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A two-dimensional knowledge authorization evaluation method enabling inter-enterprise knowledge sharing

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ABSTRACT

Virtual enterprises (VEs) are designed to be flexible in their response to changes in the market and customer needs. Such flexibility is achieved through business alliances in which resources are integrated and shared in real time and the actions of members are unified. In this paper, a three-layer VE knowledge description architecture is first presented. This architecture represents the organizational structure and fundamental elements of the VE as well as the conceptual and physical knowledge in the VE. A two-dimensional method developed for authorizing interenterprise knowledge sharing is then described. This method can be decomposed into two components: (1) A submethod for evaluating the activities of VEs to determine the range of workers who are authorized to share knowledge with other workers, and (2) a submethod for evaluating the hierarchical relationships among VE roles (VERs), correlations among various types of knowledge, and interactions that occur in VE activities to determine the degree of authorized knowledge sharing. These submethods facilitate efficiently exchanging and sharing knowledge in real time within a framework of secure and reasonable access authorization.

1. Introduction

With the increase in product complexity and the continual evolution of production technologies, enterprises strive to reduce costs, improve product and service quality, and shorten the time to market (Chen, Chen, Wang, & Chu, 2007; Davidow, 1992). In response to these trends, virtual enterprises (VEs) have been developed for effectively increasing business efficiency, agility, and competitiveness (Chu, Tso, Zhang, & Li, 2002; Zhang, Liu, & Van Luttervelt, 1997). VEs are business alliances that integrate resources and unify the actions of members to enable a rapid response to changes in the market and customer needs. The success of VEs lies in the effective sharing of resources, and particularly in the integration and sharing of information and knowledge among alliance members. Knowledge sharing involves exchanging knowledge among members of an organization, teams, or organizations. Knowledge sharing is crucial to the improvement of organizational competitiveness because it facilitates information dissemination and integration (Chen, 2008; Lawson, Petersen, Cousins, & Handfield, 2009). Most VE alliance enterprises possess large information and knowledge bases, and VEs require various types of knowledge, depending on their stage of development. One major concern for VEs is determining a knowledge authorization evaluation approach that can be adapted to a VE environment. In addition, the resilience of human-made systems, such as financial and manufacturing systems, has attracted worldwide attention (Zhang, 2010; Zhang & Lin, 2010). These enterprise information systems are used by members of VEs to support their product research and development (R&D) and manufacturing as well as to cooperate and coordinate with other partners. A web-based knowledge management system was used in VEs for facilitating the seamless sharing of product data among enterprise information systems (Yoo & Kim, 2002). Sharing the knowledge and information in enterprise information systems facilitates interlevel and intralevel interoperation and integration within extended enterprises.

Previous studies (Gollmann, 1999; Lin, Wang, & Tserng, 2006; Maria, Marcos, Borges, & Erick, 2006) on knowledge sharing among enterprises have emphasized the deployment of information technology to provide first-rate knowledge management. Strader, Lin, and Shaw (1998) and Chen (2008) have adopted an access control perspective to investigate the concerns related to access authorization and assist enterprises in controlling knowledge sharing. However, controlling knowledge sharing is more challenging in a dynamic VE than within a traditional enterprise because VEs are

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dynamic organizations comprising members who may join or leave freely. Such members may adopt various knowledge sharing strategies and techniques (Liu, Raahemi, & Benyoucef, 2011), and the distinct information resources that a member gains access to are heterogeneous (Yoo & Kim, 2002). Moreover, knowledge sharing within VEs is determined by factors such as VE processes, knowledge categories, trust among enterprises, and the infrastructure of information technology and access control mechanisms.

Effective organizational knowledge-sharing practices prepare employees to share and accept novel ideas and learn new perspectives, enabling them to identify and leverage their knowledge and capabilities (Almahamid, McAdams, & Kalaldeh, 2010). Knowledge sharing is a learning process. Hence, deficient learning resources cannot maximize the added value of business activities, whereas excessive learning resources result in learning overload. Therefore, a fundamental problem of knowledge sharing in VEs is identifying the knowledge that should be shared.

On the basis of knowledge dispersion and the necessity of knowledge integration in VEs, this study proposes a two-dimensional (2D) method for evaluating the level of authorized knowledge sharing for VEs. The proposed method is based on ontological technologies, considering factors such as VE processes, knowledge categories, roles, and authorizations. This method was developed with the objective of effectively integrating knowledge scattered throughout alliance enterprises for providing VE members with authorized access to knowledge. This study applied the following research procedures to achieve this objective: (1) The first procedure involved identifying and analyzing knowledge and knowledge properties, such as the relationship between VE processes and knowledge, by using definitions of the structure and pattern of VE knowledge. (2) The second procedure entailed developing knowledge-sharing modes, in which the results of a VE process analysis served as a basis for designing a VE knowledge-sharing model. (3) The third procedure involved designing a VE knowledge description architecture according to the results of the VE knowledge analysis. In this architecture, various types of knowledge existing at various levels are described using ontological technologies. (4) The fourth procedure entailed designing the 2D knowledge authorization evaluation method. This method is subdivided into two submethods: (1) The first submethod entails evaluating the range of authorized knowledge sharing, and this submethod is based on VE activities; and (b) the second submethod involves evaluating the depth of authorized knowledge sharing, and this submethod is based on a hierarchy of VE roles (VERs), with knowledge and activity correlations calculated through fuzzy logic (Klir & Yuan, 1995; Zimmermann, 1991). To secure VE knowledge and allow reasonable access, the proposed 2D knowledge authorization evaluation method can enable members who share knowledge to determine the range and depth of authorized knowledge sharing with other members. Finally, this study applied a simplified example to simulate the feasibility of the research procedures and implemented the proposed method.

2. Related research

2.1. VE and knowledge identification

Enterprises currently face various challenges including increasing product complexity, shorter product lifecycle, and higher R&D costs (Song, Ming, & Wang, 2013). Therefore, VEs are generally formed for realizing collaborative product development, which has been widely accepted as an advanced collaboration paradigm for efficiently developing products (Jiang, Shao, Qiu, & Li, 2008). VEs must learn to respond swiftly to changes in the market and customer needs by integrating various enterprise resources through business alliances (Chu et al., 2002). VEs do not follow fixed patterns in practice, and their members engage in mutually beneficial activities (Chen, 2008; Chen et al., 2007; Davidow, 1992; Schonseleben, 2000). A typical VE life cycle involves four stages: opportunity identification (s_1), formation (s_2), operation (s_3), and dissolution (s_4) (Davenport & Prusak, 1998). At the formation stage, a leading enterprise serves as team leader to convert customer needs into a project involving concrete objectives and specific processes. Team members are then selected to assume specific VERs and execute VE tasks. The leading enterprise coordinates the range and depth of knowledge sharing among all members of the VE. Moreover, knowledge categories are defined and analyzed at this stage. Knowledge is required to conduct all activities included in VE operations. Such knowledge may be derived from several resources: (1) employee knowledge, such as knowledge owned by the employee, including skills, experiences, habits, and instincts; and (2) organizational knowledge, such as the intellectual property of the enterprise that is often stored in the enterprise knowledge bank (Chen, Chen, Lin, & Chen, 2010).

At the operation stage, VE members perform their respective tasks, and they access and share resources according to their respective authority levels. The activities of VEs must be analyzed to understand the knowledge required for specific actions. The relationships between VE processes and activities are first analyzed, and the information and knowledge required for each activity according to input, output, constraints, and resources are subsequently determined. Finally, the knowledge categories required for and generated by VE operations are derived (NIST, 2010). At the dissolution stage, the strategies of VE members and the authorizations granted for accessing resources are revised, with certain resources remaining accessible under the new sharing strategies.

Knowledge can be structured according to experiences, values, text-based information, or unique expert insights. Knowledge is available in documents stored within a system and in daily routine tasks, processes, executions, and norms (Davenport & Prusak, 1998; Lee, 2001). Knowledge categories vary according to perspective. Therefore, this study referred to VE knowledge categorization and defined knowledge according to various categories, layers, and patterns by applying three dimensions (Beckman, 1997; Chen et al., 2010; Quinn, Anderson, & Finkelstein, 1996): (1) dimension involving abstractness, which can be divided into formal knowledge and practical knowledge; (2) dimension involving the comprehension of phenomena and the purpose of an application, which can be divided into declarative (know-what), causal (know-why), procedural (know-how), and relational (know-with) knowledge; and (3) dimension involving openness: based on security concerns, knowledge can be classified as either public knowledge or private knowledge.

2.2. Knowledge-sharing modes and methods

Various factors may influence knowledge sharing, and they can be divided into various levels. The researches related to the factors of knowledge sharing are listed in Table 1.

The results of these studies indicated that factors related to the availability and usability of technology, leadership support, and motivating structures all influence knowledge sharing. Organizations can foster knowledge sharing by implementing a formal incentive system that rewards members for participating in knowledge sharing (Alavi & Leidner, 1999; Gold, Malhotra, & Segars, 2001; Panteli & Sockalingam, 2005). Trust and conflict are fundamental factors of knowledge sharing within the context of virtual interorganizational arrangements (Panteli & Sockalingam, 2005). In addition to human-oriented research, another category of