can be seen in the *verification* component.

The increase of each dimension can increase the quality and the knowledge value and can be represented by the proposed model.

Another aspect is quantity of knowledge which can be represented by the *Amount* component. We have summarized the extracted knowledge value aspects which can evaluate knowledge and the corresponding component in our proposed model in table 1.

The real value of knowledge depends on its application. A knowledge base can be a precious knowledge base in one organization, but not precious in the other because of usefulness or retrieving ability. Our model can cover this characteristic of knowledge value too. The relevant knowledge gets more degree in *Amount* component and more value.

Scientific journals have large amount of verified useful information, but those journals in a foreign language have not much value for the organization in which people don't know that foreign language. The value decreases because of low retrieving ability.

This model can help decision maker to evaluate different knowledge bases. For example if you read an explanation of how to do something, you may not retrieve the knowledge easily, but you can retrieve the knowledge if you see an expert doing it. So, although the verification and amount components are the same, the expert's knowledge is more valuable because it can be retrieved better than the written text. An individual's knowledge cannot be useful to others unless it is in such a manner as to be interpretable (Bradley et al., 2006) and this can be represented by the *Retrieving ability* component.

This model can be applied in comparing value of different knowledge bases. Comparing each component is possible and easier than the whole knowledge evaluation. Even different knowledge bases can be compared in each component and so in their value.

The advantages of this model are: easy use, large domain of use, high contingency, and applicable for different types of knowledge.

6-A Case Study

We applied our model in Ghods newspaper office to evaluate customer knowledge (Hashemian et al., 2008). Ghods newspaper has published from 1986 in Mashad-Iran. It has 20 pages and is published everyday and distributed every morning. More than 100 people work in it. It has family pages, social pages, politic and law pages, advertisement, news and scientific papers. Customer relationship management (CRM) has been widely regarded as a company activity related to developing and retaining customers through increased satisfaction and loyalty (Xu, Walton, 2005). Gathering, managing, and sharing customer knowledge can be a valuable competitive tool (Murillo and Annabi, 2002). Many companies are using customer data, but few are turning it into useful knowledge (Hsieh et al., 2005). Customer knowledge processing can be done in two main stages: knowledge acquisition and analyzing of it. There are many web-based methods for gathering customer knowledge too. Some scholars discuss these methods in E-commerce field (Lopez and Molina, 2008). There are two main methods for capturing customer knowledge. One method of knowledge capturing is interviewing with customers which can provide a good communication, but it costs a lot and the interviewer can affect customers' declarations. Another method is using questionnaires. It can provide more knowledge from more customers, but it has a one way communication and cannot consider the customers' knowledge value. A newspaper should follow news and write it better than the competitors. It should be innovative and follow the customers' taste to keep them. A newspaper has various readers in different social levels. In customer knowledge processing, large amount of knowledge with different value levels

should be processed. To evaluate customer knowledge, we applied the three-dimensional model. We published a questionnaire form in the newspaper three times. The advantage of this method is a good access to different customers. We contracted with the post office to deliver all forms to Ghods newspaper office.

Table 1: verification of the model

Knowledge value aspects	Corresponding components in the model	x p l a n a t i o n s
Quantity	Amount	More knowledge, more value
Newness	Degree	Older information gets less value
Accessibility	Retrieving ability	Retrieved knowledge can be accessible
Availability	Retrieving ability	Retrieved knowledge can be available
Reuse	Retrieving ability	Retrieved knowledge can be reused
Sharing	Retrieving ability	Retrieved knowledge can be shared
Accuracy	Verification	More accuracy needs more verification
Credibility	Verification	The validation of verifier causes credibility
Consistency	Verification	Consistency with existence knowledge bases and verification with them shows the consistency
Correctness	Verification	More correctness needs more verification

For each questionnaire the *Retrieving ability* component has no difference, because they tick a specific place in each questionnaire. So the knowledge of each form can retrieve easily.
Our method of gathering information can provide only related knowledge, so the degree is the same for all questionnaires. There was 34 items we asked about them. No extra information was accepted in the forms. They assessed the quality of 34 items by Likert scale. So, there is no difference in *Amount* of information.
The surrounded volume depends on the third component and it is the *Verification*. In each filled form, we have verified information from different sources. The knowledge value depends on the rate of verification and validity of verifier. The Rate of verification is the same, because when they made their decision they tick on questionnaire. So, the knowledge value depends on only the validity of verifier.
For validity of verifiers, we developed a value function based on 4 criteria: duration of reading (d), period of reading (t), customers' education (e) and customers' interest to read newspapers(r). These criteria show the validation of verifier. We developed a linear function based on these criteria and used AHP to find the weights.

The Expertchoice software calculated each weight (Fig.2).
We developed this linear value function:

$$U=0.532r+0.294d+0.120t+0.054e$$

We received 1486 questionnaire. In traditional processing we calculated simple average for each item. We ranked 34 items based on the traditional method.

Inconsistency: 0.02

Fig. 2: The weights of criteria

The quality ranking of products of each group is important for the chief editor.
We ranked 34 items based on weighted average method too. We used the weight of information based on the customer knowledge value function.
The results showed there is 9 items in different ranks.

We needed another verifier to choose one result. We asked the chief editor to send the questionnaires for some experts and other chief editors.

Comparing weighted data to experts' data showed only 2 items in different rankings.

The total average (average of all 34 items) for experts' data was the less. After it, there was the average of weighted data, and the higher average was for traditional data.

So, the total average of weighted data was closer to experts' data.

Data analysis showed that the Spearman and Pearson correlation between weighted data and experts' data was more than the Spearman and Pearson correlation between traditional data and experts' data.

The chief editor accepted weighted data and the ranking generated by it because experts data verified it.

7. Conclusion

In this paper we presented a three-dimensional model for knowledge valuation. One component is the *Amount* of information ($\sum$ volume × relevance of information), the next component is the *Verification* (rate of verification × validity of verifier) and the last component is the *Retrieving ability*. The surrounded volumes amount the three components represent the knowledge value.

This model especially can be applied for comparing the value of different knowledge bases. The advantages of the model are its easy use, contingency and large domain of use.

The proposed model can evaluate different types of knowledge and even human and artificial knowledge bases.

The proposed model provides a general framework for knowledge evaluation. The model employs three main components to evaluate knowledge. It should be mentioned that sometimes it is not an easy task to measure these component.

We applied this model to evaluate customer knowledge in Ghods newspaper office.

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