The role of universities for the change of a network structure in the regional business ecosystem

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Abstract

Purpose – This paper aims to focus on the changing role of universities in university–industry collaboration (UIC) for enriching the regional business ecosystem network. For this, the authors analyze "Business Clinic Day," (BCD) a specific UIC program which provides a consulting service for firms, small- and medium-sized enterprises (SMEs) having a specific problem, by a group of facilitators. It includes consultants such as chief executive officers (CEOs), professors and heads of regional public or private service providers. This study illustrates that various types of networks are formed between consultants and problem-owners by facilitation of university after the program.

Design/methodology/approach – This study has analyzed with social network analysis how the business network was changed from clinic day program. Furthermore, the networks surrounding SMEs are extended to the other people connected to them. This means that the business network of SMEs had been diversified via the facilitation of "BCD" provided as UIC program.

Findings – Local SMEs have difficulties in enhancing their competitiveness in the market both in terms of internal resources and networks with external organizations. Thus, universities need to promote university–industry collaboration programs to enable SMEs to strengthen their competitiveness by building networks in local business ecosystems.

Originality/value – This study throws new highlights on the facilitator role of a university as a network promoter, in addition to the partner as a technology provider, in the regional business ecosystem.

Keywords Facilitation, Business ecosystem, University–industry collaboration

Paper type Research paper

1. Introduction

Recently, there has been an increasing awareness in the importance of business ecosystem for innovation in corporate management (Moore, 1993; Peltoniemil and Vuori, 2004). In business ecosystem, various organizations, including companies,

universities, public sectors and other influencing entities, are interconnected, compete and cooperate simultaneously (Peltoniemi and Vuori, 2004). Business ecosystem is defined as an economic community in which organizations and individuals are interconnected by integrating innovative ideas for a strong influence over the co-evolving their core businesses (Iansiti and Levien, 2004; Moore, 1993; Peltoniemi and Vuori, 2004).

The entities in the business ecosystem are interconnected to affect each other so that they share the role of ecosystem by competition, collaboration and interdependence. The failure of a company in the ecosystem can lead to the failure of other objects because each object is dependent upon each other (Peltoniemi, 2006).

Therefore, it is important to increase the interdependency between the entities for strengthening the innovation capacity of entities and regional business ecosystem. In other words, it is essential for companies to strengthen the collaboration network between organizations for continuing innovation in an increasingly competitive environment.

Especially, the collaboration network between organizations has been spreading since the 1990s, characterized by a rapid change in technology environment, the fast globalization of business areas, the emergence of knowledge and information as the core of competitive advantage, stressing the promptness of management action and a surge in the scales of resources and capabilities. Prior researchers stress that the collaboration network between organizations allows companies to have a competitive advantage (Dyer and Singh, 1998; Gomes-Casseres, 1997). In this notion, the open innovation which allows the company to use inflows and outflows of knowledge to accelerate internal innovation and to expand the markets is a prerequisite for health and competitiveness of business ecosystem (Chesbrough, 2003; Chesbrough *et al.*, 2006). It means that whether companies take advantage of the belonging networks determines companies' growth and survival.

Nevertheless, the benefit of business ecosystem can be affected by the condition of the regional innovation environment. For example, the metropolitan area in which most of companies are gathered and related infrastructure is sufficient can provide a maximal benefit of the business ecosystem. However, most of the regional firms apart from the metropolitan area are small- and medium-sized companies and have difficulties in finding partners, so they have limitation in their internal resources and business network.

In this notion, university–industry collaboration (UIC) should focus on providing complementary role for this problem. When considering the harsh condition of regional business ecosystem compared to the situation in the metropolitan area, the core role of universities is great to strengthen the competitiveness of the ecosystem.

Although UIC provides much broad benefits to the companies in regional business ecosystem in terms of accessing universities' expertise, and receiving general support with problem-solving, most prior studies have focused on R&D collaborations (Gertner *et al.*, 2011; Fabrizio, 2006; Tidd and Trewhella, 1997; Lee, 2000). Few focus on the role of university to strengthen and mediate the network of business ecosystem. In fact, despite the interest in UIC, some companies consider university as being of low importance as a source of knowledge for innovation (Hughes, 2008).

This research analyzes a specific UIC program called as "Business Clinic Day" (BCD) and examines how the business network ecosystem has changed after the program and what factors make the transition. Based on this, we propose the new role of universities to enable business ecosystem.

2. Research background

2.1 Business ecosystem

Business ecosystem means a community in which firms and individuals share one or more resources and co-evolve in the concept of common destiny (Moore, 1993), a set of multiple organizations interact within certain environment (Fransman, 2007) and a community is spontaneously connected to share their mutual destiny with a mechanism of both competition and cooperation with no geographical limit (Peltoniemi, 2006).

In other words, business ecosystem means a set of community which co-evolves with focusing on core business by interchanging, exchanging and combining technologies, knowledge, experience, resources and innovative ideas within the business realizing space (Moore, 1993, 1997).

Ecosystem perspective has emerged because the supply-chain and value chain theories have limitations in explaining how the entities serving a variety of roles in industry or market interact with, depend on and share their experience with other actors.

With the notion of ecosystem perspectives, it is relatively easy to explain the phenomena of competition, symbiosis, selection of deficit and coevolution among the economic entities.

According to Iansiti and Levien (2004), there are four different roles in business ecosystem. The first one is keystones, which are the kind of organizations that serve as enablers and have a great impact on the whole system. Keystones tend to assume roles of hubs in the network, which are the most richly connected and often lie at the network's core (Basole, 2009). Niche players are small ones consisting the largest mass of the business ecosystem. Dominators occupy network hubs and attempt to integrate both horizontally and/or vertically to control functions and capture most values in the ecosystem. Hub landlords take central role but catch little value.

Even though there are increasing attempts to analyze the competitive or symbiotic relationship among firms, the research agenda on the business ecosystem is still in the early stages.

In terms of ecosystem, desirable actions of firms are to participate in new competition based on the business ecosystem, to act strategically in accordance with the evolutionary stages established and to innovate and co-evolve cooperatively and competitively for satisfying customers' needs and creating new products (Moore, 1993, 1997).

2.2 An affiliate model enhancing the openness of business ecosystem

Firms have conventionally searched for the source of innovation within the business and recognized external sources as aids for internal innovation. Consequently, the competitiveness of firms has been enhanced by strengthening entry barrier through massive investment to R&D internally. However, the paradigm of the closed innovation has already reached the limits by the end of the twentieth century. Affiliating knowledge and infrastructure from different outer sources has been highlighted for business competitiveness (Chesbrough, 2003). In particular, technology development through affiliation with external organizations is crucial because of relatively limited resources and workforce of small- and medium-sized enterprises (SMEs) compared with large companies. Therefore, the utilization of knowledge from outer sources is more demanded by SMEs than large firms (Huizingh, 2010; Lee et al., 2010).

Universities provide sources of appealing innovation to firms. Meanwhile, firms get opportunities to be directly provided with various technologies and outstanding human resources from universities (Lee, 2000; Lee and Win, 2004; Pertuze et al., 2010). Moreover, firms are provided with opportunities to be affiliated with different organizations, corporations and university professors and students.

UIC institutes are organizations retaining the framework for higher education qualifications. Those institutes organize cordial structures to officially and privately share

various resources to achieve corporate goals as industrialization entities and to maintain and enhance mutually interdependent relationship (Lee, 2000; Lee and Win, 2004). The need for UIC aims to secure technology innovation sources and cost-time effectiveness by establishing mutual cooperation system and to manage organizations by strengthening problem-solving capabilities of different entities (Lee, 2000; Rappert et al., 1999).

In this model, universities are regarded predominantly as producers and transferors of knowledge and industry as a producer of goods and services, while the role of the government is not only to control and regulate but also to support the cooperation of the first two (Suvinen et al., 2010; Metcalfe, 2010). The core of this model is the linkage of university–industry–government, which provides collaborations from temporary cooperation to strategic alliances. As this model is based on the collaboration of different types of organizations with very different goals and characteristics, it is important to coordinate and communicate between them. So, it may be natural to stress the intermediary or boundary spanning role to overcome the gap between three different organizations (Lee, 2000; Pertuze et al., 2010; Suvinen et al., 2010).

Previous studies have highlighted the role of universities as the cooperators providing technologies and human resources for the open innovation of firms. Many previous studies have underscored the importance of universities' roles as affiliates in UIC to establish a network with major members of business ecosystem, including corporations, public sectors, local government and research institutes. In addition, they also emphasized on the core function of affiliates within technology-related projects for performance enhancement of technology transfer or industrialization (Pertuze et al., 2010; Gertner et al., 2011; Metcalfe, 2010). Informal relationships are more important for successful knowledge transfer than formal one in UIC in the dense areas of small firms, in particular, with relatively low importance of technology development (Gertner et al., 2011; Perkmann and Walsh, 2007). This paper focuses on the intermediary role to strengthen the relationship between the entities of regional innovation economy.

2.3 Social network analysis

Social network analysis was first introduced in the field of social and behavioral science in the 1930s. Although the analysis did not draw attention of many researchers until the late twentieth century, it has been recently applied in various fields of study, including sociology, business management and economics (Stevenson and Jarillo, 2007). Social network analysis mainly uses the graph theory in expressing links among nodes within a network to matrix. Making an index of diverse graph characteristics of nodes and links explains the social network structures (Wassernam and Faust, 1994). The categorization is mainly used in identifying the relationship between network status and social structure by interpreting interactions among nodes, progress of nodes to hubs, distance and intensity among nodes, etc. Data for network analysis require more than one relationship among nodes. The relationship is viewed as interchange, contact or the flow of information among nodes.

For the measurement of relational data, researchers need to decide two factors depending on the content and purpose of studies. First, researchers need to determine if they will measure only the relations among nodes or the degree of relations in numeric numbers. Binary measurement is applied in simply examining the presence of relations. In contrast, relations are measured in valued data to express the degree of relationship in numeric values. Second, the relations can be measured as either directed or undirected data depending on the matter of measuring direction of relationship. Studies in business administration are mainly performed on different fields of study to identify online community, knowledge-based business management, customer marketing and the status of businesses in ecosystems based on social network analysis.

Therefore, this study aims to analyze the changes in social network relationship of participants and consultants before and after implementing UIC programs (Table I).

3. Research methods

3.1 Investigation of the relationship in networks
The UIC Foundation of G University in Korea runs the Clinic Day to diagnose problems and suggest solutions on current managerial issues of regional businesses confronted by many chief executive officers (CEOs) in small firms to facilitate participation in UIC activities and enhance their social relationship.

UIC foundation mainly operates the BCD every once a month regularly. In the BCD, problem-owner presents his/her problem to the consultants. Then, consultants from various fields listen to the problems and define problems through Q&A and generate ideas by proposing suggestions with their experiences in the business. As shown in Figure 1, consultants come from university (professors), industries (CEOs), regional government office (executive) and service sectors (executives), including a bank and technology-funding organization. The whole process is guided by a facilitator from university. Totally, the consultants and facilitator were 15. In each session of the BCD, seven-eight consultants, a facilitator and two-three problem-owners attended to the meeting. A facilitator is a professor who is assigned to the meeting, and the other ones become consultants. Problem-owners attended to the BCD were members of family-corporate of G University. This study includes all types of the participants in the BCD as research subjects (Table II).

We had a survey with 23 problem-owner firms and 15 consultants for the network analysis. The survey process is as follows:

- List all participants of the BCD.
- Find out both the existing and newly formed relationships among participants, including problem-owners, facilitators and consultants after the BCD, and the relationship is only limited to the ties formed because of the BCD.
- Draw the network relationships before and after the BCD into the 2×2 matrix.

Researcher	Contents of major previous studies	Differences with our study
Huizingh and Lee (2010)	This study investigated on facts that technology development along with external organizations is more essential in SMEs with limited resources and workforce, and SMEs demand to utilize knowledge from outer sources than large firms	Studies on measures to be provided with knowledge from external sources are insufficiently performed
Moore (1993, 1997)	From ecosystem perspective, desirable actions of firms are to participate in new competition based on the business ecosystem, to act strategically in accordance with the evolutionary stages established, to innovate and co-evolve cooperatively and competitively for satisfying customers' needs and creating new products	Approach from the early perspective of business ecosystem
Peltoniemi (2006)	The entities in the business ecosystem are interconnected to affect each other so that they share the role of ecosystem by competition, collaboration and interdependence. The failure of an entity in the ecosystem can lead to the failure of other objects because each object is dependent upon each other	Studies on the causes of success or failure in implementing network types are insufficiently performed

Table I.
Analysis of previous studies
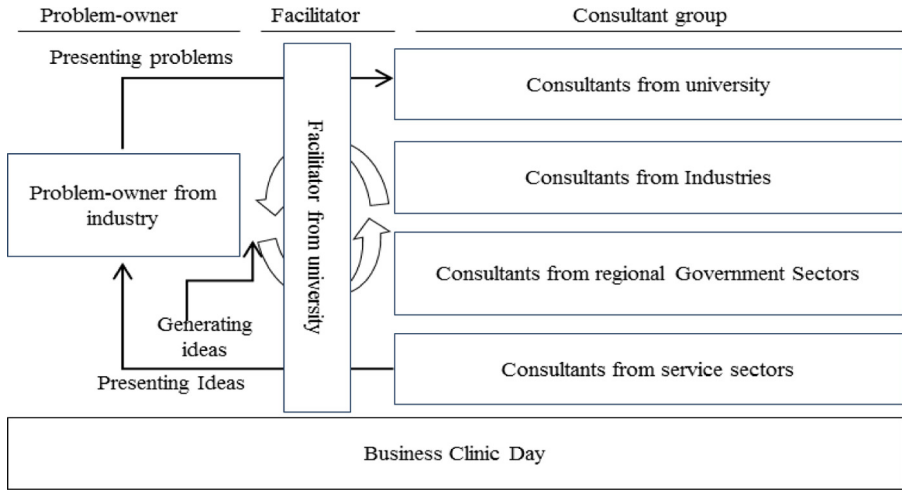
Figure 1.
Operation model of
BCD

Categories	No.	Business experience	Specialty
University (professor)			
Trade	1	N/A	Trade
IT	1		IT
Technology Management	1		Business management
Industries (CEO)			
IT	2	1.5/9.5	IT
			Social commerce
Manufacturing	5	2 ∼ 44	Transport machinery
			Power-generating equipment
			Medical equipment
Food industry	1	2.5	Food distribution
Civil engineering industry	1		Civil engineering
Public sectors (executive)			
Supporting SMEs	1	N/A	Investment
Service sectors (executive)			
Bank	1	N/A	Funding
Technology funding	1	N/A	Technology evaluation
Total	15	Ave. 13.9	

Table II.
Overview of
consultants of the
BCD

3.2 Network analysis

Centrality, density and centralization are the basic notions in identifying network structure used in social network analysis (Bonacich, 1987). Each social network indicator implies its unique meaning. Density indicates the degree of connection among network nodes, representing social cohesion among people. Exchange and spread of information is accelerated in network with high density. Centrality and centralization are indicators of power and authority. Core-periphery signifies social classes, while reciprocity suggests friendliness among people (Scott, 1991). Table III shows major variables necessary in social network analysis used in previous studies.

Among many social network indicators, identifying the centrality of businesses aligns with the purpose of the study, which aims to clarify the role and significance of firms within digital ecosystem. Centrality is an indicator representing the degree of closeness of performer to the center of the network and is classified into degree centrality, closeness centrality and betweenness centrality.

3.2.1 Degree centrality. Degree centrality represents the degree of direct connection of a node to other nodes within a network (Wasserman and Faust, 1994). The degree of closeness to the network center has been numericalized using the number of ties of a performer with other performers, and this index is the total number of directly linked ties of a performer with other performers. A high figure implies that a performer is playing a pivotal role within a network. The degree centrality is calculated using the following equation:

$$Ci = \sum_{i=1}^{n} (z_{ij} + z_{ji})$$

where z_{ij} means the relationship from i performer to j performer in K network. Degree centrality is estimated by the ratio of inward degree and outward degree of each performer in the entire connection.

3.2.2 Closeness centrality. Closeness centrality is a method characterized by measuring the centrality by adding either directly or indirectly connected distances to all performers within a network based on the distance of each node.

As shown in the equation below, closeness centrality is calculated by inverting the total distance of shortest paths connecting two performers. High closeness centrality could be regarded as a notion resembling the high efficiency of information delivery. Therefore, a performer plays a pivotal role as the degree and closeness centrality increase. Furthermore, the performer could more easily secure and access to information power, influential power and social status within a network:

$$C_i = \left(\sum_{i=1}^{n} d_{ij} \right)^{-1}$$

If d_{ij} is the shortest distance between i and j, closeness centrality is estimated inverse value of the total distance of all possible connected points.

3.2.3 Betweenness centrality. Betweenness centrality represents the mediated links to other nodes and is evaluated by the level of involvement of a performer responsible for mediation within a network. When a performer is strategically positioned on the communication path of two performers, the performer symbolizes the power of influence in conveying information. Nodes with high betweenness centrality perform the role of

Variables	Definition
Degree	The number of connections directly linked to other performers
Closeness	Indicates the degree of closeness and accessibility of a performer to other performers within a network and generally measures the average path distance to other performers
Betweenness	Indicates the included extent of a performer to the shortest path of two performers and generally uses the average of all possible pair within a network

Source: Scott (1991)

mediators significantly affecting the network flow (Brandes, 2001). The betweenness centrality is assessed using the following equation:

$$C_B(i) = \frac{\sum_{j<k} g_{jk}(i)}{g_{ik}}$$

where g_{ij} is the number of cases having the shortest distance in the path between two certain points (i and j) within a network and $g_{ik}^{(i)}$ is the number of passages via i present between $ik(j \neq k)$.

4. Research result
4.1 Pre-test on network relationship
Figure 2 shows diagrams after surveying newly created business relationship between problem-owners and consultants by comparing with the existing relationships before the BCD. Based on this figure, we could intuitively identify that the BCD has created new relationships between problem-owners and consultants. Subsequently, we conducted a survey for network relationships formed among them and then analyzed the social network.

This study used network centrality to explain the structures and characteristics of social network. Degree centrality, closeness centrality and betweenness centrality are measured. These indicators are used in explaining the network structures of business ecosystem:

- *Degree centrality*: It is the number of connections directed linked to other performers.
- *Closeness centrality*: It is directly and indirectly linked distances.
- *Betweenness centrality*: It is the position of a performer two performers.

Figure 2.
Diagram of relationships between participants in the BCD of G university

The above indicators are used in presenting the degree of closeness of a performer to the network center. When the information is expressed as a network structure model, structure and position could be easily identified. An organization high in all three centralities is presented as a hub organization. The hub organization takes a pivotal role in interaction as a member with relatively high linkage to information than other members and continuous expansion and maintenance of other relationships within a network. In addition, it belongs to a platform company within business ecosystem network. "Structural niche", also called broker organization, is the affiliated location where the tie could be formed only through the specified performer without overlapping relationships with other performers. The broker organization exists in the substructure of business ecosystem network and constructs the whole network structure.

4.2 Network analysis

The study used Netminer software for social network analysis. Figure 3 shows the network structures. The figure implies that the network relationship has become diversified and elaborated after operating the BCD program.

The study analyzed different kinds of network indicators (degree centrality, closeness centrality, betweenness centrality, etc.) of participating firms and consultants before and after operating the BCD program. Significance probabilities were 0.01 in degree centrality and 0.05 in closeness centrality, showing a statistically significant difference. However, no significant results were shown in betweenness centrality. As shown in Table III, the overall indices in degree centrality and closeness centrality were higher after implementing the Clinic Day program. As statistical evidence of Figure 3, substantial social network relationships were created and participating firms and consultants became closer in their relationship (Table IV).

Professor-centered network relationships were formed, especially with professors in G University. Diverse networks were constructed with participating businesses based on consultants.

4.3 Interview with problem-owners and consultants

Interviews were performed mainly on firms with considerable changes in network indices. The relationships identified from interviews include additional requests for advices from
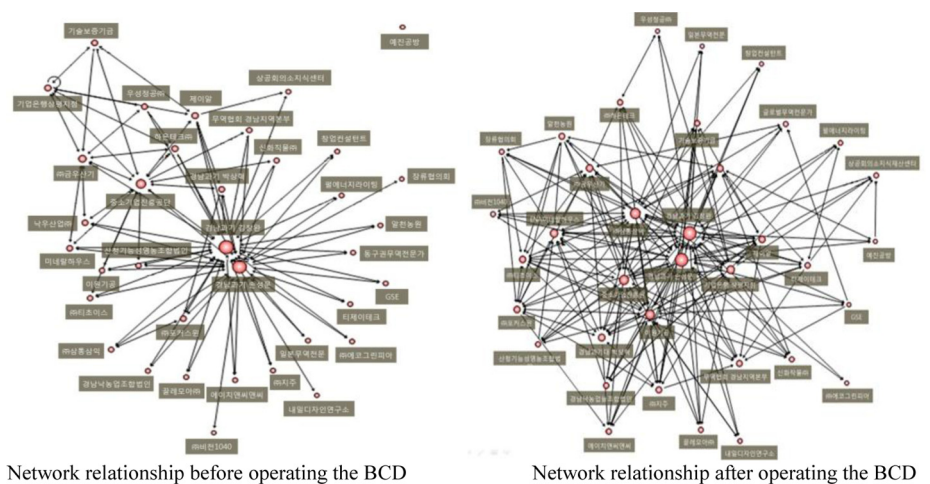

Network relationship before operating the BCD   Network relationship after operating the BCD

Figure 3.
Changes in network
structures after
operating the BCD

consultants, discussion for business collaboration between problem-owners and consultants and the diffusion of collaboration to the other firms that did not participate in the BCD (Table VI).

The relationships among problem-owners and consultants could be classified into four types. Type 1 is the relationship between consultants and problem-owner, and Type 2 is formed between consultants and the other parties connected to the problem-owners. Type 3 describes the relationship between problem-owners and the other parties connected to consultants, and Type 4 is formed among the other parties connected to problem-owner and consultants (Tables V and VI).

5. Conclusion

Network building among various entities is a prerequisite in the business ecosystem, which co-evolves with interchanging, exchanging and combining technologies, knowledge, experience, resources, capacity, innovative ideas, etc. within the business realizing space (Moore, 1997). Being a part of business ecosystem and forming relations with diverse regional agents are very hard but important for SMEs with limited resources and networks.

As the importance of business ecosystem has been highlighted, regional SMEs have been struggling to go in the business ecosystem through open innovation to overcome the shortage of specialized workforce and budget. UIC provides one of the effective alternatives for SMEs to enter the regional business ecosystem. Universities have roles to create new UIC models and to connect various regional players to business ecosystem.

Although the BCD was originally designed for solving problems of regional SMEs, we found that it not only solved the inherent problems of the company but also strengthened the network ties of SMEs with various entities in the business ecosystem. This study examines various network relationships formed after the BCD among consultants and problem-owners. Networks were being built mostly based on G University's professors who mainly led the program. We were able to confirm that Network type 1 (the relationship between the problem-owner and the consultant) was additionally formed. Moreover, we observe Network types 2 and 3, where new relationships were formed among organizations previously tied with consultants and problem-owners. These results suggest that the networks of business ecosystem have been newly formed through the BCD.

Although various UIC programs have been implemented, they are still not sufficient to strengthen business ecosystem in public sectors and universities for the innovation of regional SMEs. As mentioned above, as key success factors, promoting the network among the business entities is very crucial for successful implementation of innovative programs.

	Before clinic day ($N = 40$)		After clinic day ($N = 40$)				
Network index	Mean	SD	Mean	SD	Mean difference	t-value	Significance probability
Degree centrality	0.112	0.161	0.241	0.209	0.128	3.066	0.003***
Closeness centrality	0.402	0.171	0.487	0.188	0.084	2.108	0.038**
Betweenness centrality	0.018	0.068	0.014	0.043	0.003	0.313	0.755

Notes: ***$p < 0.01$; **$p < 0.05$

Table IV.
Analysis on network indices before and after implementing the BCD

Types of networking	Cases
1. Relationship between consultants and participating firms	*[Helping to start a new business]* A IT firm named H (problem-owner) started a new business after collaborating with consultants from industry (a CEO of IT firm) and university (A professor). They helped H firm to review the business plan *[Guiding a new marketing channel]* A CEO of a garlic adhesives manufacturing firm who attended to the ABC as a problem-owner is collaborating with one of consultants from an industry for B2B business *[Promoting on-line marketing]* A Food company B has developed its own social commerce with collaboration of a social commerce company T, which participated as a consultant in the BCD *[Participating the students for the marketing ideas]* University professor P who is a consultant let the social commerce firm T to come and present his problem in the class and to collaborate with students for marketing ideas during a semester
2. Relationship between consultants and the other parties tied to the problem-owners	A Food company B introduced social commerce firm T to the other partied in the Association of Traditional Sauces in Sancheong, Korea. The T firm has extended its business to other parties with help of a B company for co-marketing with them now
3. Relationship between problem-owners and the other parties connected to consultants	Professor K, a consultant in the BCD introduced Intellectual Property Rights Center in the Chamber of Commerce and Industry to the firms, problem-owners and IPR center helped them to secure intellectual property rights
4. Relationship among the other parties connected to problem-owner and consultants	N/A

Table V.
Interview survey on the changes in social network relationship

Table VI.
Classification of the types of network relationships after the business clinic day

The parties connected to the problem-owners	Type 2	Type 4
Problem-owners	Type1	Type 3
	Consultants	The parties connected to the consultants

Network analysis could be regarded as a valid method proficiently describing and identifying relational characteristics among firms within regional business ecosystem with nodes and links. The results of this study are anticipated to be utilized in the following areas:

- Evaluating the effectiveness UIC through comparative studies on network types among various business units.
- Utilizing experts as consultants and mediators to broaden SMEs' network; suggesting new ways for consulting by utilizing easily accessible human resources from regional universities, industries, public sectors, and others.
- Enhancing the role of university as fundamental agent in establishing business ecosystem; academia and industry leading innovation are anticipated to provide different alternatives that will promote UIC in regional small firms with relatively insufficient resources.

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