THE ROLE OF BUILT ENVIRONMENT IN DEVELOPING SUSTAINABLE HIGH TECH PARKS: ESTABLISHMENT OF PHYSICAL DEVELOPMENT AND KNOWLEDGE COMMUNITY NEEDS

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ABSTRACT

This paper emphasize the role of built environment in developing sustainable high tech park, the needs of knowledge community and the relationship between the physical development of high tech parks. In addition, it's describes the comparative physical development between Cyberjaya, Malaysia and Tsukuba Science City, Japan. Thus, this study is engender towards identify the significant role of high tech parks in terms of the build environment, physical planning and design strategy in knowledge community planning. The analysis of the case study through physical elements and community participation in Cyberjaya, Malaysia and Tsukuba Science City, Japan indicates how people perceive their living and working environment. This study demonstrates and posits that sustainable environment can be achieve through effective physical planning and design approach in high tech park development.

Keywords: *Built Environment, Knowledge Community, High Tech Parks, Sustainable Planning.*

1. Introduction

The word today is moving fast towards the transformation of its regions and cities into knowledge based societies than being characterized by the dawn of the new millennium. The phenomenon of high technology industrial parks (HTPS) which also refers to as "High Tech Parks" is showing an excited vitality all over the world. The number of high technology industrial parks (high tech parks) keeps growing according to International Association of Science Parks [1]. New models are conceived and implemented and more companies find high technology industrial parks as a fertile ground to expand and become more competitive. Moreover, they are important building blocks of the knowledge economy architecture and a convenience place for research and development activities. Based on the industrial revolution, high tech parks were emerged from conventional industrial parks [2]. High tech parks contribute an important role of our modern economic today. The significant functions of high tech parks are not only as a knowledge transfer and incubator activities but also as a place which gives the implication to the local and regional environment. Recently, the importance of place making has become a main consideration in developing high tech parks. The aim of this study is to define the significance of physical planning and design concept of high tech park. In this paper, we examine physical characters in high tech parks development from theoretical aspects and in the case study of Cyberjaya in Malaysia and Tsukuba Science City in Japan. This paper illustrates the importance of built environment for high tech park development. In addition, we conducted a questionnaire survey which targeted the public opinions on the physical setting in the high tech park.

2. DEFINITION OF HIGH TECH PARKS

There are various terms used to represent high tech parks as applicable in different regions or country, among the notable names using are: Technology Park, Science Park, Science and Technology Park, Research Park, Technopole /Technopolis, science cities, intelligence cities, knowledge society or research parks among other terms [3], [4]. The terms have been used

closely almost in similar definitions. International Association of Science Parks [8], has classified five famous names which have been used to represent high tech parks; technology parks; science parks; science and technology parks; research parks and technopolis. High tech parks provide for technology transfer with high skill people and have a very strong relationship with the university and research institute. Moreover, these places offer a high quality working and living environment and are well equipped with advance technology facilities to support the research and development (R&D) activities."Reference, [5]" asserted that, a high tech park, referring to an urban property development which precisely aims to provide an amenable physical place for the commercialization of new ideas and knowledge resulting from R&D activities that occurred within an urban context.

High Tech Parks, Technopolis, Science Cities, Research Parks are common names in a regional innovation strategy that generates sustained and propulsive economic activity through the creation and commercialization of new knowledge [6], [7]. A technopolis is not merely concentration of high technology firms or research and development organizations but also the comprehensive physical development of new technologies, translating the resources output into commercial products or processes and also the careful approach to take a competitive regional growth in terms of economic, social and environmental sustainability. The high tech park's concept emphasizes the need for a balanced approach to a high technology development. Instead of only focusing on technology, it involves the creation of new settlement, complete with research parks, new universities, technology centers, housing and cultural facilities [8].

3. SUSTAINABLE BUILT ENVIRONMENT AND HIGH TECH PARKS DEVELOPMENT

Sustainability has become an important strategy to be considered in the planning area particularly in high tech parks development. The term of sustainability has been defined as the process of meeting the needs of the present without comprising the ability of the future generations [9]. It focuses on a balance development for future preservation of society/community,

economy/commerce and ecology. "Reference [10]" affirmed that, a high tech park as a place for R&D that exists within the urban environment. The transition from conventional industry into the industrial park concept has significantly changed most of the planning and design ideas; the land use and zoning, scales, locations, site characters and transportation. The transformation has equally changed the physical patterns of the park setting [2]. The trend of society also shifted from informational into knowledge oriented and from manufacturing into service based. A high tech cluster is a combination of R&D, knowledge based economic activities and pleasant surroundings. The ambiance of high tech parks includes picturesque, gardens, open lawns, and stimulating cultural activities in the surrounding area that entertain well educated workers. Hence, The strong links between quality of place and quality of life are widely recognized in the new urbanism era as well as in the high tech park trends. Creating places of high quality environment in the high tech parks always become important agenda [11].

4. PLACE MAKING IN THE HIGH TECH PARK

Place making is much about meaningfulness to local people as its unique and memorable form. Memorable of physical elements in the high tech park will create sense of belonging as well as place and identity in the park. Place making enhances life and promotes human activities through spaces and other physical environments. A good high tech administrator will provided an overall context with integration of residential, offices, commercial and entertainment activities; thatwill reflected purposes, values and principles which in turn led to a clearer image and branded park; helped make the place a desirable work-life environment. Good incorporation of all physical structures and landscape can build an identity of place. The growth of various generations of high tech parks illustrates have reflected how important the built environment is to a growing company. The importance of place making makes high tech parks unique development compare to other industrial areas. Today's parks are creating environment that fosters collaboration of activities (see table 1.0).

5. HUMAN AND SOCIAL NEEDS IN THE HIGH TECH PARKS DEVELOPMENT

The physical development should be developed in accordance with the inhabitants/community needs in the high tech park. As a settlement and working place, the provision of high quality public spaces as a platform for social activities is needed. Public space is an area in a neighborhood that is accessible for active and passive activities that provide other public benefits [12]. Sense of enjoyable environment in the high tech park should offer a variety of social activities. The connection between physical design and community should strive to:

- Encourage physical development links with social activities;
- Develop a clear understanding of public, semi public, and private space and the physical transition between spaces;
- Integrate high tech industrial zone, residential, recreational and mixed use development;
- Provide "eyes on the street and path";
- Integrate civic buildings such as schools, institutions, libraries, community centre, religion buildings into the community, and give them special prominence.

These design concepts and innovations have potential social implications in the high tech park development. Building design and site development need to provide pleasant and enjoyable environment that make pedestrian the preferred mode of travel (see table 1.0). Furthermore, the built environment should respect local climate, local culture and lifestyles. Creative and high quality environments should be encouraged in the site development.

Table 1.0. Images Indicate Built Environment Of High Tech Parks Development And The Relationship Between People And Place

Building and Surrounding	Corridor: Pedestrian and Street	Open Space
Garden / Courtyard	**Path and Cycling**	**Recreation and Leisure**

6. HIGH TECH PARKS, QUALITY OF LIFE AND A LEARNING REGION

The basic concept of a learning village is a place for people to live, learn and work in high quality environments [13]. The physical aim of learning village is to provide people living nearby their work place, learn and research with advance equipments in a healthy environment. The term high tech parks community is also known as a knowledge community. Knowledge community is based on knowledge living environment. The concept of knowledge cities as defined by "Reference, [4]" as a place designed purposely to encourage the nurturing of knowledge. "Reference, [14]" asserted that, a science city as a research community. A research community derives from three characteristics. The first characteristics includes a communication among scientist and engineers, who represent an unusually large proportion of the population; secondly a place for concentrations of scientific, technological and intellectual resources, such as laboratories, testing equipments, libraries, technicians; thirdly, the university graduate students. The rapid rate of scientific innovation based on research activities, publications and products. Therefore, an investment in quality of life is one of the important aspects in the high tech park development policy [6]. The concept of integrated telecommunication network provides the opportunities of sharing knowledge in the active learning village environment. As a result several technology districts have grown in

cluster form and well connected to each other by high quality telecommunication networks. The environment of high tech parks is based on a multi pole system composed of various zonings, building characters, public spaces, communities, landscapes and facilities. Starting from 1980s, economic contribution of high technology parks to the local development began to be noticed. It consists of distinctive high technology industrial zone, education, culture, residential, business, commercial and recreational space.

Sustainability in high tech parks can be described from various angles; the sense of community, characters of the place, the built form, and the environmental management. It was reported that 15% of high tech districts now have residential elements [13]. High tech parks stands as a symbiosis between the universities and the high technology industry.

7. A CASE STUDY OF CYBERJAYA, MALAYSIA

Cyberjaya is the nucleus of the Malaysia Multimedia Super Corridor (MSC-Malaysia). The city is designed to equip businesses and corporations located with the latest Information Communications Technology (ICT). Cyberjaya is located approximately 50 kilometers from Kuala Lumpur, 10 kilometers from Kuala Lumpur International Airport and 5 kilometers from Putrajaya. It aims to be an "intelligent city" engenderd to develop Malaysia's multimedia industry which complement Putrajaya, a new federal government territory. In 2008, population in Cyberjaya in the day-time consists of 37,000 people and for night-time 13,000 people. Total land development of Cyberjaya is approximately 2890 hectares. Land use planning in Cyberjaya can be divided into seven categories: residential (28.3%), enterprise (13.5%), commercial (4.2%), institutional (10.2%), mixed zone (3.8%), open spaces (5.8%), and infrastructure (34.2%) [3]. The land use distribution indicates two major developments in Cyberjaya consisting of residential zone and enterprise zone [15].There are two main groups living and working in Cyberjaya: students and workers. The population rate in Cyberjaya is increasing from year 2007 (16,400 people) to year 2008 (18,700 people). Currently, there are many projects in Cyberjaya still under construction such as office blocks, entertainments, enterprise and commercial blocks.

The concept of balanced, harmonious relationship between 'Man and Nature' can be recognized from Landscape Master Plan pattern of Cyberjaya [15]. Thirty percent of the entire Cyberjaya project is allocated for greenery and open spaces [16]. Thirty percent of each development plot is reserved for green spaces. Green areas in the master plan are classified into five categories: green areas, parks, buffer zones, retention ponds and sewerage systems. Urban blocks and plots at enterprise zone in Cyberjaya provide varieties of open spaces such as green at the perimeter of plots, courtyards, islands, corridors and parking spaces.

7.1 Tsukuba Science City Case Study

Tsukuba Science City is the biggest national project undertaken in 1963 [17]. It has two purposes: to meet the need for high level R&D and improve higher education; and to cope with overcrowded conditions in the Tokyo district. Under the Basic Plan for Science and Technology, Tsukuba Science City is outlined to be the core city to promote science and technology. Tsukuba is expected to serve as "Center City of Excellence" by developing its creative and advanced research activities and by providing information to the world. The Basic Plan for Science and Technology is topromotes an active research exchange and joint study between public research and educational institutes and private research institutes.

7.1.1 Physical Planning and Design Concept

The development process of Tsukuba Science City can be divided into three periods; a planning phase in 1960s a construction phase during the 1970s and a collaboration phase since the 1980s. Creation of New Growth Industries. One of Japan's global mandates are to create and foster new growth industries in Tsukuba Science City which compiles Japan's top-level scientific research. The basic principles development of Tsukuba Science City based on Academic New Town Construction Promotion Headquarters, 1971 is to develop a place for research and educational activities by maintaining mutual organic connection, preservation of the natural living and heritage elements and maintaining the cultural living [18].

7.1.2 Development of Eco-Life Model City and the Greenway System

Important assets of Tsukuba Science City are the urban city environment as well as the natural and rural environment which includes Mount of Tsukuba, Ushiku Marsh, flatland forests, traditional scenes of villages, and groves around traditional residences. As an attractive city of high quality, Tsukuba preserves the natural and rural environment, make the best use of each regional characteristic, enhance the living environment and beautiful scenery, and afforest unused land. Considering Tsukuba 3E Forum Declaration 2008, developing and promoting innovative technologies towards low carbon, safe and healthy environmental science city, and promoting environmental education become important agenda in Tsukuba model. An environmental technology fostered by research institutes in Tsukuba is expected to be used for the development of the Eco-Life Model City. Advanced urban facilities and public facilities in the Research and Education district describe the importance of living and working environment.

Figure 4.0 5km walkway across town center of Tsukuba Science City that link series of green spaces
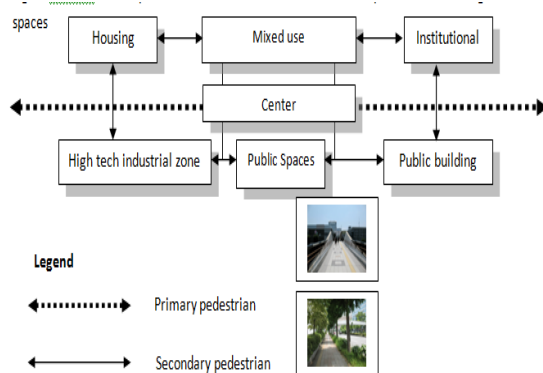

Figure 1.0 Schematic Pedestrian Oriented Development Based On The Tsukuba Science City

A pathway system that links buildings or parcels to each other and to their parking areas, transit stops, recreational areas, shops, and public buildings. In Tsukuba City Centre, the master plan includes significant amounts of open space, commercial support, office and mixed residential uses within convenient walking distance. Figure 1.0 shows a schematic pedestrian oriented development based on the Tsukuba Science City. In Tsukuba Science City, wide pedestrians are attached with cycling lanes.

Walking is the most basic movement in the high tech park especially to connect the areas within 500 meters radius. Pedestrians were linked between plots and blocks. The pedestrian networks are attached with cycling lanes of about 2-3 meter wide.

8. BUILT-UP IN HIGH TECH PARKS

In the high tech park development, the built area for tenant's lot is averagely between 30 to 50 percent, but some developers provide up to 40 to 50%. Large proportion of the green spaces provides various amenities, natural zone, and outdoor spaces for activities as well as for future developments. The building height creates sense of human- scale in the high tech park development [12]. For example, an area for 1600m², and the built area is 20-40%, the appropriate of building height is between one to two stories. If the plot size is expanding into 8000m², the built area can be 40-50% and the building height can up to three to five stories. This indicates that, the provision of green areas is around 20-40% and the development provides two stories to five stories of building height which depends on the plot size. Most of the buildings in the high tech parks are not solid buildings. The building massing provides some open spaces such as pocket gardens, courtyards, plazas and green corridors around the perimeter blocks. Generally, a rectangular building is the most building form in high tech parks. Building placement and edge character indicates a clear block patterns, provide active sidewalk and perimeter with green planting (see figure 2.0). Typically, high tech parks characterized by a wide buffer zone.
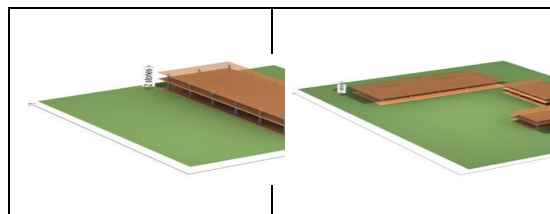

Figure 2.0 Proportion Of Built Areas And Open Spaces At Tenant's Lot

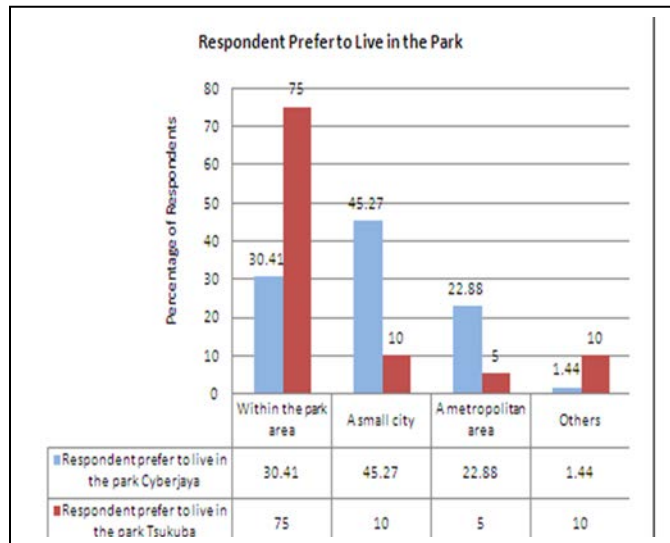**8.1 Questionnaire in Living Environment**

Figure 3.0 Comparative Result Between Cyberjaya And Tsukuba Science City Based On The Memorable Features In The Park.

Respondents were asked to choose from a selection of four answers which reflected their opinion on the place they prefer to live in the park or other areas (see figure 3.0). The options offered were divided into four categories: living within the park area, in a small city, in metropolitan area and others. In Cyberjaya, 45.27% respondents choose that they preferred to live in a small city. 30.41% of responses select preferred to live within the park area. On the other hand, to live in a metropolitan (22.88%) or other areas (1.44%) are not so popular rated by the respondents in Cyberjaya. In contrast, respondents in Tsukuba Science City were highly preferred to live in the park area i.e. the respondents percentage is (75%). Other areas are not so significant popular to the respondent such as living in a small city (10%), a metropolitan area (5%) and others (10). Based on this result, the residents in Tsukuba Science City highly preferred to live in the park (75%) compared with responses in Cyberjaya which only 30.41% voted to live in the park.

8.2 Comparative Study Between Cyberjaya And Tsukuba Science City, Favorable Features In The Park
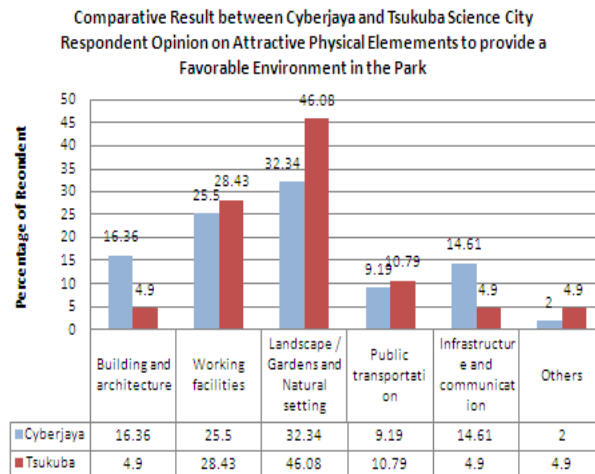

Figure 4.0 *Comparative Result Between Cyberjaya And Tsukuba Science City Based On The Favorable Features In The Park*

Respondents were asked to select among six categories which reflected their opinions on physical elements that provide a favorable environment to the park (see figure 4.0). The options given were:
   i.   Building and architecture
   ii.   Working facilities
   iii.   Landscape, gardens and natural setting
   iv.   Public transportation system
   v.   Infrastructure and communication
   vi.   Others

From the result, , 32% of the respondents in Cyberjaya stated that landscapes, gardens and natural settings provide a favorable environment to the park. Twenty six percent of respondents reported that working facilities contributed in developing a favorable environment of the park, followed by building and architecture (16%), and infrastructure and communication (15%). On the other hand, public transportation (9%) and other factors (2%) as these were not considered as significant elements. Based on respondents' opinion in Tsukuba Science City, 46% of respondents stated that landscapes, gardens and natural settings provide a favorable environment to the park. Twenty eight percent of respondents reported the working facilities involved in

developing favorable environment of the park, subsequently followed by public transportation (11%). Other factors were not considered to be so significant according respondents' opinion such as building and architecture (5%), infrastructure and communication (5%) and other factors (5%). The results describe in both case studies indicate that landscape and gardens play an important role to provide a favorable environment to the park. The comparative results as shown in (see figure 5.0) describe that the physical setting in the Tsukuba Science City provides more elements that are creating sense of memorable to the communities and visitors compared with the physical setting in Cyberjaya. The percentage of each element in the Tsukuba Science City is higher than the percentage of each element in Cyberjaya. For instance, the highest element that creates sense of memorable in Tsukuba Science City park in landscape category is(77.5%) whereas the highest element that creates sense of memorable in Cyberjaya buildings category is (66.6%).

8.3 Comparative study between Cyberjaya and Tsukuba Science City (in percentage), Memorable Features in the Park

Figure 5.0 Comparative Result Between Cyberjaya And Tsukuba Science City Based On The Memorable Features In The Park.

In addition, this result indicates that, the most significant element that creates sense of memorable in Tsukuba Science City is the parks and landscapes category. While in Cyberjaya, buildings category plays an important element to create sense of memorable.

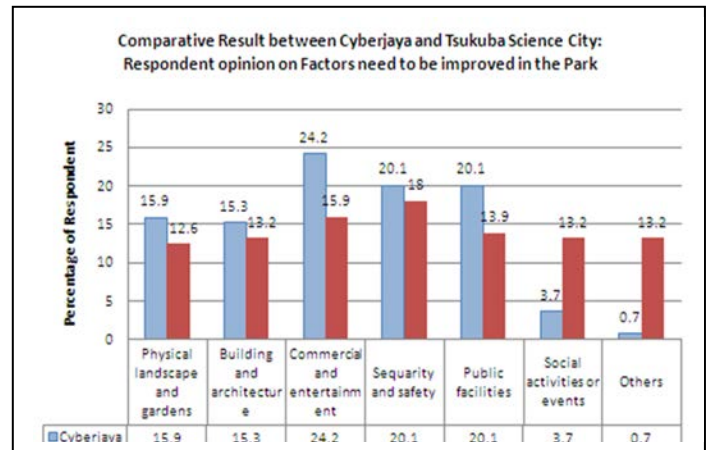## 8.4 Questionnaire on Respondent Opinion on Factors needs to be Improved in the Park

Figure 6.0 Comparative Results Between Cyberjaya And Tsukuba Science City Respondent Opinion Of Factors Need To Be Improved In The Park

Figure 6.0 indicates the comparative results between Cyberjaya and Tsukuba Science City .This encompass the factors that needed to be improved in the park. In Cyberjaya, the most significant factors needed to be improved are commercial and entertainments (24.2%) followed by security and safety (20.1%) and public facilities (20.1%). The other categories are landscape and gardens (15.9%), and the building and architecture (15.3%). Social activities and other factors are not so significant. However, in Tsukuba Science City the most significant factors that need to be improved is security and safety (18%). Thus, this factor was followed by commercial and entertainment (15.9%). Other factors are averaged such as public facilities (13.9%), landscape and gardens (12.6%), social activities and other aspects (13.2%).

Summarily, physical characters and high quality of place making in the high tech park need to be incorporated significantly into a spatial master planning. The importance of physical characters as well as their built form will improve spaces, activities, movement patterns, and the sense of place which further create an enjoyable experience and livable communities in the park.

Individual work place	Small working area	Public area and sharing space

Figure 7.0 Images For Several Types Of Workplaces: Individual Working Space, Small Working Space And Public

9. DEVELOPMENT OF SOCIAL SPACES AND WORKING PLACE ENVIRONMENT IN THE HIGH TECH PARK

Currently, most high tech parks consist of various types of land uses as well as various types of spaces. The provision of public spaces in the high tech park is quite dominant such as in the commercial blocks, central parking spaces, food courts, parks, community centre and street and pedestrian corridors. However, some of these places are not well function due on some problems such as lack of linkages, unattractive environment and activities [19], [20]. Social spaces in the high tech park could play more significant role in develop an attractive and enjoyable environment in the high tech park. The social life occurred at public spaces played a significant in creating vibrant atmosphere and facilitates human interaction [21]. The development of social spaces in the high tech park should get a strong support by the site management. In term of location, there are two types of social spaces: first, inside the tenant lot, and secondly, social space that is located around the whole development. Social spaces are essentially discretionary environments: people have to use them and conceivably could choose to go elsewhere. Man must be offer an attractive and safe environment to get the best result for reasonable development [22]. Work place is one of the important aspects of the physical planning and design development in the high tech park. Workplaces have to provide the best possible working conditions. Smaller functional distances facilitate social interaction [23]. Sharing facilities and public spaces can create opportunities for people to meet each other and exchange information.

10. CONCLUSION

High tech parks are new type of property investment with a different degree of risk from other industrial properties.High tech park physical environment required to be shape to suggest pleasant, comfortable, and a desirable outdoor. Cyberjaya and Tsukuba Science City have demonstrated a concern over sustainable development from their physical characters based on the relationship among the physical elements, landscape and gardens. However, the two Science Cities create a human friendly environment, providing a balance by putting people needs into considerations and ensuring a safety and healthy place to lives and works. Based on the case studies, public activities play an important role to make an active living and working environment in the park. The physical characters and high quality of place making in the high tech park need to be incorporated significantly into a spatial master planning. The physical planning and design should not only cater for high technology industrial activities but the place should be varied in terms of land use and zonings of infrastructural facilities and programs. The new agendas of high tech parks should also determine the uniqueness of the place such as the relation of physical setting to the community, place making and environment, social activities, architectural expression, sustainability, events and special programs, transportation systems, and the location. Interesting and conducive environment should be provide to attract people to live and work in high tech park

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