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TERRITORY DEVELOPMENT INNOVATION STRATEGY OF THE INTELLIGENT SCIENCE PARK: DEVELOPING THE INTELLIGENT PARK

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Abstract. *The transformation of territory relies on innovation. The purpose of the study is trying to set targets of development, operation and management, to form a complete intelligent service and build an intelligent system of the park in planning stage. The result of this study will provide the important principles of planning strategies of the intelligent park through innovative thinking from theoretical basis and the Fuzzy Delphi Method.*

Keywords: Science park, Intelligent park, Territory, Innovation strategy

1. **Introduction.** The development of science parks started in the second half of the twentieth century. They are very important tools to improve industrial competitiveness for the countries around the world, and so far their developments have become important industrial assets and landmarks for advanced countries [1]. Also, they have connected the industry development with urban management. With digitalization technique, the science parks can plan a complete integrated intelligent system in the aspects of development, management and operation, which can provide the innovation of management and service, and the intelligent park with good quality sustainable green environment [2]. So these regions have become a part of the "new territory" with cluster, technopôle and competitive park [3].

The purpose of study is to explore the intelligent park's system construction principles and evaluation factors through the Fuzzy Delphi Method. It will first collect the intelligentilization related studies and research to sort out the systematic evaluation items via literature analysis, and then discuss the deployment of innovation territory from the theoretical base, and finally conduct an in-depth analysis about the strategy of the intelligent park construction through the literature review and expert interviews.

2. **New Strategy of Territory Development in Taiwan: Intelligent Park.** For Taiwan, "intelligentilization" could be a new strategy of the future development of the science park [4]. In order to ensure the implementation of principle of the construction of the intelligent science park, and to meet the requirement for long-term operation, it is necessary to conduct comprehensive investigation and research on park function, management mode, industrial positioning choice in the early planning stage, and make a well considerate integration planning of intelligent systems according to the results, and hence propose the key planning principles in terms of the following issues in the planning stage:

A. It should make unified standards and hence take strict control and compliance [5]: the establishment of intelligent system should have unified planning and uniform design standards and hence be planned and designed according to the property hierarchy [6].

And also, it should take the techniques and the experience of the original park into account and conduct in-depth investigation on different departments of the enterprises to understand their management requirements in order to eliminate the information gap between different departments and make preparation for mutual information communication [7].

B. Implementation principle of staged construction: as the constantly updated technology, the characteristic of the rapid development of intelligent technology becomes conflict to the characteristic of long period construction work [8]. It is essential for the planning stage to have forward-looking and operational characteristics leaving space further development [9].

C. Pay attention to the application principle and development trend: the intelligent science park has a multi-function environment in which it covers different function spaces and different types of buildings. The use of intelligence should pay more attention on the different attributes of applications and integrate the existing technology, advanced technology and standards in the planning stage. And also, it should give corresponding desired requirements to different types of buildings [10].

D. Strengthen and promote technical advantages of industrial contents: one of the construction objectives of the intelligent science park is to strengthen industrial advantages through the park and to provide the technical development service for industries. As it can develop the existing industrial advantages of the park, it can also use the existing resources to reduce the investment cost and highlight the company competitiveness [11].

3. **The Intelligent Park's System Construction Principles and Evaluation Factors.** This study will conduct a questionnaire on "the intelligent park's system construction principles and evaluation items" to select the evaluation index for each system through the Fuzzy Delphi Method. And there is a panel of 12 experts who participate in this study. The traditional Delphi method has the disadvantage of ignoring the opinions of the experts, so this study adopts the Fuzzy Delphi Method to replace it. According to the mean standardization mode, we establish the triangular fuzzy function ($\widetilde{\mathrm{N}}_{\mathrm{A}}$) with the obtained experts' evaluation values from Equations (1) to (4), in order to achieve the consensus in expert opinions: ($\mathrm{X}_{i\mathrm{k}}$ = the evaluation value of i factor from k expert; $\mathcal{L}_i$ = the low limit of evaluation value of i factor from expert panel; $\mathcal{M}_i$ = the geometric mean of evaluation value of i factor from expert panel; $\mathcal{U}_i$ = the ceiling of evaluation value of i factor from expert panel; i = factor; k = expert).

$$\begin{cases} \widetilde{\mathrm{N}}_{\mathrm{A}} = (\mathcal{L}_i, \mathcal{M}_i, \mathcal{U}_i) & (1) \\ \mathcal{L}_i = \mathrm{Min}(\mathrm{X}_{i\mathrm{k}}), \quad \mathrm{k} = 1 \sim \mathrm{n} & (2) \\ \mathcal{M}_i = \left[\prod_{\mathrm{k}=1}^{\mathrm{n}} \mathrm{X}_{i\mathrm{k}}\right]^{1/\mathrm{n}}, \quad \mathrm{k} = 1 \sim \mathrm{n} & (3) \\ \mathcal{U}_i = \mathrm{Max}(\mathrm{X}_{i\mathrm{k}}), \quad \mathrm{k} = 1 \sim \mathrm{n} & (4) \end{cases}$$

Through the above method, the Traditional Delphi Method can be converted into the Fuzzy Delphi Mode as illustrated in Figure 1: The upper limit (b) and the lower limit (a) of the generalized average number function will be the two end points of trigonometric fuzzy function of the expert's consensus, and the expert's consensus will be expressed by the geometric mean (M). In the figure, UN(X) = the subordinate function of the experts' consensus; J = experts' assessment value; a = the minimum value; b = the maximum value; M = geometric mean. Finally, the decision-maker will determine the threshold value (S) based on the purpose of the study in order to decide whether to remove or retain a particular factor. If the geometric mean of a factor is greater or equal to the threshold value ($\mathrm{M} \geqq \mathrm{S}$), then the factor will be retained to be an assessment factor; on the contrary, when the geometric mean of a factor is smaller than the threshold value ($\mathrm{M} <$

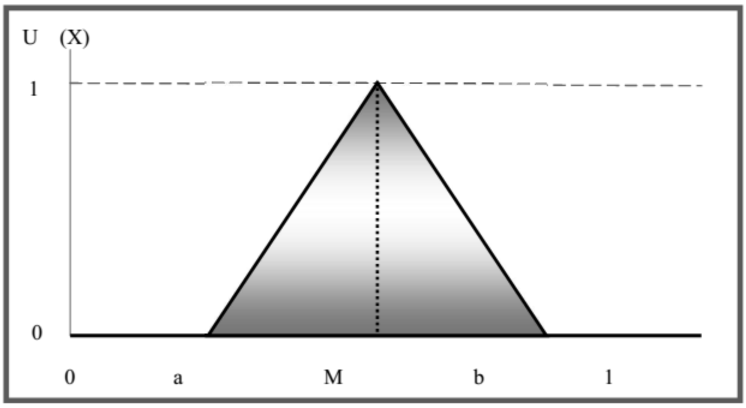

Figure 1. Fuzzy Delphi Method diagram (Source of data: X. L. Chen, 1995)

S), that particular factor item will be removed. The threshold value can be adjusted by the decision-maker; when there are too few factors left, the threshold value can be lowered. The Delphi Team has decided: This study will perform an indicator questionnaire on "The System Construction Principle and the Assessment Items of the Intelligence Park", through the Fuzzy Delphi to select the assessment indicators of each system, with 12 people on the team. The respondents should meet at last one of the following principles:

a. The professionals actually engaged in the planning and design of architecture.
b. The personnel engaged in teaching or research on the topics related to this study.
c. Someone whose professional background is related to the topics of this study.
d. Someone who currently has considerable reputation in the related fields domestically.
e. Someone who has published articles or reports related to or similar to the topics of this study.
f. Managers who currently actually work inside the Science Park.
g. Someone who is concerned about this study or has sufficient professional expertise or knowledge of the topics of this study.

The Design of the Questionnaire: The first questionnaire will be unstructured. The Delphi Team will be interviewed for their opinions, and the second questionnaire will be prepared based on the team members' opinions. The content of the first questionnaire will be based on the discussion on documents and the interview result of the experts by the researcher. Except for the content of the questions, how the questions should be answered was communicated with the respondents in advance. Before sorting out the intelligent park's system construction principles and evaluation factors, this study first collects the intelligentilization related studies and research to sort out the systematic evaluation items through literature analysis, and hence the total of 62 indexes have been summarized. In addition, the total of 62 indexes have been classified, so the intelligent park's system construction principle and evaluation item index involve 30 mid indexes (1. Monitoring and data transmission technology; 2. Energy storage and conversion technology; 3. Energy deployment technology; 4. The application of Internet of Things technology; 5. Intelligent monitoring technology; 6. Intelligent parking guidance system; 7. Intelligent car tracking system; 8. Parking reservation; 9. Comprehensive wiring; 10. Safety disaster prevention; 11. System integration; 12. Facilities management; 13. Safety and disaster; 14. Health and comfort; 15. Care and convenient; 16. Energy saving management; 17. Process control visualization; 18. Comprehensive system supervision and control; 19. Developing greenization; 20. Application cloud information platform; 21. Mass data analysis techniques; 22. Intelligent warehouse management; 23. Information security intelligence report; 24. Automatic management control mechanism; 25. Initiative pre-warning; 26. Disaster monitoring data safety and sharing mechanism; 27.

Cloud service integration; 28. Intelligent administrative; 29. Intelligent industries; 30. Intelligent livelihood and society), which are under hierarchy of 9 indexes [A. Energy system control platform technology (mid index 1-3); B. Park video surveillance system and intrusion detection (mid index 4-5); C. Intelligent parking guidance system (mid index 6-8); D. The intelligent building system (mid index 9-16); E. Intelligent manufacturing system (mid index 17-19); F. Intelligent logistics management system (mid index 20-22); G. Intelligent information security protection system (mid index 23-25); H. Intelligent science park's disaster prevention and control information system (mid index 26-27); I. The Intelligent Science Park's Application Service Platform (mid index 28-30)]. The design of this questionnaire is intended to perform in a semi-open way, and based on the level classification, the experts were asked to give subjective value rating on the importance of each indicator factor in order to obtain the experts' assessment value of each factor. (Following each indicator item, there will be an option to add another indicator in order to supplement for the inadequacy of the factor indicators initially chosen.) The importance rating on the questionnaire will be assessed from one point to five points; the higher the points the more important it is. No personal data will be on the questionnaire in order to comply with the anonymity requirement of the Delphi Method. Besides that we collect experts' opinions in the first round, and we have to conduct a second round with a feedback questionnaire. The results obtained from the second round will be performed in geometric mean (G) to represent the opinion value of all members of the expert panel, which does not need to conduct a further feedback questionnaire and analyze the quartile deviation. Moreover, we set the standard value (S = 3) as screening criteria to delete any index of which the importance level does not reach the limit, and therefore, we obtain the results for the intelligent park system construction principles and evaluation items index are summarized in Table 1 with geometric mean score, of which the total qualified small indexes are 62 items, under 30 mid indexes and 9 indexes.

Table 1. The description of the intelligent park's system construction principle and evaluation items

mid indexes	Small Indexes	Geometric mean (G)
1.	1. Able to real-time monitor and control physical and chemical state of various types of energy and the operation of the equipment	4.57
	2. Able to learn data information which is transmitted to the control platform	4.37
	3. The requirements and specifications on production, storage, and transmission stage which meets the energy planning and design	4.57
	4. Make sure the normal, stable and safe operation of each equipment	4.78
	5. Whether the wireless sensor network is simply deployed to reduce the construction cost and increase system expansion flexibility	4.18
2.	6. Whether the different regional and spatial conditions have appropriate energy corresponding storage system	4.18
	7. Whether it is the core technology of energy system	3.95
3.	8. Have to deal with the energy change problems	4.13
	9. Able to make the supply and demand of energy production reach the equilibrium point	4.57
	10. Able to conduct the dynamic demand analysis and optimization at the same time	4.13
	11. Able to predict the types of future real-time demand and the required flow	4.78
	12. Able to adopt the dynamic energy management mode and operation decision technology for supporting dynamic energy distribution technology	3.56
4.	13. Able to extensively monitor and multifunctional management	4.78
	14. Available to fully automatic monitor	4.78
	15. A security mechanism with rapidly seeking integration and instant response	4.57
	16. Able to early detect and actively defense	4.18
5.	17. Able to accomplish intrusion detection	4.57
	18. Camera or video encoders with video analysis function	4.78
	19. Able to be used as an auxiliary tool for management and service	3.56
6.	20. Able to provide the assistance including parking guidance, reverse cars tracking, toll administration, and parking reservation, etc.	4.78
	21. Able to automatically identify, lead vehicles to enter, and allow the owner to have inverse tracking query	3.78

7.	22. Able to quickly learn which section has empty parking lot 23. Able to locate the vehicle and show the shortest route from the query point to the vehicle park location	4.57 4.18
8.	24. Able to make parking reservation through telephones, SMS, and online booking service center, etc.	3.44
9.	25. The infrastructures with open, flexible and scalable wiring	4.78
10.	26. Information and communication systems with high security and efficiency and reliability and able to perform mass data transmission	4.78
11.	27. Integration management and comprehensive service capabilities 28. Application system resources can be shared with information exchange	4.78 4.18
12.	29. Good facilities management and mechanism 30. Able to ensure the intelligence systems' safety, reliability and convenience	4.78 4.32
13.	31. Able to effectively use automation systems 32. Able to realize the active prevention	4.78 4.18
14.	33. Six major projects include space environment, visual environment, thermal environment, air environment, water environment, and health care management system	4.18
15.	34. Whether the spatial auxiliary system of building space, information service system, and the service life system are personalized or intellectualized	4.78
16.	35. Whether the buildings' energy management, energy monitoring and energy saving benefit shall reduce energy consumption, and utilize the renewable energy	4.78
17.	36. Able to show the real-time situation direct to the administrators 37. The administrators are able to implement management maintenance with complete information	4.57 4.78
18.	38. The systems should have functions including identification, analysis, reasoning, decision-making, and control 39. Able to integrate the manufacturing information intellectualizing technology	4.57 4.78
19.	40. The recycle concept of green product life cycle management 41. Able to use the green ICT value added application, extending to the green supply chain synergy management, process management and intelligent environment monitoring	4.18 3.57
20.	42. Able to establish full monitoring and management mechanism, and to provide logistics industry with high-end cloud services	4.78
21.	43. The systems must have the ability to take the initiative to inform the administrators in the case of a major event or accident	4.78
22.	44. To provide more efficient and flexible operation management for enterprises' problems	4.18
23.	45. To ensure the administrators to learn and obtain sufficient information 46. Able to determine the risk level of the future risk and make pre-prevention	4.57 4.18
24.	47. The analysis tools with predictive statistic 48. Standardized management standard and procedures	4.78 4.78
25.	49. Able to initiatively predict and find out the problems and weaknesses and hence make correction 50. To ensure the enterprises and users have safety network environment 51. The dynamic immediate response mechanism to reduce damage	4.57 4.78 4.18
26.	52. The disaster prevention and rescue work with the ability of performing functions such as intelligent scheduling, collaborative command, comprehensive release and joint protection 53. To improve efficiency, and the active target is disaster prevention and mitigation 54. To strengthen the professional united disaster prevention mechanism 55. To establish a comprehensive pre-warning system with reliability and process 56. To establish a technology innovation mechanism of disaster prevention	4.78 4.18 4.57 4.78 3.95
27.	57. To conduct proper and sufficient investigations, real-time monitoring, observation, data storage, and disaster information 58. Able to provide important information as references, and then to provide a variety of early warning and decision supporting information to the managers through system research and analysis and integration 59. The abilities of automatic learning and integrating innovation and connecting with a variety of information	4.78 4.78 4.78
28.	60. To involve electronic administrative service platforms, public information publishing platforms, emergency dispatching platforms, park security platforms, virtual management centers, park comprehensive management platforms, and park traffic management platforms, etc.	4.78
29.	61. To involve smart business platforms, intelligent logistics and distribution, logistics information platforms, and enterprise public service platforms	4.57
30.	62. To involve the intelligent medical service platforms, smart education platforms, and the intelligent community service platforms	4.32

Source: From this study

4. **Conclusion.** This study adopts the theory of the Fuzzy Delphi Method to select the intelligent science park's construction principles and evaluation items via questionnaire, and combines the results of the questionnaires and comprehensive in-depth interview to learn that the concept of stability, security, integrity management and autonomous

learning system is the most important for this research subject. From this result and the interview with many experts, it shows that the most problems needed to be overcome for the system construction of the intelligent science park include information fusion, system integration, and system upgrade restriction. In addition, the involved integration scope of the system construction of the intelligent science park is very extensive and the discussed contents are also in a wide range and not easy to concentrate, which are discussed systematically. Finally, for the future development of science parks, it is expected to refer to the reform and innovation strategies from the advanced foreign countries in order to implement systematic integration with innovative strategies of intellectualization in the course of development trend of the times and in the direction of developing the science parks in Taiwan with characteristics. And the development of the intelligent science parks shall become the pilot project for smart city. And also, this study is expected to shed lights on the direction of future research on the complete and detailed practices, implementation and supporting measures for each future strategy.

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