A Study on Value Chain Analysis Model based on Inter-Company Transactions Information

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Abstract: Background/Objectives: For understanding the industrial structure and developing new products of a firm, we propose the value chain analysis model based on real data of firms' transactions. Methods/Statistical analysis: Utilizing real data of inter-company sales transaction and aggregated big data up to about 28 million cases with a firm's representative product and trademarks, we designed a pilot system to visualize the value chain network relationship where an arrowed line means the direction of service or goods and size of a node concentration of a transaction, respectively. Findings: By analyzing the demander information of competitors, which produce the same or similar products, it is possible to discover new sales distributors. In a reverse way, we could find new suppliers from company information which produces sub-products or lower leveled modules. For researchers or engineers, it can be the idea source for new product development by analyzing other products produced by competitors that produce the same product, furthermore we are able to apply to various business models or organizational roles such as research and development, marketing, purchasing, and management by concretized value chain network relationship. Improvements/Applications: The data used in the study is taken from the entire population, thus we need to generalize the findings and implications fit to both the entire firms and the entire transactions information.

Keywords: Value chain analysis model, Inter-company transactions information, Product deal relationship, Extraction of potential supplier/demander, Competitors by product or industry.

I. INTRODUCTION

In Korea, small-and-medium enterprises take a considerable portion of gross domestic product in Korean economy; however, in many cases they experience the less competence level compared to large companies. To promote the commercialization outcomes of small-and-medium enterprises (SMEs) and enhance their internal and external competitiveness, the institution of Small and Medium Business Administration (SMBA), as one of the government-funded organizations, has been founded, and it has been assisting them with financial aids/matching or industry trends/information in terms of promotion of technology innovation of SMEs.

While SMBA runs numerous financial support programs towards either pure R&D or commercialization linkage projects where two or more SMEs participate in 'technology-based business development through inter-company collaboration', most enterprises corresponding to about 67.6% find their partner through 'individual contacts' [1].In terms of 'individual contacts', it is difficult for small and medium enterprises that have the relatively weak competence in company reputation and ability of accessing firm information compared to large firms to find appropriate potential partners. To overcome the weakness of SMEs, establishing online and off-line support framework for inter-company collaboration among SMEs has been proposed by many industry employees and public servants [2]. Therefore we realize the necessity to suggest a methodology for building up a web-based value chain network visualization infrastructure that can assist small and medium enterprises to find potential business partners in their same industry sector.

If we utilize various types of databases with business deal information, firm information and Korean trademark rights information, we could design a web-based business support system about retrieving and matching potential business partners that produce or supply the same items in the supply chain of the specific industry that the target company is categorized into.

In terms of business management, enterprises (either small or large firms) will encounter to various adversities and difficulties during their business activities, and many of them struggles to overcome those hardships. Most companies are seeking multi-phased solutions for securing their competitiveness, such as developing new products, exploring new markets, and searching for competitors. An alternative is currently in use of the analysis methodology of value chain, which the emeritus professor of Michael Porter have progressed to a sophisticated, systematic analytics tool from the concept of McKinsey's *Business Systems*. Business System herein implies a useful methodology to systematically analyze the key activities for delivering value to customers and to effectively identify differentiation factors superior to competitors [3,4].

Value chain often refers to the linkage of a series of activities, functions, and processes related directly or indirectly to the creation of added value in providing value to customers.

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M. Porter says that value creation is one of the components that creates the competitive advantage for a company, and that these activities are systematically organized activities that are related to one another rather than a simple collection of independent activities [3,5]. In this paper, we propose a method of analyzing these series of value chain based on corporate transactions relationship and visualizing the results, and ultimately propose an efficient value chain network analysis model.

II. MATERIALS AND METHODS

2.1. Preceding case studies

The value chain analysis performed by government-supported research institutes in Korea is often as a tool to show the competitive situation in terms of market, technology, and firm participants by the criteria of specific product or sub-technology. The Korea Industrial Technology Evaluation and Management Service (KEIT) has developed 3 indicators of marketability (market size, market growth potential, value added effect), technological viewpoint (ripple effect of technology, prioritization of technology), strategic viewpoint (degree of dependence on import, prioritization of future markets, compliance with government policy), and then conducted value chain analysis regarding the selected item which represents its industry sector. In addition, the Korea Industrial Technology Development Organization (KIAT) proposes the value chain diagram that specifies participating companies by portfolio of 'material-intermediate goods-finished product' in order to understand the structure of the industry in creating a technology roadmap for establishing R&D strategies in the industry. In other hands, the Korea Trade-Investment Promotion Agency (KOTRA) promotes the industry value chain (VC) map project as part of the 'Inter-industry Cooperation Platform' program and utilizes the outcome of value chain map to promote economic cooperation projects with official development assistance (ODA) countries.

The concept of supply chain has been studied by many researchers, as well as in various academic fields. Out of those studies, the initial concept of supply chain has been defined as 'the bi-directional network of organizations which is activated through both upstream and downstream linkages, where participants in various activities either create or add up value in form of goods or services delivered to the end-user group. In fact, a supply chain is composed of multiple firms, i.e. suppliers, demanders and the ultimate end-user [6-8].

Competitor identification (CI) in a single market or industry is one of the useful metric to identify the competitors or similar companies which could be a potential collaborate partner in the business. In the 1980s, M. Porter extended the concept of competitor in terms of buyers, suppliers (sellers), substitutes and potential entrants, and later Chen & Miller explained that while traditional research primarily relies on attribute information about firms such as strategic profiles or firm capabilities, competitor identification on certain determinants about firms' competition such as firm size and market shares based on the closed range of a market or industry [9]. They employed the internal perspective of resource similarity (RS) and the external perspective of market commonality (MC) to generalize the framework of competitor identification [10].

In fact, there exists little research on inter-company transactions information and value chain-based competitor identification with it. There exist only a couple of approaches to explain product or component analysis with transaction data. In terms of hierarchical structure of products, it is suggested that a "product-to-product" network is built with products as nodes and transactions between two firms, which are characterized by their representative products, as edges [11]. On the other hand, association of products leads to the implication that a "product co-occurrence" network is built with products as nodes and the co-occurrence of pairs of products in transactions as edge [12]. An exemplary supply chain map has been proposed in two focal car manufacturers (Audi and Suzuki) [13] and it showed how supply chains are affected by different corporate strategies, where interview with the suppliers might not be efficient to develop supply chain for a large number of companies.

Inter-firm relationships can also be represented as a network model [14]. Firms perform several commercial transactions by dealing in either products or services with other firms [15]. Transactions form a fundamental part of economic analysis and are considered an important aspect of the relationships between firms. [16-19]. A network representation can be used to show the existence of transactions among firms, where the nodes and edges of the network represent firms and inter-firm transactions, respectively [20].

Regarding inter-firm networks in the areas of management, there have been quite a volume of empirical and theoretical research [21-23]. However, the identification of key players using network analysis tools has drawn limited attention from the research community. The limited information we can obtain through the key player identification leaves us room to further research in order to support to the decision making of managers and researchers 1) to identify the transaction partners of firms, 2) to understand the agglomeration of economic activities, and 3) to identify the potential and indirect competitors of firms.

In perspectives of network-theoretic multimarket competition, there have been studies on complex interdependencies of objects (e.g., inter-firm or inter-business relationships), which can be manifested in the form of networks, and later conducted based on these networks. Such studies have focused on firm competition within or between networks using the cooperative relationships of firms in alliances and competitive relationships based on niche overlaps [24], structural embeddedness with respect to firms' market engagement [25], and firms' behavioral characteristics with respect to product market entry within a competition network [26,27].

To the best of our knowledge, there exists no practical methodology based on value chain network analysis which enables to identify the key players in an inter-firm transaction network.

From the literature review performed so far, we have reached the motive herein to develop a novel methodology of value chain analysis model and design a web-based visualization platform from a pilot system with tested dataset.

2.2. Research Framework and Methodology

2.2.1. Research Framework

To design a pilot system and verify implementation results for practical transaction cases, we first conceptualize the inter-company transactions relationship as below in [Figure 1]. It explains the illustration of business deals which are centralized in terms of a company 'CA'

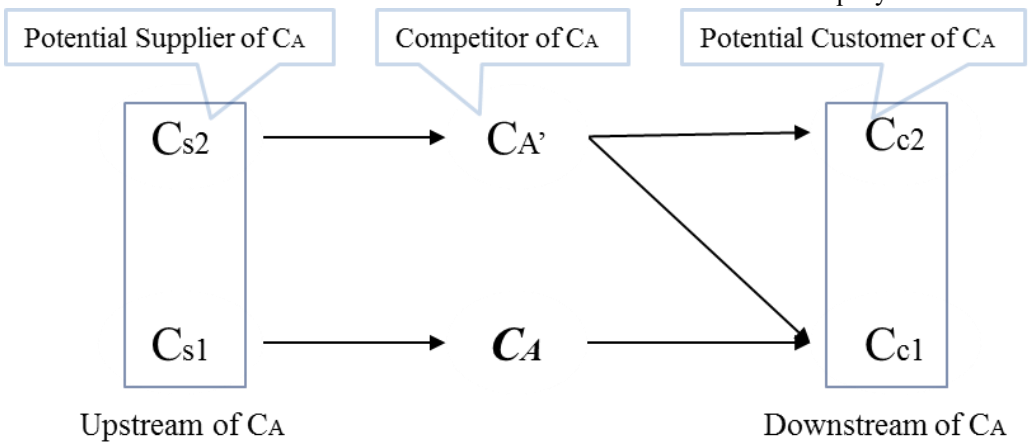

Figure 1. Business transaction-based relationship in value chain analysis model

For instance, from the perspective of CA, CA' is found as a potential competitor of CA because it can provide its products to either CC1 or CC2. In the meantime, CS2, as the preceding vendor of C A' becomes a "potential supplier" of C A in [Figure 1].

The proposed system has the ability of visualizing to a company in interest useful business flow diagram such as its supply chain map-based position and surrounding relationship, where the directly-linked participants are regarded as competitors, forward demanders or backward suppliers in the supply chain. In addition, provided information would make crucial factors for a specific company to recognize potential business partners for upcoming collaboration or affiliation, when the system includes multi-phased modules such as the data-driven analysis modules with technological characteristics, financial status, deal relationship with other participants in the networked supply chain,

Then, we perform the mapping of the supply chain and structure the portfolio of 'parts-module-final products' as shown in [Figure 2], where the keywords of 'muffler, silencer, etc.' and the known companies of muffler (i.e. C1, C2, etc.) regarding each item are respectively defined by expertized practitioners. The supply chain comprises two steps of 'Extracting confirmed companies' and 'Extracting companies by refined parameter' which will be explained later.

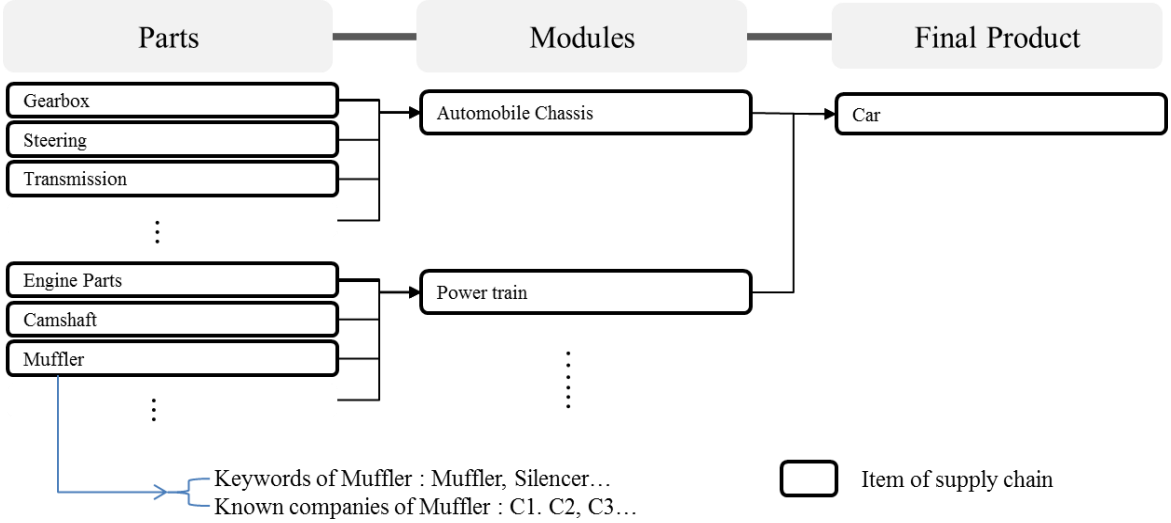

Figure 2. Structure of the supply chain in value chain analysis model

2.2.2. Methodology

The value chain analysis model proposed in this study is based on real business transactions data rather than forecasting or estimating the value chain relationship among firms and it is possible to infer the value chain network associativity between domestic companies by using about 28 million big data. In particular, only the principal production products are indicated in the company information, so that there exists the limitation to understand the inter-company deal relationship by their respective products. As shown in [Table 1], we make the connection of trademark rights with other types of databases and utilize them.

Table 1: Types of databases used in value chain analysis model

Name of DB	Major Data Contents	Number of Data	Source
Business Deals DB	Sales company name, products for sale, transaction amount, purchase company name, date of purchase	16,300,000	Korean Enterprise Data
Business Information DB(in details)	company status, credit information, financial information, etc.	300,000	Korean Enterprise Data
Business Information DB(in summary)	company overview, principal partners (supplier/demander),etc.	3,000,000	Korean Enterprise Data
Trademark rights DB	applicant (company or individual), designated goods, Korean Trademark Classification Code(KTCC), etc.	4,000,000	Korean Intellectual Property Office
Patent rights DB	Applicant (company/institution name), patent title, registration number, etc.	4,000,000	Korean Intellectual Property Office
Korea Standard Industry Classification (KSIC)	Principal indices by standardized industry classification (ex. C264)	30,000	Korea Institute of Science and Technology Information
TOTAL		27,730,000	

From the illustration above in [Figure 1], we consider that we could extract potential demanders or suppliers of a specific company throughout the visualized transactions relationship of the target company's competitors. In this study, we established a value chain analysis model as in [Figure 1] on the premise that list up of competitors and those ranking is feasible in terms of either items or industry classification. In order to discover new potential purchasers for CA's, we first assume the suppliers CS2 of the competitor company C'A as potential suppliers, and the best potential suppliers are then selected by evaluating them from various indicators (financial soundness, technical ability, credit rating, etc.). The extraction of new potential vendors (or suppliers) can be done in the same way. Optimized design of the hardware is also very important in order to find competitors in tens of millions of big data, to statistically process a large volume of dealings of these companies and to achieve the optimum visualization speed. In fact, fast processors such as GPU enables the value chain network visualization within 2 or 3 seconds or so.

The approach to extract companies in interest by value chain is conducted as follows. First, we select a retrieval keyword as an optimal search condition in order to find major companies. Alternatively, we could utilize the condition of Korea Standard Industry Classification (KSIC) corresponding to (estimated) major companies. Then, we verify by comparing the products of companies in interest and checking whether trademark rights of both parties lie in the same or similar groups.

In the value chain analysis model proposed, it is expected that we find various industrial application fields in [Table 2] through analyzing the network relationship between the super-ordinate and sub-ordinate companies. By analyzing the demander information of competitors, which produce the same or similar products, it is possible to discover new sales distributors. In a reverse way, we could find new suppliers from company information which produces sub-products or lower leveled modules. For researchers or engineers, it can be the idea source for new product development by analyzing other products produced by competitors that produce the same product, furthermore we are able to apply to various business models or organizational roles such as research and development, marketing, purchasing, and management by concretized value chain network relationship.

Table 2: Possible application fields of the value chain analysis model proposed

Type of Information	Type of Analysis	Detailed Information	Company				Other organization	
			R&D/ Production	Marketing /Sales	Purchasing/ Procurement	Management	Consulting Firms	Public Sector
Company Information	Status Analysis	Upper level items Production company		Understanding Industry Structure			All Information associated with Company Analysis and Customer Company	Extraction of Major Companies by Value Chain
		Same level Items Production company	Understanding Industry Structure			Understanding Competitor Trends		
		Lower level items Production company			Understanding Industry Structure			
	Decision-making		Competitor Analysis	Demander Discovery	Supplier Discovery	New Entrants Discovery		
Product Information	Status Analysis	Upper level items		Industry Trends by items				Extraction of Major Items by Value Chain
		Same level items	Industry Trends by items			Competitor Item Trends		
		Lower level items			Industry Trends by items			
		Promising Items	Promising Items Trends	Upper level Promising Items Trends	Lower level Promising Items Trends			
	Decision-making		Development Fields Discovery	New Business Discovery	Substitutes Discovery			

III. RESULTS AND DISCUSSION

We have investigated the structure of the supply chain in value chain analysis model in [Figure 2]. In fact, we divided into two steps of 'Extracting confirmed companies' and 'Extracting companies by refined parameter' sequentially and finally obtained the illustration of supply chain diagram visualizing business transactions and figuring out the deal relationships. Then, we reach the overall process diagram of extracting competitive (or similar) firms that produce the same item with the target firm by the business information given in [Figure 3].

In the 1st step, the 'refined keywords' is input to minimize unintentional errors that can occur while the experimenter retrieves companies in interest by only one or a few keywords and aims to achieve the high accuracy of discovering the list of firms which produce the items that the experimenter bears in mind. In the example of 'muffler' in [Figure 2], the keyword of 'muffler' has differential meanings: first we read in a Wikipedia or dictionary it as 'a device tipped to the engine of a vehicle to remove mechanical noise' and on the other hand as 'a piece of fur or wool-based cloth to wear around your neck for keeping warmth'. Due to the duality of the meaning of a 'muffler', if the experimenter enter an input keyword of 'muffler' alone, there is chance that the clothing or similar companies will be returned. To avoid such unintentional results, refined keywords may be necessary and useful such that a combination of the upper-level item name in hierarchy, i.e. 'car or vehicle' and the end-user lower-level product name, i.e. 'muffler, exhaust or silencer'. The group of companies retrieved from the procedure of utilizing 'refined keywords' in the 'Business information database' in hold is herein defined as 'refined companies'. Hence, both 'known companies' and 'refined companies' are redirected to the actual manufacturers of the production items, i.e. 'mufflers in automotive industry', and taken as 'confirmed companies' in [Figure 2].

At the 2nd step, since the 'Business information database' is accumulated from the data collected each company has provided, there occurs often cases of returning the unwanted or inexact name of the product in the hierarchy of 'products'. For a company supplying a muffler for automobiles, if 'various parts for automobile' or 'parts for automotive exhaust' is entered to the input field, the appropriate companies cannot be retrieved by only the 1st step. Thus, in order to extract companies that do not belong to 'confirmed companies' from Step 1, it is recommended to search by common KTCC and KSIC from the 'confirmed companies'. Fundamentally, it is based on the concept that if the enterprises which have the same KSIC and KTCC of the 'confirmed companies', it is likely that the filtered enterprises will be manufacturers of the subject item, i.e. 'muffler for automobiles' in [Figure 2].

By repeatedly conducting two-staged process, we will able to retrieve and extract companies in interest by items as in [Figure 4].

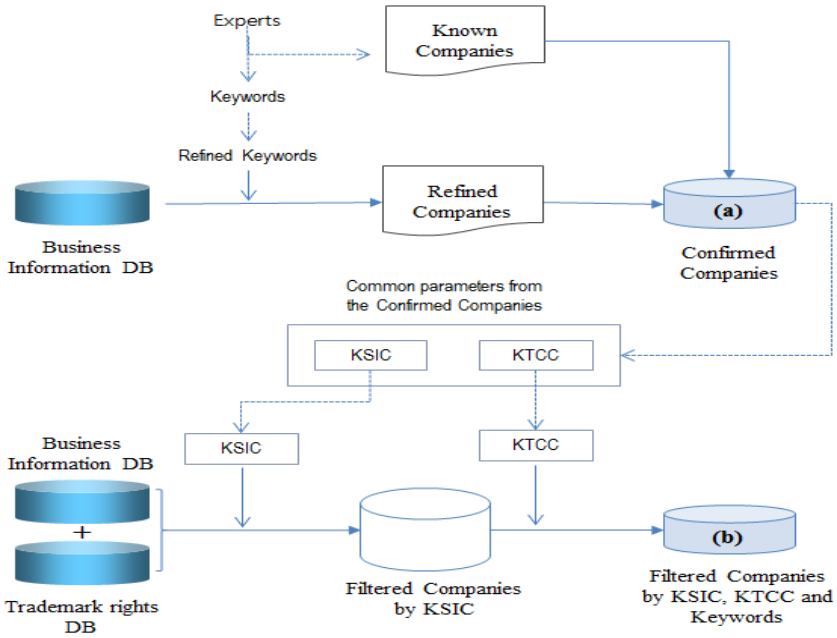

Figure 3. The overall process diagram of extracting competitive (or similar) companies that produce and distribute a specific item by the help of business information database

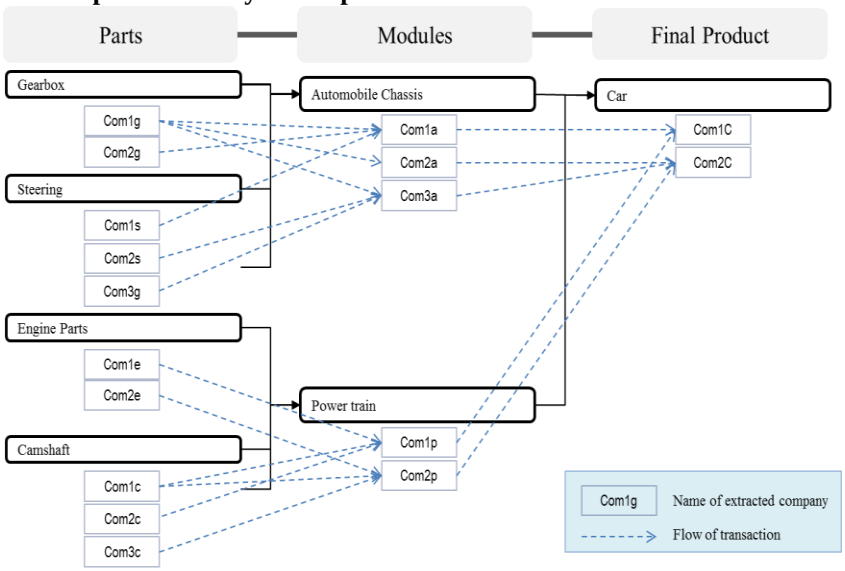

Figure 4. An illustration of the exemplary supply chain diagram in value chain analysis model

By integrating the sub-modules in the value chain analysis model discussed so far, we could expect that the supply chain in it is to be extensively applicable, according to department or roles in charge as follows.

1) For representatives in R&D department

Let us revisit the company CA in [Figure 1]. The staffs in R&D department can understand the visualized supply chain and recognize the principal products of their competitors. In addition, the associated personnel would achieve novel strategies or business directions about how to enlarge their business areas by analysing and thoroughly examining the products of backward suppliers, forward demanders, and competitors.

2) For representatives in sales or marketing department

The staffs in in sales or marketing department first investigate who their competitors have as the customers. Furthermore, they will be able to make use of the information about the potential forward demanders, as an intermediate foothold for ultimately finding potential customers. Extensively, by scrutinizing the list of the competitors' products or services, they will have opportunity to grasp business activities, dealer information, and strategies of their competitors.

3) For representatives in purchase or procurement department

The staffs in purchase or procurement department will find alternative substitutes for the existing raw material or modules in use by exploring the products of the backward suppliers. In other words, by tracing the backward supply chain, the staffs will catch up the trends of their competitors' suppliers, and establish the directionality about how the subject company could improve their existing products or technologies.

In any sectors of the above, we might predict numerical indicators from financial information which the subject of business information such as forward demanders, backward suppliers, and competitors might hold or display in value chain network diagram.

These metrics become value chain analysis indicators by which the company could figure out the current status of the potential business partners in aspects of technology, financial stability, successful commercial -lization with collaboration in [Table 3].

Table 3: Example of Value Chain Analysis Indicators by Business Information Database

Analysis Indicators	Formula
Technological competence	(Research and development cost of an enterprise / amount of sales) / (Average research and development cost per item of the filtered companies / amount of sales)
Rate of technological growth	(Rate of increase of (research and development cost of an enterprise / amount of sales) for the last three years) / (Rate of increase of (average research and development cost per item of the filtered companies / amount of sales) for the last three years)
Growth	Rate of increase of the amount of sales for last three years / average amount of sales of the filtered companies for the last three years
Profitability	Business profit rate / average business profit rate of the filtered companies per item
Safety	Debt rate / average debt rate of the filtered companies per item
Activity	Working capital turnover ratio / average working capital turnover ratio of the filtered companies per item

In referring to as we have explained the proposed model above, we designed a pilot system with the following characteristics. The model consists of a line and a node, and the thickness of the line indicates the trade or transaction relationship. The color in gray or red indicates whether the target product is included or not. The direction of the line means the direction of movement of goods or services. A node represents one company, and the size of a node represents the transaction concentration. The color of the node represents the classification of the industry and while integrating all these information and relationships, we identify the industrial characteristics of the product in the value chain network of the specific product in [Figure5].

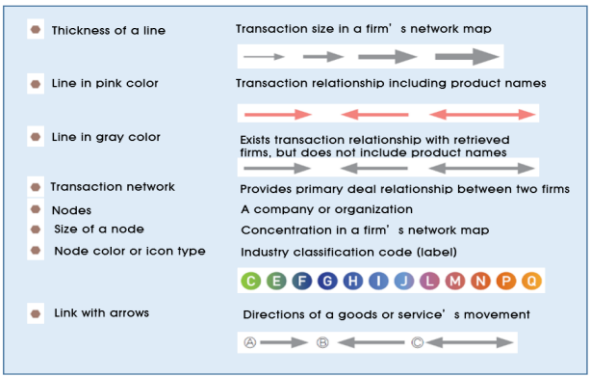

Figure 5. Explanation of line and node in value chain analysis model

[Figure 6] shows the actual visualization of value chain network relationship among companies. Edge nodes (companies) in interest can be expanded by clicking them and can compete with specific products or industries. Our pilot system in English is in preparation for establishment, while the visualization map is all in Korean. Each node denoted in Korean explains company name while the arrow means the occurrence of real transactions. In [Figure 6], two discrete companies, which both are yellow-circled, represent the target one (left) and one of the major companies with transactions (right). However, since the utilized database (DB) does not include the entire group of all companies and the entire transactions information, the analyst or data scientist must derive its significance by taking it into consideration.

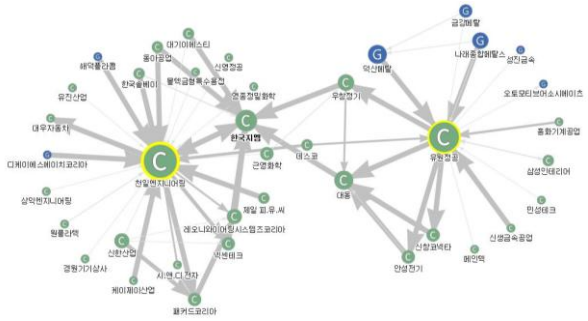

Figure 6. Cases of visualization using the value chain analysis model proposed (where the version of node representation for company name is not provided in English)

IV. CONCLUSION

For the past decades and until recently, in order to promote the 2nd leap of many small-and-medium enterprises and to enhance their business competitiveness, the Korean government has been pushing ahead by running various financial support programs for SMEs. However, there exists still questionable opinions on whether the business support programs are still efficient or effective. A good way to improve the efficiency of those programs is that the relevant agencies in charge gives exclusive financial aids to company applicants who have concrete planning for voluntarily gathering and seamless collaboration. Nevertheless, it is not often the case for SMEs to easily find their business partners for product distribution

or new technology development since they do not have sufficient information as much as large firms in business deal relationship or potential competitors who produce similar items.

We have here by suggested a methodology-based pilot system of 'value chain analysis model' so that it helps retrieving and match-making potential partners who produce the same items on the visualized supply chain of a specific industry field. If a company makes use of this system into their business, it is easily accessible to the information of the backward suppliers and forward demanders in position of its competitors. In addition, the companies will be able to obtain the list of potential partners as well as the competitors who are un-collaborative by the metrics of supply chain analysis indicators.

This paper proposed a novel framework referred as to the value chain analysis model to visualize inter-company transactions relationship based on real data of transaction deals among firms in Korea. By analyzing the demander information of competitors, which produce the same or similar products, it is possible to discover new sales distributors. In a reverse way, we could find new suppliers from company information which produces sub-products or lower leveled modules. For researchers or engineers, it can be the idea source for new product development by analyzing other products produced by competitors that produce the same product, furthermore we are able to apply to various business models or organizational roles such as research and development, marketing, purchasing, and management by concretized value chain network relationship.

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