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Beyond the Landlords: Exploring Perceptual Attributes and Benefits of Science Parks from an Ecosystem Perspective

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ABSTRACT

Science Parks (SPs) are expected to boost the growth and capabilities of their tenant companies, most research on their performance focuses on the outcomes or performance of these companies. However, SPs are in social ecosystems with responsibilities to a range of stakeholders, including tenant companies, the community, residents, and employees. This paper explores how different stakeholders evaluate SPs, and the relations between perceptual attributes and benefits from the perspective of stakeholders. We took Zizhu national SP as a case study and found that this relationship is affected by the heterogeneity of various factors, including the type and size of the company, the respondent's role, and the position of employees etc. We identify the top three attributes and three benefits and explored their relations. This paper provides a detailed and nuanced view of their roles within the broader ecosystem.

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1. Introduction

Policy makers and academia have explored many ways and instruments to spur economic development, and there have been stronger initiatives to promote innovation over the past decades [1]. Science Park (SP) is one such initiative used to stimulate technology transfer and economic advancement. The UK SP Association [2] defines SP as "a business support and technology transfer initiative that: (1) encourages the growth and development of innova-

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tion-led, knowledge-based firms, (2) provides an environment where firms can develop interactions with centers of knowledge creation, and (3) has formal and operational links with academic institutions." As such, SP is not a traditional real estate investment in which a landlord simply leases the space to tenants; rather, SP requires a designated management team to actively operate a creative environment for supporting the entrepreneurial process, from ideation to business launch and growth. By studying SP in the UK, Helmers [2] showed that clustering of knowledge-based firms can facilitate firm-level innovative activity. Another study on Taiwanese SP also suggests "agglomeration spillovers are a major driver of policy creating science parks across the world" [3]. To create such agglomeration economies, SP has attracted enormous public investment [4]. It is therefore important to understand how SP works and performs. As SP is expected to boost growth and capabilities of tenant firms, majority of research attention on SP performance was to examine the outcomes of tenant firms, or their "performance" [5]. The outcomes generally fall into Economic Performance [6], [7] and Innovative Performance [6], [8], [9].

One possible explanation of these less than univocal findings is that not all firms have the same objectives because they are at different life stages. Besides, SP contribution might take time or a different form to manifest, not necessarily in the form of financial or innovative measures [10]. Some authors then addressed the need for additional research on perceptual measures such as perceived benefits or values of SP firms [10], [11] to complement the performance measurement because perceptual measures might provide an account for the different objectives among different firms [10]. One of the most recent academic attempts to fill this under-researched topic of perceived values is by Ng et al. [12] where the authors conducted an in-depth empirical study involving 51 firms on SPs in the Netherlands to explore the perceived benefits that tenants associate with SP attributes. The research reveals that the managerial attributes are associated with all three categories of economic, innovation and networking benefits by tenants [12]. As such, the SP management and its activities are highly valued by tenants and could lead to increased tenant firm performance [12], [13].

To our best knowledge, there is little prior empiric research on the relationship between SP attributes and perceived benefits in China and this study will learn from previous studies and provide additional insights to fill the knowledge gap in this regard. This paper takes Shanghai Zizhu High-Tech Park as the main research object with the aim to enrich Ng et al. [12] findings from the following perspective: First, heterogeneity of stakeholders. one of the inherit hypothesis in Ng et al. [12] work is that all firms are homogeneous, while this paper will try to demonstrate that heterogeneity among all key SP stakeholders, which could potentially impact their value perception and association. Second, more diverse attributes in the Chinese Context. As a geographically bounded initiative, SPs are often compared to spontaneous Cluster [14] whereas park management plays an important role in facilitating the agglomeration effects, fostering network with VC firms and Research institutes [15], [16]. The author intends to add other little-researched attributes such as SP management's marketing & promotion capabilities; dedicated SP service team; legal, tax and payroll advisory services, etc.

2. Theoretical Model

Attributes, perceived benefits as well as key factors inside SP that may potentially impact on tenant's rents [10], [17]. The basic idea of the conceptual framework is to consider all the elements inside a science park. According to the spiral innovation theory, the performance of SP is influenced by various factors from multiple stakeholders, including the government, businesses, the park itself, and the surrounding environment. When these factors are effectively integrated, they can enhance the performance of the park (such as profits, knowledge, and capabilities), as well as the attitudes of different stakeholders toward these outcomes, that is, the perceived performance.

Considering this conceptual framework and drawing reference from previous studies, SP attributes discussed in this research are categorized into Proximity, Real-estate, Managerial and Unpromoted attributes and listed in *Appendix (Table 1)*. The list of benefits is primarily from previous empirical studies where most of the research attention on SP performance was to examine the outcomes of tenant firms, or their "performance." The outcomes generally fall into three categories: Economic Performance, Innovative Performance and Other Performances. Table 2 quoted some of the previous studies that have discussed captioned benefits. It is worth noticing that all of these discussions are under two contexts: some as performance indicators, and some were later on referenced by Ng et al. [12] as Perceived Values/Benefits (*Appendix Table 2*).

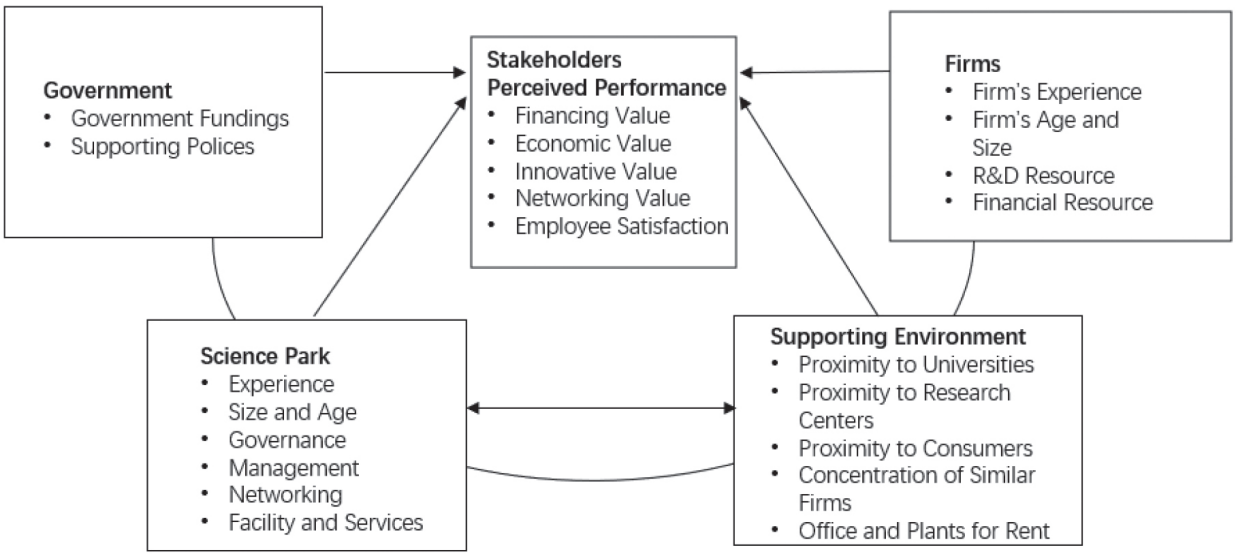

Figure 1. Conceptual framework

3. Materials and methods

3.1 Samples

China's SP are industrial zones with a high level of technological content, created to promote the development of high-tech industries. These zones have helped optimize and upgrade traditional industries while accelerating regional economic growth. The first SP in China were established in 1988, and there are now more than 170 national SPs. Zizhu SP is a technology park established in September 2001 [18]. It was jointly funded by seven shareholder entities, including the Minhang District People's Government, Shanghai Jiao Tong University, Zijiang Group, and Shanghai Lianhe Investment Company [18]. In 2011, Zizhu SP became a National High-tech Industrial Development Zone [18]. The park focuses on six leading industries: integrated circuits and software, new energy, aerospace, digital content, new materials, and life sciences. By 2023, the park hosted over 6,100 enterprises and employed more than 150,000 technology professionals [18].

The interviews were hosted online during Feb - Apr 2024 in Shanghai Zizhu Science Park, China. In total 51 online effective interviews were completed. One of the primary propositions of this study is that heterogeneity exists which might in turn impact respondent's value perception towards Zizhu SP. To provide relevant insights and data in this regard, interviews were designed to recruit respondents that have dissimilarities at both company level and personal level. The companies from which respondents were recruited have dissimilarities in terms of size, ownership model (state owned/private owned), usage of property (rent/purchase the land) and sectors. Instead of talking to top level executives, or 'employers', interviews are directed to employees too. Zizhu SP management were also invited to share their inputs serving and finding appropriate projects/companies to invite on-site. To understand if there are possible externalities brought by the SP, respondents also included some 'inhabitants' of SP: nearby students who had internship/full-time jobs in the SP; Residents who purchased residential property nearby (developed by Zizhu SP).

A total of 51 respondents from 18 different companies participated in the interview. Following Table 3 illustrates the characteristics of 18 companies. 18 companies have fair representations of companies of various scales: 7 are with less than 100 employees, another 6 companies are medium in size with less than 500 employees and 5 companies are large corporations with at least 500+ employees. Table 4 gives an account of the 'roles' or 'identities' of 51 respondents in total. In addition to 14 senior management-level respondents, or 'employers'; the survey also covered 21 employees who may share different experience/encounters in the SP. In addition, the survey also included eight people working in Zizhu SP, providing financing/infrastructure planning services to tenant firms, etc.; and another eight 'inhabitants' of SP including students currently working in Zizhu and residents nearby that may have experienced 'spillovers' of Zizhu.

3.2 Methods

In this paper the intention is to identify the strength of association between Attribute Ai and Perceived Benefits B, Bj under the condition that Ai is already being selected. Lift Ratio has been used in previous works of Ng et al. [12] and defined as below: where Ai represents one of the attributes and Bj represents one of the benefits, Lift Ratio first consider the conditional probability of Bj given A, divided by the probability of Bj happening as a single incidence.

$$\text{Lift Ratio (I) (Ai-Bj)} = \frac{P(B_j|Ai)}{P(B_j)}$$

If Lift Ratio > 1, then the Ai and Bj are associated. In other words, the occurrence of Ai will increase the probability of Bj happening. On the contrary, if Lift Ratio <1, then A and B are considered independent incidence, the occurrence of one does not impact the probability of another happening. *Appendix (Table 2)* illustrated the lift ratio of a benefit given a certain attribute, the average probability for any given attributes to be selected is 2.4%.

4. Results and Discussions

Each respondent was asked to map up to three perceived benefits to the attributes of SP they've previous selected. A total of 41 attributes were mapped against 31 perceived benefits, generating 1536 total effective mentions. The detailed conditional probability of perceived benefits given attributes were listed in *Appendix (Table 1 and 2)*. Top three attributes most frequently associated with benefits are Close to University (7%), Supporting Facility and Services (7%), and Image/Reputation of the SP (7%). Top three benefits most frequently mentioned are Employee Satisfaction (12%), Easier to Recruit (10%), and Develop Tie with Other Firms (8%). For conditional probability, Financing Benefits (reduced cost and higher chances of secure financing) are most strongly associated with managerial attributes, especially the governance of SP, as well as the existing access to financial resources. Economic Value (Cost-saving) specifically are most strongly associated with different forms of rebate (Tax rebate, rent rebate and deduction).

It is worth mentioning that Employee Value such as easier to recruit, low turnover rate and employee satisfaction, all of which were previously underdiscussed, saw high association with 1) Proximity attributes (Close to transportation hub/With Mature residential and shopping amenities); 2) Supportive Attributes such as great natural/ecological environment, flexible and orderly park management.

4.1 Proximity Attributes and Perceptual benefits

Among all proximity attributes, close to university, transportation hub, with mature residential and shopping amenities are top three in terms of condi-

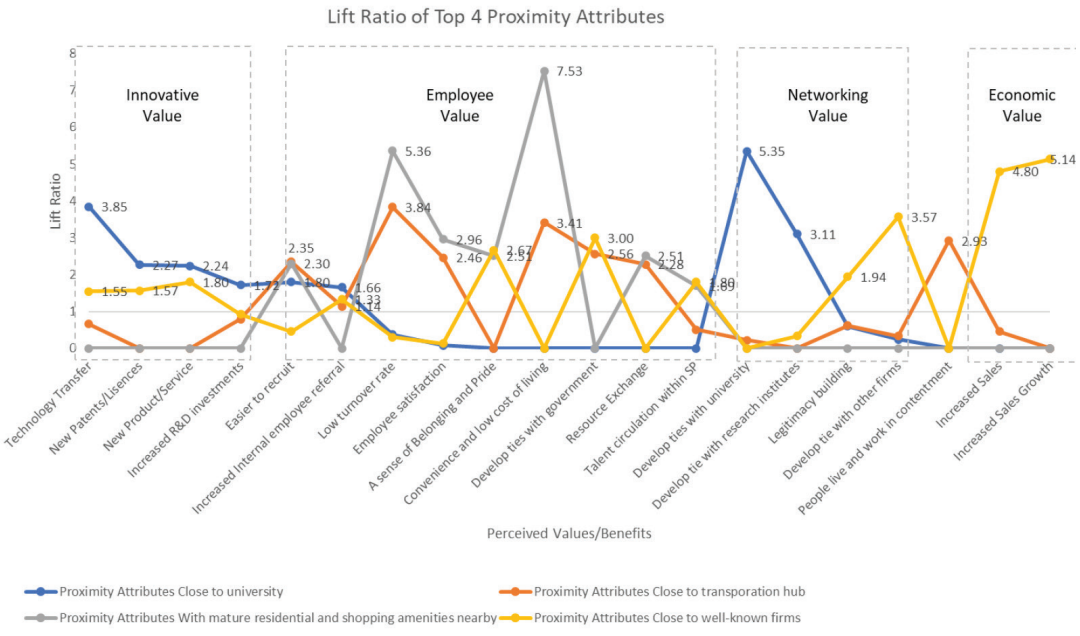

Figure 2. Lift Ratio of Proximity Attributes

tional probability. For the sake of clear illustration, following Figure 2 demonstrate all key perceived values strongly associated with identified top proximity attributes.

For Close to University, it is most strongly associated with Network (Tie with University/Innovation (Tech Transfer)/Employee Benefits (Easier to Recruit), not much so on economic/finance value; While for close to transportation hub, it is much more related to Employee Benefits (Low Turnover Rate/Employee Satisfaction/Convenience and low cost of living)

Close to University (6.7%) is predominately and intuitively associated with innovative value (Tech transfer, New patents and products) and networking value (Develop tie with university and research institutes) with. Considering Zizhu has considerable network of adjacent university alumni working, there are two distinctive employee values closely associated as well: easier to recruit and employee referral. Many real-world examples show that a close relationship between universities and science parks can create a positive feedback loop, driving innovation through knowledge transfer, talent development, resource sharing, and interdisciplinary collaboration. For instance, research and technological advancements at Stanford University have played a key role in shaping the tech innovation ecosystem of Silicon Valley [19]. Similarly, the high-quality talent developed by the University of Cambridge has provided technical and managerial expertise to the Cambridge Science Park, fostering its innovation. Additionally, universities and science parks can collaborate more closely by sharing resources: universities can offer lab facilities, research funding, and specialized knowledge, while science parks can provide real-world application scenarios and market feedback [13].

Close to transportation hub (4.9%) is more associated with Employee value. By increase the convenience and reduce the cost of living, this attribute is also highly associated with low turnover rate and high employee satisfaction. Transportation hubs make commuting easier for employees, reducing the time and energy spent on travel. This is especially important for workers in tech parks, who often need to stay efficient and energized [20]. Good transportation connections can lower commuting stress and boost job satisfaction. Convenient transportation can also be a major factor in attracting talent, particularly in large cities where traffic congestion can be a serious problem. Employees are more likely to choose a job with better transportation access. This pattern coincides with another proximity attribute-With mature residential and shopping amenities nearby (4.4%). Close to well-known firms (4.2%) saw higher association with both employee value (employee satisfaction/talent circulation within SP) and economic value and is the only top proximity attribute associated with economic value (increase sales/sales growth). Therefore, being located near or partnering with well-known companies can boost a science park's reputation and influence. Renowned companies often have a strong brand presence, which can positively impact the surrounding area, increasing the overall visibility and appeal of the entire SP [21].

4.2 Real-Estate Attributes and Perceptual benefits

Top two real-estate attributes are also among the top attributes with highest endorsement. *Supporting facilities and service* (6.8%) are strongly and intuitively associated with most employee values. One of the 'spillovers' of SP supporting facilities is that residents nearby get to enjoy some of the resources/activities organized by SP. This result can be interpreted from three perspectives: First, modern employees' expectations for their work environment extend beyond just salary and position to include comfort and quality of life. They want to enjoy a better quality of life outside of work, including opportunities for health, learning, and recreation. Second, a good work environment and recreational facilities help employees relax and reduce work-related stress, which in turn enhances productivity and creativity. Third, in many large cities, employees often deal with traffic congestion, which increases commute times and decreases comfort. Moreover, employees in these cities typically have heavy workloads, making it challenging to find time for services like fitness. For these reasons, supporting facilities and services have become a key competitive advantage for science parks [22].

Image/Reputation of the SP (6.6%) on the other hand, is mostly related to company entity, rather than individual employees, hence saw higher association on Finance Value (Higher chances of secure financing), Economic Value (increased sales and sales growth) and Networking Value (Develop ties with other firms and Legitimacy building). At employee level, SP with strong and positive reputation can translates to a sense of belonging and pride which can in-turn help with recruitment.

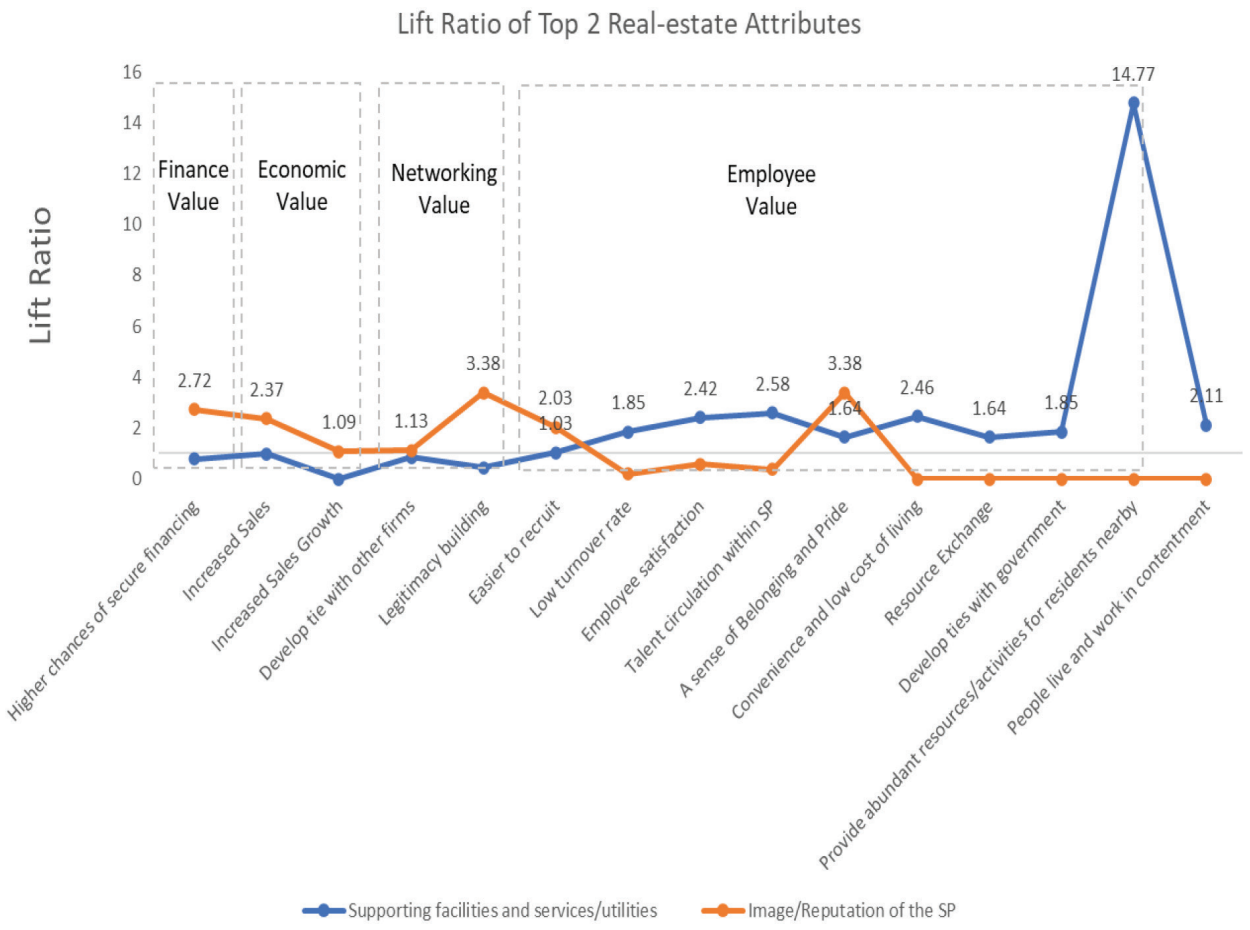

Figure 3. Lift Ratio of Real-estate Attributes

4.3 Managerial Attributes and Perceptual benefits

Good communal atmosphere (5.5%) is predominantly associated with employee value, namely talent circulation within SP, increased referral and higher satisfaction (as a result of convenience/low cost of living). In a positive communal atmosphere, employees are more inclined to share ideas and feedback. This open environment fosters innovative thinking, helping businesses identify new opportunities and solutions, drive improvements in products and services, and ultimately boost company growth and profitability. Additionally, a strong communal atmosphere helps employees feel valued and accepted, enhancing their sense of belonging and job satisfaction. Involved SP management (5.1%) to many, especially SMEs, are highly associated with financing service (higher chances of secure financing, reduced financing cost and increased subsidy), which can in-turn translates into Economic Value (Increased sales growth) and Innovative Value (Increased R&D investment).

Unity of University-Government-Private entity (4.6%) shares similar association with Involved SP management: to many tenants, the unique governance structure of Zizhu SP enables the management with more financial resources and flexibility in operation, which are crucial benefits for SMEs. Management with Marketing& Business Development capabilities (4.5%) is another distinctive characteristic of Zizhu Management previously discussed. This attribute is associated with a variety of benefits including financing, economic, networking and other 'unprompted' values. This result further underscores the importance of collaboration between schools, government, and businesses [23]. Cooperation among these three sectors can generate profits and deliver social and economic benefits, but in practice, such tri-sector partnerships often face numerous challenges. Inconsistent goals, difficulties in resource allocation, complex coordination and management, regulatory constraints, and risk and responsibility distribution all impact their collaboration. Addressing these challenges requires the development of a collaborative framework and solutions by all parties involved, which can enhance the success and effectiveness of the partnership. Private science parks face intense market competition and must continually innovate to maintain a

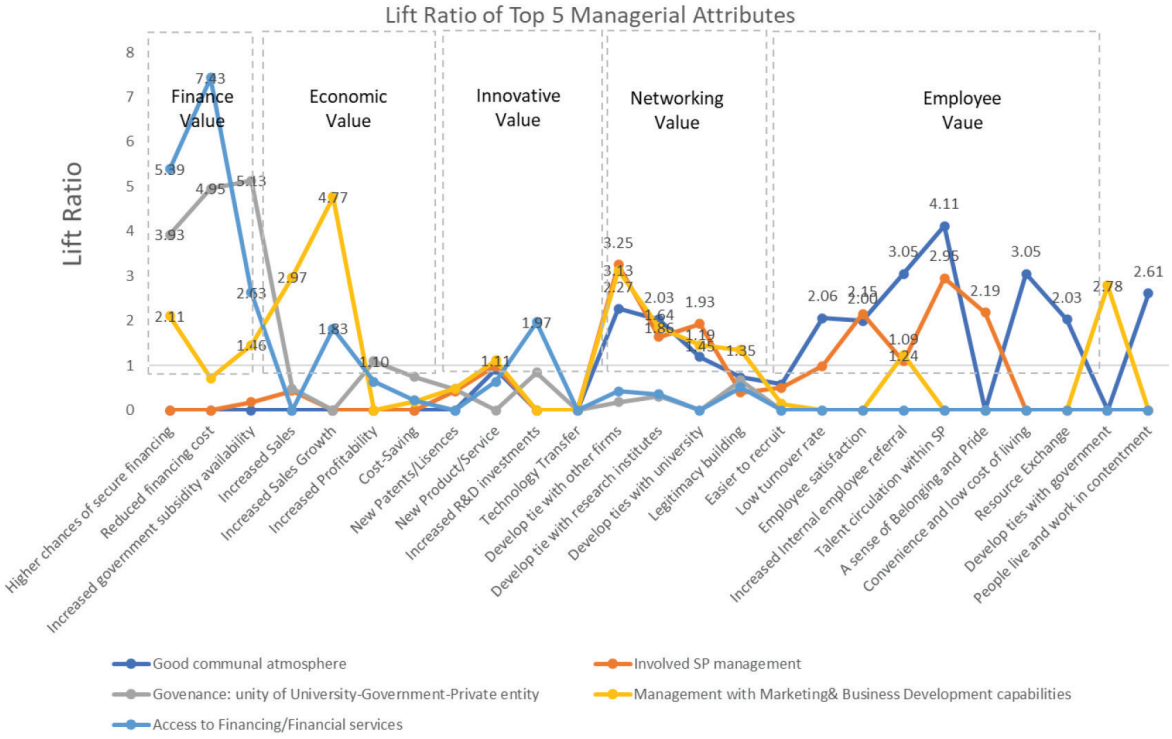

Figure 4. Lift Ratio of Managerial Attributes

competitive edge. Therefore, private park managers need to closely monitor market demands and trends, driving innovation to meet customer expectations. For example, at Zizhu Science Park, park managers have facilitated collaboration between government, universities, and park-based companies by integrating resources, organizing events, providing funding and technical support, overcoming collaboration barriers, and enhancing the park's attractiveness.

4.4 Supportive Attributes and Perceptual benefits

During the data-collection stage, respondents have spontaneously mentioned a few attributes and perceived values. To avoid asserting unjust influence on respondents by adding-in these unprompted statements, all attributes/values were recorded and later on categorized to reflect their frequency of mention, etc. Among all unprompted, top attribute (1.3%) is Great natural/ecological environment. This attribute is mostly mentioned by residents/employees as one of its distinctive 'externality' and are strongly associated with higher employee satisfaction, or 'people live and work in contentment', and 'provide good environment for upbringing of kids, which are crucial consideration factor for many people when they are making career choice consideration. Employees' focus on natural and ecological environments offers valuable insights for SP managers, emphasizing the importance of incorporating environmental factors into park planning and operations. By enhancing green spaces, health facilities, innovative environments, and sustainability measures, managers can improve employee satisfaction and well-being while also boosting the park's attractiveness and long-term value [24]. These efforts can help attract and retain top companies and talent, driving the park's sustainable development. In China, some national-level economic development zones have significantly improved their environmental quality by adopting green building standards and eco-friendly technologies, even with limited resources [15]. While investment in environmental resources is often seen as not providing immediate economic benefits, this study shows that such investments can deliver long-term value for the development of science parks [25], [26].

5. Conclusion

SP is an intricate ecosystem that harbors inhabitants of different identities: other than employees and employers from companies of different scale, there are inhabitants engaged in other forms: inhabitants including students/teachers who studied/worked on-site of SP, and residents living in SP (real-estate developed by SP) whose partner work in SP and children

study in schools planned/orchestrated by SP. The difference in such identities/life stages was naturally reflected in their perceptions/attributes towards SP; the values they recognize as provided by these distinctive attributes are essentially also different.

Traditionally, governments around the world have provided significant support to tech parks through tax breaks, financial aid, land use policies, and more. The U.S. Department of Commerce (DOC) has designated 31 technology centers across the United States (in 32 states and Puerto Rico), providing more than $1 billion in financial support [19]. To develop Tsukuba Science City, the Japanese government has implemented planned initiatives, offering policy support such as the "Tsukuba Research and Educational City Construction Act" and developing public infrastructure, including education, highways, and environmental facilities. Over the years, Tsukuba Science City has become one of the most renowned science cities in the world. China's High-tech Zones have a history of over 30 years, with government support in the form of policy backing, the development of public infrastructure, and a regulated business environment. These incentives have helped businesses in the parks grow. Tenant firms benefit from advanced office facilities, good transportation connections, and comprehensive living amenities, as these factors directly impact operational efficiency and the quality of life for employees [20]. Thus, the association between proximity attributes / real-estate attributes and perceptual benefits from all stakeholders are identified in this study. Since existing research has not explored how management factors and support environments affect stakeholders' perceived benefits, this paper identifies the causal relationship between these factors and stakeholders' perceived benefits [27].

The performance of SPs is influenced by various stakeholders, including the government, businesses, the external environment, research institutions, universities, and residents. The long-term success of these science parks depends on the collaboration and contributions of all these stakeholders. Thus, science parks need to shift from just providing basic infrastructure to becoming comprehensive service platforms. They should offer a range of services that businesses need, such as startup mentoring, technical consulting, market expansion, and legal support. This requires the parks to build specialized service teams that can deliver high-quality support. Science parks develop ecosystems, which is critical to foster collaboration and interaction among businesses, research institutions, investors, and government agencies.

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Appendix

Table A1. SP Attributes

Categorization	Description (ENG)	Label
Proximity Attributes (source: [6])	Close to university	Uni
	Close to research institute	Research
	Close to similar firms	SimiF
	Close to well-known firms	WellF
	Close to competitor	Compet
	Close to customer	Client
	Close to transportation hub	Hub
	With mature residential and shopping amenities nearby	Amenity
Real Estate Attributes (source: [6])	Access to R&D facilities	RDAcc
	Supporting facilities and services/utilities	SupFac
	Flexibility to expand	Flex
	Attractive Pricing	Pricing
	Image/Reputation of the SP	Image
	Customization of plants/office	Custom
	Standardize office/plants	Stdard
	Waste treatment services	WasteTreat
	SP Age/History	SP Age
	Real estate age	Propty Age
	Real estate nature (leasing/own/co-own)	Propty Nature
Managerial Attributes (Source: [5])	Governance: unity of University-Government-Private entity	Governance
	Advisory and Services like payroll, tax and legal topics	Advisory
	Dedicated fund/policy for my type of company (of specific industry/ scale)	Fund/Policy
	Management with Marketing& Business Development capabilities	Mkt&Biz Capability
	Good communal atmosphere	Communal
	Fast-track privilege for certain government projects	Fast-track
	Access to certain forums/summits	Summits
	Access to Financing/Financial services	Financing
	Involved SP management offering various forms of exchanges/communal activities	Involved SP
	Other forms of rent rebate/deduction	Rent
	Tax rebate	Tax
	Resource/Access to University-Enterprise collaboration	CollabAcc
	Targeted talent programs	Talent
Supportive Attributes (Source: [26])	Great natural/ecological environment	Eco
	Flexible and orderly park management (public order/safety, etc.)	Flex Mgmt
	Park management team with strong sense of service	Service
	Mentality	
	Highly-educated/skilled workforce	Educated Labor
	Park culture that encourages entrepreneurship	Entrepreneur
	Educational resources for employee's kids as part of the amenity	Edu Amenity
	Resource sharing/re-distribution between residential, educational and SP	Resource Redistribution
	Lifetime service from dedicated park management team with service and guidance needed	Lifetime Dedicated Svc
	Discover and support new enterprises/abundant investment resources	Scout

Table A2. SP Benefits

Categorization	Description (ENG)	Source (As Performance Indicator/perceived benefits)
Financing Value	Higher chances of secure financing Reduced financing cost Increased government subsidy	[12]
Economic Value	Increased Sales Increased Sales Growth Increased Profitability Cost-Saving	[6]
Innovative Value	New Patents/Licenses New Product/Service Increased R&D investments Technology Transfer	[7]
Networking Value	Develop tie with other firms Develop tie with research institutes Develop ties with university Legitimacy building	[13]
Employee Value	Easier to recruit Low turnover rate Employee satisfaction Increased Internal employee referral Talent circulation within SP A sense of Belonging and Pride Convenience and low cost of living Resource Exchange Develop ties with government Facilitate the growth and efficient operation of startups Provide abundant resources/activities for residents nearby Residents share common interest and access to job opportunities	[7]
Other Value/externalities	Provide good environment for upbringing of kids Real-estate appreciation People live and work in contentment Amenities for easier commute	Practices of the Zizhu Science Park