
Build Enterprise Relationship Network to Support Collaborative Business

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ABSTRACT: Collaborative business among enterprises is based on a symbiotic relationship, where each company has a product or service that will help the other, when they trade or share these items, both companies benefit. Enterprise relationship network (ERN) can be used to support the business collaboration by maximize current and future opportunities and facilitate network-enabled processes, leading to value co-creation.

The main technical difficulty is in the expression of ERN which combined by many forms of relations that address specific organizational constituencies and product structure. We proposed a new definition of ERN and gave the analysis of its characteristics. The ERN model in this paper consists of four graphs, the enterprise relationship graph (ENTG), the employee relationship graph (EMPG), the product relationship graph (PROG), and the three-level hypergraph (TLHG). The comprehensive utilization of these graphs can string the main objectives in the business together, such as enterprise, business, employee and product.

ERN can be used in supporting business analysis, applications, employee collaborations and other commercial appreciation services. We introduced a case study on SDCMSP and some relationship visualization results at last.

KEY WORDS: enterprise relationship network; enterprise social network; enterprise relationship management; business collaboration; social network.

1. Introduction

Collaborative business is a concept where companies share information with each other in order to create stronger operations. The collaboration functions as a symbiotic relationship, where each company has a product or service that will help the other, when they trade or share these items, both companies benefit.

Social networks (Wikipedia 2013) have got tremendous development and popularity in the past few years, and it has changed the way of people's communication and information research to a large extent. There are some distinctions of ERN compared to existing social networks, such as social network, Enterprise 2.0 and enterprise social network. The core factor of social network is people, and the social relationships are often not related to business. Enterprise 2.0 is the use of emergent social software platforms within companies, or between companies and their partners or customers. It aims to help employees, customers and suppliers collaborate, share and organize information via Web 2.0 technologies (Capuano, N. et al., 2010). Enterprise social network (ESN) emerged and grew quickly, some software based on ESN has come out, e.g., Salesforce's Chatter, Microsoft's Yammer and IBM Connections. This software provides convenience for collaboration and communication among employees. But in these applications ESN is confined to communication among people ignoring the business.

For the similarity to social network, it's reasonable to organize the enterprises with a network based on business relationships, we name it as 'Enterprise Relationship Network'. The main purpose of ERN is to support collaborative business as well as to discover valuable information from enterprise relationships. And we propose a new ERN model to build the network with the enterprise as the core entity and the business between enterprises as the principal line.

The remainder of this paper is organized as follows. In section 2, we introduce the related work mainly about the theory and analysis of social network. The definition and modeling of ERN is provided in section 3. Our ERN model is applied to support collaborative business which is discussed in the section 4. In section 5, we present a case study and relationship visualization works. Finally the conclusion and future work are given in section 6.

2. Related Work

To build a stable and reasonable social network, there are some points should be considered. (Holroyd, P. 1983) examined the general characteristics of networks and the factors which influence their stability. (Junhua Ding et al., 2011) extended a high level Petri nets with channels for formally modeling social networks.

Some methods are useful to build an employee social network. (DiMicco, J.M. et al., 2009) designed a social network site to support employees within an enterprise in communicating with each other through personal and professional sharing. (Jin Cao et al., 2013) combined the organization graph and the social interaction graph to

analyze and model user interaction in enterprise social networks. (Kohout, J. et al., 2013) introduced an algorithm for social network graphs clustering, which can be applied in ERN. (Dong Liu et al., 2013) used an expert finding model to carry on the influence analysis. (Bennett, S. 2012) gave the benefits of communicating and collaborating in a real-time enterprise social network.

Social network analysis (SNA) has been a hot topic and provided many algorithms for us to apply in ERN. (Jamali, M. et al., 2006) presented a state of the art survey of the works done on social network analysis ranging from pure mathematical analyses in graphs to analyzing the social networks in semantic Web.

3. Enterprise Relationship Network Definition

Definition 1 (ERN): enterprise relationship network. An ERN is a social structure made up of a set of entities and a set of the relationships ties between these entities. We propose a hypergraph-based hierarchical model to support ERN.

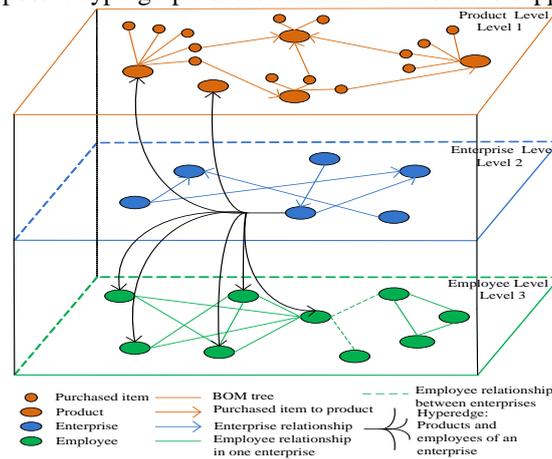


Figure 1. Hypergraph-based Hierarchical ERN Model.

Definition 2 (ENTG): enterprise graph. $ENTG = (ENT, E)$. ENTG is a directed enterprise graph. ENT is the enterprise node collection of the graph. E is the edge collection. A directed edge in E is a relationship from an enterprise to its partner.

Definition 3 (EMPG): employee graph. $EMPG = (EMP, E)$. EMPG is an undirected employee social graph. EMP is the employee node collection of the graph. E is the edge collection. An undirected edge in E is a social relationship between two employees.

Definition 4 (PROG): product graph. $PROG = (PRO, PUR, F, E)$. PROG is a combination of BOM (Bill of Material) trees and a directed graph. PRO is the product collection and PUR is the purchased item collection. F is a forest of BOM trees. E is the edge collection. A directed edge in E means that the source of a purchased item is a product from another enterprise.

Definition 5 (TLHG): the three-level hypergraph. $TLHG = (ENT, EMP, PRO, H)$. TLHG is a directed hypergraph. H is the hyperedge collection. A directed hyperedge in H is from an enterprise to a collection composed of subsets of ENT, EMP and PRO. A hyperedge in TLHG means that an enterprise has some employees in EMP and products in PRO.

Definition 6 (BUS): business. $BUS = (ENTG, EMPG, PROG, TLHG, B)$. BUS is a group of edges of the four graphs with some parameters. B is the business collection. A business in B is an edge collection composed of subsets of $E(ENTG)$, $E(EMPG)$, $E(PROG)$ and $E(TLHG)$. Though BUS may be an incomplete business process, it can link all the factors in part of the business process, through which we could describe the business clearly.

4. Supporting Collaborative Business

We can get a lot of valuable information and applications on the base of ERN, which are extremely promising in the enterprise management and industrial innovation. We can do more deeply work in the following directions to support collaborative business.

Business Analyzing. The information in ERN provides the original data for analyzing the business of one or some enterprises, e.g., we could find out all the suppliers of an enterprise through the supply relationships. Then the sub-tier suppliers are easy to get after one more traversal.

Application based on ERN. Many applications are developed to manage the business relationships such as Customer Relationship Management (CRM) and Supplier Relationship Management (SRM). ERN is good at collecting and describing business relationships so that it's more effective and simple to develop such applications. An important part of ERN is employee social network, which makes it possible to collaborate with colleagues in one enterprise and employees in other enterprises with restrictions to guarantee security and privacy.

Recommendation. Recommendation is always a commercial appreciation service for its effect of advertisement. In ERN we can master the information of every enterprise, product and business process, which can be used to run analysis algorithms to recommend enterprise, product or service to target enterprises.

Data Mining. We can analyze the ERN data in a way similar to SNA and big data analysis to get more valuable information. SNA and big data analysis have been widely studied and become more mature gradually.

5. Case Study

5.1. Generating Dataset

In this section, we introduce a case study based on Shandong Cloud Manufacturing Service Platform (SDCMSP). We made a dataset trying to simulate the real situation. In this dataset, we just consider one kind of relationship, the supply-purchase relationship. We simulated one thousand enterprise entities, based on which we made 5009 business relationships, 14438 products and 52013 purchased items.

5.2. Relationship Virtualization

Relationship visualization becomes quite necessary for people to understand and deeply analyze the data in ERN. We carried out some primary data visualization work. Figure 2 is the picture of relationships from suppliers to purchasers. The grey disks are enterprises and the directed edges are relationships from suppliers to purchasers. The ten core red enterprises are extremely obvious to find. Figure 3 is links between purchased items of a purchaser and products of its suppliers, which helps to understand the source of the parts of an enterprise's products. The biggest red disk is the purchaser. The smaller red disks are the suppliers. The upper green disks are the products of the purchaser for producing and selling. The lower green disks are the products of the suppliers. The black disks are the purchased items of the purchaser. And the purple edges are the links. The red path goes through products and purchased items from an enterprise to another.

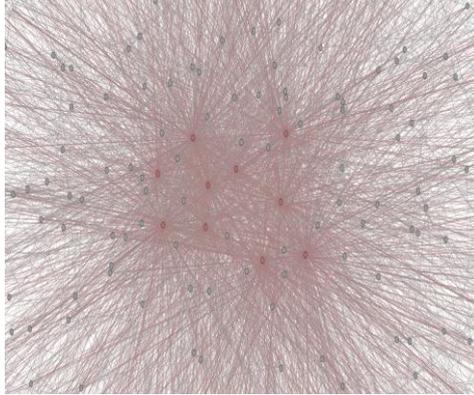


Figure 2. Enterprise graph

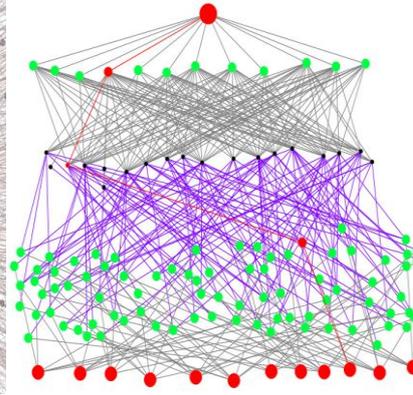


Figure 3. Product graph

6. Conclusion and Future Work

In this paper we proposed a new definition of enterprise relationship network and gave the analysis of the characteristics and differences with other social networks. Then we built a model to explain the ERN like other social networks, but our model is composed by ENTG, EMPG, PROG and TLHG. ERN has broad application prospects to support collaborative business. Furthermore, we introduced a case study on SDCMSP with a simulated dataset. We achieved some relationship visualization and social analytics results based on this dataset.

Our plans for future work include to continue investigating the analytics and visualization technologies on ERN and to develop suitable means for enterprises to leverage to get advantages over the competitors. Moreover, with the increasing amount of enterprises involved in ERN and more applications based on ERN being developed, the problems of security and privacy are unavoidable, which will be a valuable topic.

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