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# A review on attraction factors of science and technology parks to firms in health sector

Abbas Mohammadzadeh, Shaghayegh Haghjooy Javanmard

## Abstract:

**BACKGROUND:** Over the past few years, a rapidly growing number of science and technology parks (STPs) in health sector have emerged across the world. There has been little discussion in the literature to show how STPs could make an attractive environment to absorb and retain potential firms. This is even more challenging for specialized STPs in health sector. The aim of this study is to identify the attractive factors for firms in a STP in health sector.

**MATERIALS AND METHODS:** A scoping review method was undertaken to review the literature on seven databases (ScienceDirect, Scopus, ProQuest, Google Scholar, EconPapers, PubMed, and ISI Web of Science) for peer-reviewed articles published until 2019. The search results were screened against the inclusion of criteria to ensure they met the objectives. The eligible papers were then assessed on the basis of the full text, and finally the results were extracted.

**RESULTS:** The attractive factors for firms and talents in multidimensional STPs and those in health sector are extracted and summarized. The attractive factors of multidimensional STPs, which includes health sector firms, and those specialized in health sector are summarized in three main categories; factors created by government and universities, and factors related to STP policies and those expected by the firms.

**CONCLUSION:** To make STPs attractive for firms in health sector, there is a list of factors that are required to be done not only by STP itself, but also by the national and local government and industries. It is important to consider the factors that are expected by the firms to be implemented. The results of this study suggest that making STPs attractive for health sector firms needs close collaboration between government, universities, related industries, and STPs all together.

## Keywords:

Attraction factors, firm, health sector, science and technology park

Department of  
Physiology, School of  
Medicine and Applied  
Physiology Research  
Center, Cardiovascular  
Research Institute, Isfahan  
University of Medical  
Sciences, Isfahan, Iran

## Address for correspondence:

Prof. Shaghayegh  
Haghjooy Javanmard,  
Department of  
Physiology, School of  
Medicine and Applied  
Physiology Research  
Center, Cardiovascular  
Research Institute, Isfahan  
University of Medical  
Sciences, Hezar Jerib  
Street, Isfahan, Iran.  
E-mail: [sh\\_haghjoo@med.mui.ac.ir](mailto:sh_haghjoo@med.mui.ac.ir)

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## Introduction

Science and technology parks (STPs) were formed in 1950s in the United States as an essential tool to boost university and industry collaborations. The higher interaction brings up more support for knowledge-based firms, high-tech industries, and university spin-offs. To attain this goal, numerous efforts are made in other countries to foster economic development through STP implementation.<sup>[1]</sup> To achieve its goals, a science park stimulates the

knowledge flow between universities, research and development institutions, businesses, and related markets.<sup>[2]</sup> In addition, it facilitates the formation and development of innovation-based firms through incubation and spin-off processes along with high-quality services and environment.<sup>[3]</sup>

Some empirical studies show that settlement in the park could be beneficial for the firms for several reasons such as foreign cooperation, which may lead to the positive impacts on the firm's output, research performance improvement, and support

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in patent application.<sup>[4]</sup> However, due to heterogeneity within park, not all the firms located in a park will equally benefit from that.<sup>[5]</sup> The capacity of absorption is an important concept here. The ability of a firm to recognize the value of new external information, absorption, and its application in business goals. Cohen and Levinthal<sup>[6]</sup> express that this ability is mainly due to the firm's accumulated knowledge and R&D.

Unlike the absorption capacity of firms, the attractiveness of STPs is the less-discussed issue in the literature which could be created through undertaking attractive features and policies within park and region where the park is located in order to attract firms and talents with high absorptive capacity. Characterizing the factors which make STPs attractive for firms is necessary for a better operation and functioning of both STPs and firms. This is not only important for scaffolding new STPs but also helps forming highly motivated firms to be part of the STPs. Consideration of attractive factors for firms in STPs would obviously gather more motivated firms and guarantee their success. Highlighting these factors helps local and national governments to plan and provide their supports in line with the STP needs as well. This study is a literature review on identifying these important attractive factors in general STPs and more specifically in STPs active in health sector.

University partnership with pharmaceutical industry in Brazil studied by de Medeiros Rocha *et al.*<sup>[7]</sup> points out, since this partnership is mainly through public universities; therefore, the government has a very prominent role in promoting drug innovation. The results showed that from the university perspective, the best instrument for the government to undertake is to promote innovation programs, support more startup firms in drugs field, in the Technology Innovation Centers, and financial support or tax breaks. Some other tools were considered in this study such as increasing the regulatory process speed and promotion of private-public partnership to develop drugs that are remained neglected; however, they were not considered as important as the three tools mentioned earlier. It is also suggested in this study that the government needs to reconsider the academic output measurement, which is mainly on publications, as sometimes the efforts to develop a new medicine is ignored by the academics as it might have the risk of not being accepted by the stakeholders. Moreover, the Technology Innovation Centers may not be completely aware of the public demand or the real market demand, which highlights the importance of the university to be in a closer cooperation with the government and the market.

The results of this study not only help STP managers but also local and national government, health sector

policymakers, firms, and health sector innovators to create an efficient innovation environment.

## Materials and Methods

In this study, the scoping review approach was undertaken, and the academic journal articles were searched in title and abstract in EconPapers, Google Scholar, ProQuest, PubMed, ScienceDirect, Scopus, and ISI Web of Science in October 2019. The following terms were included in the search: ("science park" OR "techno park" OR "technology Park" OR "Research Park" OR "Innovation Center" OR "High-Tech Park") (As the definition of UNESCO shows: The term "science and technology park" encompasses any kind of high-tech cluster such as: science park, hi tech (industrial) park, innovation center, university research park, research and technology park, technology park, techno park, etc.)<sup>[8]</sup> AND (firm OR tenant OR company) AND health. However, as including "health" resulted in only a few records, therefore, the search was repeated without it to make sure that no relevant article was missed. No date restriction has been considered in the search results. The details of the searched terms in each database is provided in Table 1. The selected papers at the first stage are based on the title/abstract, and the list is shortened in the next stage based on their relevance in full text.

### Characteristics of selected papers

The literature review in this study reveals that the attractive factors of a STP for a firm are often discussed under other topics which need to be extracted from these papers. The topics such as success factors of STPs, geographical location of a STP, challenges of STPs, challenges of knowledge-based firms, etc., The screening process is shown in Figure 1. As the first step, the duplicate articles were identified and removed. The obtained articles were then screened in full text, which resulted in excluding 349 articles due to being irrelevant. In this process seven more records were identified from other sources, which included in the articles reviewed in this study.

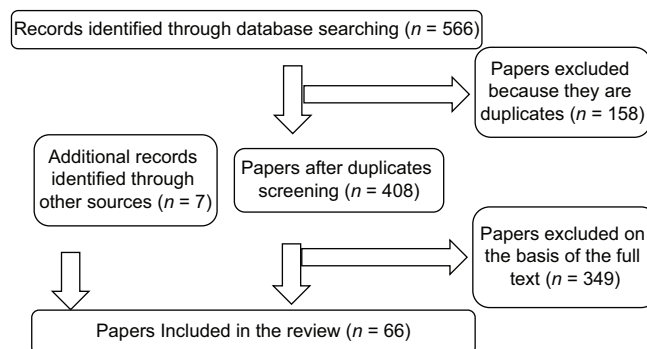


Figure 1: Screening process of papers

**Table 1: Search strategy details in seven databases and the number of records retrieved**

Database	Search strategy	Document type	Records
ScienceDirect	A. Title, abstract . . : (“Science park” OR “techno park” OR “technology park” OR “Research Park” OR “Innovation Center” OR “High-Tech Park”) AND (firm OR tenant OR company)	Document type: Research article	114 records
	B. Find articles with these terms: Health Title, abstract . . . : (“Science park” OR “techno park” OR “technology Park” OR “Research Park” OR “Innovation Center” OR “High-Tech Park”) AND (firm OR tenant OR company)	Document type: Research article	28 records
Scopus	A. Title, abstract . . . : “Science park” OR “techno park” OR “technology Park” OR “Research Park” OR “Innovation Center” OR “High-Tech Park” AND Title, abstract . . . : firm OR tenant OR company	Document type: Article	598 records
	B. Title, abstract . . . : “Science park” OR “techno park” OR “technology Park” AND Title, abstract . . . : Firm OR tenant OR company AND Title, abstract . . . : Health	Document type: Article	13 records
	A. In Abstract: (“Science park” OR “techno park” OR “technology Park” OR “Research Park” OR “Innovation Center” OR “High-Tech Park”) AND (firm OR tenant OR company) OR In Document title-T1: (“science park” OR “techno park” OR “technology Park” OR “Research Park” OR “Innovation Center” OR “High-Tech Park”)	Source type: Scholarly journals Document type: Article	101 records
ProQuest	B. In Abstract: (“Science park” OR “techno park” OR “technology Park” OR “Research Park” OR “Innovation Center” OR “High-Tech Park”) AND (firm OR tenant OR company) AND health OR In Document title-T1: (“science park” OR “techno park” OR “technology Park” OR “Research Park” OR “Innovation Center” OR “High-Tech Park”)	Source type: Scholarly journals Document type: Article	69 records
	Google scholar	Allintitle: “Science park” OR “techno park” OR “technology Park” OR “Research Park” OR “Innovation Center” OR “High-Tech Park”	Only english
EconPapers	A: Free text search (firm OR tenant OR company) AND (health) Keywords and Title: “science park” OR “techno park” OR “technology Park” OR “Research Park” OR “Innovation Center” OR “High-Tech Park”	Journal articles	397 records-10 records selected
	B: “Science park” “techno park” “technology Park” “Research Park” “Innovation Center” “High-Tech Park” AND (firm Tenant OR company)	Journal articles	76 records
	C: “Science park” “techno park” “technology Park” “Research Park” “Innovation Center” “High-Tech Park” AND (health)	Journal articles	20 records
PubMed	A: Title/abstract: (“Science park” OR “techno park” OR “technology Park” OR “Research Park” OR “Innovation Center” OR “High-Tech Park”) AND Title/abstract: (Firm OR tenant OR company)	Journal articles	0 results
	B: Title/abstract: (“Science park” OR “techno park” OR “technology Park” OR “Research Park” OR “Innovation Center” OR “High-Tech Park”)	Journal articles	140 records-4 items were selected
	C: Title/abstract: (“Science park” OR “techno park” OR “technology Park” OR “Research Park” OR “Innovation Center” OR “High-Tech Park”) AND Title/abstract: health	Journal articles	47 records-2 items selected which were already in the above search where 4 items selected
ISI web of science	Title: (“Science park” OR “techno park” OR “technology Park” OR “Research Park” OR “Innovation Center” OR “High-Tech Park”)	Journal articles	150 records/95 records selected based on title

Source: Authors

While attractive factors of STPs for firms are supposed to be promoted by the STP itself, however, the role of STPs are mainly to facilitate the novel ideas to be developed and supported to get in the right line and eventually create wealth for the society; there are also other pillars in the country in which their role in the abovementioned goal is undeniable such as government, universities, and industries. In fact, a STP is not simply a landlord of high-quality buildings and offices, rather, a complex organization with multiple owners, but they are all in line with the economic development goals drawn by public sector.<sup>[9]</sup>

As a result, the full capacity of STPs in being attractive to firms is only achieved when all the players are performing the expected policies in the right direction. Therefore, the retrieved papers were categorized into studies where the role of governments and universities in creating attractive factors were identified; those studies that focus on the role of STP itself in creating an attractive atmosphere for firms, and finally those studies that consider the firms expectations. The next section reflects the findings from these three dimensions.

## Results

The review of selected papers is conducted by categorizing them into three broad scopes; the role of national and local governments and universities in creating attractive factors in STPs for firms; the role of STP policies in creating those factors, and ultimately the expectations by firms and talents on what make a STP attractive for them to move-in and operate. The findings from the review of selected papers in the three abovementioned dimensions are discussed in this section.

### Science and technology parks and the role of government and university

It is clear that there are some vital characteristics of a country and a region where a STP operates and makes it attractive for international and regional inventors; however, the management framework of STPs and policies of government and universities have an important role in the attractiveness of STPs for firms and talents. Zhang<sup>[10]</sup> examines the critical factors of science park management and finds *Park location, Park preparation* (the stage before opening a science park), and having a very professional and committed management team are vital in attracting high-quality firms and park's success. Huibing and Nengli<sup>[11]</sup> suggest a number of strategic advices to develop science parks in China such as "Strategic positioning" within an industry and applying "branding strategy" to remain in the current high competition market.

A science park has a multidimensional aspects and economic, political, and social activities affects the social face and the reputation of the park.<sup>[12]</sup> Wasim<sup>[13]</sup> believes that "external factors" including monetary environment, business environment, policy instrument, global economy, and innovation model needs to be considered among other issues. Hladchenko and Pinheiro<sup>[14]</sup> discuss that the Triple Helix model implementation depends on the institutional logic of the state, that is, "knowledge" is the key factor for economic growth, which in nonwestern societies might be different from western societies. Machado *et al.*<sup>[15]</sup> highlights the role of civil society as another active agent besides firms, universities and government. Rowe<sup>[16]</sup> believes that STPs need to carefully select the new knowledge based industries and tenants within that industry to remain sustainable. Leyden *et al.*<sup>[17]</sup> provides an approach to find the optimal number of firms locating in a park.

Yang and Lee<sup>[18]</sup> evaluated the management performance of the Hsinchu Science Park, as the first science park in Taiwan, which is fully government oriented. Land development, tax exemption and infrastructure-related facilities determined as the favorable incentives to support early-stage startups in order to promote regional industry development.

"Government-led infrastructure provision" is identified as one of the most important growth mechanisms for STPs in the study of Koh *et al.*<sup>[19]</sup> This has been mainly the case in many Asian countries where the governments were eagerly investing in STPs to attract multi-national companies to their country and therefore, strengthen their STPs. However, for European STPs, agglomeration effect was considered more important as created a very competitive and innovative environment for tenants to grow through factors such as knowledge spillover or informal exchange of ideas.

In summarizing the government policy tools in the literature in supporting the new technology-based firms, the study of Ghoronh *et al.*<sup>[20]</sup> provides four major types of policy tools: Regulatory tools, financial tools, information tools, and administrative tools. In considering the role of government, the report of Rowe<sup>[16]</sup> argues that there are two important dimensions which make it difficult to have a clear answer for this question. The first dimension is the stage of development where the STP is located, and the second dimension is the nature of the innovation system where the STP works. Whether the innovation system is advanced or weak would suggest different issues that need to be considered. The study of Lindelof and Lofsten<sup>[21]</sup> differentiates the required supports for new technology-based firms in STPs based on their origin. The NTBFs are considered to be either university spin-off or corporate spin-offs and because of different origins required different supports and services. For instance, firms owned by experts in academia may perform less than those firms owned by professional businessman either because academicians already have the university income and are not financially dependent on the firm's revenue or they simply focus on the research and technology of the firm instead of its growth and revenue. Phillimore<sup>[22]</sup> argues that the interaction is not just from university to industry, and the interaction and networking within STP and between STP firms and universities are required.<sup>[23]</sup>

### Attractive science and technology park policies for firms and talents

As quoted from Phan in Salvador<sup>[24, p. 227]</sup> "You can't just 'build (a park) and they will come' –you have to make it attractive in the first place." Surprisingly, only a limited attention has been paid to the firms' required supports and services<sup>[25,26]</sup> and what makes STPs attractive for potential firms and talents. The summary of the literature review on the role of STP policies to attract firms and talents is provided in Table 2.

Attracting existing firms into science park is considered as a generic aim for most of the science parks as pointed out by Guy *et al.*<sup>[49,p. 87]</sup> besides other aims such as promoting start-ups or so called the new technology-based firms.

**Table 2: The summary of the studies on attractions and services provided by science and technology parks in the literature**

Author (s)	Study approach/ country	Selected attractions/services	Classification of attractions/services	Study objective
Jamil <i>et al.</i> <sup>[27]</sup>	Systematic approach	Property development Interaction with local and international markets R and D Proximity to university Providing advanced equipment Managerial support Institutional reputation	To promote commercialization	Review the commercialization tools and the role of university incubators and STPs to promote it
Tajpour and Hossini <sup>[28]</sup>	Practical, descriptive/Iran	Government encouragements Competitors and competitiveness (accepting university as a major player in economic growth) Technological advances	External factors to improve academic entrepreneurship	To find the factors affecting the academic entrepreneurship
Salvador <sup>[24]</sup>	Empirical/Italy	Shortages expressed by firms Funding support Managerial support Hospitality Tutor services Lack of information on sources of finance	Shortages of turin STP reflected in firms' responses	To find whether STP is a good brand name for university spin-offs
Chan and Lau <sup>[29]</sup>	Empirical/Hong Kong	Pooling resources (trainings, exhibitions, etc.) Sharing resources (such as labs) Consulting Public image Networking Clustering Geographic proximity (access to market, university, etc.) Costing Funding	Assessment criteria of incubators	To assess technology incubators in science park
Cattapan <i>et al.</i> <sup>[30]</sup>	Case study/Italy	Innovation brokerage <sup>a</sup> activities (such as TTS as a European best-practice innovation broker)	Brokerage activities	To study the effects of innovation brokerage activities on innovation and growth of small and medium enterprises
Şimşek and Yıldırım <sup>[31]</sup>	Case study/Turkey	Confidentiality and conservativeness of the firm Human resources, brand and image Resources and costs Management and organization Market, partnership, and technology sources Administration	Constraints to open innovation	To examine the constraints for the firms to use open innovation in STP
Liefner <i>et al.</i> <sup>[32]</sup>	Survey/China	Cooperation with foreign companies (helps to get new ideas) Cooperation with universities (helps to design new products)	Cooperation	To find how cooperation patterns benefit firms in developing countries
Narasimhalu <sup>[33]</sup>	Review	Access to early adopters Accounting Business consulting Flexible physical infrastructure Food and beverage ICT infrastructure Industrial design Intellectual property Investment community Legal Market research Networking sessions	Key factors for open innovation in STPs (critical success factors for STP)	To review key elements of STPs related to open innovation

Contd...

**Table 2: Contd...**

Author (s)	Study approach/ country	Selected attractions/services	Classification of attractions/services	Study objective
Jin and Lingyan <sup>[34]</sup>	Review/China	Patent attorneys Public and media relations Science and technology consulting Security Shared lab and other facilities Transportation Management center Marketing center Service department for financial advice Productivity promotion center Service department for intellectual property rights Information networks Venture capital Technology service organization	University STP service organization	Design and role of university STP in China
Corrocher <i>et al.</i> <sup>[35]</sup>	Empirical/Italy	The strength of research networks plays an important role on innovation performance of tenants	Overall effectiveness of STPs	To find the effect of STP on innovation performance of on-park tenants
Fikirkoça and Saritas <sup>[36]</sup>	Literature survey/ Turkey	Complementarity (activity of firms in relation to related industries [value chain]) Networking Strategic positioning of STP considering the global industry and the country's own institutional arrangements	Success factors for policy design of STP	To report a foresight exercise in developing a business model and research strategy for Ankara university
Cadorin <i>et al.</i> <sup>[37]</sup>	Case study/Sweden	Coordinating all types of connection with university Approaching international organizations and firms to establish in the park (CEOs, board members, etc.) Recruiting high quality managers and leaders to complete start-up teams Facilitating the connection of students with the park	Four cases of talent attraction and recruitment	How to attract and develop talents in STPs and the related issues
Alishiri <i>et al.</i> <sup>[38]</sup>	Case study/Iran	Human resources factors Business environment and investment Supports and services of incubators Organization and management factors Location factors	Success factors of business incubators in STP (ranked factors based on their rating)	To identify and prioritize success factor of STPs, a case study
Weng <i>et al.</i> <sup>[39]</sup>	Case study/China	Construction of infrastructure in the park and its surroundings Industrial chain and enterprise development Capability to support scientific and technological innovations Park management and public services Government support	Success factors of private STP starting from brownfield regeneration	To identify the success factors of private STPs transforming former factory sites abandoned around urban space
Shams <i>et al.</i> <sup>[40]</sup>	Literature review and questionnaire/ Iran	Marketing facilities and supports Keep business secrets Communication services Funding and investment sources Legal support Contract supports The availability of technomart data bank Providing technology data bank including technology owners, etc. Supporting firms' financial needs Suitable administrative process for banking and investment issues	The most important supports out of 79 required supports based on their priority	To identify and prioritize the required supports for new technology-based firms

Contd...

**Table 2: Contd...**

Author (s)	Study approach/ country	Selected attractions/services	Classification of attractions/services	Study objective
González-Masip <i>et al.</i> <sup>[41]</sup>	Secondary database/Spain	Corporate social responsibility practices positively moderate the relationship between locating in a STP and talent attraction	Talent attraction	To propose that corporate social responsibility by STP firms can attract talented human resources
Kharabsheh <i>et al.</i> <sup>[42]</sup>	Interviews/Jordan	Lack of entrepreneurship culture (weakness of education system) Lack of independence of STP from university and government Lack of the required number of STP firms to create enough synergy Lack of similarities between the STPs' stakeholders vision	STP success obstacles	To find obstacles of STP success in Jordan
Ng <i>et al.</i> <sup>[26]</sup>	Empirical/ Netherlands	Being near to clients (for more commercially oriented firms) STP image benefits (for technology-based firms) Being near to university, customers and similar firms (for mature firms) Cost benefits (younger firms)	Important benefits of STP for tenants	To gain insights on how STP firms perceive the benefits associated with various supports and services
Albahari <i>et al.</i> <sup>[25]</sup>	Case study/Sweden	A configuration-oriented component (during planning STP): Amplifying agglomeration effects, increasing availability of venture capital funding, proximity to a major university A process-oriented component: Incubation, training and networking	Business support (two components)	How STPs create value for tenants, a case study
Cadorin <i>et al.</i> <sup>[43]</sup>	Case study/Sweden	Headhunting key personnel for start-ups Facilitating exchange of knowledge and talents with universities Organizing required platforms for foreign companies to establish	Talent attraction activities	To explore activities done by the STPs to attract talents for their tenant firms
Cabral and Dahab; <sup>[44]</sup> Cabral <sup>[45]</sup>	Case study/Brazil; Review	Highly qualified R and D personnel A suitable market to be accessible Managerial and marketing skills supports (especially for younger firms) Industrial secrecy and patents Selection of firms (based on market potential and being in line with the performing area of STP) Having a clear identity for STP <sup>b</sup> Good management Backing by a dynamic institution A great mediator manager between university an industry Service and consultation firms	STP success factors (10 items)	Suggesting necessary success conditions for a STP
Cadorin <i>et al.</i> <sup>[46]</sup>	Empirical/Sweden	Involving major stakeholders (university and government) in STP activities Characteristics of talents important for the success of firms Creating effective links with universities as the major source of talents	Collaboration and talents in STP success	To investigate how the success of STP is affected by the collaboration of stakeholders and the characteristics of talents
Eckard <sup>[47]</sup>	Empirical/ Netherlands	STP functional effects Regional upgrading effect External attraction effect Personal attraction effect	A new multidimensional model	To find the attractive effects of STPs on international knowledge migrants (human capital)
Roldan <i>et al.</i> <sup>[48]</sup>	Bibliographic research and interviews/Brazil	Support services Physical infrastructure Networking with other firms Networking with other universities	Favorable conditions for innovation	To find the favorable conditions for innovation in STPs

Contd...

**Table 2: Contd...**

Author (s)	Study approach/ country	Selected attractions/services	Classification of attractions/services	Study objective
Guy <i>et al.</i> <sup>[49]</sup>	Book chapter	Intrinsic success factors: (1) focusing on the limited number of technological sectors, (2) correspondence of these sectors with research institutions, (3) employment pattern (ratio of R and D to general personnel), (4) linkage of firms with universities, (5) firm to firm interactions, (6) patents and publications, (7) number of start-up firms, (8) number of established firms, (9) satisfaction of firms with provided facilities, (10) return for private investment Extrinsic success factors: (1) employment number, (2) specific jobs created by park, (3) general jobs, (4) relocated jobs from elsewhere, (5) jobs created somewhere else due to the park existence (multiplier effect), (6) net trade balance of the region, (7) net cost of the park to government funds	Success factors	A handbook on STP evaluation
Triadó-Ivern <i>et al.</i> <sup>[50]</sup>	Empirical/Spain	Basic business support services: (1) incubator services such as office space, services and incubator management Social support services: Such as informal and personal connections, social networks, proximity and interaction with university	STP services that develops its value-added	To evaluate services provided by STP
Kang <sup>[51]</sup>	Review	Location factors: (1) proximity to a prominent engineering university, (2) desirable living environment, (3) accessible transportation, (4) fiber optic backbone Facilities and services: (1) incubation and innovation center, (2) joint researches and employees interactions, (3) low rental cost Support mechanism: (1) collaboration between university, firms and research laboratories, (2) strong leadership in the region, (3) venture capital existence	Key success factors	To identify development models for research parks

<sup>a</sup>An intermediary or bridge between research and industry. The brokerage service is generally for university spin-offs, however, this services benefits SME in the local area, therefore help the local economy. This is an attraction for firms off-park to get advantage of innovation brokerage might be active in STPs. <sup>b</sup>Such as the “Kitchen of the World” or “Healthcare Center of Asia” as examples in Thailand.<sup>[65]</sup> Source: Summarized by the authors. STP=Science and technology parks, TTS=Technology transfer service, ICT=Information and communication technology, SME=Small and Medium-sized Enterprises, CEO=Chief Executive Officer

It is, however, globally acknowledged that it takes time for STPs to emerge, and they do not produce instant results, that is, the costs incur up-front. In the study of Alishiri *et al.*<sup>[38]</sup> among the support and services factors, “supporting the commercialization of research results” was ranked highest. Tang *et al.*<sup>[52]</sup> highlight the importance of quality of services provided for the firms in China and conclude that the business and technology expertise of the government is weak. Based on two case studies in Denmark and UK, Hansson *et al.*<sup>[53]</sup> introduce a new mediating role for STPs as creating grounds for development of social capital required for facilitating entrepreneurship in networks, beside the known mediating role for STPs (science-industry relationship). Tenant firms have different characteristics, and the STP managers need to consider the real needs of their tenants when performing the talent attraction policies.<sup>[43]</sup>

**Demand side expectations: Science and technology park attractions expected by firms**

Zhang<sup>[54]</sup> studies the demand side factors expected by the knowledge-based SMEs in Malaysia and classifies

the expectations as follows: Good basic infrastructure, advanced technological infrastructure, tax incentives, venture capital, rental subsidies and grants, growing publicity, and support services including technological, administrative, and secretarial.

Ustundag and Kilinc<sup>[55]</sup> identify the critical and important decision criteria for start-up firms to select a STP as it becomes a major decision for this kind of firms. The criteria are cost, physical and technical infrastructure, consultancy and services, and location characteristics. The details of these items are listed in Table 3.

The university spin-off’s may also have their own criteria to select a STP which is listed in Calvo *et al.*<sup>[56]</sup> as to identify a business opportunity, to increase the participation in the market, partnerships with universities and companies, and obtaining support in management, consulting and market research activities.

The motivations of firms to settle in a STP and expectations of established firms in a STP are studied



**Table 3: Evaluation criteria of science and technology parks by start-up firms**

Criteria	Attribute
Cost	First cost, rental cost, general expenses
Physical and technical infrastructure	Lab facilities, IT infrastructure, sufficient area for expansion, architectural structure, age of building
Consultancy and services	Technology transfer, finance and accounting, marketing, management, consultancy, preparation of project proposals, venture capital, intellectual property, patent, trademark, export and import
Location characteristics	Market, financial institutions, human resources, industrial clusters

Source: Ustundag and Serdar Kilinc.<sup>[55]</sup> STP=Science and technology parks, IT=Information technology

by Castonguay *et al.*<sup>[57]</sup> By conducting 12 semi-structured interviews with managers of established organizations in seven science parks in Canada they found six major motivations to settle in a science park; (1) availability of premises and equipment, (2) availability of skilled human resources, (3) financial incentives, (4) reputation of the park, (5) geographical proximity with specific actors, and (6) geographical positioning of the park. Once the decision to settle in is made, then they found eleven expectations of the science park's contribution: (1) to develop a network, (2) to be accompanied, (3) to have access to business people from foreign countries, (4) to increase their credibility, (5) to develop a competitive advantage, (6) to improve recruitment and retention of human resources, (7) to access new knowledge, (8) to access equipment and premises, (9) to access financial benefits, (10) to collaborate on the park's strategic planning, and (11) To benefit from an ecosystem that is conducive to innovation.

Three main aspects of factors motivating firms to move in a science park in China are pointed in the study of Yang *et al.*:<sup>[58]</sup> (i) motivation of technology gain, (ii) motivation of penetrating market such as acquiring high-quality marketing human resource, and (iii) motivation of policy gain.

The literature review in this study highlighted different aspects of STP attractive factors to be done by the government and universities and those elements to be done by STP. An overview of the areas, in which the major pillars have the capacity to provide services to achieve the goal of STPs in being highly attractive to firms is presented in Table 4.

The investigation showed the limited sources of studies in the area of specialized STPs in the health sector. In addition to the above mentioned attractive factors in the Table 4, there are some other factors specific to the health sector which are summarized in Table 5.

## Discussion

There are more and more specialized STPs growing in developed and developing countries, especially in health sector. The specialization decision is considered by McCarthy *et al.*<sup>[59]</sup> as a form of selection, which makes it easier for the park to have a successful performance by more concentration. Moreover, the specialization in a specific industry by a university research park is driven by the internal capabilities within the university, the management team along with the capability of the local environment where the park is located. There are a number of implications of specialization; first, as the tenants are active only in one specific industry, therefore, they would need similar resources, and this increases the efficiency of the provided resources by the park. For instance, a university research park focused on biotechnology would provide access to biotechnology laboratories and the related scientific equipment. This is proven to be attractive and beneficial for the tenant firms. From the economic point of view, specialization increases returns as offering similar resources which leads to higher efficiencies in terms of budget allocation and infrastructure maintenance.<sup>[60]</sup> Second, specialization narrows the pool of potential tenants, which increase the risk of not filling the required positions within the park which may lead to underutilization of the park and moreover makes the park vulnerable to industry-specific recession or crisis.<sup>[61]</sup> Finally, as the firms are in the same field and use the same resources and networks, high competence against each other may influence the networking benefits.<sup>[59,62]</sup>

Specialization in healthcare for a STP would surely enhance and transform the developments in this industry by more healthcare-specific innovation environment and promote regional, national, and even global economic development and human welfare. The number of STPs and innovation centers focused in this area are currently limited but highly increasing (Some popular health science and technology parks are: Granada Health Technology Park [Spain], Illinois Medical District [Chicago, USA], BioRio [Brazil], Genopole [France], Leiden Bioscience Park [Netherlands] Biomed [Taiwan], Hsinchu [China]).<sup>[63]</sup>

As highlighted in Tseng *et al.*<sup>[63]</sup> digital health is an example of an increasingly growing healthcare sector around the world. However, there are still several challenges with testing and implementing the digital health innovation outcomes. In addition, the inventors of new digital health ideas are not much familiar with the health system requirements. They may not have a clear understanding about the time required to test the digital health products. The inventors may also find working with medical academics difficult due to possible different

**Table 4: A framework on the major pillars and the directions on making science and technology parks attractive for all kind of firms (including health related firms)**

Major pillars	Areas of intervention/management/policy
Government (local/national)/parliament	"Knowledge as the key factor for economic growth" implemented in the institutional logic of the state A strong regional and national innovation system Suitable business and monetary environment Geographical proximity (between academic and business communities) Supportive legislation (business, customs, taxation, finance, etc.) Net trade balance of the region Desirable living environment (transportation, close to airport, markets, etc.)
University/research institutions	Facilitating the connection of students with the park Revising the academic output measurement from publications to STP firm's improvements Creating effective links with industry Market oriented research Provision of laboratories for STP firms
Industry/large companies	Effective relationship with a high quality research organization/university Complementarity: activity of firms in relation to related industries (value chain) Establishment of international organizations and firms (CEOs, board members, etc.) in the park Corporate social responsibility practices Proactive R and D units Offering professional laboratories Support national ideas and risk it
STP/innovation centers/etc.	Strategic positioning within an industry Branding strategy considering the high competition market Applying an appropriate innovation model Dynamic interaction with civil society, local and international private sector Careful selection of new knowledge-based tenants (based on market potential, performing area, etc.) Setting out objectives and strategies in line with the innovation system Promoting the social face and reputation of park Optimal number of tenants in park to create enough synergy Management structure like an independent private firm (depends on the source of firm; university or industry) Innovation broker Cooperation with foreign companies Mature commercial and financial facilities and consultancies Venture capital The availability of technology data bank including technology owners Independence from university and government Similarity between the vision of STP stakeholders Headhunting key personnel for start-ups A clear identity for STP Focused on the limited number of technological sector Balance between startup firms and established firms Low rental cost Creating grounds for development of social capital required for facilitating entrepreneurship
Demand side expectations/motivations	Proximity to potential customers Access to business networks from foreign countries Increase the credibility of the tenants Performing in an innovation leading environment Penetrating into market

There are some overlaps on the role of each pillar which are unavoidable due to the nature of the STPs but ignored here for the simplicity. Source: Summary of the literature review by the authors. STP = Science and technology parks, CEO = Chief Executive Officer

cultures related to the workplace or other reasons. Moreover, many health systems are suffering from the shortage of standardized approaches in relation to digital solutions in different stages such as identification, development, validation, or deployment.<sup>[64]</sup>

Agriculture/seafood and medical services are among the major elements of the Thai economy, therefore, the promotion of biotechnology innovations which well serve these two sectors is significantly supported by the government. The study of Chanvarasuth and

**Table 5: Science and technology parks attraction factors more specific to health-related firms****Attractive factors**

Concentration on health sector (or specific health industry) makes STP attractive for all potential firms and talents due to similar laboratory equipment and needs

Performing in health-care innovation environment enhances health-related ideas

Supportive policies on the required time for testing and implementation of health-related outcomes

Specific services to familiarize non-health innovators with the health sector working conditions when working with experts in this sector

High-quality experts to create standardized approaches to enrich the health system, for instance, in relation to digital health solutions in different stages such as identification, development, validation, or deployment

Public university partnership with health-related industries to promote innovation programs

Increasing the regulatory process speed

To reconsider the academic output measurement

Source: Summary of the literature review by the authors. STP=Science and technology parks

Indaraprasirt<sup>[65]</sup> focuses on this issue and elaborates the six main goals of the Thailand's National Biotechnology Policy Framework 2004–2009, in which two goals are considered to be more important in catalyzing the industrial productivity and enhancing economic growth and sustainability. "Healthcare center of Asia" and "Kitchen of the world" are the two main goals considering the fact that 65% of new biotechnology firms in Thailand are active in medical/health sector and 27% in agriculture/food sector. The Thai government incentives to support these national goals included corporate income tax exemption for all qualified projects and import tax exemption on equipment and machinery. Two autonomous government agencies, NSTDA and the Thailand Centre of Excellence for Life Sciences are responsible to support biotechnology investors. This is an example on how the government could support new technologies in health sector.

Few studies have examined the health technology innovators and the way they deal with the economic actors and health systems through the social constructing of their firm. To fill this gap the study of Beaulieu and Lehoux<sup>[66]</sup> aimed to find the differences between the health technology startups (HTS) and other startups by testing a conceptual model on five firms (listed in the Toronto Stock Exchange) including three HTS. The study examined the social emergence of HTS by considering their media coverage, press releases and their observable market actions from the neoinstitutional theory perspective. The organizational response to pressures was also studied considering the type of firm, health or nonhealth and the stage of activity, whether established or startup. The results showed that regulatory bodies and health professionals had more content and

control-related pressures on the HTS firms compared to nonhealth firms. In the use of symbolic actions and marketing, health startups focused more on cognitive and pragmatic legitimacy rather than moral judgments or actors' self-interest. While during the expansion phase, the nonhealth firm had more emphasis on marketing, possibly due to the larger and more heterogeneous actors, the health firms had more marketing during the stable phase with more simplified actions to help the availability of firm in the memory of the observers.

## Conclusions

Health sector STPs such as other multidimensional STPs need to attract high-quality potential start-ups and firms to locate into the park. The health sector has more complications due to dealing with the health of the population, and any innovation in this sector needs to be highly monitored and supported. The aim of this study was to fill this gap. The literature review conducted in this study showed that it is not only the STP that requires to take actions in creating an attractive atmosphere for firms but there are other players such as government, universities and industries that have a great potential to catalyze STP policies in providing an attractive environment for firms. It is also important to consider what is demanded by the firms to make the STP attractive as well. The items which are retrieved from the review are listed in the finding section; however, it appears that having a knowledge-based economy plays a leading role in the effective corporation of abovementioned players. Beside the attractive factors mentioned for multidimensional STPs, which are applicable for the health sector, some factors which might be more specific to the health sector were explained. It appears that brokerage services in health sector are one of the requirements to commercialize novel ideas in this sector and thus make STPs an attractive place for firms.

The results of this study would mainly help the STP managers, local and national governments, universities and industries to have a better understanding of firms needs in health sector and apply that in their policy and decision making. While the attractive factors of STPs for firms were retrieved from the literature review in this study, however, the importance of each factor for firms remains to be identified by conducting extensive interviews with the active firms in the health sector in future studies.

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## Conflicts of interest

There are no conflicts of interest.

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