Matching demanders and suppliers in knowledge service: A method based on fuzzy axiomatic design

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A B S T R A C T

The advancement of knowledge service has enabled the demanders and suppliers to find satisfied cooperation results. An optimal match between demanders and suppliers can facilitate continuous improvement and efficiency in knowledge services. While selecting suitable matching knowledge demander and supplier pairs is of significance for effective knowledge services, an area that has been generally neglected in previous studies. This paper reports on a method for effectively matching suitable knowledge service demanders and suppliers in which the expectation levels of attributes given by demanders and suppliers are considered. Linguistic information is used to describe the demanders and suppliers' expectation levels and their actual levels. A new matching degree calculation method is proposed which takes account of the fuzzy linguistic information. First, the matching relationship between the demanders and suppliers is defined. Then, from the principle of axiomatic design (AD), a method based on fuzzy axiomatic design (FAD) is developed to identify the matching degree between the knowledge demanders and suppliers. Further, a multi-objective optimization model is formulated to maximize the overall matching degree of the pairs and to select the optimal matching pairs. Finally, an example illustrates the potential applications of the proposed method. The obtained computational process and results clearly demonstrate how optimal matching pairs can be identified for knowledge services' demanders and suppliers.

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1. Introduction

In an ever-increasingly competitive and changing environment, knowledge services have become important in organizations to ensure the creation of sustainable competitive advantages [5,8,21]. Effective and professional knowledge services are able to create value-added activities and customized solutions to satisfy the requirements of both the knowledge demanders and suppliers [2,16,31,42]. In the knowledge services market, there are three players: the demanders (buyers) who seek the knowledge services, suppliers (sellers) who provide the systematic knowledge services, and the brokers who match the

demanders and the suppliers [7,29]. Since the individuation of knowledge demand and the diversity of knowledge supply appear significantly, a proper match between the knowledge demanders and suppliers has become increasingly important [9,32,36]. As information and resources are often restricted or proprietary, it has become necessary for knowledge demanders to use the expert knowledge services of brokers as a bridge to suitable suppliers [16,17,30]. Consequently, matching problems among knowledge demanders, brokers, and suppliers have emerged [26]. To expedite transactions, proper matching can assist demanders and suppliers to easily find suitable partners.

A two-sided matching design has attracted much attention over the past few decades for classical matching problems [6,11,12,34,35]. Gale and Shapley [12] were the first to develop a two-sided matching design for a classical marriage problem with preference information. Roth [34,35] proposed a two-sided matching concept and analyzed the existing examples in the markets using preference information, such as in the matching of graduating medical residents with hospitals. Some studies in recent years have used a demand–supply view to solve the matching problem. Cable and Judge [3] presented a "demand–supply", "requirement–capability" viewpoint to analyze the matching of persons and organizations. If an organization can satisfy the demand or expectation of a person, and the ability of the person can also satisfy the requirement or expectation of the organization, then the organization and the person can form a proper matching pair. Jung and Jo [22] investigated a constraint satisfaction problem (CSP) to determine an optimal solution through brokerage to satisfy various preferential requirements for buyers and sellers. Jiang et al. [20] presented an optimization approach to the matching of multi-attribute exchanges with quantity discounts in E-brokerage.

Existing methods have made significant contributions towards the solutions to two-sided (bilateral) matching problems in different situations. However, while the use of knowledge services has become more popular, studies focusing on matching knowledge demanders and suppliers have been somewhat limited. Some guidelines have been proposed to assist brokers to optimize the matching between knowledge demanders and suppliers. For example, Hoppe and Ozdenoren [16] analyzed the functions of an invention service broker and constructed a balanced model for two-sided demand and supply matching. Klerkx et al. [25] described the process and the linkage building of knowledge brokering for innovation in the agricultural knowledge sector. Lomas [29] focused on a health knowledge service market supported by a knowledge broker, in which the broker could transfer knowledge and also match the knowledge demanders and suppliers who lacked knowledge of each other. Geng et al. [13] integrated an analytic network process (ANP) approach and the quality function deployment (QFD) to develop an optimal product-service system, in which the requirements of the customers and the requirements of manufacturers were both considered. Benassi and Minin's study [30] focused on a patent broker and discussed the importance of a broker by demonstrating how a broker can greatly reduce transaction costs.

A common assumption proposed in most prior studies was that the demanders and suppliers were able to express their opinions or perceptions using numerical values. In many realistic situations, however, people most often describe their opinions or perceptions using linguistic assessments rather than numerical values [1,15,23]. Attributes can be measured as linguistic labels (or terms) such as 'very high', 'high', 'middle', 'low', and 'very low' [44]. In addition, previous studies have also ignored the matching degree of the expectation information given by the knowledge demanders/suppliers and the actual information of the suppliers/demanders.

The objective of this paper is to develop a method for brokers to match knowledge demanders and suppliers, in which the linguistic expectations of both the demand side and the supply side are considered. In a knowledge service process, the expectation information of knowledge demanders and suppliers refers to as the level of an objective that they desire to achieve. The broker evaluates the actual status of both sides to determine the information needed. Therefore, a two-sided matching approach for knowledge demanders and providers is proposed by considering the linguistic expectations and the actual situations. First, the framework and description for the matching are figured out. Then, according to the basic theory of axiomatic aesign (AD) [40,41], an approach based on fuzzy axiomatic design (FAD) is developed to measure the matching degree. Further, a matching model is constructed to solve the matching problem in knowledge service.

The remaining of this paper is organized as follows. Section 2 presents the matching framework of knowledge service. Section 3 reviews the basic theory of AD and FAD. Section 4 formulates the matching design model so as to match the knowledge demanders and suppliers. Section 5 gives a practical example to illustrate the application of the proposed method. Finally, Section 6 summarizes and highlights the main features of the method in this paper.

2. Problem presentation

In this section, the matching relationship between knowledge demanders and suppliers in knowledge service is first described, and a hierarchy structure with two dimensions for two-sided matching is given. Then, the notations of parameters and variables for the problem formulation are defined.

2.1. Description for the two-sided matching problem in knowledge service

In the real world, there is usually a broker between knowledge demanders and suppliers. Exchanges (also called double auctions) are two-sided marketplaces where both buyers (demanders) and sellers (suppliers) submit their trading requirements [10,33]. In the knowledge service process, the broker accepts the responsibility for matching the knowledge demanders and knowledge suppliers based on the demander's expected level and the supplier's actual level. A good match between knowledge demanders and suppliers can create significant common values and benefits. The interrelationships among the