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Development Of Guideline On Smart Industrial Estate Management For Sustainable Growth

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Abstract

Today regional and global environment is rapidly changed and expanded. The government sector realizes the importance and necessity of development of public utility, public assistance, and other facilities for entrepreneurs to support and promote the industrial advancement and service sector to meet sustainable growth as well as the supervision of environment and safety in industrial estates for economic growth, business balance, and global economic connection. The purpose of this research was to study Development of Guideline on Smart Industrial Estate Management for Sustainable Growth. Qualitative research by in depth interview from 9 experts and focus group with 11 successful businesspersons for approve this model. The sample group was 500 executives in the fields of business and industry. The research instrument used to collect data was a questionnaire. The data was analyzed by descriptive, inferential statistics, and multiple regressions.

The results of the study found that the components of Development of Guideline on Smart Industrial Estate Management for Sustainable Growth were placed according to the order of their importance as follows: 1) Smart Eco System with $\bar{X}$ = 4.21: the most important point was the support of utilizing solar energy generated by solar cells by providing a reasonable discount and expanding a period of factory rent to the business operators who participate the project. 2) Smart Facility

with $\bar{X}$ = 4. 20 : the most important point was the implement of clean energy or
transformation of transportation ways that may reduce energy, such as pipeline transportation, rail transport, corridor lighting system, with solar energy, and so on. 3) Smart Servitization with $\bar{X}$ = 4.19: the most important point was the provision of services as the Great Service Total Solution Center (TSC) do by implementing modern technology for service integration and management to meet clients or customers' needs precisely, rapidly, and effectively. 4) Smart Regulations $\bar{X}$ = 4. 15: the most important point was to monitor and follow the improvement of the law, regulations, and rules to communicate with organizations located in the industrial estates precisely,rapidly, and on time. The results of hypothesis test found that the First S-Curve and New S-Curve industries focused on the components of guidelines for smart industrial estate management to meet sustainable growth at the statistical significance level of 0.05.

The results of structural equation modeling analysis found that all the indexes passed the criteria with consistency and harmony of the model and empirical data. The Chi-square minimum probability (CMIN/P) was of 0. 093, the Chi- square minimum discrepancy per degree of freedom (CMIN/ DF) was of 1. 127, the goodness of fit index (GFI) was of 0. 958, and the root mean square error of approximation (RMSEA) was of 0.016.

Keywords: Structural Equation Model, Industrial Estate, Smart Industrial

Derivation and significance of the problem

Currently, the global environment is changing and expanding rapidly, including changes in industry, economy, society, and community. Therefore, the government recognizes the importance and necessity of developing an area with public utilities and facilities for industrial operators. Promoting and supporting the development of industry and the service sector in terms of growing steadily along with environmental and safety governance within the industrial estate forms that will not affect the environment and community is essential. For quality economic growth, balancing business and connecting the global economy is mandatory (Industrial Estate Authority of Thailand, B.E. 2566). From the results of a comparative study of management and ranking of industrial estates in B.E. 2565, when compared to industrial estates in Thailand and the ASEAN region, the Industrial Estate Authority of Thailand (IEAT) is ranked seventh.As in Figure 1.

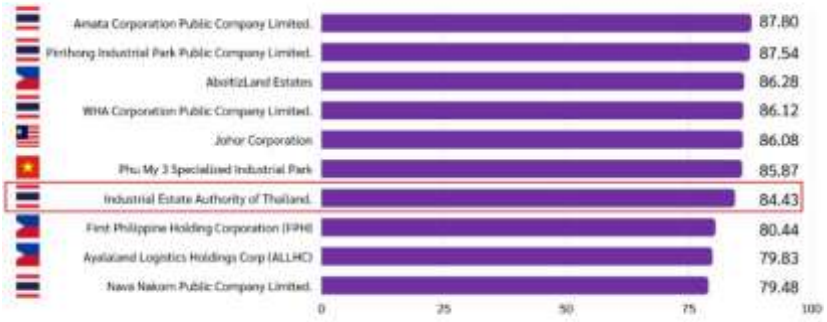

Figure 1 Comparison of management and ranking of industrial estates in B.E. 2565 (Industrial Estate Authority of Thailand by the Policy Research Institute Foundation Fiscal Economy, B.E. 2565).

The study of the position and competitiveness of IEAT in industrial estate management in the ASEAN region revealed the following six aspects:

1) Approval/permission for business operations and business operations in industrial estates ranked 1 has a score of 86.43.

2) Safety, Welfare and Occupational Health Management were in the 1st place with a score of 100.

3) Management in other sections ranked at a 2nd place with a score of 93.75.

4) Public utilities and basic utility services ranked 27th with a score of 71.65.

5) Environmental and energy management in industrial estates ranked 13th with a score of 79.10

6) Convenient facilities ranked at 10^{th}, points 75.60 as shown in Figure 2

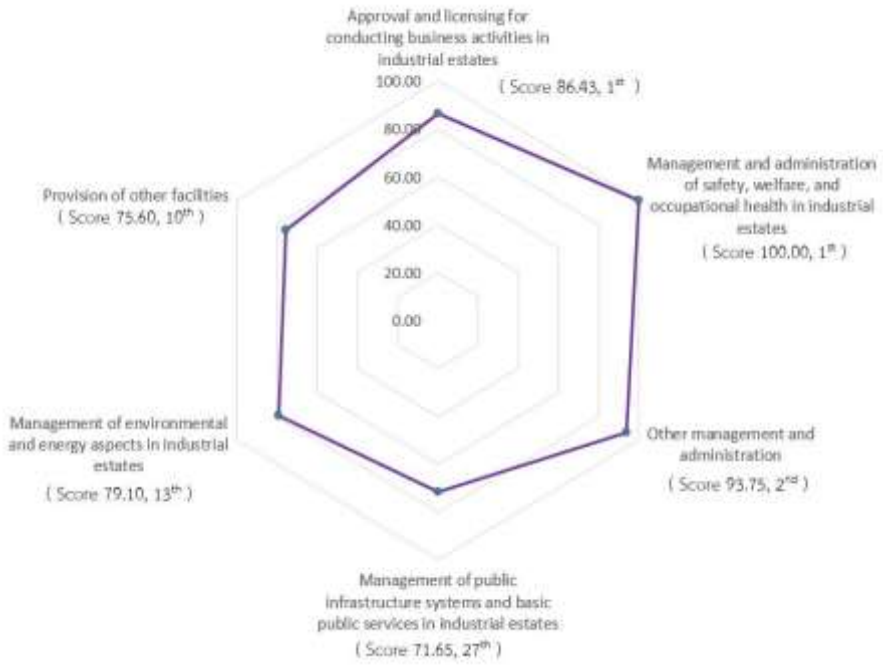

Figure 2: The ranking of industrial estates for the year 2565 B.E. in each aspect (The Industrial Estate Authority of Thailand by the Fiscal Policy Research Institute Foundation, B.E. 2565).

The number of complaints against industrial factories each month every year has increased, as shown in Figure 3. It can be seen that the number of complaints against industrial factories in B.E. 2564 from January to December ranged from 40 to 383 times throughout the year. This reflects that complaints issues in the industry still exist and are still a problem. This consists of trouble types such as; loud noises, vibrations, dust, bad smells, soot, wastewater, chemical vapors, waste/sewage, magnetic waves, nighttime work, traffic obstructions, safety, conflicts, foreign workers, and illegal factories (Department of Industrial Works, B.E. 2564).

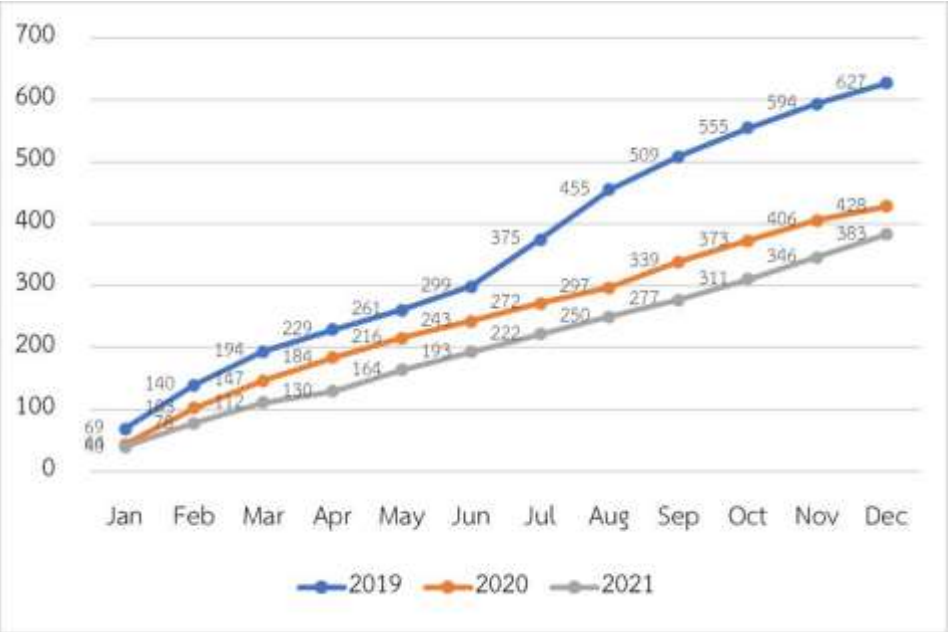

Figure 3: Number of industrial factory complaints (Department of Industrial Works, B.E. 2564)

A summary of the overall ranking of the position and competitiveness of industrial estate management of IEAT in the ASEAN region in the year 2565 B.E. was ranked seventh. It was found that public utilities and essential utility services were ranked 27th, together with complaints to the Department of Industrial Works, causing the industrial sector to encounter industrial management problems. If the industrial sector does not manage such problems, it will be challenging to meet the development needs of smart industries. Further, it affects macro-level competition, thus affecting the overall economy.

Sustainable industrial estate management is becoming increasingly important as the world grapples with the negative impacts of industrialization on the environment and communities. If not managed sustainably, industrial activities can have severe negative impacts on the environment, including air, water, and land pollution, loss of biodiversity, and climate change. Additionally, these activities can adversely affect nearby communities by harming health, reducing the quality of life, and causing social and economic disruptions. Therefore, effective industrial estate management is essential for mitigating these negative impacts and promoting sustainability. This involves adopting environmentally friendly practices such as reducing energy and resource consumption, minimizing waste and air and

water pollution, and promoting renewable energy sources. Sustainable estate management also involves

- promoting community engagement, including informing and empowering local communities,
- building community trust, and
- creating social and economic benefits for nearby communities. Therefore, researchers are interested in studying the management of smart industrial estates for sustainable growth as a guideline for industrial estates, including economic, social, and community promotions.

Literature review

Based on past concepts and theories of smart industrial estate management guidelines for sustainable growth, this study summarizes the guidelines for managing smart industrial estates for sustainable growth into four components as follows:

1. Elements of Smart Regulation, compliance with laws and regulations, and review improvement of law regulations to support and promote the implementation of smart industrial estates. A study by Yu, H., Dong, S., & Li, F. (2019) found that the regulatory compliance of the industrial policy system is designed to assess the overall effect of the industrial system. The simulation results indicate the eco-industrial system's advanced environmental and economic benefits, along with future economic growth. Some shortcomings and limitations of Western China's general industrial system. For example, due to the widespread increase in specialty industries following local policies, the limited and hasty development of the industry, and the instability of the industrial structure to a certain extent. Finally, industrial structure coordination options were proven by the model to balance the local environmental and economic impacts.

2. A smart ecosystem implies the ecological industry has an environmentally appropriate operating system. It involves concentrating on clean energy, which is safe for both human beings and living beings. This also covers the planning process. Further, create clean energy infrastructure and reduce environmental pollution to coexist with all sectors in an integrated manner. According to Kupoluyi et al. (2018), the amount of industrial wastewater in the Oluyole Industrial Estate exceeded the specified standard. When such wastewater is released into the Alaro River, aquatic animals, such as

fish, are damaged and cannot survive. Therefore, government organizations have proposed measures to implement a system to receive wastewater and industrial wastewater to be treated before discharge into the Alaro River.

3. Components of intelligent services (Smart Servitization) facilitate service to stakeholders and support and promote business by providing services with modern technology intelligence. Important information is coherence as a central source for quick, accurate, transparent, and verifiable responses. Noor-A-Rahim et al. (2022) studied the transition to Industry 5.0 with smart manufacturing. As Industry 5.0 aims at human and machine collaboration, which requires high accuracy and reliability, aims for human and machine collaboration. In addition. To communicate with industrial business organizations in industrial estates, fast-forwarding information, and support the use of AI and IoT technologies in the work process of the organization. Therefore, 6G wireless communication networks should be installed in the future.

4. The components of smart facilities support intelligent facilities in industrial estate areas by providing utility systems, such as road systems, water supply, wastewater, electricity, and security systems with smart CCTV cameras. This includes supporting the surrounding facilities to enable stakeholders to conduct business conveniently and quickly. Enhance customer satisfaction and support business operations related to industrial estates. According to Sarjana et al. (2020), the industrial business sector in industrial estates expects the management of industrial estates to develop convenient transportation within industrial estates, fast and stable communication systems, logistics transport networks, and supply chain management support for each industry sector. Examples of the first three well-developed industrial estates studied in this research from Indonesia have been supported by the government for exemplary implementation in formulating supply chain management and innovation strategies.

Objectives of the research

The objectives of this research are to study the factors that affect the management of smart industrial estates towards sustainable growth, are as follows:

1. To study the structure and operation characteristics of industrial businesses in industrial estate
2. To study the components of smart industrial estate management guidelines for sustainable growth.
3. To develop a structural equation model for managing smart industrial estates for sustainable growth.

Confirming the validity of the research model

Research on "Development of Guideline on Smart Industrial Estate Management for Sustainable Growth" consists of experts in 3 groups as follows: Group of business executives (three), officials from government organizations (three), and three experts from educational institutes (Sunee, 2022).

1. Qualitative research was conducted using in-depth interview techniques. The population used in this research consisted of nine experts using Purposive Sampling with the qualification criteria of experts. The criteria were followed according to the Executive Committee of the Doctor of Business Administration Program, Industrial Business Administration Faculty of Business Administration, King Mongkut's University of Technology, North Bangkok.
2. Quantitative Research: The population used in this study was 1,498 people.The sample size was determined using the criteria of component analysis or structural equation modeling. The determined size of the sampling group was very high at 500 samples using the multi-stage sampling method (Silpcharu, 2021). This study adopted a Cluster Sampling process and divided it into two types of businesses. It includes First S-Curve and New S-Curve in Industrial Estate, using Probability Sampling by Lottery Method and collecting data from a group of samples (Sunee Wattanakomol and Thanin Silpcharu, 2022).
3. A purposive sampling method was used to certify the population model used in this Research as 11 qualified experts.

Results

Table 1.
Priority levels of smart industrial estate management guidelines for sustainable growth, classified by industrial business groups

Smart Industrial Estate Management Guidelines for Sustainable Growth	Industry First S-Curve			Industry New S-Curve		
	$\overline{X}$	SD.	Important Level	$\overline{X}$	SD.	Important Level
The importance level of the overall element	4.20	0.38	high	4.18	0.40	high
1. Smart Regulation Aspect.	4.14	0.43	high	4.16	0.45	high
2. Smart Eco System Aspect.	4.23	0.48	high	4.20	0.48	high
3. Smart Servitization Aspect.	4.20	0.42	high	4.18	0.44	high
4. Smart Facility Aspect	4.23	0.44	high	4.17	0.46	high

1. The overall results showed that the First S-Curve industry gave more importance to the management of smart industrial estates for sustainable growth than the New S-Curve industry. The overall First S-curve industry business was at a high level, with an average of 4.20. The components of smart industrial estate management for sustainable growth can be sorted as follows:

1) Smart Facility is important at a high level, with an average score of 4.23.

2) Smart Eco System is important at a high level, with an average of 4.23.

3) Smart Servitization is important at a high level, with an average of 4.20.

4) Smart Regulation is important at a high level, with an average of 4.14 respectively.

The overall New S-Curve industry is important at a high level with an average of 4.18.

The components of smart industrial estate management guidelines for sustainable growth in each aspect are as follows:

1) Smart Eco System is important at a high level, with an average score of 4.20.

2) Smart Servitization is important at a high level, with an average of 4.18.

3) Smart Facilities were important at a high level, with a mean of 4.17.

4) Smart Regulation is important at a high level with a mean of 4.16, respectively.

2. The statistical results used to compare the differences in the importance of smart industrial state management guidelines for sustainable growth overall, when classified by the First S-Curve industry and the New S-Curve industry , showed no significant differences at the level of 0.05.

3. The statistical value assesses the consistency of the comparative structural equation model before and after model improvement. The chi-square probability (CMIN-P) was 0.093, which was higher than 0.05, indicating that the model was not statistically significant. The relative chi-square value (CMIN/DF) was 1.127, which is less than 2. The Goodness of Fit Index (GFI) was 0.958, with a value higher than 0.90. The root mean squared index of error estimation (RMSEA) was 0.016, which was less than 0.08. Therefore, it was concluded that all four statistics satisfied the evaluation criteria. Therefore, the structural equation model for the management of smart industrial estates for sustainable growth after revision is consistent with empirical data.

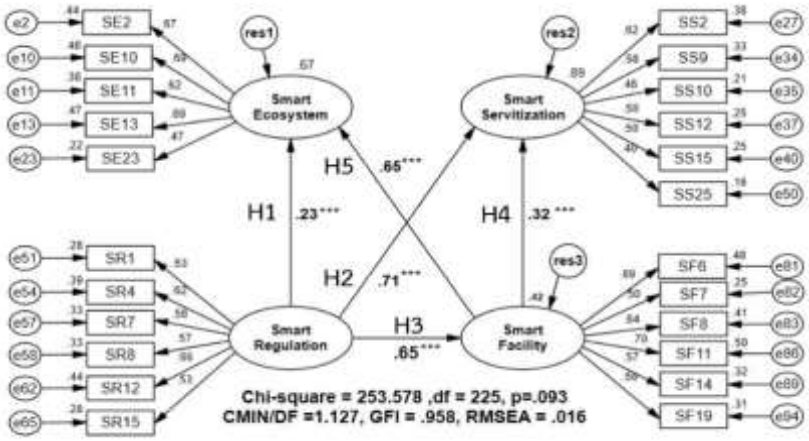

Figure 4. Structural equation model of smart industrial estate management guidelines for sustainable growth in Standardized Estimate mode after model improvement.

The results of the hypothesis test to analyse the causal influence between the latent variables in the structural equation model are 5 hypotheses as follows:

H1: The Smart Regulation component directly influences Smart Eco System component at a statistical significance level of 0.001 with a Standardized Regression Weight of 0.23, according to the preset research hypothesis.

H2: The Smart Regulation component directly influences Smart Servitization component at a statistical significance of 0.001, with a Standardized Regression Weight of 0.71, according to the hypothesis preset in this research.

H3: The Smart Regulation component directly influences Smart Facility component at a statistical significance level of 0.001 with Standardized Regression Weight = 0.65, according to the preset research hypothesis.

H4: The Smart Facility component directly influences the Smart Servitization component at a statistical significance level of 0.001, with a Standardized Regression Weight of 0.32, according to the research hypothesis preset.

H5: The Smart Facility component directly influences the smart Eco System component at a statistical significance level of 0.001, with a Standardized Regression Weight of 0.65, according to the research hypothesis preset.

Discussion

1. The components of the smart industrial estate management for sustainable growth are the components in the Smart Eco System which is consistent with the researcher's (Gamidullaeva et.) and others who said that, good Eco System management in industrial estates also has a positive effect on the communities surrounding the industrial estates. Due to the reduction of the causes of pollution, the quality of life of the communities around the industrial estates has been sustainably improved.

2. The components of smart industrial estate management for sustainable growth are the support of using solar energy by pushing the use of Solar Cell, with giving the factories participating in the project a discount or extending the lease period. This is consistent with the studied of researcher's (Lee and Shepley, 2020) who said that South Korea's Solar Cell installation funding with financial support from the government in order to reduce the amount of carbon dioxide as much as possible.

3. Comparison of the importance management about components of smart industrial estates for sustainable growth Types of First S-Curve industry and New S-Curve industry overall and each aspect found that, there was no statistically significant difference at the 0.05 level. This is in line with the results of Sarjana and Khayati researchers who said that, the management of smart industrial estates for sustainable growth in the First S-Curve industry category and the New S-Curve industry category aims to gain a competitive advantage, concentrating on improving the efficiency of human resource, infrastructure supply chain and technology with support from government organizations in industry groups, which builds confidence among entrepreneurs in industrial estates.

4. The Smart Regulation component has the most direct influence on Smart Servitization, according to the researchers (Myeong, Jung and Lee) that said, in the development of smart cities in South Korea, the central government is adjusting the regulations on smart city technology services to reflect current conditions. There is a collaboration between the private sector and local government organizations, this is consistent with the studied of researchers (Lee and Shepley, 2020) who said that, South Korea's Solar Cell installation

funding, the government provides financial support to reduce carbon emissions as much as possible.

5. Having a data system and analyzing results (Big Data and Analytics) quickly has the highest correlation with the application of Smart Grid Systems for managing electricity generation, distribution, and consumption, which is consistent with the research of Chan, S. C., Chui, S., & Karczmarski, L. (2023) and Judge, M. A., Khan, A., Manzoor, A., & Khattak, H. A. (2022).

Due to the rapid advancement of digital technology the complexity and precision of the platform used requires a precise approach to data management and has fast processing.

The Smart Industrial Estate Management Guidelines for Sustainable Growth's all four components which are: Smart Regulation, Smart Eco-Systems, Smart Servitization, and Smart Facilities, were of the high importance. The hypothesis testing results showed that, the Smart Regulation component overall influenced the Smart Servitization component. It had the highest overall influence (Standardized Regression Weight) at 0.91. The smart regulation component also directly influenced the Smart Servitization component, which had the most direct influence (Standardized Regression Weight) at 0.71. Empirical evidence shows that, smart regulation is essential for smart service governance because service conditions must be clearly defined to benefit customers. The results of the smart service are also analyzed further to improve the service following regulatory requirements (Dreyer et al., 2019).

In the case of smart city development in South Korea, the central government has adjusted regulations for smart city technology services in line with the current situation. Cooperation between the private sector and local governments has made smart technology services acceptable to most urban residents (Myeong S., Jung Y. and Lee E., 2018).

Suggestions

Smart industrial estate management guidelines for sustainable growth is a management approach that prioritizes management within a smart industrial estate. Various issues and improvements in the structure and nature of operations for sustainable growth. In this

research, the researcher proposed the following guidelines for managing smart industrial estates for sustainable growth:

Recommendations from the research at policy-level

1. The government should provide advice and encourage the use of solar energy by promoting the use of Solar Cells. This can be achieved by giving participating factories a discount or extending the lease period and using energy-saving devices in industrial estate utilities to increase the energy efficiency of industrial estate offices and common areas.

2. The Industrial Estate Authority of Thailand's Ministry of Industry should be a specialized agency that advise on using clean energy (Green Energy). It should be used as an alternative supplementary primary power source for utilities in industrial estates and central buildings in industrial estates.

3. The Government should be given to design or renovate buildings to be energy-efficient and environmentally friendly.

4. The Government should support the implementation of traffic monitoring and reporting systems (Real-timeTracking). To be applied carefully to the development of a transportation system that is suitable and efficient. It includes developing an application for analyzing and organizing a Supervisory Control and Data Acquisition (SCADA) system to connect with the measuring and controlling equipment of machinery or production systems.

5. The government should design tax requirements for operators in industrial estates in line with international standards. Along with enforcing and auditing measures to build investor confidence.

Recommendations derived from operational research-level

1. Industrial estates should pay more attention to setting up alarm notification systems and reporting the situation to communities or factories through easily accessible channels. It includes line 3219

applications, mobile applications, and data transmission via a stable 5G network and pay more attention and prioritize the importance of wastewater treatment services to efficiently handle wastewater from various factories within the industrial estate

2. Industrial estates should pay more attention to setting up systems for using renewable energy, energy storage systems, charging stations for electric vehicles, and electricity meters to create a business ecosystem. Arranging the power distribution system and installing equipment that can immediately monitor electricity usage is of great advantage.

3. Industrial estates should pay more attention to developing modern road structures to support the underground and land transportation systems. Also establishing a CCTV system project around the estate area by inspecting flares from factories in the area by having a supervision officer under the EMCC center 24 hours a day.

4. Industrial estates should focus more on establishing a Flexible Regulation unit. Accepting recommendations on legal issues, rules, and regulations to push relevant laws jointly, comparison (benchmark) laws, and regulations are key benefits in improving work processes to be more competitive and attract investors.

Suggestions for further research

1. First S-Curve industrial enterprises place more emphasis on smart industrial estate management approaches for sustainable growth than New S-Curve industrial enterprises. It concentrates on smart facilities, using clean energy or adjusting transportation modes that use less energy, such as Pipeline Transportation, Transportation by Rail systems, and solar-powered pathway lighting systems (solar cells). Therefore, it is necessary to promote the use of clean energy in industrial estates to reduce operating costs further.

2. According to studies and interviews with experts, qualitative research has been conducted to study the model or approach to managing smart industrial estates for sustainable growth from the industrial group executives of the First S-curve and New S-Curve industry groups. This is based on experience in promoting and supporting industrial estate management, which is a way to improve the management of smart estates for sustainable growth. Therefore, the management of smart estates for sustainable growth should be examined through in-depth interviews. It is obtaining vital information

from Industry and business executives of First S-Curve or New S-Curve in developing smart estate management solutions to grow in another way.

3. Guidelines for investment promotion for new entrepreneurs in the New S-Curve industry

Bibliography

Chan, S. C., Chui, S., & Karczmarski, L. (2023). Application of multi-species photo-ID database management systems: a user's perspective. Mammalian Biology, 1-11.

Department of Industrial Works. (B,E. 2565). [Online]. Factory Environmental Technology Promotion Division. [Retrieved February 6, 2022]. From https://greenindustry.diw.go.th/webgi/nameindustry_list/.

Dreyer, S., Olivetti, D., Lebek, B .and Breitner, M.H) .2019 .(" Focusing The Customer Through Smart Services :A Literature Review". Electronic Markets .Vol .29 : 55-78.

Gamidullaeva, L., Shmeleva, N., Tolstykl, T. and Shmatko, A. (2022). "An Assessment Approach to Circular Business Models within An Industrial Ecosystem for Sustainable Territorial Development."

Industrial Estate Authority of Thailand (IEAT). (B.E. 2559). [Online]. IEAT Enterprise Plan, Fiscal Year 2561-2565 B.E. [Retrieved February 6, 2022]. From https://old.ieat.go.th/assets/uploads/cms/file/202105071549511.639708768pdf.

Judge, M. A., Khan, A., Manzoor, A., & Khattak, H. A. (2022). Overview of smart grid implementation: Frameworks, impact, performance and challenges. Journal of Energy Storage. 49, 104056.

Kupoluyi, A .Y., Alarape, S .A., & Adeyemo, O .K) .2018 .(Impact of industrial effluents on Alaro river in Oluyole industrial estate, Ibadan and its suitability for aquatic life .Sokoto Journal of Veterinary Sciences 16(1), 38-44.

Lee, J. and Shepley, M.M. (2020). "Benefits of Solar Photovoltaic Systems for Low- Income Families in Social Housing of Korea: Renewable Energy Applications as Solutions to Energy Poverty." Journal of Building Engineering. Vol. 8 : 101016.

Maarten, V. G., Bedir, T., & Cagatay, C. (2020). Design of a Reference Architecture for Developing Smart Warehouses in Industry 4.0. *Computers in Industry*, Vol. 124.

Myeong, S., Jung, Y .and Lee, E) .2018 .("A Study on Determinant Factors in Smart City Development :An Analytic Hierarchy Process Analysis". Sustainablility .Vol .10 No .8 :1-17.

Noor-A-Rahim, M., Firyaguna, F., John, J., Khyam, M .O., Pesch, D., Armstrong, E., & Poor, H .V .(2022) .Toward Industry 5.0: Intelligent Reflecting Surface in Smart Manufacturing .IEEE Communications Magazine60 .(10), 72-78.

Sarjana, S. and Khayati, N. (2018). "Industrial Estate Development: Challenges and Opportunities in Strangthening Competitiveness of Manufacturing Industries". The Indonesian Jounanl of Development Planning. Vol. 2 No. 2 : 152-169.

Sarjana, S .S., Bencheikh, I., Nouari, M., & Ginting, A) .2020 .(Study on cutting performance of cermet tool in turning of hardened alloy steel . International Journal of Refractory Metals and Hard Materials. 91, 105-255.

Silcharu, T., (2020). Research and Statistical Analysis with SPSS and AMOS. 18th Edition. Nonthaburi : Business R&D Ordinary Partnership, .2020 Sunee Wattanakomol. "The effect of guidelines on reducing logistics costs". Uncertain Supply Chain Management. Vol.9 No.3 (July 2021) : 667-674.

Sunee Wattanakomol and Thanin Silpcharu. "Second-order confirmatory factor analysis of auto parts manufacturing industry management guidelines for sustainable success". Uncertain Supply Chain Management. Vol.10 No.3 (2022) : 905-912.

Yu, H., Dong, S., & Li, F .(2019) .A system dynamics approach to eco-industry system effects and trends .Polish Journal of Environmental Studies. 28(3), 1469-1482