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Science Parks: Problems and Strategies*

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1. Introduction

Even though the history of science parks can be traced back to the 1950s, only since the early 1980s science parks have become prominent features in national and regional development strategies in the developed countries such as U.S.A., western Europe, Japan, and Australia. More than three quarters of existing science parks in U.S.A. and the U.K. have been established during the last decade (Carter, 1989; Luger and Goldstein, 1990; Park and Lim, 1992). Accordingly, the number of newly constructed parks in the developed countries culminated in the 1980s. Even in the newly industrializing countries have been much interested in the construction of science parks since the mid 1980s in order to nurture high technology industries.

The science parks, also refered to as research parks, technology parks, and technopolises are generally intended to serve as seedbeds with a concentration of innovative and technology intensive firms (Luger and Goldstein, 1990). Underlying rationales for a global frenzy of science park construction in the 1980s in the developed countries for the purpose of inducing regional economic development were mainly based on the notion that innovation in the information technology sector is science based, and the new firm creation can be incubated by an appropriate mix of regional innovation factors (Gordon, 1991). Therefore, the science park development was, in general, derived from deliberate policy initiatives. Key purposes of the science park development in the developed countries are formation of new start-up high tech firms, job creation, and facilitation of R & D links and technology transfer. These key purposes are clearly shown in the definition of science parks by the U.K. Science Park Association (UKSPA). According to the UKSPA, a science park is a property-based initiative which:

(1) has formal operational links with a university or other higher educational or research institutions;

(2) is designed to encourage the formation and growth of knowledge-based businesses and other organizations normally resident on site; and

(3) has a management function which is actively engaged in the transfer of technology and business skills to the organization on site (Worral, 1990).

Even though the establishment of science parks has good underlying rationales and purposes, many

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problems and difficulties in the development of science parks have appeared in recent years in the developed countries. Based on the analysis of U.K. science parks, Massey et al. criticized that science parks are founded on a notion of scientific production and industrial innovation which is, intrinsically, socially divisive as well as technically inappropriate (Massey, Quintas, and Wield, 1992). Accordingly, in promoting the science park development policy, developing countries need to consider the problems and difficulties with which the developed countries had experienced in the development of science park.

In Korea, a structural transformation of industry by fostering technology intensive industries has been one of the major national tasks because of the rapid increase of real wages of production workers and the growing competition from the NICs in labor intensive products. Another critical issue in Korea, in recent years, is a balanced regional development. Despite the government's efforts to lesson regional disparities and to encourage industrial dispersal, the disparities have persisted. Especially, the continuous concentration of high technology industries in the Capital Region during the 1980s caused an overall concentration of the total manufacturing in the Capital Region (Park, 1991a).

In order to achieve these two national goals, Korean national government, bearing in mind the effect of serving double purposes, initiated the construction of Taeduk Science Park twenty years ago and set up another plan for science park construction in Kwangju in recent years. Furthermore, many provincial governments have been ardent in fostering high technology industries set up development plans for high-tech centers in recent years. Taeduk Science Park has attracted many national research institutions and R & D centers of private firms. Accordingly, Taeduk Science Park has generated considerable high-tech related employment opportunities. There exist, however, a lot of difficulties and problems for Taeduk Science Park in the light of the promotion of the two national goals, a high tech industrial development and a balanced regional development. In addition, there are many difficulties and problems in the construction of science parks in the provincial areas.

The purposes of this study are to examine major problems of science parks and to discuss major strategies of science park development in Korea with consideration of the two national goals. Organizational and regional logics of innovation with relation to the science park development are examined in the second section following this introductory section. Major problems of the science park experienced in developed countries and in Korea are examined in the third section. Finally, strategies of science park development in Korea are discussed in the last section of this paper.

2. Industrial Organization, Region, and Innovation

In the early orthodox innovation theory, spatial dimension of technological change tended to be eliminated since innovation was regarded as a random process and indifferent to the specification of place (Gordon, 1991). However, technological paradigm, which has evolved during the last three decades, has granted a significant role in technological change to regional factor as well as to organizational factor. Many researchers in recent years have confirmed that a new technological paradigm emerged in the 1960s and began to penetrate most industries and services in the 1970s (Freeman, 1987). The new paradigm can be identified as that of "information technology" which is based on a combination of micro-electronics and telecommunications.

Recent empirical researches, on the one hand, reveal that innovation is strongly affected by territorial environment (Perrin, 1991). Specific locational attributes such as research institutions, scientific and technical manpower, venture capital operations, 'quality of life' amenities, etc. are regarded as important factors for regional innovation potential. On the other hand, recent advocates of spatial reconcentration assert that location is a product of industrial organization rather than spatial attributes (Gordon, 1991). That is, it is asserted that vertical disintegration of industry promotes spatial agglomeration with the reduction of transaction costs (Scott, 1988). Vertical integration can also be considered as a necessary response to high levels of market uncertainty and barriers to contractional agreement.

Even though the two views above contributed to understanding the high-tech industrial location under the information technology paradigm, they are both one-sided. Innovation is a collective process of organization and space. Industrial organization and region are, together, significant dimensions of innovation. It is suggested that regional factors and organization act not only as a complement to firms and market factors but also, they may, play as a part of a strong relationship with them, a fundamental role in innovation process (Perrin, 1991). The interrelationship between industrial organization and regional characteristics are also regarded as significant in understanding the high-tech industrial location and spatial linkages (Park, 1991a; Miller and Cote, 1987).

Network is also important for innovation in the contemporary industrial society. Without networking regions and organizations, the role of a region or an organization in innovation is insignificant. In the spatial aspect, the network is important in both intraregional level and interregional level. Innovation for any firm in contemporary circumstances is necessarily dependent upon external linkages and local innovation linkages must be complemented by the resources available in national and global interfirm networks (Gordon, 1991). Networks can mobilize the unique regional innovative potentials of different regional production systems. An isolated region which does not have global inter-firm networks, even though it has good local innovative potentials, can not continuously support successful innovations and high-tech agglomeration. Therefore, innovation network at both regional and global level is critical for maintaining innovation. This is why we have witnessed a profound elaboration of cross-national and trans-organizational strategic alliances, particularly in sectors impacted by information technology in recent years. Gordon (1991) suggests that strategic alliances enhance technical sophistication and innovation capabilities by improving access to contemporary technical developments and direct incorporation of external know-hows. Cooperative partnering or collaboration permits networks to mobilize, coordinate and reconfigure the production organization necessary to create permanent innovation capabilities and also involves radical changes in business culture and practice (Gordon, 1991).

Establishing a networking is a social learning process. Under the contemporary technical change, technological innovation is increasingly a result of social innovation. That is, individual firms can no longer rely upon the mysteries of individual genesis, endogenous technical search or adjustment to environmental stimuli, but must create and maintain an organizational structure permitting continuous innovation with interorganization and interregional networks.

From the above discussions, there are three dimensions in innovation: organizational factor; regional factor; and networking. These three dimensions of innovation are not independent each other. Rather, they are complementary and innovation is the product of the integration of the three complementary dimensions. Accordingly, under the new information technology paradigm, the new regional policy should consider the organizational changes, regional factors, and institutional changes (Thwaites and Oakey, 1985; Freeman, 1987). In the regional dimension, especially, both local level and global level should be considered simultaneously, because "localized agglomeration" becomes the principal basis for participation in a global network.

3. Problems of Science Parks

World history of science parks is just about forty years long. The Stanford Science Park (originally called Stanford Industrial Park), widely regarded as the "grandfather" of science park, was operated in 1951 by Stanford University. The evolutionary path of the Stanford Science Park is mainly a consequence of changing university's needs, the research capabilities and entrepreneurial spirit at Stanford University, the burgeoning post-World War II West Coast technology sector, and the adaptability of park planners and managers (Luger and Goldstein, 1990). The development of the Stanford Science Park surely contributed to the growth of Silicon Valley. Growth and agglomeration of high-tech sectors in Silicon Valley have become an object of envy around the world since the early 1980s. The success story of Silicon Valley diffused throughout the world with many publications in journals and books about the development of Silicon Landscapes (Hall and Markusen, 1985). Following this Silicon Valley mode, many regions in the United States and many developed countries, especially Japan and the United Kingdom, were enthusiastic in developing science parks in the last decade.

However, not all the science parks established in the developed countries have been successful. Since the history of the development of science parks is short, an evaluation of the science park strategy might by too early as of now. Nevertheless, it is true that many science parks in U.S.A. and the United Kingdom have failed in generating jobs and agglomerating high-tech sectors and they showed many other problems (Luger and Goldstein, 1990; Park, 1990; Park and Lim, 1992).

Even the large scale science parks, which were conceived as successful, showed limited impact on local economy and other social problems.

The Research Triangle Park (RTP) in North Caroline of the United States was, for example, conceived to stimulate the economic development of the state following an implicit growth pole strategy. Even though the RTP has had a large scale effect within the Research Triangle region itself, it has failed to stimulate economic development, particularly manufacturing production facilities, in other parts of the state to the degree that it was intended (Luger and Goldstein, 1990). Furthermore, the incidences of spin-offs from park organizations and of new high-tech business start-ups have been relatively small compared to other regions in the U.S. with large concentration of high-tech firms.

In the U.K., recent studies on the U.K. science parks reveal three major problems (Massey, Quintas, and Wield, 1992; Park and Lim, 1992). First, in the spatial context, the development of science park has not contributed to reducing regional disparities in high-tech sectors and moreover distribution of science parks themselves reveals regional disparities in terms of the number of employees and the number of firms. Second, the existing spatial separation of science parks with production activities further encouraged a spatial separation between different elements of technical division of labor. That is, it is criticized that the archetypal science park model is focused on, and reinforcing, social inequality and social polarization. Third, spatial separation of R & D activities from direct production contributes to the reformulation of social hierarchies and may by negative in its real effects on industrial regeneration. Even though the role of academic institutes as the source of research ideas has been emphasized in the science park, there is relatively a low level of academic spin-offs, R & D links, etc.

The above three problems of science parks can not be easily solved as long as the basic logic of science park is based on the linear model of innovation: basic research → applied research → experimental production → initial full production → diffusion (Figure 1). Actually, there is no one model that precisely explains the way innovation takes place. For example, in the interactive model of the processs of technological innovation, instead of one process of innovation from research to commercialization, new ideas are generated and developed at all stages of innovation, including the production stage (Figure 2).

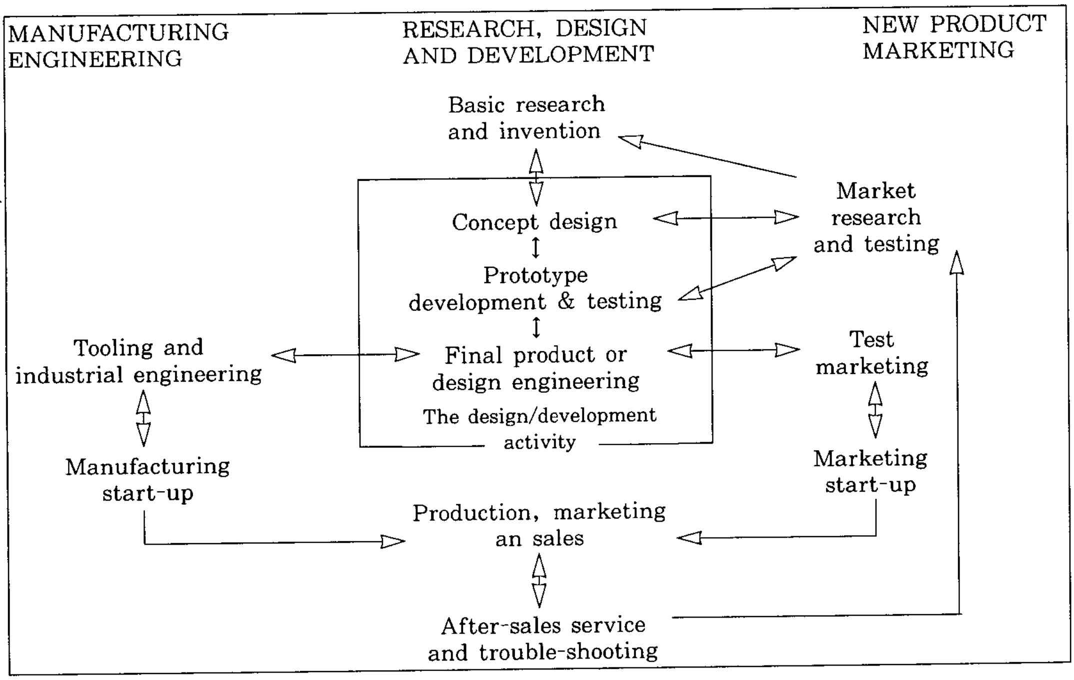
In Korea, ten major cities established basic plans for science parks. Except Taeduk Science Park, most of the science parks are under an initial planning stage and R & D units or firms are not actually located in the parks. The key contents of the basic plan of each science park are identified in Table 1. There are no significant differences in the selection of key industries among the proposed science parks, suggesting that each region's unique development potentials and competitive advantages are not fully explored in the basic plan. Moreover, it is not clear at the present time that all the science parks planned can be successfully developed because most of the high-tech parks are relatively too large and have not developed significant strategies mediating constraints and difficulties in attracting research institutes and high-tech firms to provincial areas.

In Taeduk Science Park, which started its development in 1973, thirty one institutes including fifteen government's research institutes and eight private firm's R & D centers are

	RESEARCH	▷	DEVELOPMENT	▷	DIFFUSION ▷
	1	2	3	4	5
Box	Basic research →	Applied research →	Experimental development →	Initial full production →	Diffusion
Location	academe, pure gov't/ private research labs	academe, government research labs, industrial research labs	industrial research & development labs	factories & offices, etc.	factories, production/ service units, shops, markets
Who does the work? Technical division of labour	scientists in laboratories, supported by technician aides	scientists, engineers in laboratories, supported by technicians	scientists, engineers in labs, engineers & technicians to design, build & test prototypes	production managers, craft workers, production line workers	as 4 in an increasing number of factories, sales people, users. etc.
Outputs	scientific knowledge, ideas, research papers	patents, scientific papers	patents, blueprints, specifications	new products and processes	a wider availabilty of products/ processes
	SCIENCE		TECHNOLOGY		MARKETS

Source: Massey, Quintas, and Wield (1992)

Figure 1. The Linear Innovation Model



Source: Roy and Bruce (1984)

Figure 2. The Process of Technological Innovation — An Interactive Model

Table 1. Status of High-Tech Industrial Park Development in Korea

Location	Area (km^2)	Development period	Key industries	Types
Taeduk	27.6	1974~1992	Gov't research institutes R & D centers of firms	National
Kwangju	9.9 (9.5 in addition)	1989~1995 1996~2001	Bio-engineering precision chemicals information industry new materials	National
Pusan	6.6	1990~2001	Semiconductors industrial robots precision machinery airplane parts telecommunication machinery	Regional
Taegu	3.5	1990~1995	Computers, semiconductors precision instruments bio-engineering new materials	Regional
Taejeon	4.5	1990~1995	Precision chemicals precision instruments telecommunications new materials	Regional
Chongju	9.9	1991~1997	Semiconductors, computers communication instruments airplane parts precision chemicals	Regional
Jeonju	3.5	1990~2001	Semiconductors, computers new materials precision chemicals bio-engineering	Regional
Chuncheon	4.3	1992~1996	Semiconductors, computers optical instruments medical instruments	Regional
Kangneung	3.4	1990~2001	New materials precision chemicals telecommunication machinery maritime technology	Regional
Jinju	2.8	1992~	Telecommunications precision instruments airplane parts	Regional

Source: Park (1991b)

located and in operation presently. Thirty five institutes including twenty seven private firm's R & D centers will be further located and in operation soon. Presently located institutes have about 12,300 employees and additional thirty five institutes will provide about 8,200 direct jobs. Considering the effect of direct job generation in high-tech labors and the land size of Taeduk Science Park, the impact of the science park on local economy can not be underestimated. Nevertheless, Taeduk Science Park is not out of exception from the problems of the science park identified before. Taeduk Science Park is almost an isolated island for scientists and engineers within the Taejeon city. The science park has no interaction to the nearby Taejeon industrial park. The result of direct interview surveys on Taejeon industrial park reveals that there is no direct interrelationship between the industrial park and the science park in terms of material, information, marketing and technical consulting linkages.

The business services sector of the Taejeon city has rapidly grown during the last decade with the establishment of Taeduk Science Park (Table 2). However, the industrial structure of the Taejeon city has not much changed during the last decade as seen in Table 3. The share of the technology intensive sector of manufacturing in Taejeon is less than that of the national average and those of other cities such as Kwangju and Chongju (Table 4). High-tech industries are overwhelmingly concentrated in the Capital Region and the concentration trend of the high-tech sectors has not been mitigated during the last decade (Park, 1991b). Therefore, just the inducement of R & D centers in Taeduk Science Park has made only limited impacts on the local economy and has no enough synergy effects. Furthermore, the spatial separation of R & D activities from industrial production, which is based on the logic of the linear model of innovation, may have only limited innovation effects.

4. Strategies of Science Park Development in Korea

Models of scientific knowledge production and industrial innovation have varied over time and still do vary between cultures (Massey, Quintas, and Wield, 1992). Because of this variation over time and space, strategies for innovation are a very difficult issue to handle. Experiences in the developed countries might be a lesson but can not be entirely applied to developing countries.

Considering the fact that the science park development policy in Korea is related to the two national tasks of high tech industrial development and balanced regional development, the science park development in Korea is a very important but problematic issue. Contemporary technological changes, problems related to the model of science parks, experiences in other countries, and our own socio-economic-cultural environment should be considered and integrated in the strategies of science park development in Korea.

In this study, on the assumptions that the innovation network is critical and an interactive model of innovation process is more applicable to the contemporary technological paradigm than the linear model, the three factors are synthetically considered for strategies of science park development in Korea, especially for Taeduk Science Park. These three factors are organizational factor, regional factor,

Table 2. Taejeon's Employment Structure of Service (1980/1985/1990)

Types of industry	1980		1985		1990	
	person	%	person	%	person	%
Electricity, gas, water	535	2.7	616	1.4	534	0.9
Construction	1600	8.1	7165	16.2	11082	17.8
Retail	491	2.5	2135	4.8	2320	3.7
Restaurants & hotels	1443	7.3	1767	4	1992	3.2
Trans., storage, commun.	5793	29.2	11766	26.6	13757	22.1
Sub total	***9862***	***49.8***	***23449***	***53***	***29685***	***47.7***
Wholesale	1391	7	3518	8	3082	4.9
Financing	2617	13.2	2964	6.7	4231	6.8
Insurance	809	4.1	1086	2.5	1120	1.8
Real estate	174	0.9	393	0.9	1460	2.3
Business svc.	551	2.8	1644	3.7	6028	9.7
Sub total	*5542*	*28.0*	*9605*	*21.8*	*15921*	*25.5*
Community, social, personal svc.	***4439***	***22.4***	***11107***	***25.2***	***16672***	***26.8***
Total	19843	100.0	44161	100.0	62278	100.0
Service/ Manufacturing[1]	56.6		100.6		117.3	

Note: 1) is the ratio of the number of service to that of manufacturing.
Source: Ministry of Labour, 1981, 1986, 1991, *Survey Report on Establishment Labour Conditions.*

and networking.

At the local level, interorganizational network with close linkages of technology, information, labor training and materials should be maintained in order to promote innovation and synergy effects. In addition, agglomeration economies with many spin-offs and new start-ups in high-tech sectors should be emphasized. Therefore, at the local level, the three following strategies should be promoted.

1) Provision of Local Innovative Culture or Technological Infra-Structure

Innovative regional factors are very important for providing local innovative culture. Telecommunication networks, technological and scientific education, applied research agencies, advanced services to enterprises, etc. are important for upgrading development capacities of firms (Perrin, 1991). Fostering research universities is critical at the local level. In the studies of U.S. science parks, existence of research universities at a region was critical to the success of science park development (Luger and Goldstein, 1990). Location of government's research institutes and private firms' R & D centers is also important for providing technological infrastructure. Firm headquarters and production services should be also attracted in order to enhance the innovation potential. Information and technology centers at science park should be

Table 3. Taejeon's Employment Structure of Manufacturing (1980/1985/1990)

Types of industry	1980		1985		1990	
	person	%	person	%	person	%
Food	1219	3.5	1384	3.2	2626	4.9
Wood	255	0.7	239	0.5	358	0.7
Paper	1318	3.8	1354	3.1	1626	3.1
Petroleum & coal	29	0.1	214	0.5	147	0.3
Nonmetaillic	1124	3.2	1633	3.7	1693	3.2
Non-ferrous metal	27	0.1	265	0.6	35	0.1
Resource type	*3972*	*11.4*	*5089*	*11.6*	*6485*	*12.3*
Leather	1987	5.7	1351	3.1	1261	2.4
Furniture	32	0.1	109	0.2	114	0.2
Plastic	378	1.1	745	1.7	1349	2.5
Fabricated metal	2440	7	2957	6.7	4138	7.8
Machinery	1408	4	2103	4.8	4187	7.9
Electric & electronic machn.	2502	7.1	2654	6	3097	5.8
Trans. equip.	966	2.8	748	1.7	2230	4.2
Precs. machinery	100	0.3	491	1.1	681	1.3
Assembly type	*9813*	*28.1*	*11158*	*25.3*	*17057*	*32.1*
Textiles	5928	16.9	10395	23.7	8555	16.1
Apparel	7135	20.4	8028	18.3	4740	8.9
Footwear	1294	3.7	1593	3.6	2455	4.6
Rubber	418	1.2	612	1.4	2551	4.8
Others	1046	3	1171	2.7	1286	2.4
Labor intensive type	*15821*	*45.2*	*21799*	*49.7*	*19587*	*36.8*
Ind. chemicals	1493	4.3	1281	2.9	1999	3.8
Petrl. refinery	0	0	22	0.1	79	0.1
Iron & steel	536	1.5	291	0.7	219	0.4
Capital intensive type	*2029*	*5.8*	*1594*	*3.7*	*2297*	*4.3*
Beverage & tobacco	382	1.1	466	1.1	2657	5.0
Printing	2385	6.8	1788	4.1	1161	2.2
Other chemicals	630	1.8	1938	4.4	3604	6.8
Pottery & china	0	0	7	0	0	0
Glass	18	0.1	77	0.2	244	0.5
Other special type	*3415*	*9.8*	*4276*	*9.8*	*7666*	*14.5*
Total	35050	100.0	43916	100.0	53092	100.0

Source: Ministry of Labour, 1981, 1986, 1991, *Survey Report on Establishment Labour Conditions.*

established in order to support technical information diffusion and technology transfer. In Korea, in order to develop planned science parks successfully, government's support for universities and incentives for location of firm headquarters at provincial areas should be deliberately promoted.

Table 4. Employment Structure of Manufacturing (1990)

unit: %, person

Types of industry	Nation	Taejeon	Kwangju	Pusan	Taegu	Chongju	Jeonju	Chun-cheon	Kang-neung	Jinju
Food	5.8	4.9	7.0	4.9	2.0	6.9	4.0	4.2	18.4	4.0
Wood	1.2	0.7	0.9	1.5	0.7	0.2	0.9	1.1	0.7	0.4
Paper	1.9	3.1	0.7	0.8	1.5	1.0	7.9	0.0	0.0	9.4
Petroleum & coal	0.3	0.3	0.4	0.2	0.2	0.2	0.9	2.1	4.2	0.5
Nonmetallic	3.0	3.2	2.5	0.6	1.0	1.4	2.1	3.0	13.9	6.5
Non-ferrous metal	0.8	0.1	0.0	0.5	0.8	0.0	0.0	0.0	0.0	0.0
Resource type	*13.0*	*12.2*	*11.5*	*8.5*	*6.3*	*9.7*	*15.8*	*10.5*	*37.3*	*20.9*
Leather	1.3	2.4	0.0	1.9	0.0	1.8	0.0	0.0	0.0	0.0
Furniture	1.2	0.2	0.5	0.2	0.1	0.0	0.4	0.0	0.0	0.1
Plastic	3.2	2.5	3.2	2.1	2.2	3.9	0.9	1.1	0.0	2.4
Fabricated metal	7.4	7.8	3.0	6.4	8.9	2.3	1.6	8.6	13.0	6.0
Machinery	9.0	7.9	10.0	6.9	10.1	12.9	3.9	32.0	2.6	26.2
Electric & electronic machn.	15.0	5.8	20.6	3.3	3.4	30.5	2.4	14.9	9.0	7.8
Trans. equip.	7.5	4.2	22.2	5.7	6.9	0.4	0.9	1.2	7.0	9.0
Precs. machinery	1.2	1.3	0.1	0.2	2.2	4.7	0.1	0.5	0.0	0.0
Assembly type	*45.8*	*32.1*	*59.5*	*26.6*	*33.7*	*56.5*	*10.3*	*58.4*	*31.7*	*51.6*
Textiles	11.6	16.1	9.8	7.7	48.8	18.2	23.5	7.6	0.0	15.8
Apparel	7.4	8.9	2.8	9.7	2.7	0.2	39.1	11.6	10.3	0.9
Footwear	5.0	4.6	0.1	33.9	0.2	0.1	0.1	0.0	0.0	0.0
Rubber	1.5	4.8	5.8	4.6	0.6	0.5	0.4	3.6	0.0	4.8
Others	2.8	2.4	0.8	2.1	2.0	0.3	2.2	0.3	0.6	0.0
Labor intensive type	*28.3*	*36.9*	*19.3*	*58.0*	*54.2*	*19.3*	*65.2*	*23.0*	*10.8*	*21.5*
Ind. Chemicals	1.8	3.8	0.3	1.1	0.5	0.2	0.1	0.0	0.0	0.9
Petrl. refinery	0.5	0.1	0.1	0.2	0.0	0.0	0.0	0.5	0.0	0.0
Iron & steel	2.1	0.4	0.6	2.6	1.3	0.3	0.2	0.0	0.0	0.8
Capital intensive type	*4.4*	*4.3*	*1.0*	*3.9*	*1.9*	*0.5*	*0.3*	*0.5*	*0.0*	*1.7*
Beverage	0.7	2.2	1.5	0.2	1.0	1.3	2.1	0.8	16.8	1.0
Tobacco	0.2	2.8	1.7	0.0	0.4	1.6	2.7	0.0	0.0	0.0
Printing	3.1	2.2	3.1	0.9	1.7	2.0	2.7	6.6	3.4	1.6
Other chemicals	3.3	6.8	2.4	1.7	0.5	6.6	0.9	0.0	0.0	0.5
Pottery & china	0.5	0.0	0.0	0.0	0.2	2.5	0.0	0.0	0.0	0.0
Glass	0.7	0.5	0.1	0.2	0.2	0.0	0.1	0.2	0.0	1.3
Other special type	*8.5*	*14.4*	*8.7*	*3.0*	*3.9*	*14.0*	*8.4*	*7.6*	*20.2*	*4.4*
Total (Employees' No.)	100.0 3053572	100.0 53092	100.0 49049	100.0 357240	100.0 161714	100.0 39028	100.0 22914	100.0 5540	100.0 1735	100.0 12313

Source: Ministry of Labour, 1991, *Survey Report on Establishment Labour Conditions.*

2) Support of Spin-offs and New Start-ups

In the long run, spin-offs and new start-ups are more important for local economy than the branch plants of mass production. In order to support the spin-offs and new start-ups in high technology sectors, an incubation center should be established. Cheap premises, telecommunication network, computer services, and other secretarial services can be provided at the incubation center. Provision of venture capital is also critical for high-tech spin-offs and new start-ups. Universities and government research institutes should be more flexible for providing innovative entrepreneurs and should offer incentives for spin-offs.

3) Formation of Innovation Network

Technological innovation is increasingly a product of social innovation and, accordingly, a collective learning process is important (Gordon, 1991). Local alliance, cooperation, trust relations and social-institutional solidarity are important for local agglomeration economies. Interorganizational relationships such as university-industry, university-research institutes, and industry-industry linkages should be formed for local innovative environment through networking. Exchange programs of highly qualified scientists and engineers between universities and industrial firms and R & D centers should be set up and supported. Internship of graduate students at industrial firms or research institutes and retraining of workers at university can also be developed for industry-university-research institute cooperation. In general, public-private partnership is useful for providing territorial effects and networking a wider number of local potentials. Consortiums of R & D activities for small and medium can be organized at local level. R & D centers in the science park should have close relationship in production and marketing at the local level. Furthermore, the science park should have intensive linkages to adjacent industrial parks. If a science park has only R & D function and no production function like Taeduk Science Park, an additional high tech industrial park should be constructed and linked together. The innovation network strategy is critical for keeping business and enhancing competitiveness of firms under the uncertain and dynamic economic environments.

Economic activities tend, more and more, to be globalizing. Amin and Robins (1991) even argue that there exist powerful tendencies toward the global rather than local organizational network. Therefore, the logic of externalization at the international level as well as agglomeration economies at the local level should be considered for strategies of science parks development. At the interregional and international level, the two following strategies can be considered.

(1) Promotion of interregional and international innovation network

Technical innovation is also progressed through interregional linkages facilitating firm's access to different innovation capabilities. Even small and medium size enterprises in the developed countries cannot rely any more upon the sole local agglomeration economies and more and more have to link-up with external firms in cooperative networks (Sole and Valls, 1991).

In order to provide the innovation network internationally, firms should be involved in internationalization through marketing, production, and R & D activities in foreign countries. In terms of R & D activities, developed countries such as U.S.A., Japan and Western Europe countries should be considered for networking as a short term strategy. Cooperation with Northeast Asia in terms of firm's production and R & D activities should be strategically supported. At the interregional and international levels, intraorganizational linkages as well as interorganizational collaboration should be simultaneously progressed. Information, technical and marketing linkages can improve firm's competitiveness.

(2) Development of Business Information Support System(BISS) for small and medium size firms

The objectives of BISS are to establish the business infrastructure for promoting cross-national links for local firms and to improve the performance of local firms (UNCRD, 1992). Small and medium size firms in the science parks can improve innovation potentials through participation in the BISS. In Korea, the national government or local governments can support the operation of BISS in science parks in collaboration with the United Nations Centre for Regional Development. Successful operation of BISS can surely enhance international competitiveness of existing enterprises.

The above strategies can not be considered independently. They are all interrelated and strategies at both the local and international level should be concurrently promoted for providing innovative environments and enhancing international competitiveness. From the above strategies, the emphasis can be varied by types of science parks. In case of Taeduk Science Park, since local technological infrastructures are relatively well provided, other strategies which are related to innovation network at both the local and international level and support of spin-offs should be emphasized. Considering the interactive model of innovation, the development of a high-tech industrial center and its linkages to Taeduk Science Park are also critical for local economic development.

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