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# Fuzzy logic based model to measure knowledge sharing

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**Abstract**— Nowadays, trust is one of the most important variables in business. Lack of trust has a direct impact on business components' confidence. Trustworthiness can create value and leads business to obtain high market share. Trust is also the most important variable in knowledge sharing on the basis of the knowledge context. A different kind of trust is required in knowledge sharing. Complexity and structured level of knowledge are the two important factors in knowledge classification. In this paper competence-based trust and benevolence-based trust are discussed. Effective knowledge sharing can be encouraged by improving the different types of trust. In this paper, we discuss on trust definition and trust measurement in knowledge sharing. We propose to improve knowledge sharing within a community to lead organizations to high level of productivity.

**Index Terms**— trust, knowledge, knowledge sharing, fuzzy logic

## I. INTRODUCTION

Trust and knowledge sharing are important variables in business. Knowledge is a fundamental capital in the economy and trust is increasingly becoming a critical issue. In the literature the interactions between knowledge, trust, and role of trust in knowledge sharing have not been explored in the literature previously. The sharing of knowledge can not be enforced and trust is required in the sharing of knowledge. Effective tools to measure the level of trust and the way it affects knowledge sharing are critical research issues. In this paper we review the related work and subsequently propose fuzzy logic based method for knowledge propagation.

The rest of this paper is structured as follows. In section II we review the existing literature on the concept of trust. In section III, different types of trust are discussed. In section IV we present the role of trust in knowledge sharing. We introduce a fuzzy logic based method to measure trust in different knowledge context in section V. The paper contributions of this paper and the future work are discussed in Section VI.

## II. TRUST

Trust is one party's confident belief in another party's specified action [1]. Mayer defines trust as "the willingness of a party [trusting agent] to be vulnerable to the actions of

another party [trusted agent] based on the expectation that other [trusted] will perform a particular action important to the trusting, irrespective of the ability to monitor or control that other party". [2]. Gefen has defined three dimensions of trust including: ability, benevolence, and integrity [3]. Bhattacharjee has defined three dimensions of trust as: ability (expertise, information, competence, expertness, dynamism), integrity (fairness in transaction, fairness in data usage, fairness in service, morality, credibility, reliability, dependability), and benevolence (empathy, resolving concerns, goodwill, responsiveness) [4].

Trust plays an important role in knowledge sharing within a community and makes value for business. Trust affects on knowledge sharing in business. In communities, business trust can lead to high level of knowledge sharing between employees. Additionally, trust plays a main role in knowledge sharing between market components such as suppliers, customers, stakeholders, etc. Additionally, in a relation between suppliers and mother organizations, trust is the basis of just-in-time (JIT) method to decrease inventory cost. Trust also affects on a way of paying (credit, cash, etc.), price mitigation and many other issues in our day to day lives. Trust between customers and organisations can decrease promotion cost and customer replacement cost and increase income. The level of trust between customers is a key factor in knowledge sharing between customers. The new methods of promotion now are using this strategy to improve promotion effectiveness. In an internal resource data, trust also plays a very important role where in vertical view trust is important to leadership and in horizontal view trust is important for knowledge sharing and team working. As a result, level of trust in different parts of business should be considered in a knowledge-based economy to increase knowledge sharing and improve productivity in business to achieve high performance.

The concept of trust is related to various fields including philosophy, sociology, business and computing. The notion of trust involves having confidence in the other parties; hence, having an expectation without risks will not result in loss. In business contexts, an individual is dealing with a business enterprise that has advantages over them, in the forms of scale, resources, information and expertise. Sole traders have an evident economic incentive to maximise their profit at the expense of the other party. In the case of corporations, it has been institutionalized through the legal requirements that directors and employees make decisions based on the best interests of the organization, not of the

parties it deals with. As a result, trust in the context of business is not grounded in culture, but is merely what a party has to depend on when no other form of risk amelioration strategy is available [5, 6].

Trust can be formed in different ways. The most common way is by a direct relationship. Some other ways such as direct experience (like a prior transaction), referred trust (trust provided by someone else), signifiers or images of trustworthiness (like brand effect) have an effect on trust level.

### III. TRUST DIMENSIONS

As we discussed previously, trust has three dimensions, namely benevolence, ability and integrity. In this paper we will focus on two most important dimensions of trust by considering benevolence and competency as the two dimensions of trust. In the context of knowledge sharing, benevolence is related to the willingness to share knowledge. This kind of trust can be positive or negative where agents within a community may believe on others' willingness to share knowledge and subsequently, trust level would be high [7, 8]. On the other hand, they may refuse to believe in others willingness and in such a case trust would be negative. We assign 1 for the highest level of trust within community and -1 for the lowest level of trust within community. The benevolence trust changes at different points in as shown in Figure 1.

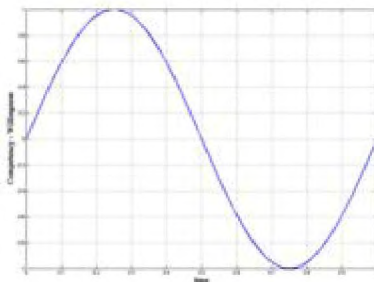


Fig. 1 Benevolence trust changes in time

The second dimension of trust is competency. This kind of trust refers to trusting agent's belief on the trusted agent's capability. It describes a relationship in which an individual believes that another person is knowledgeable about a given subject area. Competence-based trust also can be negative or positive and agents could believe in other agents being capable or vice versa. Again we assign 1 for the highest level of competence-based trust within community and -1 for the lowest level of competence-based trust within community. Similar to benevolence-based trust, competence-based trust may change with time as shown in Figure 2.

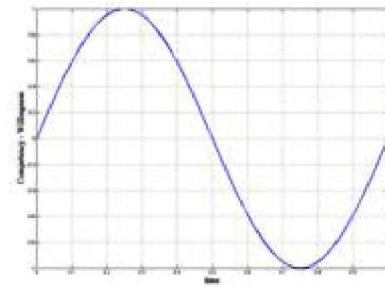


Fig. 2 Competence trust changes in time

### IV. KNOWLEDGE AND KNOWLEDGE SHARING

There is no universal definition of knowledge and knowledge management. Knowledge is a combination of the data and information being made by human thought. Knowledge management is the process through which organizations generate value from their intellectual and knowledge-based assets. The objective of this research is to measure the impact of knowledge and trust on knowledge sharing. Figure 3 shows an overview of knowledge sharing and the similarity of the shared knowledge with original knowledge.

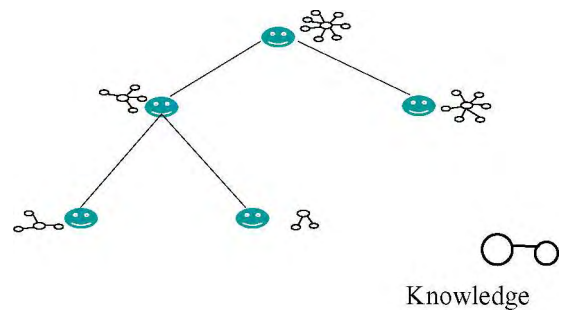


Fig. 3 Overview of knowledge sharing similarity

Effectiveness of knowledge sharing to share experience and knowledge is very important in knowledge-based firms. The nature of the knowledge itself affects the importance of trust in knowledge sharing. When knowledge is simple competence-based trust is not necessary or important and people care more about benevolence-based trust. On the other hand, when the knowledge is complex and professional, people care more about competency-based trust [9, 10]. Also for structured, semi-structured and unstructured knowledge importance of competence-based trust and benevolence-based trust are different. In order to gain a better understanding of knowledge sharing within a community we have used two indexes to categorize the nature of the knowledge in two broad categories.

The first index reflects the complexity of the knowledge. Knowledge could be simple or complex. We can measure and express the degree of complexity of knowledge, on a spectrum of values between [0-1] where 0 is used to represent simple knowledge and 1 is used to represent complex knowledge.

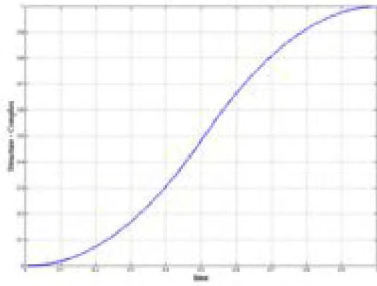


Fig. 4 Complexity of the knowledge

The second index shows the structure of the knowledge. We represent unstructured knowledge by 0 and structured knowledge by 1. Figure 5 shows the structured level of the knowledge.

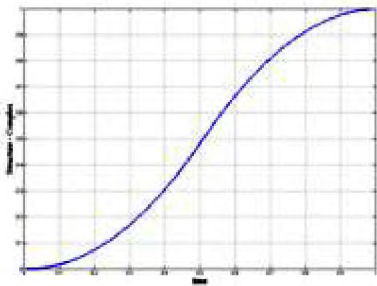


Fig. 5 Structured level of the knowledge

Before we discuss about the role of trust in knowledge sharing on the basis of knowledge nature, we discuss briefly about fuzzy logic. We intend to make use of fuzzy logic to measure the effect of trust on knowledge sharing within community.

V. FUZZY LOGIC BASED MODEL

Fuzzy inference systems (FIS) can efficiently handle the situations that cannot be characterized by a simple and well-defined deterministic mathematical model. This method utilizes simple rules and a number of simple membership functions to derive the result. The subjective and heuristic FIS is specifically efficient at various aspects of uncertain knowledge. FIS structure is composed of three basic elements: fuzzification, fuzzy reasoning, and defuzzification.

A. Fuzzification:

Crisp input variables are first transformed into fuzzy values based on input membership functions (MF). These fuzzy variables will then be used to apply rules formulated by linguistic expressions of the fuzzy rule base. The membership function (MF) essentially embodies all fuzziness for a particular fuzzy set. The shape of the membership function (triangular, trapezoidal, Gaussian, etc.) is chosen based on the work that need to be conducted. In this work, four crisp input variables are transformed into fuzzy sets as shown in Figure 6. It is clear from Figure 7(a) that for the two first input variables (competency and willingness), the

crisp universe of discourse is considered between -1 and 1. The fuzzy membership functions include the linguistic fuzzy sets of Negative, Zero, and Positive. Other two crisp input variables (Complex and Structure) are laid in the universe of discourse [0 1], which are transformed to fuzzy linguistic variables of Low, Medium, and High, as shown in Figure 7(b). All fuzzy sets are Generalized Bell shape.

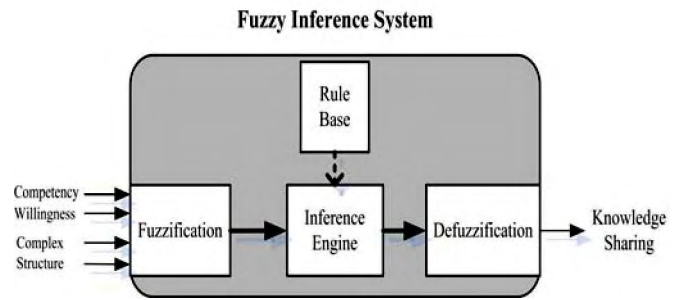


Fig. 6 Fuzzy inference system

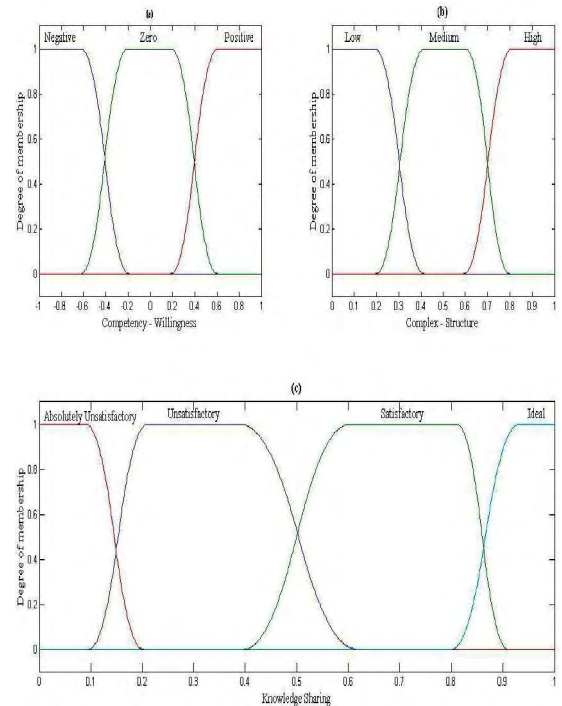


Fig. 7 Fuzzy logic in knowledge sharing

B. Fuzzy Reasoning:

As shown in Figure 6, information flows from four-input variables to a single-output. Though there are various ways to represent human knowledge in the fuzzy rule base, the most common way is to form it into natural language expressions of the if-then type. An expression in such a form is commonly referred to as the if-then rule based form. It typically expresses an inference such that, if we know a fact (premise), then we can infer, or derive, another fact called a conclusion. This form of knowledge representation can express human empirical and heuristic knowledge in our language of communication. In the inference engine, the truth value for the premise (if part) of each

fuzzy logic rule is computed and applied to compute the conclusion part of the rule (then part). The output fuzzy sets of all rules are then combined together to form a single fuzzy set for the output variable.

### C. Defuzzification:

As shown in Figure 6, defuzzification is the last stage in a fuzzy inference system, which converts the conclusion made by the fuzzy inference into a crisp output value. The fuzzy membership functions of the output variable are shown in Fig.7c. The output linguistic variables are “Absolutely Unsatisfactory”, “Unsatisfactory”, “Satisfactory”, and “Ideal”. Among different methods of defuzzification we intend to make use of the most popular defuzzification method, centre of gravity, formulated as

$$P = \frac{\int_p \mu_c(p) \times pdp}{\int_p \mu_c(p) dp}$$

Where, p is the fuzzy output value of each rule and P is the crisp output value of fuzzy inference system.

### VI. CONCLUSION

In conclusion, we discussed in this paper, knowledge sharing depends on knowledge context and trust. We characterized knowledge by its level of complexity and its level of structure. Fuzzy logic is used to measure both of these variables and fuzzy based model is proposed to measure the

impact of trust on knowledge sharing. In our future work, we intend to relate the trust function to knowledge because of the fact that benevolence and competence based- trust are related to complexity or structured level of knowledge.

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