

## Local R&D Networking of SMEs in the Shihwa Industrial Complex

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**Abstract** : Knowledge spillover among firms is a crucial ingredient in realizing the benefits of agglomeration. This paper provides an overview and critical assessment of the Shihwa Industrial Complex (SIC) in Korea. In order to identify the relationships and interplay among different agents in the area, a survey was conducted on business networking of industry-academia-government collaboration in research and development. Unlike the closely knit input-output relationship, the findings suggest that the technological linkages in the SIC still have room for improvement. As the role of small and medium enterprises as catalysts of regional economic development in Korea is expected to grow in importance, more effort should be made to nurture clustering and R&D networking among them.

**Keywords** : Shihwa Industrial Complex, Small and Medium Enterprises, R&D Networking

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### 1. Introduction

This paper presents the preliminary results of a survey on small and medium enterprises (SMEs) based in the Shihwa Industrial Complex (SIC) in Korea. The SIC epitomizes the country's effort to boost industrial competitiveness through clustering, and it has been quite successful in achieving this outcome. The string of industrial complexes in the SIC has become one of Korea's premier incubators of manufacturing firms. Located on the west coast of the capital area, the SIC has been a preferred destination for companies seeking a favorable business environment.

In order to identify the relationships and interplay among different agents in the area, a survey was conducted on business networking and development of industry-academia-government collaboration in the SIC. The main objective of this survey is to obtain information about what kind of business relationship has been built with respect to other branches of the company and business partners in the SIC or other regions in the areas of input procurement, output delivery, information exchange and R&D collaborations. In section 2, the role of R&D and clusters in the development of SMEs is discussed. In section 3, the development process of the SIC is described. Section 4 explains

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the survey methodology, the results of which are summarized in section 5. Section 6 concludes.

## 2. SMEs, R&D and clusters

Nooteboom (1993) argues that the success of SMEs hinges upon their ability to utilize external networks more efficiently, which allows them to overcome inherent barriers to growth because of limited resources. Likewise, Audretsch and Vivarelli (1996) find considerable evidence suggesting that SMEs tend to have a higher R&D productivity, largely due to their ability to innovate by exploiting knowledge created outside the firm.

The benefits of smallness such as greater flexibility and rapid response compensate for some of the disadvantages of size, and may allow SMEs to maintain a high rate of technological change. The tacit nature of innovation and the risks associated with loss of technological competitiveness, however, encourage a high level of in-house R&D activity.

R&D outsourcing is only undertaken when it does not threaten the competitive advantages of the firm. Narula (2004) acknowledges the limitations of collaboration as an alternative to in-house R&D. Firms tend to outsource R&D to public research institutes and universities because of the fear of giving away their technology to competitors.

Meanwhile, the activities of SMEs tend to be spatially concentrated in certain locations. Gordon and McCann (2000) build a taxonomy of agglomeration and industrial clusters according to the nature of the relations between the firms. In

*pure agglomeration*, firms are atomistic, and there is no loyalty between the fragmented firms. The *industrial complex* is characterized by long-term, stable and predictable relations between the firms, where proximity is required to minimize the interfirm transactions costs of overcoming distance such as transportation and communication costs. Here, tacit knowledge spillover is not a major feature. In the *social network*, mutual trust and loyalty relations exist between firms. Iammarino and McCann (2006) extend this typology to innovation and clusters evolving into the next phase. In this context, it is of interest to investigate and identify the current phase of the SIC as well as its potential for further development.

## 3. Shihwa industrial complex

Korea's regional development policy has involved strict regulation of metropolitan growth through construction of planned industrial sites. Along with restrictions on new construction and expansion of existing plants in the capital region, Kim and Gallent (1998) emphasize that industrial parks were the main vehicle for carrying forward the decentralization policy.

Another concern was increasing environmental hazard. In the 1960's, the Korean economy grew rapidly in the fields of light industry with the aid of foreign capital and technology. However, from the 1970s, it became difficult to maintain this growth and competitiveness without proper management of pollution. In response to such challenges, the government began developing complexes for polluting industries in the Siheung and Ansan areas

near Seoul. Threats from North Korea also added a sense of urgency, and some plants were even ordered to move out of Seoul.

Under the central government's plan, the Shihwa National Industrial Complex was established in 1986 and completed in 2004. The total land size of this complex is 16,568,000m<sup>2</sup>, which is divided into production (10,942,000m<sup>2</sup>), support facilities (1,324,000m<sup>2</sup>), public facilities (3,487,000m<sup>2</sup>), and green areas (815,000m<sup>2</sup>), as shown in Figure 1. Nearly half of this site is composed of industries specializing in machinery, electronics and steel products. Currently there are approximately 5,100 firms employing about 86,000 workers (see Table 1).

With the older neighboring park of Banwol, the SIC has benefited from its proximity to seaports, airports and the capital city of Seoul, as well as the relative ease of attracting a well-educated workforce. Companies gravitated to the complex to take advantage of the good quality labor, ample supply of intermediate goods, favorable funding and various incentive programs. In addition, cheap

land, tax exemptions and loan guarantees induced firms to the area. As a result, the SIC is now in a very unique position of having highly diverse and innovative SME start-ups while being dependent on Seoul for the supply of producer services. Nonetheless, industries there are still mostly labor-intensive, and rising land prices on top of the pollution problem are hindering its sustained growth.

To make matters worse, firms face threats from Chinese competitors and the government's balanced growth policy forcing the relocation of factories outside the capital region. Foreign firms in cutting-edge fields are usually granted locations in the areas surrounding the capital. However, for domestic firms, permission is given only in a very reluctant and selective manner. Some argue that this leads to an exodus of manufacturing firms to China rather than to operate in locations outside of Seoul.

Table 1. Sectoral distribution of firms in SIC (as of September 2008)

Industry	No. of Firms	Share	No. of Employees	Share
Food	42	0.8	1,317	1.5
Textile	106	2.1	3,582	4.2
Wood & Paper	169	3.3	3,648	4.2
Petrochemical	463	9.0	12,595	14.7
Non-metal	28	0.6	4,205	4.9
Steel & Machinery	3,008	58.6	37,825	44.0
Electric & Electronics	595	11.6	11,824	13.8
Transportation	325	6.3	8,590	10.0
Other Manufacturing	127	2.5	2,092	2.4
Non-manufacturing	267	5.2	287	0.3
Total	5,130	100.0	85,965	100.0

Source: KICOX (Korea Industrial Complex Corp.)

## 4. Survey methodology

Cooperation with various business partners enhances the R&D capability of SMEs, especially when the partners are located in close proximity, as it fosters frequent contact and communication. Spontaneous face-to-face contact facilitates transfer of tacit, intangible and complicated information.

Unfortunately, it is often argued that the SIC has not developed into a fully fledged innovative cluster because of the lack of cultural and social amenities, easy access to financial and commercial centers, diversified producer services, and efficient market mechanisms that stimulate active long-term collaboration. Jung (2006) suspects that proper consideration for innovation and network formation was lacking from the very start. There also has been criticism that the SIC has seen only a few networks created among its constituents. To address and further investigate these concerns, a postal survey was conducted on small firms in the SIC.

In addition to the nature of their business and major products, the following attributes were solicited: the degree of own R&D efforts, collaboration with other firms in terms of procurement and sales, information exchange, number of business partners in the SIC, the capital region, the rest of Korea and overseas. In designing the questionnaire, a high level of detail was sacrificed for the sake of a simple and inviting appearance. Anonymity was assured by including an unmarked postage-paid reply form. The questionnaires were dispatched in March of 2008. Within the following four weeks, 109 out of 1,000 envelopes were returned unopened because the

addressees had moved with no forwarding address.<sup>1)</sup>

Eventually, 59 usable responses were received from the pool of 891 eligible firms, showing an effective response rate of 6.6%. This rather low rate is understandable, given that firms are generally reluctant to share their sensitive business information. On average, the respondents had been in business for 14.9 years and generate 10.3 billion won in annual sales revenue. All of the questionnaires were filled out by individuals who are knowledgeable about the company's affairs and able to make important managerial decisions.

## 5. Major findings

### 1) General characteristics

The findings shed light on the current state of the manufacturers in the SIC and, more importantly, their relationships with other firms and agencies at different stages of production. The results are expected to reveal the effects of local networking on the productivity of firms. Hopefully, they would confirm the notion that face-to-face communication is still a major driving force for innovation in manufacturing, and that agglomeration is good, not only for reducing material production costs but also for the active exchange of new ideas on product design and marketing through formal and informal relationships.

Given the relatively small sample size, we could only gain a limited statistical overview of the sample. As shown in Table 2, firms specializing in

Table 2. Sectoral distribution of respondents

Industry	No. of Firms	Share
Chemical	7	10.4
Metal	11	16.4
Steel	3	4.5
General Machinery	11	16.4
Precision Machinery	10	14.9
Electric Machinery	4	6.0
IT Machinery	2	3.0
Semiconductor	3	4.5
Autoparts	10	14.9
Ceramic	3	4.5
Designing	3	4.5
Total	67	100.0

Note: Firms were allowed to identify themselves with more than one sector.

various machinery and metal products form the majority of the sample, suggesting that the complex has retained its original constituents and that newcomers who are similar to existing firms are lured to the existing facilities. When compared with Table 1, the food, textiles and wood and paper sectors are missing from our sample, but the general picture remains more or less the same.

Table 3 chronicles the changes in vital statistics of the firms after 2000. The number of employees, sales revenue, R&D personnel and R&D expenditure all show steady growth. It is noteworthy that they do seem to be investing more in research and development by mobilizing more personnel and resources, while relying less on external funds. This would potentially generate synergy effects when combined with such outcomes from the other firms. It may also bring about cost reductions by helping to avoid redundant investment in projects of a similar nature.

Table 3: Characteristics of respondents

Year	2001	2004	2007
Employees	26.7	30.9	35.3
Sales (Million Won)	5,970	7,976	10,318
Patents	15.9	14.3	12.2
R&D Personnel	2.7	3.5	4.9
R&D Expenditure (% of Sales)	4.05	4.83	7.44
External Fund (% of Sales)	2.52	7.29	3.94

## 2) Products and R&D linkages

The respondents have many business partners through their input-output linkages. Table 4 shows that a large portion of orders comes from firms in different industries located outside of the SIC. An even stronger relationship exists with their suppliers in the complex. However, information exchanges (at least once in three months) are not common, and firms seem to depend more on partners outside the complex.

This is clearly not a good sign because firms need to exchange information and turn it into knowledge in order to survive. In the seminal work by Marshall (1890), a specialized labor pool is deemed to create something in the air to be shared by others. This concept of a spatial knowledge externality was later refined by Porter (1990) in the context of industrial clusters. Although the new economic geographical approach à la Fujita et al. (1999) tends to focus only on pecuniary externalities, creation and transfer of knowledge are essential to the resolution of difficulties associated with design, manufacture, installation and operation of equipment.

Lim (2005) points out that the vertical relationships that many suppliers in the SIC

Table 4. Linkages in goods and information (Total number of partners)

Activity		Order Entry				Order Placement				Information Exchange <sup>3)</sup>			
		SIC	Capital	Korea	Overseas	SIC	Capital	Korea	Overseas	SIC	Capital	Korea	Overseas
Group Business <sup>1)</sup>	Same Industry	9	7	5	4	5	7	6	4	5	7	6	6
	Different Industry	0	4	8	0	3	4	7	0	0	4	1	0
	Research Laboratories	1	3	0	1	0	3	0	1	1	6	0	1
Outside of Group	Same Industry	45	45	28	33	92	60	29	32	23	31	20	11
	Different Industry	73	655	564	58	202	304	399	16	11	23	15	23
Universities		3	19	5	0	0	3	0	1	7	15	3	3
Research Institutes		2	7	0	0	1	5	0	0	2	9	1	0
Industry Organizations <sup>2)</sup>		6	11	5	1	3	7	1	0	11	17	5	0
Nonprofit Organizations		1	1	0	0	1	1	0	0	1	6	0	0
Total		140	752	615	97	307	394	442	54	61	118	51	44

1) Group businesses are a parent company and an affiliate company which have a capital alliance, or a company which used to have a branch when the company was established.

2) Industry support organizations are trade associations, government institutes, industry groups, cross-industrial associations, SME support institutes, and incubation centers.

3) Information exchange refers to activities to obtain information for promoting technology development and product development and also to utilize opportunities for human resource development to obtain such information.

maintain with respect to large external companies are putting those firms in a position to accept unfair treatment with no room for investment for innovation. Because of a high degree of dependence on their customers, they are more accustomed to maintaining security of information than its exchange, and competition rather than cooperation vis-à-vis other firms in the area.

Table 5 displays the numbers and locations of partners involved in R&D activities for both in-house and collaborative projects. Firms are apparently not very interested in maintaining

relationships with other entities, and the level of cooperation is still lower in the SIC than outside. Why, then, do they stay away from universities and support agencies rather than reaching out for help?

As Sohn and Kenney (2007) point out, the traditional role of Korean universities has been supplying well-educated graduates to industry, rather than transferring their research results. Traditionally, neither the university nor the professors had incentives for developing industrial linkages. It is only recently that there have been incentives for collaboration at an institutional level

Table 5. Project participation (Total number of partners)

Activity		In-house Projects <sup>1)</sup>				Collaborative Projects (Management) <sup>2)</sup>				Collaborative Projects (Participation) <sup>3)</sup>			
Location		SIC	Capital	Korea	Overseas	SIC	Capital	Korea	Overseas	SIC	Capital	Korea	Overseas
Group Business <sup>1)</sup>	Same Industry	2	3	1	2	2	2	2	0	2	3	0	1
	Different Industry	1	3	1	0	1	2	0	0	1	2	0	0
	Research Laboratories	2	2	0	0	1	1	0	1	1	1	0	1
Outside of Group	Same Industry	5	7	3	5	5	11	2	0	4	0	2	1
	Different Industry	2	24	12	1	9	7	1	1	3	4	1	0
Universities		1	9	1	0	1	7	1	0	2	3	0	0
Research Institutes		2	5	2	0	3	8	0	0	1	2	0	0
Industry Organizations <sup>2)</sup>		2	3	1	0	0	4	0	0	3	2	1	0
Nonprofit Organizations		1	1	0	0	1	1	0	0	2	1	0	0
Total		18	57	21	8	23	43	6	2	19	18	4	3

- 1) In-house projects are research projects funded and conducted by a company to do a research and investigate the needs for commercialization of products.
- 2) Collaborative projects (management) are those conducted within the framework of collaboration such as industry-academia collaboration at the expense of the respondent including outside fund.
- 3) Collaborative projects (participation) means participation in a collaborative project conducted in the framework of collaboration at the expense of other companies or organizations.

through technology licensing.

In addition, Hassink (2001) is critical about the dirigiste regional innovation system of Korea with little regional embeddedness. A rigid and vertical structure of support agencies hampers provision of tailored support for specific regional demand. As a result, intraregional coordination among agencies and local firms remains at a rather low level.

It is worth noting that the localization economy was found not to be very influential for the respondents, although the externalities of informal

technology transfer are generally regarded as very important factors for firms locating together. In other words, the spatial agglomeration of small manufacturing firms in the SIC is mainly the outcome of individual decision making with regard to material linkages with their customers and vendors.

### 3) Problems and concerns in the SIC

According to Zhan (2005), as of 2004, the labor

costs of the SIC were 10 times higher than those in Qingdao Industrial Park in China's Shandong Province, while land prices were nearly 40 times more expensive. The corporate tax rate and utility costs were also about twice as high as those in China. There have been considerable efforts to maintain the competitiveness of the SIC by transforming the traditional industrial park into a center of innovation. Still, those measures were not a large enough incentive for those firms attracted to China. In this regard, Park (2004) lists five problems with the SIC: (1) visions and strategies

for specialization are lacking; (2) resources for innovation such as universities and research institutes are missing; (3) support facilities and their services are inadequate; (4) rent hikes hamper entry of new knowledge-based industries; (5) the complex is simply too big to be considered as a cluster.

Labor mismatch seems to be an especially thorny problem. Han (2005) surveys 189 firms in the park to find that the majority were suffering from a shortage of production workers because of the applicants' high wage expectations and

Table 6. Voices of respondents

Aspect	Opinions
Material	Raw materials are in short supply. Raw materials are getting too expensive. Parts prices are skyrocketing.
Labor	Experienced workers and qualified R&D personnel are hard to find. Good workers avoid small firms. Shortage of production workers and increasing wages pose a threat.
Land	Factories are too expensive to purchase. Real estate speculation is causing rent increases. Land price hikes are driving many factories away.
Technology	Technology for stain prevention and heat treatment etc. are missing. Rental fees for test equipment and clean rooms are too high. Odor-management technology is not provided.
Knowledge	Collaboration with large plants is desired. Price information for some products is difficult to obtain. Marketing information does not flow very well.
Support	Investment tax credits would be nice. More government support is needed for vertical integration of firms. Environmental regulations are too strict.
Environment	The ground vibrates when nearby shops operate presses. Water shortage can become serious in summertime. Pollution is threatening workers' health.
Infrastructure	Dormitories for workers are needed. More street lights should be installed. Public transportation and snow removal service need improvement.

Note: Actual opinions of the respondents are grouped according to their relevant attribute.



discrepancies in education levels of workers and that desired by employers, not to mention a high turnover rate. Jung (2006) also points out a chronic labor shortage problem due to low wages, poor working conditions and workers' preference for big firms, which led to the creation of a large pool of foreign workers. Seok (1998) surveys 420 foreign workers-mostly from China and Southeast Asia-in the SIC, and concludes that work environment and relationships with co-workers and superiors exerted more influence on their job commitment and the degree of satisfaction thereof than the remuneration.

In our survey, firms were asked to express their views on what they think the SIC is failing to offer in various aspects pertaining to the production processes; their opinions, some serious and some less so, are listed in Table 6. To follow up on the survey, interviews with five firms were conducted in August 2009. They confirm that the opinions noted in Table 6 are indeed shared by many firms in the complex. Most interesting was a company producing plastic containers. Despite its long history and employment of over 150 workers, it does not have any linkages whatsoever with other firms in the SIC, doubting the potential effectiveness of the network.

## 6. Conclusion

Since the early 1980's, balanced growth has been the central goal for Korea's regional development policy. While the province surrounding Seoul is still the most preferred location, firms have difficulty in opening and expanding plants because

of prohibitive taxes or outright bans on industrial land development.

We have considered the development and current status of a representative industrial complex in the capital area. In order to survive in a knowledge-based society, a regional innovation system based on a closely knit network of firms with universities, research institutes and governments must be created. Unfortunately, the findings in this study seem to support general perceptions of technological interfirm linkages that exist in the Korean manufacturing industry today, namely, that they do not communicate with one another very much.

The survey results summarized and discussed in this paper should not be read as definitive statements of what the firms are doing or will do in the future. Some sort of nonresponse biases and selection effects are bound to exist in this type of postal survey, calculating the exact magnitudes of which is beyond the scope of this report. More analyses are needed to gauge a true picture of interfirm relationships in the SIC. For instance, detailed information on sales revenue would better capture the strength of business linkages than the number of partners.

At the present moment, many firms in Korea are experiencing difficulties due to the global economic crisis. Rather than being a brief interlude, this crisis may prove to be a significant shakeout involving substantial disinvestment. Nonetheless, the role of small firms as catalysts of regional economic development in Korea is expected to grow in importance, and more efforts should be made to nurture their clustering and R&D networking.

Note

- 1) The survey was administered under the auspices and financial support of the International Centre for the Study of East Asian Development, Kitakyushu, Japan.

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Figure 1. A Map of Shihwa Industrial Complex

Source: KICOX

연구노트

## 시화산업단지내 중소기업의 R&D 네트워크 형성

김호연\*

**요약:** 지리적으로 인접한 기업간의 지식 파급효과는 집적의 이익을 실현함에 있어 매우 중요한 요소이다. 본 연구에서는 시화산업단지내 소재한 중소기업 제조업체를 대상으로, 연구개발 단계에서 관청, 대학, 연구기관 및 타 업체들과 어느 정도의 협력이 이루어지고 있는지 파악하기 위해 설문조사를 통하여 그 실태를 조사해보았다. 분석 결과, 긴밀하고도 다변화된 납품관계와는 달리, 지식 공유를 목적으로 연결된 파트너의 수와 종류, 그리고 네트워크의 형성은 의외로 미미한 것으로 나타났다. 지역경제 발전에 있어 중소기업의 역할이 더욱 강조되는 시점에, 혁신 클러스터의 조성과 발전을 위한 기업과 정부 차원의 지속적인 노력이 요구된다.

**주요어:** 시화산업단지, 중소기업, R&D 네트워크

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