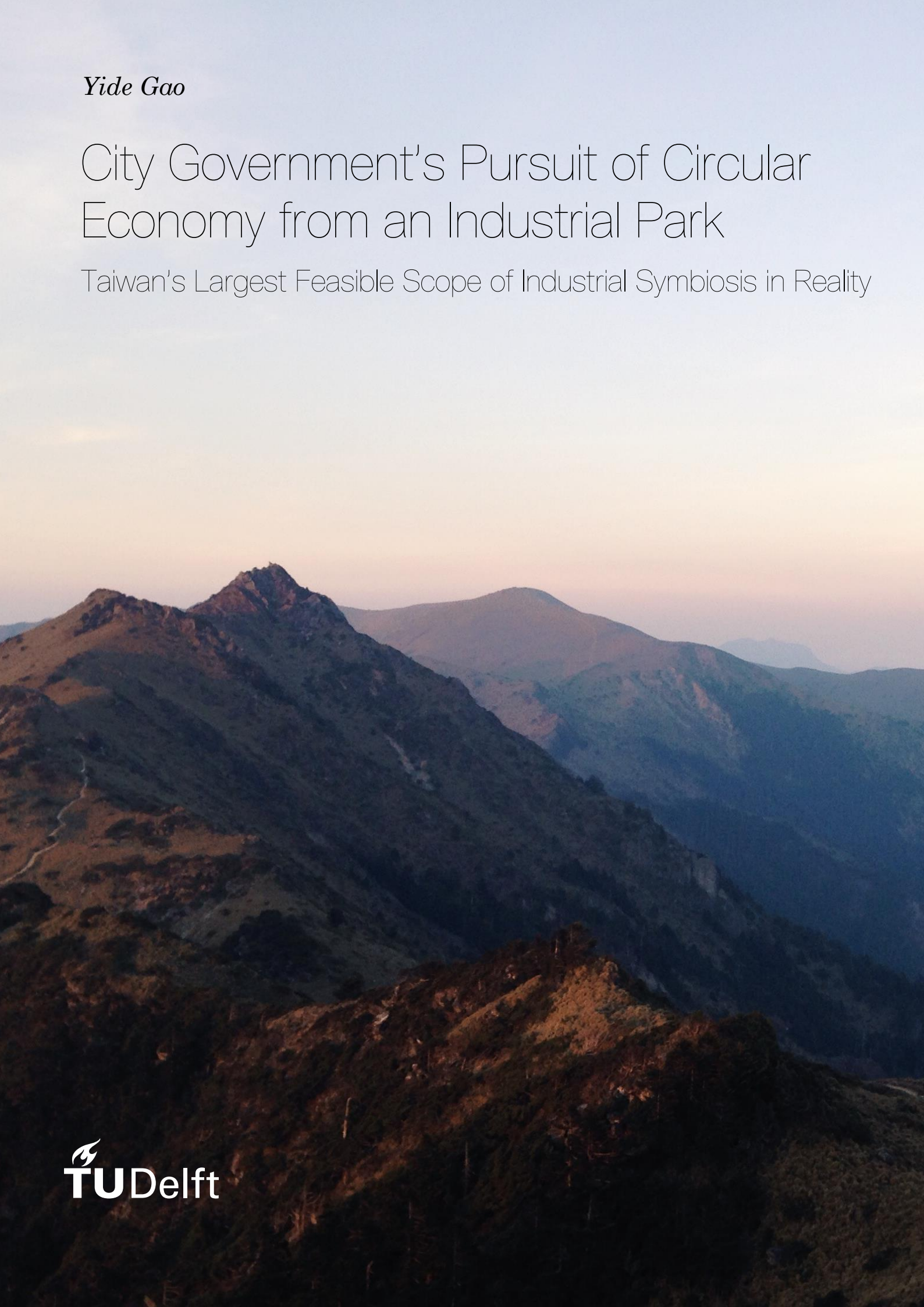
Yide Gao

City Government's Pursuit of Circular Economy from an Industrial Park

Taiwan's Largest Feasible Scope of Industrial Symbiosis in Reality



TU Delft

City Government's Pursuit of Circular Economy from an Industrial Park

Taiwan's Largest Feasible Scope of Industrial Symbiosis in Reality

By

Yide Gao

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TU Delft

Abstract

Circular economy is an economic model aiming at decoupling economic growth from the consumption of finite resources. It attracts attention to system changes at all levels, and Taoyuan City Government devotes itself to the circular economy development as well. Nevertheless, the Taoyuan environmental protection park, with the early ambition of developing an eco-industrial park, currently consists of only homogenous waste treatment enterprises. This research aims to explore the possible future of the park and the largest scope of symbiosis from the city government's perspective. It also attempts to enhance the understanding of the relationship between circular economy and industrial symbiosis. Previous literature shows that no single, universal theory can be expected to predict the emergence of industrial symbiosis. Regional difference together with contextual factors play a huge role in the industrial symbiosis and circular economy development. Several interviews have been conducted with city government officials, business representatives from the park, public administrators, and the non-government advocate. This research adopts the integrated mixed-level analysis, comprising the SWOT analysis and the context analysis, to present the holistic case knowledge and to structure the key factors. The sway between a globalized neo-liberal economy and a localized circular economy is addressed. Mainly due to the small scope, the industry type, and the inherently weak geographical location, the conclusion is to maintain the achieved sustainability of the park and not to develop into an eco-industrial park. Considering the political and economic reality at the macro-global level, six other recommendations are formulated to facilitate a circular economy from the Taoyuan city government's perspective. The key findings have been validated by all interviewees and are presented to the city government as policy advice.

Keywords: circular economy, industrial symbiosis, industrial park, city government, Taiwan, context analysis

Readers' Guide

This thesis work combines the theory and practice of industrial ecology, and it encompasses the aspects of analysis, design and implementation. The sources of information include official reports, existing literature, official websites, personal interviews and the media. An overview in both theory and practice is provided in the introduction chapter 1, with the background information of both the existing research and the Taoyuan environmental protection park, the literature review, the knowledge gap, and the research question. It shows in section 1.6, how the knowledge of the park can enhance the relationship between the research focuses, industrial symbiosis and circular economy, through answering the corresponding research questions. The methodology is developed and elaborated in chapter 2. The mixed-level analysis is conducted in chapter 3, including the in-depth analysis in the internal environment, macro-global environment, the development mode, and the context. The SWOT analysis with the C-H factors from the context analysis is used to structure the findings in the mixed-level analysis. In chapter 4, the policy gap examination, the global economic and political reality are discussed. This chapter ends with the preliminary findings, which are sent to all the expert interviewees for the validation of the analysis. Lastly, the conclusion is given in chapter 5 with key findings, relevance to both the theory and practice, as well as the recommendations for future research.

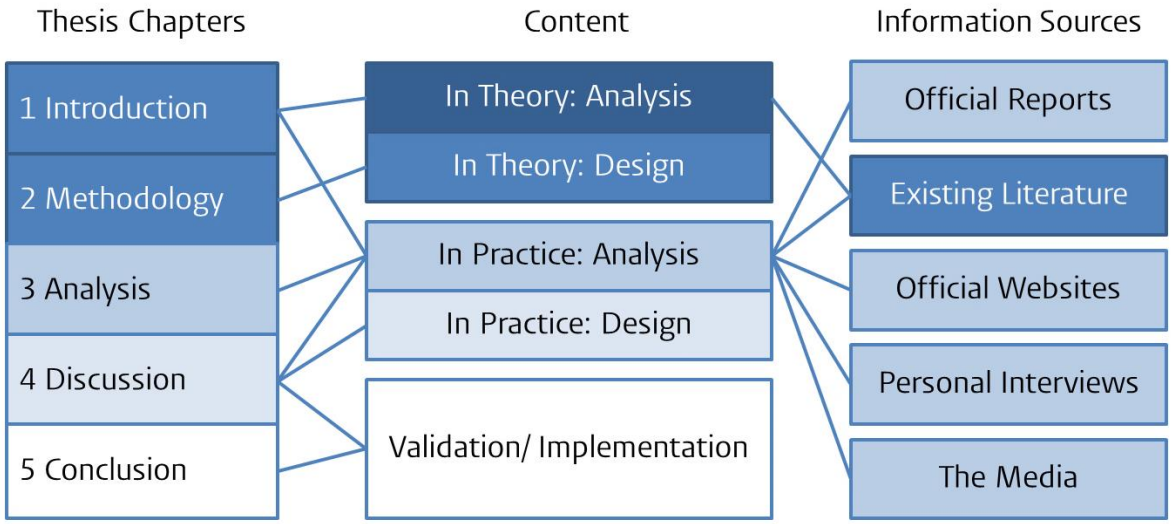

Figure 1 Report Structure

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To my family and close friends — Some lines are never enough for your love, support, and devotion. Thank you for being/ becoming an indispensable part of my life.

To the readers — Thank you for your attention and time reading this work, and I truly hope you enjoy it. Don't hesitate to contact me if you have any suggestions or feedback!

Yide Gao, Leiden, July 2016

Contents

List of Figures

List of Tables

1 Introduction

1.1 Research Background

Circular Economy (CE) is receiving increasing attention worldwide as an economic model aiming at decoupling economic growth from the consumption of finite resources. In recent years, companies, industrial parks, and city governments have all started to discover tremendous opportunity in a circular economy. Even though the implementation of the circular economy is still at an early stage, several common elements of success are identified: the formation of collaboration and exchange structure, the involvement of all entities in the society and a positive return on investment. (Ghisellini et al., 2015) In contrast to the "Take, make, discard" pattern in the linear economy, Circular economy facilitates the profitability while circulating material use and generating energy from renewable resources. With the adoption of the CE model, additional residual value of the products and materials can be captured, and the risks from material supply and price volatility can be reduced as well.

A considerable amount of existing literature about circular economy addresses the transition from linear to circular business models at the micro level, for a company or such single objects to measure how advanced they are in circulating the resources while making profits. At the meso level of industrial clusters or eco-industrial parks, industrial symbiosis (IS) remains to be the common implementation of the circular economy. However, current research about industrial symbiosis focuses mainly on the potential for achieving the ideal resource and energy efficiency, but with a lack of attention to the profitability and the individual context of various cases. (Geng et al., 2015; Yap & Devlin, 2016)

The attempts worldwide to implement industrial symbiosis have led to quite diverse results. Many critical factors, enablers, and barriers are identified and categorized into technical, economic, legal/regulatory and social aspects. They are also assessed at the national, regional, network, enterprise and personal

level. The other pattern to analyze IS behaviors is to identify the stages of evolution. (Yap & Devlin, 2016)

The crucial role of the public sector in IS and CE development is often argued in the existing research. (Ellen MacArthur Foundation, 2015; Geng et al., 2015; Ghisellini et al., 2015; Park et al., 2015; Yap & Devlin, 2016; Yu et al., 2015) The observation provides valuable lessons on the development of innovative eco-industrial parks, especially in fostering a systemic managerial approach to creating a circular economy. (Park et al., 2015)

1.2 Case Background

Taiwan is a densely populated island with 23 million inhabitants. Taiwan is not fully recognized internationally, but it functions entirely as an independent, democratic country. Taoyuan belongs to one of the six special municipalities of Taiwan, which are of a higher autonomy level. This populated city is at the highest level of administrative divisions of the country, and it is an industrial city with the advanced transport infrastructure.

Taoyuan Environmental Protection Park, established in 2005, was designed to attract a variety of companies with the vision of creating industrial symbiosis. However, the 25 companies now in the cluster all belong to the waste treatment sector, dealing with the retrieval of precious metals and compounds from different industries and supply chains. In Table 1, 8 running companies are listed with their corresponding waste treatment industries and the main income sources of products refined. The remaining 17 companies are either building or planning to build the plants.

Company #	Waste Treatment Industry	Main income sources/ products
1	Electronics and scraps	Au, Ag, Pb, Pt
2	Batteries	MnO_2, Fe, Zn
3	Fluorescent tubes	Processing CRT glass, glass fragments, Hg
4	Inorganic and organic waste	ZnO, cast iron, hearthstone
5	Tires	Fuel oil, carbon black

6	Fluoride	NaF, Na_2SiF_6
7	Printed circuit boards	Copper powder, materials for concrete
8	Solar panel	Alcohol, CSi, silicon powder, auxiliary fuel

Table 1 8 Running Companies and the Corresponding Waste Treatment Industries in the Taoyuan Environmental Protection Park (Taoyuan City government, 2015)

The total economic added value of the park in 2015 is 1.2 billion New Taiwan Dollars (NTD). It accounts for 0.4% of the total economic added value of the industry sector in Taoyuan City. Although it does not play a huge role in the Taiwanese economy, the Taoyuan environmental park forms an integral part of the industries and the resource circulation in Taoyuan City.

With the discrepancy between what was envisioned and the current situation as a waste treatment park, it is interesting for the city government to determine whether this park should be redesigned and transformed into an eco-industrial park or be maintained as a normal industrial park. With the new vision of the park, relevant management strategies can be developed for the next steps in the future. The case leads to the main research question of this research, ***what can be the possible future of the Taoyuan Environmental Protection Park, an eco-industrial park or a normal industrial park?*** More concrete research sub-questions are introduced in section 1.5 after identifying the knowledge gap in the literature review.

The recently-elected Taoyuan City government has the ambitious vision to incorporate circularity and sustainability into the city design since December 2014, especially in the Taoyuan Aerotropolis, a development site surrounding the largest international airport. It is by far the largest urban development program in history, comprising nearly 5,000 hectares and expecting to attract 10 billion investments. The program was approved by the Ministry of the Interior in July 2014, which suggests that the program will be implemented regardless of the future shift of power in the government. The mayor has promised publicly to secure the openness and transparency as well as listening to all the stakeholders in the decision-making process. The environmental and social concerns are also expected to gain more attention.

1.3 Literature Review

In this section, the recent studies about industrial symbiosis and circular economy, as well as the role of the public sector in the industrial symbiosis and circular economy development are reviewed. In section 1.3.4, a summary is provided to address the relationship between industrial symbiosis, circular economy, and the public sector, and to conclude the research progress of previous works.

1.3.1 Evolution of Industrial Symbiosis

There is an extensive literature regarding eco-industrial parks and its evolution. Early researchers focused on replicating the Kalundborg experience, but various cases in America, Asia and Europe have been studied over time. Many authors suggested that the most suitable institutional system combines top-down and bottom-up approaches, incorporating more collaborative efforts and catalyzing actions among stakeholders. (Costa & Ferrão, 2010; Geng et al., 2015; Ghisellini et al., 2015; Park et al., 2015)

A number of enablers and barriers in various aspects are identified, including technical, economic, legal/regulatory and social ones. (Ellen MacArthur Foundation, 2015; Ghisellini et al., 2015; Gibbs & Deutz, 2005; Heeres et al., 2004; Mathews & Tan, 2011; Veleva et al., 2015; Zhu et al., 2015) Yap & Devlin (2016) identified the two major patterns of IS research, concluding the critical factors of IS development and describing the stages in the evolution process of industrial symbiosis. These critical factors found in the research can provide the understanding of the emergence of industrial symbiosis, but somewhat limited, due to the path dependency and the contingency of industrial symbiosis in various contexts. (Yap & Devlin, 2016)

Yu et al. conducted the research about the evolution of industrial symbiosis in one national demonstration eco-industrial park in China, Rizhao Economic and Technology Development Area (REDA). (Yu et al., 2015) Through the investigation on enterprises and the government, three stages of development are shown in the study. Important laws and policies published by all levels of government are illustrated. The characteristics of this case include the role of government in promoting IS, the main drivers to IS are identified. Park et al.

introduced the Korean approach of the eco-industrial park development. (Park et al., 2015) The research reviewed the first 5 years of the 15-year, 3-phase plan. The national eco-industrial park development program began with a thorough study of the strengths, weaknesses, opportunities and threats (SWOT) on the industrial complexes in Korea. The evolution is stage-based, starting from several experimental pilot projects. The organizational structure is also illustrated in the research. It is worth noticing that the program has gone through leadership shifts from a non-profit leader to the semi-governmental body due to the concerns about whether a non-profit research organization could initiative the active participation of businesses. Through continuous learning and adjustments, the eco-industrial park development efforts eventually scaled up.

Yap & Devlin indicated the insufficiency of the stage-by-stage analysis, more elaboration is needed in explaining the multi-actor, multi-scalar developing process of industrial symbiosis with the supporting activities of the network, from the research and development institutions, regulators, business associations and coordinating organizations, for instance. Moreover, it is stated that no single, universal theory can be expected to predict the emergence of industrial symbiosis. The holistic understanding of the socio-historical context is required due to the equifinality characteristics, which suggests the same end state (industrial symbiosis in this case) can be achieved with various development pathways in different socio-historical contexts. (Yap & Devlin, 2016) Due to the path dependency and the IS emergence from a variety of combinations of factors, a mixed-level analytical framework is used to explain the phenomena. The decision-making of firms is influenced by the context. The contextual conditions including factors related to market forces, the state, and civil society need to be addressed in the mixed-level analytical framework, to only enhance our judgment on achieving the industrial symbiosis in practice. (Yap & Devlin, 2016)

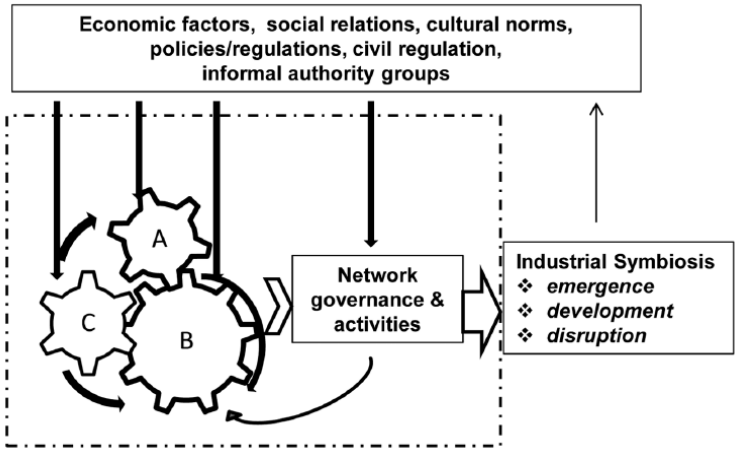


Figure 2 Mixed-Level Analytical Framework in IS Networks (Yap & Devlin, 2016)

Another limitation of the IS research lies in the lack of attention to market forces and dynamics. The existing research on IS and CE implementation has still been grounded on the benefits of physical flows rather than monetary flows. (Ghisellini et al., 2015) Indeed, there is the ideal resource and energy efficiency, which theoretically can be achieved for the public's interest. In reality, however, the full potential of industrial symbiosis is often not reached. In many cases, the established symbiosis exchanges are reduced, discontinued, or even withdrawn from the system due to the dynamic and competitive market structure. (Yap & Devlin, 2016) Businesses drive the economy and thus play an indispensable role in the development of eco-industrial parks. The debate of innovative eco-industrial parks has been gradually shifted from industrial symbiosis to circular economy due to the coverage of business involvement and market factors. (Geng et al., 2015)

1.3.2 Development of Circular Economy

Ghisellini et al. reviewed the existing literature and classified them into the micro, meso and macro level, with the corresponding themes of the research. (Ghisellini et al., 2015) (Table 2) Among the selected articles, it is evident that eco-industrial systems, industrial symbiosis districts, and networks are widely studied in terms of CE implementation at the meso level. The link shows the interconnection between the two popular research topics, industrial symbiosis, and circular economy, in the state-of-the-art research in the field. What merits attention is the cross-level implementation of the circular economy development,

ranging from consumer behaviors at the smallest scope, to the national level at the largest scope.

Implementation at micro level (single company or consumer)	Implementation at meso level (eco-industrial parks)	Implementation at macro level (city, province, region, nation)
Cleaner production (25) Green consumption and green public procurement (8) Product recycling and reuse, scavengers and decomposers (2) Policy (2)	Eco-industrial systems and industrial symbiosis districts and networks (52) Waste trade markets (1) Policy (5)	Regional eco-industrial networks and productions, eco-cities, urban symbiosis (9) Collaborative consumption (12) Zero waste programs, innovative municipal solid waste management systems (12) Policy (3)
** The number in brackets is the number of articles reviewed for each subject*		

Table 2 Classification of Reviewed Studies Related to Circular Economy at Micro, Meso, and Macro Level, Adapted from Ghisellini et al. (Ghisellini et al., 2015)

The direct benefits of implementing circular economy come from the by-product selling, transportation, reduced cost from virgin resource and energy substitution, while the indirect benefits include the reduced investments, the increase of supply security and flexibility, better reputation and so forth. (Ghisellini et al., 2015) Due to the current market mechanisms, however, economic feasibility remains a determining factor in the adoption of industrial symbiosis and other environmental improvements.

Business involvement in the circular economy is undeniably crucial since the businesses hold most of the resources to operate and are the drivers of the economy. Ellen MacArthur Foundation revealed the importance of industry involvement and cross- departmental, governmental collaboration to establish early alignments and common goals for the country or the focus sectors in achieving circular economy. (Ellen MacArthur Foundation, 2015)

To measure the progress of the circular economy, the research works on CE indicators are reviewed and highlighted. They are grouped into three scales: micro, single object level, indicators for a company or an organization; meso, symbiosis association level, indicators for an eco-industrial park or a cluster; macro, city or nation level, indicators for the entire city or a wider region. The main difference in these levels lies in the coverage of entities. From the systems perspective, the enterprises at the micro level compose symbiosis associations, while eco-industrial parks and clusters at the meso level constitute cities and regions at the macro level.

Micro Level

Ellen MacArthur Foundation developed the Material Circularity Indicator (MCI) for measuring mainly the restoration of material flows at product and company levels. (Ellen MacArthur Foundation, 2015) MCI could be used in combination with complementary risk and impact indicators, which measure the material scarcity, toxicity, and profitability. MCI could also be one of the outputs from a life-cycle assessment. Golinska et al. devised a tool based on grey decision making (GDM) to determine the sustainability level of remanufacturing companies. The sustainability performance is shown with quantifiable and measurable indicators in three dimensions, economic, environmental and social. (Golinska et al., 2015)

Meso Level

Zhe et al. proposed an emergy-based industrial symbiosis assessment method, in which emergy was defined as the available solar energy used up directly and indirectly to make a service or product. (Zhe et al., 2015) The indicators are based on the waste utilization, non-renewable primary energy inputs, total emergy and GDP of an industrial park. Liu et al. adopted a similar emergy-based approach with a case study to validate the indicators. (Liu et al., 2014) In a later research, Liu et al. integrated Kaya formula and index decomposition analysis (IDA) into creating several innovative emergy indicators. (Liu et al., 2015) Jiang et al. created the co-benefits indicator to evaluate both energy conservation and pollution reduction, which derived from geographical, enterprise pollution and energy efficiency measurements. (Jiang et al., 2015) Salmi used eco-efficiency indicators, based on input-output analysis, to prove the attractiveness of

applying the traditional end-of-pipe technology along with the upstream pollution prevention to the mining industry of the Kola Peninsula instead of creating industrial symbiosis. (Salmi, 2007) Ren et al. introduced 37 criteria in four aspects: economic, technological, environmental and societal, to analyze the sustainability of hydrogen supply chain. Decision-making trial and evaluation laboratory (DEMATEL) was used to analyze the causal relationships and identify the core driving factors. (Ren et al., 2013)

Su et al. reviewed two indicator systems for the circular economy by the National Development and Reform Commission and the Ministry of Environmental Protection in China. (Su et al., 2013) The focus of the former system is on resource output, consumption, integrated utilization and reduction rate in waste discharge. While in the latter system, material reduction and recycling, economic development, pollution control and administration and management perspectives are considered. Public satisfaction with the local environmental quality and public awareness with eco-industrial development are measured in the social aspect.

Geng et al. analyzed the indicator system proposed by the Ministry of Environmental Protection in China and indicated the economic, environmental and societal benefits. The shortcomings were also identified. They argued that the diversity of industrial symbiosis and the local definition of sustainable development considering all the stakeholders should be included in the indicator system. (Geng et al., 2009)

Macro Level

Zhang et al. proposed five emergy-based indicators to measure city's sustainability and the decoupling of economic growth from resource consumption. (Zhang et al., 2014) The indicators are economic efficiency, environmental pressure, emergy-based five-year yield efficiency, investment cost for decoupling and the cost of job opportunities. These five indicators are the calculation results of the raw data, non-renewable resources for agricultural activities, energy consumption for industrial activities, solid waste, waste water, waste gas, real GDP, environmental protection investment, the number of total employed people in agricultural and industrial sectors.

In this study, a unified unit is used to measure the use of natural resources after adjusting with the emergy transformity (Trf.). Emergy is defined as the sum of all available, direct and indirect energy inputs required by the product generation, based on the input and output flows' analysis. (Zhang et al., 2014)

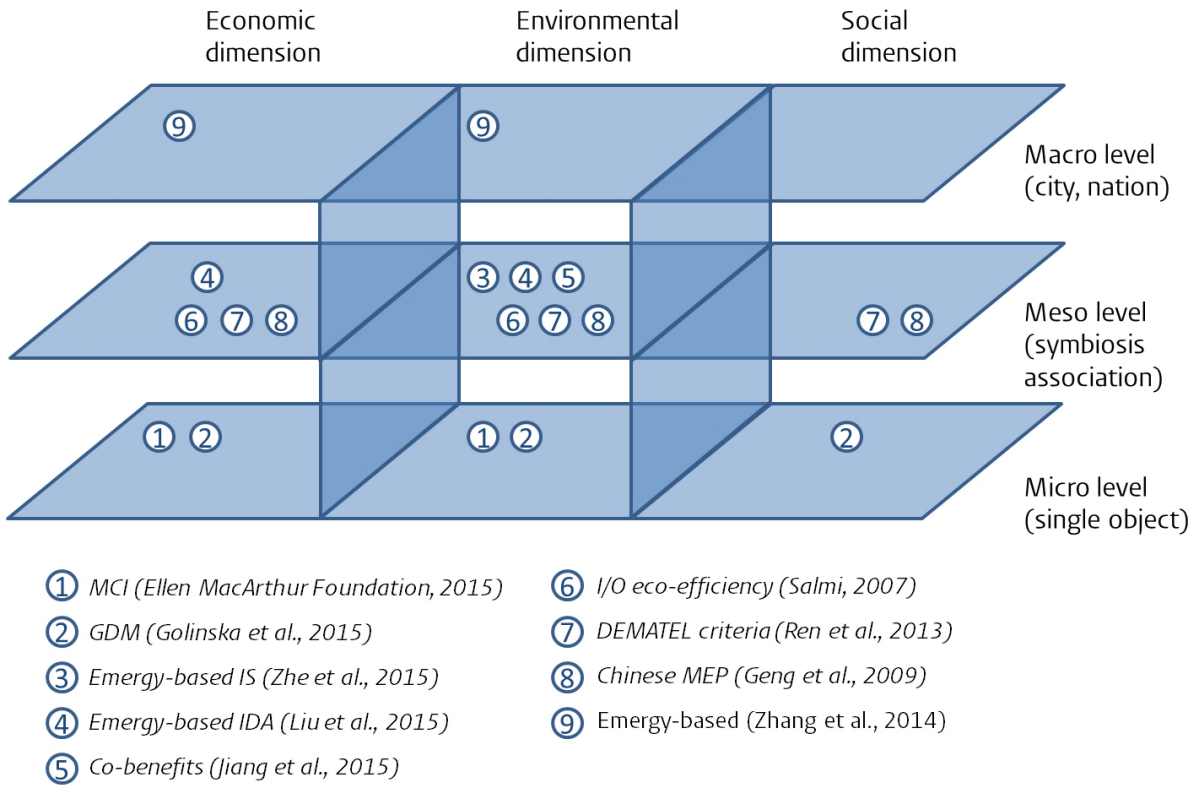


Figure 3 Circular Economy Indicators with Various Methods to Measure CE Performance

Figure 3 maps out the 9 CE indicator systems reviewed in this section, and they are listed at 3 levels, macro, meso, and micro, respectively. It is evident that most of the indicators focus on the meso level, measuring the CE performance at the level of eco-industrial parks or clusters. In the highlighted articles concerning CE indicator systems, only one of them proposed a macro-level indicator system with measurable and traceable indicators in the economic and environmental dimensions. There are a few indicators existing in the social dimension for measuring the social performance at the meso and micro level, for eco-industrial parks and companies, but the social indicators at the city level are apparently lacking. Geng et al. argued that no single indicator or method can balance the economic development, environmental protection and human quality of life due to the holistic nature of the eco-industrial park. (Geng et al., 2015) Even with the

widely-covered emergy analysis, the assessment should be combined with other assessment tools to examine the supply and demand side.

Interestingly, in U.S. eco-industrial park projects, the very high level of community involvement does not lead to different outcomes from the cases without involvement. The successful Dutch cases of eco-industrial park development limited community involvement to the representation forms of consulting agencies and educational institutions. (Yap & Devlin, 2016) No specific combination of factors can result in certain IS and CE outcomes. It thus strengthens the argument that the IS and CE development has the equifinality characteristics and is case-specific.

To facilitate the systemic transition towards a circular economy, some suggestions from the existing research to the policymakers are to specify the functions of certain civil groups so as to incorporate the clear, representing messages from the society, and to drastically change the measurement of economic performance. (Ellen MacArthur Foundation, 2015; Yap & Devlin, 2016)

1.3.3 The Role of the Public Sector in Industrial Symbiosis and Circular Economy Development

The significant role of the public sector in IS and CE development is argued extensively in the literature. It is found in many cases, that the public sector can trigger, sustain or hinder the IS and CE development. (Ellen MacArthur Foundation, 2015; Geng et al., 2015; Ghisellini et al., 2015; Park et al., 2015; Yap & Devlin, 2016; Yu et al., 2015) Among the 6 types of policy intervention, information and awareness, collaboration platforms, business support schemes, policy procurement and infrastructure are listed with high relevance at the city government level (regulatory frameworks and fiscal frameworks are with low relevance). (Ellen MacArthur Foundation, 2015)

Ghisellini et al. stressed the great importance of the public sector in promoting new symbiosis opportunities and CE advancements. (Ghisellini et al., 2015) Policies, national initiatives, removing the barriers of safe by-product reuse, informing companies of the benefits of industrial symbiosis, services and education programs are the types of support which governments can provide. Geng et al. put the emphasis on the combination of "stick" and "carrot"

strategies in China, a combination of strengthening environmental regulations and creating various benefits for the business sector. (Geng et al., 2015) Hwang et al. researched into the impact structure of the eco-industrial park development strategies and concluded that in South Korea, resource circulation systems would execute the best through cooperative system development rather than ecological environment development when executing eco-industrial park projects. (Hwang et al., 2016) Recent research progress from Ellen MacArthur Foundation indicated that stricter environmental standards, tax cut and refund policies on resource and energy use, or broader changes to existing financial system and measurement of economic performance can positively stimulate IS development and further, circular economy. (Ellen MacArthur Foundation, 2015) It is suggested that policymakers can play a crucial role in designing tailored policy interventions for different sectors and help the business sector to overcome non-financial hurdles which limit the scaling-up effect.

Ellen MacArthur Foundation analyzed the CE opportunities and potential policy interventions with the framework of barrier analysis to identify the severity of the barriers standing in the way. (Ellen MacArthur Foundation, 2015) The tool is based on EU Assessment Guidelines, and it encompasses market failures, regulatory failures, social factors and economic concern of business. (Table 3) The CE opportunities are then matched to the barriers in four categories with high, middle, low relevance.

Category	Barrier Description
Economic	*Not profitable* for businesses even if other barriers are overcome. *Capital* intensive and/or uncertain payback times. *Technology* not yet available at scale.
Market Failures	*Externalities* (full costs to society) not fully reflected in market prices. *Insufficient public goods/infrastructure* provided by the market or the state. *Insufficient competition/markets* leading to lower quantity and higher prices than is socially desirable. *Imperfect information* that negatively affects the quality of

	market decisions, such as asymmetric information. *Split incentives (agency problem)* when two parties to a transaction have different goals. *Transaction costs* such as the costs of finding and bargaining with customers or suppliers.
Regulatory Failures	*Inadequately defined legal frameworks* that govern areas such as the use of new technologies. *Poorly defined targets and objectives* which provide either insufficient or skewed direction to industry. *Implementation and enforcement failures* leading to the effects of regulations being diluted or altered. *Unintended consequences* of existing regulations that hamper circular practices.
Social Factors	*Capabilities and skills* lacking either in-house or in the market at reasonable cost. *Custom and habit* — engrained patterns of behavior displayed by consumers and businesses.

Table 3 List of Barriers for Barrier Analysis (Ellen MacArthur Foundation, 2015)

As stated earlier, the equifinality has to be considered when examining IS and CE developing process. Regional difference together with specific local context play a huge role in the IS and CE development, and this disparity is the main reason why the previous research works have led to diverse conclusions.

1.3.4 Summary

The most valuable insight from the state-of-the-art literature review is the complexity of the phenomena in socio-technical systems. Any viewpoint or hypothesis can easily be proven by the corresponding qualitative data or specific supporting materials. Many theories have been developed with diverse, or even contradictory findings regarding the industrial symbiosis and circular economy, partly due to the disparity of the socio-historical context. Therefore, it is crucial to bear in mind that the regional difference together with specific local contexts plays a huge role in the IS and CE development. No single theory can be expected to predict the emergence of industrial symbiosis universally in all

contexts; neither a single indicator nor specific methods can balance the economic development, environmental protection and human quality of life.

Furthermore, the lack of attention to market forces and market dynamics has often been identified in industrial symbiosis studies. Consequently, the utility and the contribution of these studies remain theoretical, and the various economic and market barriers still exist in developing the IS potential. More recently, the topic circular economy emerged to cover the economic aspect and to address the market failures in research. However, the implementation is still limited in the current research progress. To facilitate or implement positive changes in the circular economy, policymakers play a huge role in designing tailored policy interventions for different sectors and help the business sector to overcome non-financial hurdles. The aspects of information and awareness, collaboration platforms, business support schemes, policy procurement and infrastructure remain to be the highly relevant in the CE development and implementation from the city government's perspective.

1.4 Knowledge Gap

From the literature review, it is found that no research has been done to address the relationship between industrial symbiosis and circular economy in the form of a thorough case study from the city government's perspective. With the initial vision of building an eco-industrial park, the reasons why this industrial park was developed into a waste treatment cluster will be investigated in depth, with the understanding of the macro environment, the socio-historical development mode, the context and the industrial park itself. This research aims to bridge the gap between industrial symbiosis and circular economy, by investigating the largest possible scope of integration and symbiosis from the city government's perspective.

Deutz & Lyons stated that IS research has entered the field of comparative studies with the explicit exploration of IS examples in different locations. (Deutz & Lyons, 2015) This study also expects to contribute to the comparative research and explains the development towards an eco-industrial park in a local context. Due to the CE implementation in early stages both in Taiwan and worldwide, this study addresses the research gap in examining the potential scaling up factors of the circular economy from the meso level to the macro level as well.

As was shown through the preliminary discussion with the experts in Taiwan and desk research, the Taoyuan environmental protection park had the goals of practicing and advocating sustainability in the form of an eco-industrial park in its initial design. The author assumes that the resources in Taoyuan City are utilized at a high rate of efficiency, but given the narrow scope of the Taoyuan environmental protection park, it is not seen as an eco-industrial park with evident IS activities. Once the observation scope is enlarged to the city level or even larger to the nation, industrial symbiosis performance can be observed. Thus, one hypothesis is that the development towards an eco-industrial park would not help much with the productivity increase of circular economy a city scale.

1.5 Research Question

This research intends to explore the potential development pathways (towards an eco-industrial park or towards a specialized waste treatment industrial park) of the Taoyuan Environmental Protection Park, through the investigation into the macro environment, the context and the industrial park itself. It analyzes the case, its socio-historical development mode, the existing policies and the organizations involved in maximizing higher resource efficiency in order to explain how the current state is reached.

The research also aims to learn from the past experience of the policy translation in the industrial park development, identifying the enablers and barriers in the technical, economic, legal/regulatory and social aspect. The interplay of multiple factors at various levels leads to the high uncertainty of the outcome; hence, no unified theory can predict the emergence of neither industrial symbiosis nor circular economy. It is only the multi-level, multi-disciplinary analysis that can provide sound explanations, which help to confirm the judgment towards CE development. Combining the industrial ecology theories with the knowledge of the context in reality, the pragmatic and attainable policy interventions to facilitate circular economy at the largest scale are outlined from the city government's perspective. The research provides insights into the development of circular economy at the city government's level, complementing the actions of achieving practical CE outcomes, especially for the Taoyuan Aerotropolis development project, in the future.

The main research question and the sub-questions below follow the research purpose.

What can be the possible future of the Taoyuan Environmental Protection Park, an eco-industrial park or a normal industrial park?

- *What is the largest and feasible scope of cooperation/ symbiosis which can be achieved from the city government's perspective?*
- *How would the development help to facilitate the circular economy in Taoyuan City?*

The following concrete, practical questions are set up to help answer the research question.

- What are the city governmental goals for the environmental protection park?
- What is the organizational structure of the environmental protection park?
- What are the macro environment and the context which the actors of the park operate in?
- What insights for the Taoyuan City government can be drawn from the Taoyuan environmental protection park development for the future CE development project?
- Is industrial symbiosis an indispensable part of the circular economy development?

The methodology and the information required to answer these research questions will be treated in chapter 2.

1.6 Relationship of Research Focuses

Several terms in the field of industrial ecology, such as industrial symbiosis and circular economy, are widely used in various contexts as well as at diverse levels. Deutz & Lyons pointed out that even the basic terms such as waste can have diverse geographical specificities. (Deutz & Lyons, 2015) Table 2 have also shown that the term circular economy can have many interpretations at different levels. To illustrate the relationship between the terms and the Taoyuan environmental protection park in this research, Figure 4 shows the subordination

of industrial symbiosis to the cross-level circular economy. The circular economy incorporates industrial symbiosis as the meso-level implementation, and it highlights the consideration of economic reality. Through answering the research questions in this research, the role of the Taoyuan environmental protection park in both industrial symbiosis and the circular economy will be clarified and interpreted. (section 5.1.2) This research will also provide a validated proof of whether industrial symbiosis is an indispensable part of the circular economy development, enhancing the understanding of the relationship between the two research focuses, industrial symbiosis and the circular economy.

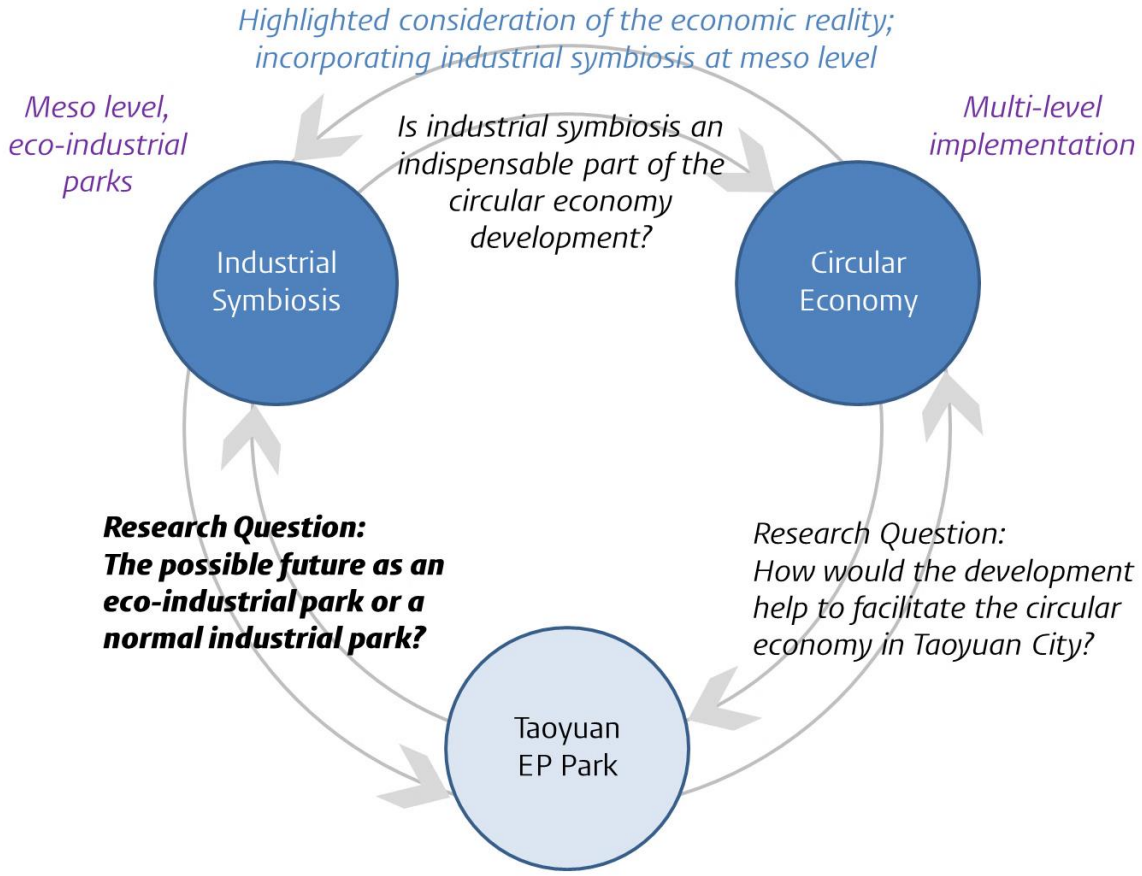


Figure 4 Relationship of Research Focuses

2 Methodology

2.1 Research Methods

Interviews and the integrated mixed-level analysis are the basis of the methodology. Worth noticing in this research is that, the Taoyuan environmental protection park is the focal point of this study, while the decision-making entity is the city government at a higher level. Figure 5 shows the relationship among the entities and the environments at multiple levels, while in Figure 6, the entities and the environments are placed on the canvas according to the levels where they belong. These two figures can be checked against each other to enhance the understanding.

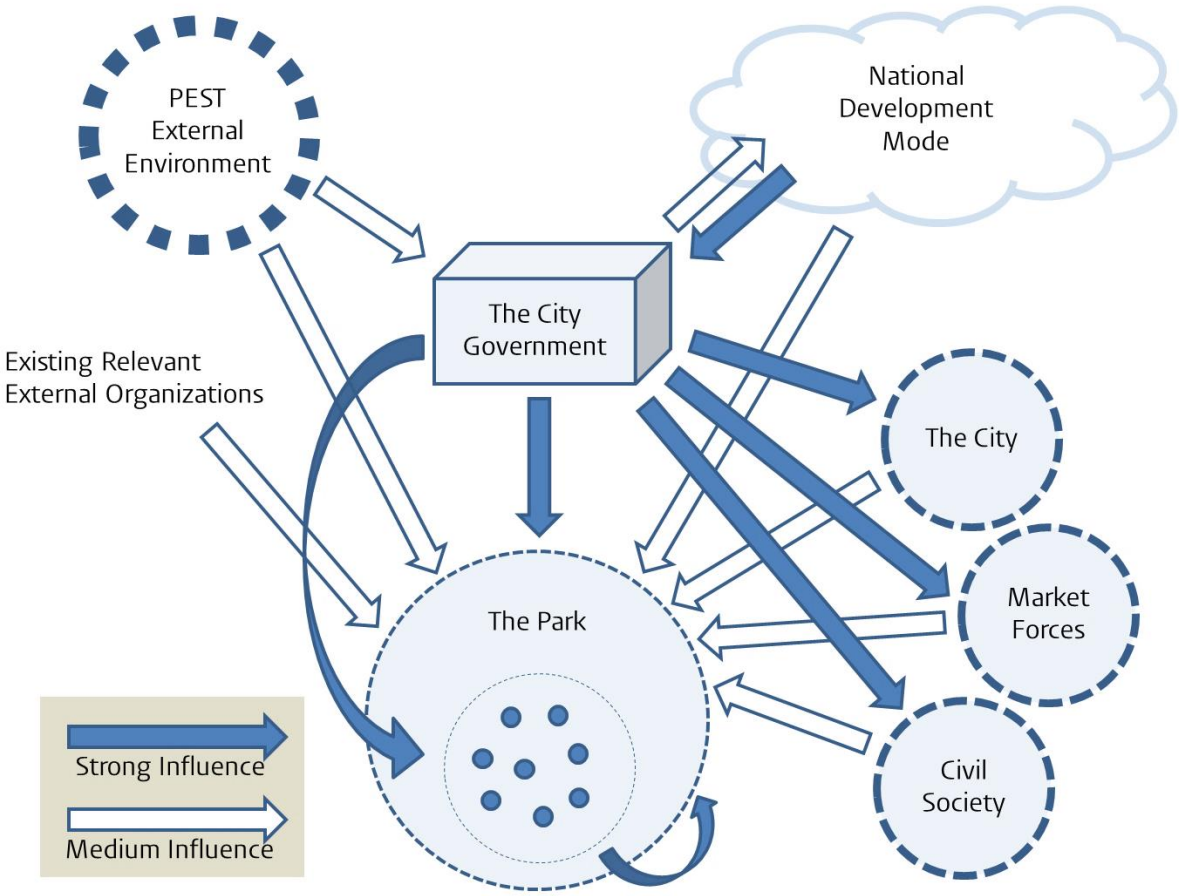


Figure 5 Relationship Between the City Government and the Park

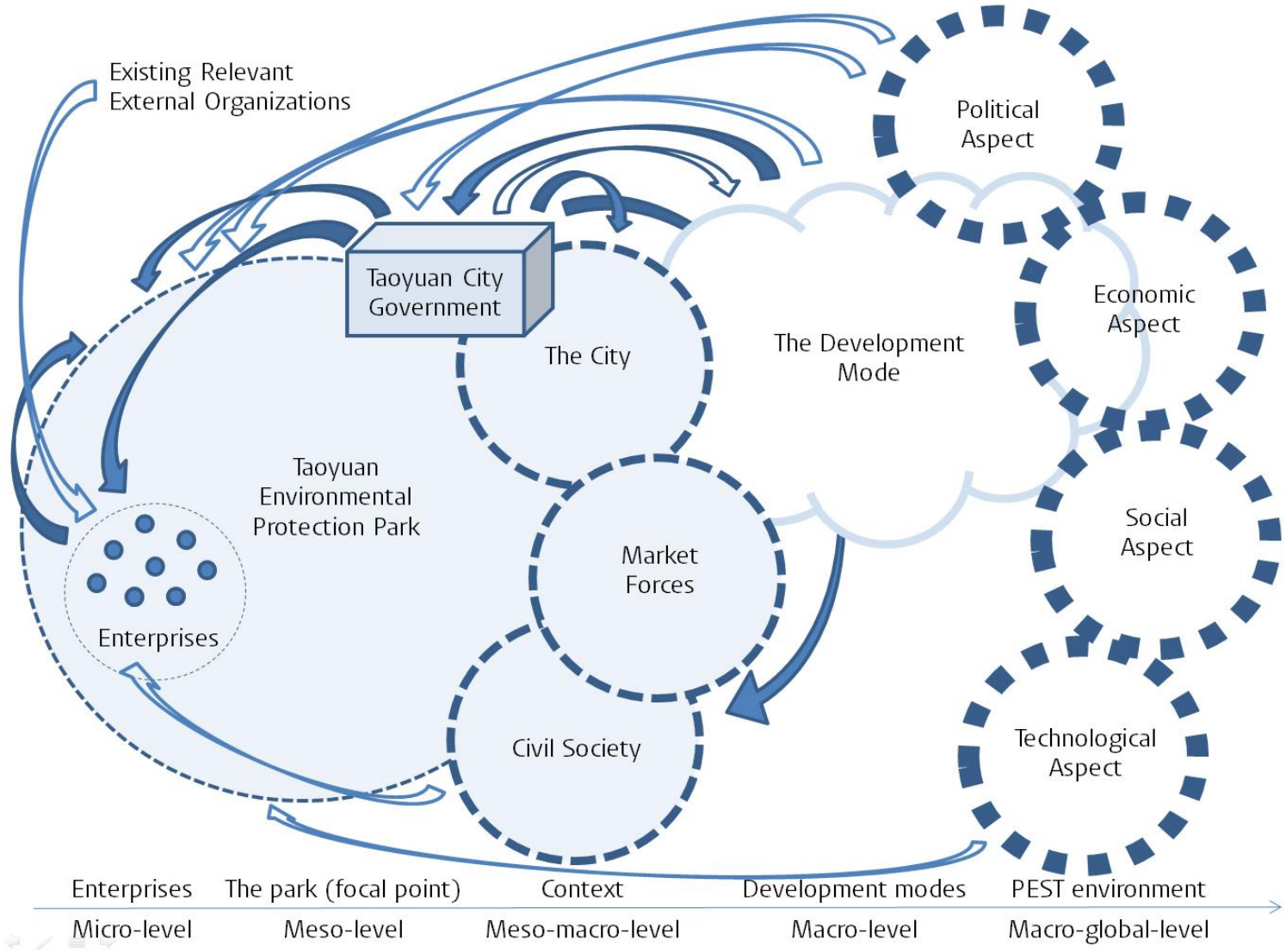


Figure 6 Mixed-Level Analytical Canvas

The enterprises in the park and the park itself are in the internal environment, while the political, economic, social, and technological aspects comprise the external environment. The context where the firms operate is constantly changing and co-evolving with the actors involved, including market forces, the city, and the civil society. Another crucial factor that deserves attention is the development mode of the state and the form of capitalism it adopts. With the analysis of the macro environment, the context and the Taoyuan environmental protection park, the comprehensive knowledge is expected to be obtained for further strategic development.

The arrows between the environments and entities show how the elements in the environment at different levels influence the Taoyuan environmental protection park and how influential these linkages are. (Figure 5 and Figure 6) The blue arrows represent the relevant linkages with strong influence, including the implementation of national development plans and the policy interventions from the city government in various aspects. The white arrows show the linkages with medium influence. Due to the interconnected reality, the linkages with weak influence are ignored to reduce the complexity.

Note that there are numerous combinations of addressing the linkages with different levels of influence. Figure 5 and Figure 6 show one of them, and this combination is used in the analysis of this research. In other cases, or with the focal point at other levels, or in other contexts, the specific combination of linkages should be considered to illustrate the different relationship between the decision-making entity and the focal point of the research.

The icons with closed outlines represent the fixedness and concreteness. The icons with closed boundaries including the entities such as the enterprises and the city government. To show the less-fixed characteristics of the development mode, it also has closed outlines with a light color. As for the PEST environment, the context, the park, and the enterprise association, the dashed outlines are used to illustrate their evolving nature. A higher flexibility and adaptation is identified with the various elements. These environments were co-shaped by multiple elements, and the environments are constantly co-evolving.

2.1.1 Interviews

In order to collect the internal and contextual information of Taoyuan environmental protection park and gain the understanding of the enablers and barriers to IS and CE development, several interviews need to be conducted with the actors in Taiwan to build a solid understanding of the system. The comprehensive understanding of the case forms the foundation of the analysis in chapter 3.

The scheduled interviews with the crucial stakeholders are listed in Table 4.

Name	Position/ Organization	Interview Date
Cosmas Lu	Consultant, SDTI e-waste recycling (in the Taoyuan environmental protection park)	17th Feb 2016
Mingte Wang	Deputy mayor, Taoyuan City government	18th Feb 2016
Jhihsiou Shen	Director, department of environmental protection, Taoyuan City government	
Chang-Tsair Chang	Director, department of economic development, Taoyuan City government	
Jack Wang	Deputy manager, Chung-Tai Resource Technology Corporation (in the Taoyuan environmental protection park)	22nd Apr 2016
Shangwen Chan (through email correspondence)	consultant and contact person of Energy and Resource Information Integration Platform, Industrial Development Bureau	25th Apr 2016
Representative (through email correspondence)	Yuansheng Renewable Energy and Technology, Envirolink Corporation (previously in the Taoyuan environmental protection park, applied for shutting down in 2015)	3rd May 2016

	service@envirolink.com.tw	
Shadow Chen (through a conference call)	Deputy CEO, Taiwan Circular Economy Network	23rd May 2016

Table 4 Interview List

Due to the logistics, the temporal and spatial limitations, a workshop discussion among all the stakeholders is not held in this case. Instead, several interviews are conducted with the main stakeholders of the environmental protection park, including the director of the environmental protection department of the Taoyuan City government, who is in charge of the development of environmental protection park, and several enterprise representatives in the park. The video conference interviews and email correspondence were used because of spatial limitation.

The purpose of the interviews is to investigate the current status of Taoyuan environmental protection park and the goals of the city government in future implementation, especially the difference in the two scenarios, the development towards an eco-industrial park or a waste treatment industrial park. The valuable information from other stakeholders in various fields in the system can provide a comprehensive understanding of the macro environment and the context of Taoyuan environmental protection park.

2.1.2 Integrated Mixed-Level Analysis

Due to the equifinality properties and the socio-historical complexity of the IS emergence and development, the research adopts the mixed-level analytical framework as the basis of the methodology. Yap & Devlin proposed the mixed-level analytical framework to explain IS emergence and development and stressed the importance of conducting the context analysis to enhance the understanding of the socio-historical characteristics of IS development. (Yap & Devlin, 2016) Figure 7 is the conceptual model of this methodology. The integrated mixed-level analysis comprises the analysis of the internal environment, the macro-global environment, the development mode, and the context. Three forms of output from the integrated mixed-level analysis are the

mixed-level analysis canvas, SWOT analysis plus contextual C-H factors, and the checklist. The numbers in brackets indicate the sections where the corresponding analysis is performed in this research.

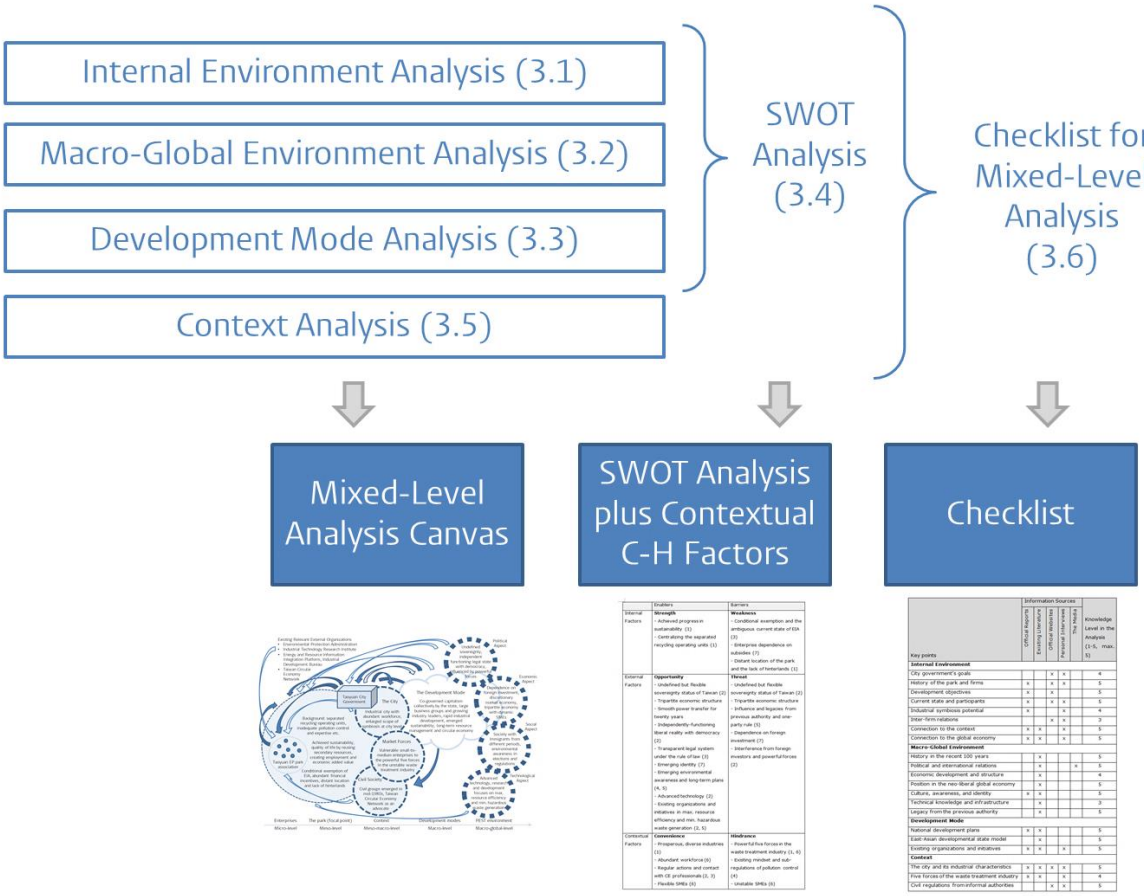
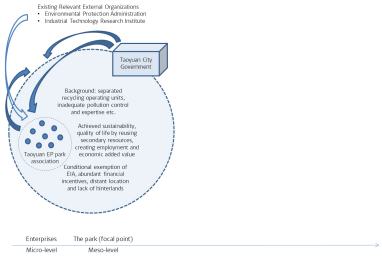
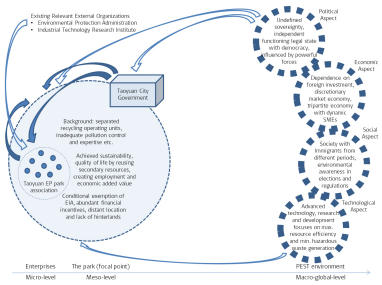


Figure 7 Conceptual Model of the Integrated Mixed-Level Analysis

The first output is the mixed-level analysis canvas. The highlights from the analysis can then be filled in the blank canvas Figure 6. SWOT analysis plus the contextual factors is the second output. Two categories of the contextual factors, convenience and hindrance, are the concluded bullet points from the context analysis. More explanation follows in this section. The third output is developed in the form of a checklist. It describes the key points of the analysis, information sources, and the knowledge level.

Three routes of constructing the knowledge as well as the three forms of output are designed for readers with different ways of thinking. These routes complement one another, aiming to cross-enhance each route in the research flow. The knowledge categories, information sources, and knowledge level are

presented in the checklist. Relationship among the entities and the key findings are illustrated in the mixed-level analysis canvas. While SWOT analysis plus the contextual C-H factors structures the findings in bullet points, from which the concrete policy advice for the city government is developed.

<table>
<tr><td colspan="4">Routes of Knowledge Building</td></tr>
<tr><td>Checklist (section 3.6)</td><td>Mixed-Level Analysis Canvas (section summary 3.1, 3.2, 3.3, and 3.5)</td><td colspan="2">SWOT Analysis plus Contextual C-H Factors (section 3.4 and 3.5.4)</td></tr>
<tr><td colspan="4">Supplementary Information</td></tr>
<tr><td>Information sources and knowledge level (Table 6 and Table 15)</td><td>Relationship map among entities (Figure 5 and Figure 22)</td><td colspan="2">SWOT analysis plus contextual C-H factors with key findings (Table 17)</td></tr>
<tr><td colspan="4">Internal Environment (section 3.1)</td></tr>
<tr><td>City government’s goals
History of the park and firms
Development objectives
Current state and participants
Industrial symbiosis potential
Inter-firm relations
Connection to the context
Connection to the global economy</td><td>  </td><td>Strength
- Achieved progress in sustainability
- Centralizing the separated recycling operating units</td><td>Weakness
- Conditional exemption and the ambiguous current state of EIA
- Enterprise dependence on subsidies
- Distant location of the park and the lack of hinterlands</td></tr>
<tr><td colspan="4">Macro-Global Environment (section 3.2)</td></tr>
<tr><td>History in the recent 100 years
Political and international relations
Economic development and structure
Position in the neo-liberal global economy
Culture, awareness, and identity
Technical knowledge and infrastructure
Legacy from the previous</td><td>  </td><td>Opportunity
- Undefined but flexible sovereignty status of Taiwan
- Tripartite economic structure
- Smooth power transfer for twenty years
- Independently-functioning liberal reality with democracy</td><td>Threat
- Undefined but flexible sovereignty status of Taiwan
- Tripartite economic structure
- Influence and legacies from previous authority and one-party rule
- Dependence</td></tr>
</table>

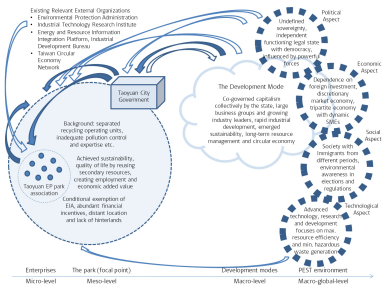
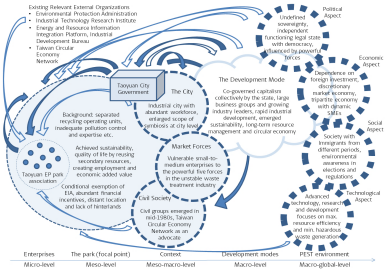
authority		- Transparent legal system under the rule of law - Emerging identity - Emerging environmental awareness and long-term plans - Advanced technology - Existing organizations and initiatives in max. resource efficiency and min. hazardous waste generation	on foreign investment - Interference from foreign investors and powerful forces
Development Mode (section 3.3)			
National development plans East-Asian developmental state model Existing organizations and initiatives			
Context (section 3.5)			
The city and its industrial characteristics Five forces of the waste treatment industry Civil regulations from informal authorities		**Convenience** - Prosperous, diverse industries - Abundant workforce - Regular actions and contact with CE professionals - Flexible SMEs	**Hindrance** - Powerful five forces in the waste treatment industry - Existing mindset and sub-regulations of pollution control - Unstable SMEs

Table 5 Overview of the Methodology

Internal Environment Analysis

The operating firms are the basis of the Taoyuan environmental protection park. Yap & Devlin identified the research gap in the analysis of firms' actions and the influence of the external environment on the firms. (Yap & Devlin, 2016) The multi-scalar, mixed-level analytical approach is adopted in this study, and the macro-global environment, the development mode of the state, the contextual factors and the inter-firm relations all contribute to the decision-making of the firms in the Taoyuan environmental protection park. The organizational structure of the stakeholders involved can be outlined with the understanding as well.

The key points to analyze at this level include the development history of the park, the firms, industrial symbiosis potential, inter-firm relations and the co-evolution of the context and the firms. How is the park connected to the global economy and the globalizing production network? Are the firms willing to collaborate or cooperate with the state? How do the firms shape and comply with civil regulations? Those are critical questions to answer to investigate the Taoyuan environmental protection park, which helps to understand the leverage points to facilitate circular economy in the future, the strength and the weakness of the park.

Macro-Global Environment Analysis

The macro environment will be described in the political, economic, social and technological aspects. The analysis is at the highest level with global issues; therefore, it can be seen as macro-global environment analysis. It is crucial to explore the influential political and economic events in the contemporary history because the events can leave long-lasting legacies in the society ever since, let alone the influence in the technological aspect, the politics, and the economic structure. The political factors include international relations and cross-strait relations with China, the type of political systems and political parties in Taiwan. To conduct this part of the analysis, it requires extra care and deliberation. It is universally a great challenge to tell the history objectively and correctly. In economic aspect, market economy, neo-liberalism, national industry structure, the position in the global economy as well as the national development plans need to be analyzed. The technological factors are the changes in technology and the technical knowledge and infrastructure, while in the social aspect, the culture,

awareness and the identity will be examined. Deutz & Lyons stressed the importance of considering the economic reality of a specific location when studying industrial symbiosis. (Deutz & Lyons, 2015) The role and the connection to the global economy should be considered. The linkage can have positive outcomes in the development, but the pressure on the environment and the society cannot be ignored.

It is especially important to consider how the development mode is designed together with the state, political factors, and economic factors. The industrial development is also path dependent. It is worthy of attention how the democratization challenges developmentalism. (Fields, 2012) The macro environment influences the context, such as market forces, the city government, and the civil society. At the focal point of the research, the decision-making of Taoyuan environmental protection park and the firms are also affected by the political nature, the competitive, dynamic market economy and so forth.

Development Mode Analysis

In the contemporary development history of Taiwan, the previous authoritarian regime contributed to the rapid development of the East-Asian developmental state model, transitioning from labor-intensive industries to information technology area. In contrast to the Anglo-American neo-liberal model, the development mode in east Asia is mainly state-led, co-governed capitalism. (Fields, 2012; J. Zhang & Peck, 2016) Through the continuous adjustment and adaptation, a distinct balance between market economy and planned, intervened economy has become the development mode in Taiwan. The contextual market factors, the region, and the civil society were directly influenced by the developmental state. Firms in the waste treatment sector also emerged under the development mode because of the existing demand.

There are several characteristics of Taiwan which co-shaped the development mode, such as the abundance of human capital and the export-based economy relies heavily on the direct investment of multinationals. (Fields, 2012; Guerrieri & Pietrobelli, 2004) The macro-level development mode of a country influences the city government and the context it operates in at the meso-macro level, which links the political and economic environment with the development of the city and the industries. In other words, it is crucial to understand how the

Taoyuan City is developed according to the evolving national development plans, as well as the remained legacy from the previous state-led economy and the authoritarian state in the context.

SWOT Analysis

With the comprehensive understanding of the macro-global environment from the PEST analysis as well as the internal factors, a SWOT analysis can be conducted to structure the characteristics of the case. The strength and the weakness are the internal factors, whereas the opportunity and the threat address the factors in the external environment. The research is conducted from the author's perspective with multiple sources of information, investigating the pragmatic policy interventions that facilitate circular economy for the city government. The focal point of this study is the Taoyuan environmental protection park, which comprises the internal environment of the SWOT analysis. While the external environment consists of the factors at the macro-global level and the development mode, which is difficult to alter by the policies introduced by the city government. These are the elements in the opportunity and threat categories which decision makers should bear in mind when designing the policies.

Context Analysis

The focal point of the study is the Taoyuan environmental protection park, and it is closely connected to the firms existing in the park and the context where the firms operate. Both the contextual factors and the firms can influence the outlook of the park; therefore, the co-evolution process of the contextual factors and the firms will be closely looked at. Based on whether the factors encourage or discourage the circular economy development, the context analysis categorizes the factors in two piles, contextual convenience and contextual hindrance. Just like the SWOT analysis, the contextual convergence and hindrance consist of key findings and can be summarized in bullet points.

What makes the context interesting is that it encompasses the socio-historical aspect, the state (the city), the specific market forces and the civil society of the focal point of this study. The analysis gives us an ample understanding of the background where the park operates. Continuing the development history, the

context is evolving, and the city government is able to influence the evolution of the city, the specific market forces, and the civil society. The policy interventions can not only influence the internal environment but also turn the contextual hindrance into contextual convenience for circular economy development. The contextual factors could also be seen as an addition row to the SWOT analysis, since the context belongs to neither the internal environment nor the external environment.

The context consists of market factors, the state and the civil society, which may either foster or hinder the development. (Yap & Devlin, 2016) The context also describes the environment where the actors interact. The shareholders, competitors, suppliers, customers, new entry and substitutes (Porter's 5 forces), price volatility, industry and market stability are important market forces to consider. In this research, the state is seen as the city government; thus, the stable handover of the tasks in the city government, how the city government collaborate or cooperate with the firms, the multiple roles of the city government as an investor, regulator or facilitator are crucial. The context of the civil society is analyzed with the civil regulations from the consumers, investors, labor groups and other informal authorities.

The development strategies can also be designed from the results from the SWOT analysis in combination with the context analysis. The strategies are designed as policy interventions for the Taoyuan City government. Some strategy examples are building institutional capacity by identifying specific roles of actors involved in the collaboration, or developing the expertise in e-waste treatment domestically and potentially for developing countries. It utilizes the currently-existing firms in the park (strength), international relations (opportunity) and meets the goals of circular economy development (convenience). With the lessons learned from the eco-industrial park development, the correlation with the CE development will be drawn. Key insights will be collected to provide sound recommendations for the circular economy in the future.

Checklist for the Mixed-Level Analysis

Due to the nature of a qualitative analysis, the basis of this research, the mixed-level analysis can be conducted with numerous variations. Therefore, a checklist

for the analysis is developed to structure the key points analyzed, the information sources acquired, and the knowledge level in the analysis. (Table 6) The research intends to provide a sound and objective analysis, and for every key point in the analysis, multiple sources of information are considered. Note that the knowledge level of the analysis can vary from the minimum 1 to the maximum 5. Several key points can be less known due to all sorts of limitation, including the insufficient information, the unnecessity to know more in order to reach conclusions, and so forth.

Key points	Information Sources					Knowledge Level in the Analysis (1-5, max. 5)
	Official Reports	Existing Literature	Official Websites	Personal Interviews	The Media	
Internal Environment						
City government's goals						
History of the park and firms						
Development objectives						
Current state and participants						
Industrial symbiosis potential						
Inter-firm relations						
Connection to the context						
Connection to the global economy						
Macro-Global Environment						
History in the recent 100 years						
Political and international relations						
Economic development and structure						
Position in the neo-liberal global economy						
Culture, awareness, and identity						
Technical knowledge and infrastructure						
Legacy from the previous authority						
Development Mode						

National development plans						
East-Asian developmental state model						
Existing organizations and initiatives						
Context						
The city and its industrial characteristics						
Five forces of the waste treatment industry						
Civil regulations from informal authorities						

Table 6 Checklist for the Mixed-Level Analysis

Applicability to Other Cases

The methodology is both transparent and simple to apply to other cases in other contexts with a similar research question. A crucial point is to clarify the decision-making entity, which can be the city government or the client from the business side. Once the focal point is determined, an examination of the influence coverage from the decision-making entity can be conducted. Wherever the decision-making entity has the influence over, where also has an influence on the focal point of the research is the context of the integrated mixed-level analysis. The context is the area which affects the focal point of the research and meanwhile is affected by the decision-making party.

With the methodology and this analytical framework, the characteristics of a specific geographical location and its unique development path can be explicitly shown. This ample understanding of different contextual backgrounds contributes greatly to the comparative research in this field.

The application to other cases with the focal point and the decision-making entity at other levels is possible, but it requires more efforts to make a logic adaptation. The key is to understand the position of the focal point and the decision-making entity in the mixed-level analysis.

2.2 Data Availability

The research gathers information from multiple sources, including the literature, interviews and the official, published information. Regarding the internal factors and contextual factors of Taoyuan environmental protection park, abundant information can be found on the official websites concerning the current status of

Taoyuan environmental protection park and the IS development. (Table 7) It includes implementation, policies, future planning of industrial symbiosis and so forth. The national development plans are also accessible to the public. The case investigation from multiple sources provides a comprehensive understanding of the internal, contextual and external environment with a neutral and unbiased standpoint. Furthermore, many reports and official documents in Mandarin Chinese are reviewed in this research. In order to reduce the misunderstanding, direct translations of the terms are adopted to reflect the intention of the original authors.

Website Title (official translation) and URL	Highlighted Information	Level
Environmental Protection Administration, Executive Yuan 行政院環境保護署 http://www.epa.gov.tw/mp.asp?mp=epa	Full report of the 10-year project of establishing environmental and science parks	macro
Energy and Resource Integration Platform, Industrial Development Bureau, Ministry of Economic Affairs 經濟部工業局 能資源整合資訊平台 http://eris.utrust.com.tw/eris/dispPageBox/REHP.aspx?ddsPageID=CHINESE&	Successful examples and case descriptions of the linkage in the country	macro
National Development Council 國家發展委員會 http://www.ndc.gov.tw/	National development plans	macro
Taoyuan Virtual Science Industrial Park 桃園 MIT 網 http://vsip.tycg.gov.tw/home.aspx	Macro environment analysis of Taoyuan City and industrial development history	meso-macro
Sustainable Development — Starting from Urban Mining 台灣環境永續發展 從城市採礦談起 http://www.urbanmining.com.tw/	Presentations and reports regarding urban mining and the Taoyuan environmental protection park	meso-macro
Taiwan Circular Economy Network 資源循環台	Forum: Circular Economy in Taoyuan	meso-macro

灣基金會 http://www.circular-taiwan.org/		
The Environment Science and Technology Park in Taiwan 環保科技園區推動計畫 http://estp.epa.gov.tw/big5/index.htm	Rules of business recruiting in Taoyuan environmental protection park and the list of subsidies	meso

Table 7 List of Official Websites

3 Analysis

3.1 Internal Environment Analysis

The focal point of this research, Taoyuan Environmental Protection Park, is a sub-development project under a larger plan of Environmental Science and Technology Parks from Environmental Protection Administration in the Taiwanese central government. The plan was initiated in 2002 and aimed to promote the concept of industrial symbiosis and eco-industrial parks when Taiwan was still at a rather early stage of environment and resource management. This section analyzes the internal environment, from the promotion plan of environmental science and technology parks to the Taoyuan environmental protection park, related policies and the existing initiatives.

3.1.1 Promotion Plan of Environmental Science and Technology Parks

Five Objectives to Enhance Sustainability and the Quality of Life

In the early 2000s, the waste treatment policies in Taiwan were transitioning from "mainly incineration and partially landfill" to "waste reduction and recycling". The waste treatment and recycling sector encountered several limitations, such as separate operating units, insufficient expertise, inadequate pollution control and the difficulties in land acquisition. Environmental Protection Administration stated that in the 2000s, Hsinchu Science Technology Park alone produced 0.1 million tons of waste, and the unused industrial lands were 1500 hectares, accounted for 14% available area and caused great financial burden. (Environmental Protection Administration, 2013) The enhancement of the energy, resource and space efficiency became an obvious urgency.

Concerning the lack of integrated clusters, the 10-year (2002-2011) promotion plan of environmental science and technology parks was developed with the 5 following objectives. (Table 8) First, reducing pollution and facilitating resource circulation. Second, activating the unused lands and providing employment. Third, attracting foreign investment and advancing the resourcification expertise. Fourth, promoting the waste treatment industry and stimulating

environmentally-friendly industrial practices. Fifth, creating circular cities and enhancing the quality of life. (Environmental Protection Administration, 2013)

Objectives of the Promotion Plan	Reduce pollution & Facilitate resource circulation
	Activate the unused lands & Provide employment
	Attract foreign investment & Advance the resourcification expertise
	Stimulate the waste treatment industry & Encourage environmental protection practices in industries
	Create circular cities & Enhance the quality of life

Table 8 Objectives of the Promotion Plan of Environmental Science and Technology Parks (Environmental Protection Administration, 2013)

Worth noticing is the early awareness of sustainability despite the transitioning waste treatment policies in early stages. From these objectives and the official report from Environmental Protection Administration, the aspects of the manufacturing, the living and the ecology, "three Sheng" in Mandarin Chinese, were well-covered in this development. The use of the term "environmental science and technology" also reduced the negative image and the connotation to waste treatment.

Principles Setting, Division of Work and Implementation

Environmental Protection Administration listed 6 key industries to reward the business participation, according to the scale of investment and the efficiency of manufacturing. The focal industries are cleaner production, resourcification (waste or byproducts turning into raw materials), recycling (waste or byproducts turning into other use), advanced and strategic environmental technology, renewable energy and systemic production, other expertise and developing other key components. (Environmental Protection Administration, 2013).

In this promotion plan of environmental science and technology parks, Environmental Protection Administration assisted the regional governments in various aspects, including the construction, attracting businesses, the operation, facilitating industrial symbiosis and maintaining sustainability. This guiding policy and the incentives were created by Environmental Protection Administration, while the regional governments took the implementation, construction, and management role. The 8 principles are expected to be applied by the regional governments in their implementation plans. They are pollution- reduction facilities, ecology-protecting measures, clean and renewable energy measures, waste reduction and recycling measures, reuse-promoting efforts, "three Sheng" sustainability efforts, ecological engineering constructions and sustainable-living actions.

With the background of the separate operating units, insufficient expertise, inadequate pollution control and the difficulties in land acquisition of the waste treatment industry in Taiwan, in 2001, the ex-Premier Chun-Hsiung Chang proposed the idea of setting a recycling demonstration site. In this assessment state of the regulations and the market, Environmental Protection Administration was appointed to take an active setup role. Ministry of Economic Affairs and Ministry of the Interior were delegated to assist the land acquisition of the industrial regions. Ministry of Finance was responsible for the low-interest loans and tax exemption policies. In 2002, the feasibility and the operating mode remained in discussion among the ministries. The subsequent premier Shyi-Kun Yu continued to support the promotion plan of environmental science and technology parks. With the encouragement of environmental protection industries, research development, and environmental technology sites indicated in the Recycling Act §24, the promotion plan of environmental science and technology parks was approved. The amendment process of the detailed regulations was started in this phase.

During the site selection in 2003, half of the counties in Taiwan submitted their proposals, but only the Kaohsiung and Hualien were selected to be the first two demonstration sites out of 10 counties. In 2004, the updates of the promotion plan were amended. The total budget was also increased due to the action and ambition of the regional governments, and the 4th environmental science and technology park was added to the original plan of 3 parks. Tainan was selected,

and the focal point of this research, Taoyuan environmental protection park, was the last one to be selected out of 4 proposals. In the later promotion and building stage until 2008, the central government strived to attract businesses and provide guidance. In 2011, the last year of the promotion plan, Environmental Protection Administration proposed another amendment to extend the funding to 2013, prolonging the subsidizing period and the management fee. This amendment was not approved by the authorities concerned due to other new projects which bring higher benefits. Starting from 2012, the regional governments took over the management of the Kaohsiung, Hualien, Tainan and Taoyuan parks, as well as the responsibility to finance the parks and propose sustainable operating plans. (Environmental Protection Administration, 2013).

3.1.2 Taoyuan Environmental Protection Park

Participants and the Division of Work in Taoyuan Environmental Protection Park

In the nested organizational structure of the Taoyuan environmental protection park development, Environmental Protection Administration initiated the incentives, and the Taoyuan City government took over the incentivizing role after the promotion plan came to the end in 2011. Environmental Protection Administration was the highest authority in the promotion plan of environmental science and technology parks. It set the regulations, assisted the regional governments in forming responsible departments, reviewed the subsidies, supervised the construction and regional management. At the beginning of the 10-year promotion period, the guiding committee was formed with related departments in the administration, several scholars, and experts in the field. In semi-annual meetings, they were responsible for building and monitoring the system, assisting the setup of regulations and the enterprise selection. The ex-director of Environmental Protection Administration Chuen Chang stated the selection criteria in the report, "high purity, high value, and a higher level of treatment in the industry", preventing improper treatment which might cause another pollution. (Environmental Protection Administration, 2013) The promotion and work team discussed the administration and implementation in the monthly work meetings. The regional governments outlined the implementation plans and assisted the enterprises in this project, while the

enterprises submitted the investment plans and the operating reports together with their application to enter the park. Environmental Protection Administration and Professor Chao, who worked in Industrial Technology Research Institute (ITRI) in 2002, both mentioned that ITRI played a crucial role in the initial stage of scheduling and project planning. With its ample knowledge and the close relations with the enterprises, ITRI also assisted in the selection process of park location. (Environmental Protection Administration, 2013; Industrial Technology Research Institute, 2015)

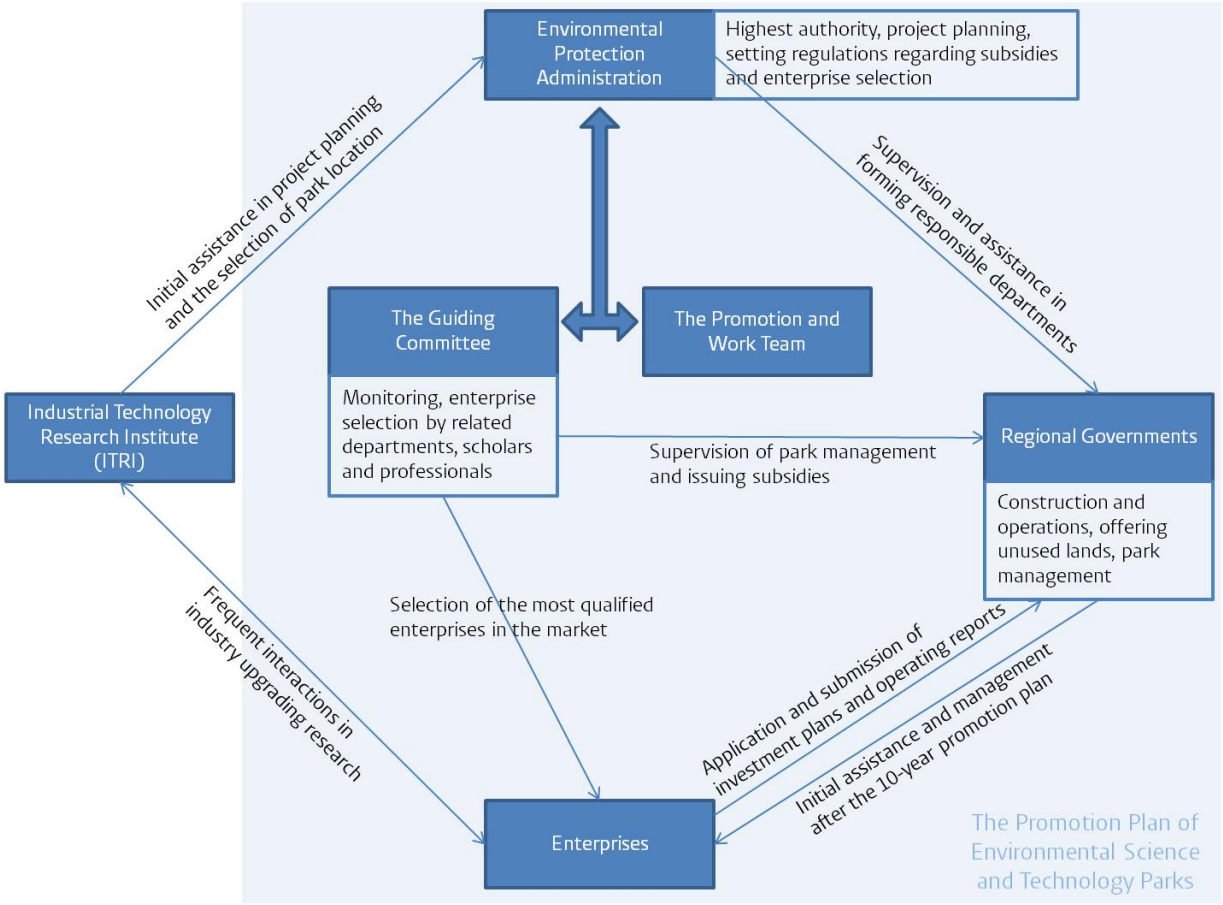


Figure 8 Organizational Structure of The Promotion Plan of Environmental Science and Technology Parks (Environmental Protection Administration, 2013; Industrial Technology Research Institute, 2015)

After the end of the promotional plan, the Taoyuan environmental protection park and the enterprises within the park stopped receiving subsidies and financial support. The Taoyuan City government took the management role and started to finance the park. There are currently no direct initiatives regarding the park, though the park became significantly more active in 2014 in the new mayor's

term of office. (Chung-Tai Resource Technology, e-mail correspondence, 2016) But outside the park, several initiatives from diverse organizations are actively ongoing at a larger scale to facilitate industrial symbiosis and resource linkages. (Section 3.3.2)

Actionable Policies at the City Level

Translating from the objectives of the promotion plan of environmental science and protection parks, the following 4 objectives are set as concrete and actionable goals. (Table 9) First, solving the existing pollution issues in lands, rivers, groundwater and so forth. Second, facilitating the circular linkages in industries, preventing resources from entering the waste treatment system. Third, pulling the domestic and foreign expertise and human resources in environmental protection industries. Fourth, implementing actively the long-term sustainability goals and maintaining sustainability. (Taoyuan City government, 2015)

Objectives of the Taoyuan environmental protection park	Solve the existing pollution issues in lands, rivers, groundwater and so forth
	Facilitate the circular linkages in industries, preventing resources from entering the waste treatment system
	Pull the domestic and foreign, expertise and human resources in environmental protection industries
	Implement actively the long-term sustainability goals and maintaining sustainability

Table 9 Objectives of the Taoyuan environmental protection park (Taoyuan City government, 2015)

Figure 9 shows the planned linkages of industrial symbiosis in the Taoyuan environmental protection park. The waste in one manufacturing process can be the raw material in another industry. Most of the inflows in the park are the waste from various industries. After processing, classification, and the refinery, the products from the park as the outflows are then sold to the market domestically or abroad.

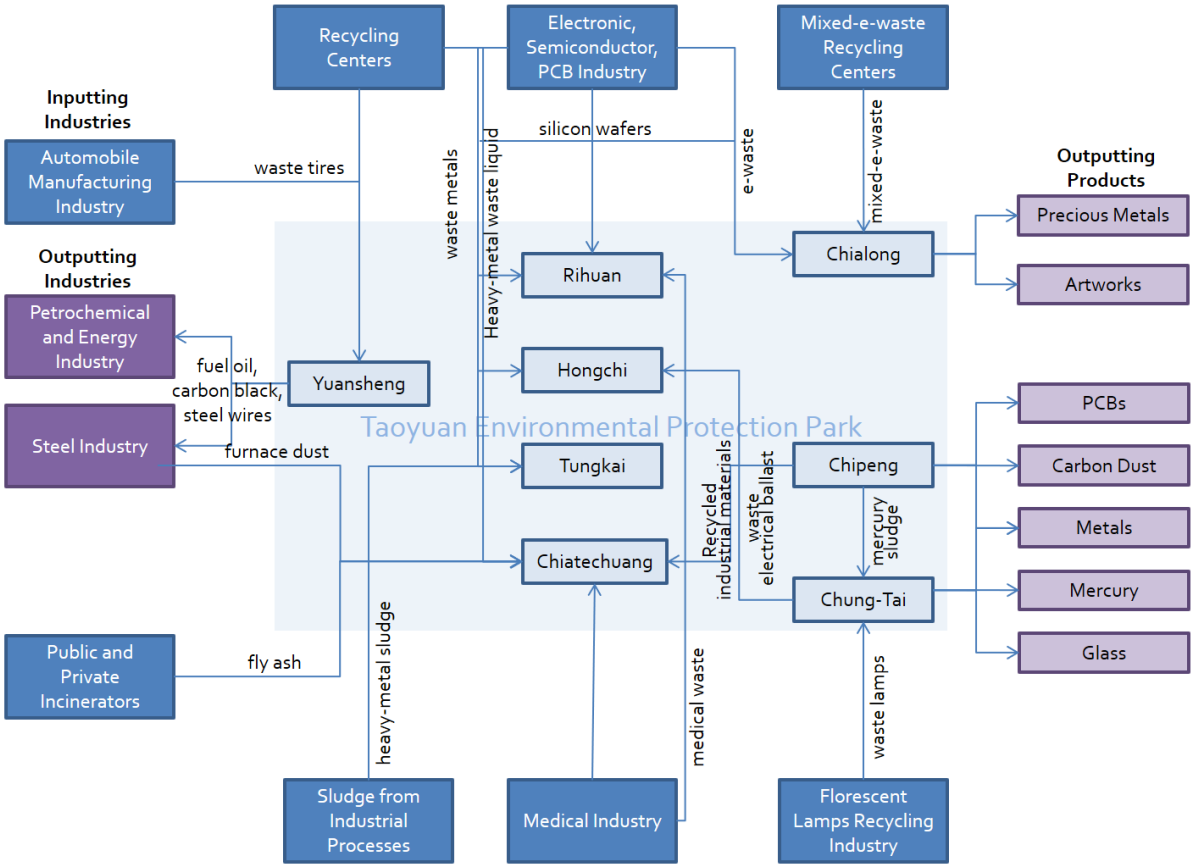


Figure 9 The Planned Industrial Symbiosis in Taoyuan Environmental Protection Park (Taoyuan City government, 2015)

Current State of the Park

Taoyuan Environmental Protection park is located in the southwest of the Taoyuan technology industrial cluster, with the area of 32 hectares. The park was divided into the manufacturing demonstration area, research and development area, administration center and the education demonstration area. Ecological engineering is adopted in greening the scenery and the relevant facilities. The manufacturing demonstration area accounts for 74% of the park, focusing on attracting the 6 key industries, cleaner production, resourcification, recycling, advanced and strategic environmental technology, renewable energy and systemic production, other expertise and developing other key components. To facilitate the development of the park, the active promotion to attract businesses resulted in the fully-sold lands. However, the enterprises attracted are mostly in the waste treatment sector, instead of the resourcification industry.

(Table 10) There is some gap between the original objectives and the current state as a waste treatment cluster. (Taoyuan City government, 2015)

Enterprise Name	Business Description	Operating Status	Entering Year
Hongchi	Precious metal refinery from the waste and waste liquid of the electronic industry	Operating	After 2011
Chipeng	Recycling dry cells	Operating	After 2011
Chung-Tai #2	Resourcification of fluorescent lamps	Operating	2006
Chiatechuang	Resourcification of abiotic/ biotic waste	Operating	2006
Yuansheng	Resourcification of waste tires	Applying for shutting down	2008
Hsiulin	Processing fluoride solvent	Operating	After 2011
Chung-Tai #3	Recycling printed circuit boards (PCBs)	Operating	2008
Dayuan	Recycling the cutting fluid of solar panels	Operating	After 2011
Tungkai	Resourcification of abiotic/ biotic sludge	Operating	2009
Taifa	Manufacturing high-activity Calcium Hydroxide ($Ca(OH)_2$) for incinerators	Building plants	2006
Chialong (SDTI)	Precious metal refinery from e-waste	Building plants	After 2011
Rihuan	Fluidized bed crystallization equipment, incinerating hearth technology and e-waste recycling technology	Building plants	2008
Changpu	Resourcification of waste solvent	Planning	After 2011
Hsiehyu	Processing sludge	Building	After 2011

		plants	
Hungshengchang	Precious metal refinery	Planning	After 2011
Luwei	Processing sludge	Planning	After 2011
Kuanshenghuanyu	Processing sludge	Building plants	After 2011
Yatong	Recycling PET bottles and polyester pieces	Building plants	After 2011
Wangchia	Processing sludge	Planning	After 2011
Shangda	Processing waste solvent	Building plants	After 2011
Chengyu	Manufacturing high-end Tin and precious metal refinery from e-waste	Planning	After 2011
Chiate	Resourcification and recycling of Silicon wafers, medical waste and PCBs	Building plants	After 2011
Lisheng	Processing sludge	Building plants	After 2011
Tairung	Process engineering of incineration equipment	Planning	After 2011
Guanbo	Cleaning waste containers (for recycling)	Building plants	After 2011
Hueineng	Heat pump	Operating in R&D Building	After 2011

Table 10 Enterprises in Taoyuan Environmental Protection Park (Environmental Protection Administration, n.d.-b; Taoyuan City government, 2015)

By early 2015, there are 9 operating enterprises out of 25 business units. Because of the smaller number of the companies which process florescent lamps with mercury content and acid liquid, these companies stay rather competitive. While for the remaining waste items, the processing/ recycling plants are more common. Price war can be observed in the market of waste processing.

The major sources of pollution in the waste treatment process are the water pollution and air pollution. 1764 cubic meter of wastewater is discharged per month, and 13 tons of NOx and 11 tons VOCs were emitted per year. (Taoyuan City government, 2015)

By 2015, the enterprises in the Taoyuan environmental protection park have reached the total investment of 2.7 billion New Taiwan Dollars (NTD), the economic value added of 1.1 billion NTD, the employment for around 350 people and the secondary resource use of 32 tons per year. (Taoyuan City government, 2015) However, due to the competition in the market and the price war, the park consisting of the waste treatment industry failed to be competitive. In Table 11, the types of pollutants, wastewater discharge and the income sources of the operating companies in the park are reported.

Enterprise Name	Pollutants (T / year)	Waste Water Discharge (M^3/month)	Sources of Income
Hongchi	SOx: 0.358 NOx: 0.25 VOCs: 0.019	55	Au, Ag, Pb, Pt
Chipeng	TSP: 0.0337 NH_3: 0.00259 mercury and compounds: 0.000207	25	MnO_2, Fe, Zn
Chung-Tai #2	TSP: 0.06 VOCs: 0.48 mercury and compounds: 0.00005	277	glass fragments, Hg
Chiatechuang	TSP: 1.136 SOx: 4.4 NOx: 5.06	214	ZnO, cast iron, hearthstone
Yuansheng	TSP: 0.377 SOx: 2.803 NOx: 6.044	86	Fuel oil, carbon black

	VOCs: 11.24		
Hsiulin	TSP: 0.04 fluoride: 0.003	975	NaF, Na_2SiF_6
Chung-Tai #3	-	14	Copper powder, materials for concrete
Dayuan	TSP: 0.0136 NOx: 1.2787	116	Alcohol, CSi, silicon powder, auxiliary fuel

Table 11 Pollutants, Waste Water Discharge and Income Sources of the Operating Companies (Taoyuan City government, 2015)

The Taoyuan City government has set the directions of the future as developing towards a circular economy and integrating neighboring regions. But the Taoyuan environmental protection park is currently facing the following issues, private ownership of the land resulting the market dominance in land transactions, limited benefits of industrial symbiosis, losing the profitability in the competitive market and the limited amount of waste processing due to the strict emission standards. (Taoyuan City government, 2015)

Conditional Exemption of EIA and Abundant Financial Incentives

To facilitate the development, in 2005, the Taoyuan City government loosened the environmental impact assessment and conducted the assessment at the scale of the entire park. The enterprises entering the park are exempt from the environmental impact assessment (EIA) with two conditions, not exceeding the regulated amount of pollution, and obtaining the consent of the department of environmental protection and department of business administration. (Taoyuan Environmental Protection Park Preparation Office, 2005) However, the regulations regarding the architecture and the scenery are very detailed, down to the size, materials used, the interior division of space and the type of plants. (Taoyuan Environmental Protection Park Preparation Office, 2005, Chapter 12)

The procedure of land sales was outsourced to Yashuo Development Company, which belongs to the Formosa Plastics Group. There is no regulation concerning the resale of the property, but if the development is not implemented according

to the investment and operating plan, or extending and changing the plan without the approval, the enterprises should leave the park unconditionally. In Chapter 8 of Land Sales Descriptions of Taoyuan Environmental Protection Park, there is a long list of available rewards and subsidies for renting the property (50% rent), the manufacturing and the research. (Taoyuan Environmental Protection Park Preparation Office, 2005)

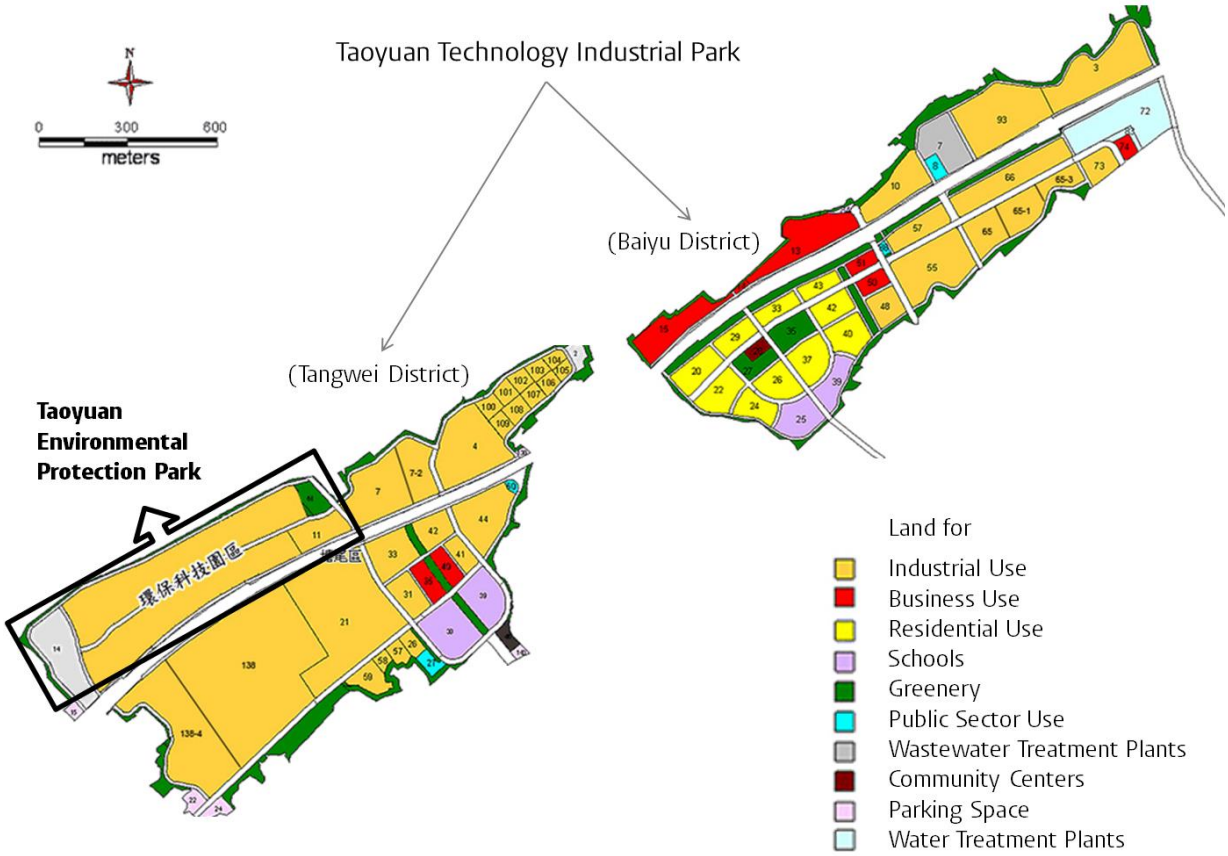


Figure 10 The Map of Taoyuan Technology Industrial Park and Taoyuan Environmental Protection Park (Taoyuan City government, n.d.)

In the inquiry of EIA reports, it was discovered that the Taoyuan technology industrial park is the smallest scale where the EIA is conducted, which covers the focal point of this research, the Taoyuan environmental protection park. Figure 10 shows that the Taoyuan technology industrial park consists of two districts, while in this nested structure, the Taoyuan environmental protection park accounts for approximately 25% area of the Tangwei district. With the EIA scope of the Taoyuan technology industrial park, a total of 11 EIA records were found in the EIA inquiry system. (Table 12) Due to the conditional exemption of EIA for the entire environmental protection park, further EIA efforts were taken in the

form of "Deviation EIA", which assesses the project changes and deviation from the original development plan. Table 12 also shows that many previous EIAs have not been completed. Most of them are still in the examining and correcting stage.

Year	Authority	Name	Type	Progress
2014	EPA	3rd Deviation EIA of the development	Deviation Analysis	Correcting
2013	EPA	2nd Deviation EIA of the development	Deviation Analysis	Correcting
2010	EPA	EIA description of phase 2 development	Description	Conditionally passed
2010	EPA	Deviation EIA of the development	Deviation Analysis	Examining/ correcting
2007	EPA	EIA description of the plan change	Comparison Chart	Examining/ correcting
2005	EPA	EIA description of the plan change	Description	Conditionally passed
2004	EPA	EIA description of the plan change	Description	Rejected/ canceled
2002	EPA	2nd deviation EIA of the development	Deviation Analysis	Examining/ correcting
2001	EPA	Deviation EIA of the development	Deviation Analysis	Examining/ correcting
2000	EPA	EIA description of the development plan	Assessment Report	Conditionally passed
1998	Taoyuan City government	Development plan	Description	Examining

Table 12 Overview of the EIA Reports and the Progress Regarding the Taoyuan Technology Industrial Park (Environmental Protection Administration, n.d.-a)

The water quality is often regularly monitored at various examination points in Taiwan, and the results are publicly disclosed. Due to the smaller scope of Dajueh creek, whose estuary receives the wastewater discharge from the

Taoyuan environmental protection park, the information of the water quality at the estuary of Dajueh creek can only be found on the official website of the department of environmental protection in the Taoyuan city government but not in the system of Environmental Protection Administration. According to the replied email for an inquiry, the department of environmental protection in the Taoyuan city government quarterly examines the water quality. The items include the total nitrogen and prosperous concentration, as well as the dissolved oxygen (DO), biological oxygen demand (BOD_5), suspended solids (SS) and nitrogen-ammonia (NH_3-N) to calculate the river pollution index (RPI). Half of the examination results in the past five years were moderately polluted, one out of 20 results was highly polluted, while the rest were lightly polluted.

The relevant conclusion from the latest meeting in 2014 regarding the Taoyuan environmental protection park is to update the information of an ecological investigation of the estuary of Dajueh creek. Another suggestion is to complement, adjust and enhance the monitoring items, locations and frequency of the upstream, downstream, estuary, ecology, groundwater and so forth. Moreover, it is reported that the reason why the park did not pass any of the evaluations from the last examination is mainly due to the unclear method and the information from 10 years ago. The information from following aspects is expected to be collected. As for the standards and chemical content of the wastewater, please refer to the tables in Appendix 2 for more technical details.

- Reasonable estimate
- Correct method of water quality monitoring
- Correct parameters in the model
- Correct information inputs in the model
- Cohesive result from reproducing the simulation
- Adapted simulation result to the format
- Qualified simulation to the standard of water quality

Business Involvement and Actions

According to the interviews, the conditional exemption of EIA and the financial incentives were the major incentives for the enterprises to enter. (Chung-Tai Resource Technology, e-mail correspondence, 2016; Envirolink Corporation, e-mail correspondence, 2016) Partly due to the strict environmental regulations

and the unprofitable investment, Environlink has applied for shutting down the plant and has left the park. (Envirolink Corporation, e-mail correspondence, 2016)

Several challenges in the development of the Taoyuan environmental protection park are identified from the business side. The distant geographical location and the lack of hinterland remain unattractive for diverse industries to enter. The gap in the transport facilities still exists. Facing the competitive market of waste treatment, some upstream companies do not choose the licensed processing plants and go for the lower-price option instead. (SDTI, personal communication, 2016)

There is an existing platform for the enterprises in the park, Taoyuan environmental protection park association. Most of the enterprises are members of the association, and the executives organize meetings regularly. (Chung-Tai Resource Technology, e-mail correspondence, 2016; Envirolink Corporation, e-mail correspondence, 2016; SDTI, personal communication, 2016) Networking and information sharing remain to be the function of the association. As for industrial symbiosis and material linkage, it is quite limited due to the homogeneity of the waste treatment plants. (Chung-Tai Resource Technology, e-mail correspondence, 2016) On the other hand, SDTI shows the ambition to discover the values in the recycling process with other enterprises. (SDTI, personal communication, 2016)

Despite the difficulties, one sight-seeing and the educational plant are located in Chung-Tai Resource Technology. At the establishment in 2008, the visiting route was also set up. In 2012, Environmental Protection Administration issued the certificate of qualified environmental education facilities. In 2015, the certificate of the industrial museum was obtained from the Taoyuan City government. Annually there are 400 to 600 visitors coming to the museum. (Chung-Tai Resource Technology, e-mail correspondence, 2016)

Taoyuan City Government's Pursuit of Circular Economy

The recently-elected Taoyuan City government has the ambitious vision to incorporate circularity and sustainability into the city design since December 2014, especially in the Taoyuan Aerotropolis. The mayor has promised publicly to secure the openness and transparency as well as listening to all the stakeholders

in the decision-making process. The environmental and social concerns are also expected to gain more attention. According to one business respondent, the activities in the Taoyuan environmental protection park have been evidently more active since the new management team entered the city government in December 2014. (Chung-Tai Resource Technology, e-mail correspondence, 2016) So far, the new city government has been keen to promote the circular economy. In September 2015, the delegation of Taoyuan City government visited several circular economy cases in the Netherlands. In April 2016, Taoyuan and Kaohsiung City government attended Netherlands Circular Hotspot—3-day Trade Mission. The delegation from Taoyuan City government included the deputy mayor, the director of the department of economic development, the chief secretary of the department of environmental protection and the general manager of Taoyuan Aerotropolis Corporation. The mayor will also visit circular economy cases in end-June 2016. (Taiwan Circular Economy Network, personal communication, 2016) The development towards the circular economy of the city government is expected to continue as a long-term policy translated from the new development plan of the central government. (Section 3.3.1)

3.1.3 Summary

For the validity and reliability, the analysis of the internal environment considers various sources of information, including official reports, official websites, databases and several personal interviews with the city government officials and the experts in the field. The results obtained are cohesive and aligning well with one another. One crucial fact is that the Taoyuan environmental protection park is at a smaller scale. It belongs to one of the four environmental science and technology parks in Taiwan, and it accounts only for approximately 25% of the Taoyuan technology industrial park. (Figure 11) How the objectives translate from larger projects to the Taoyuan environmental protection park merits attention.

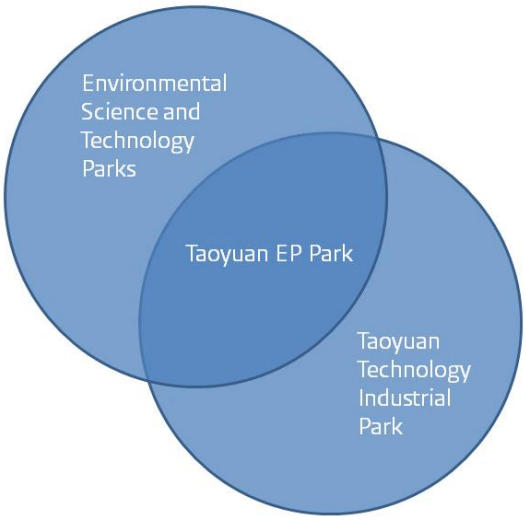


Figure 11 Taoyuan Environmental Protection Park as a Subordinate

Figure 12 depicts the internal environment analysis on the canvas of the mixed-level analysis. The park was built to cope with the background of separated recycling units, inadequate pollution control, and expertise. Despite the conditional exemption of environmental impact assessment and its distant location, the Taoyuan environmental protection park has achieved several sustainability targets. The existing Taoyuan environmental protection park association provides the enterprises with networking and information opportunities. The box represents the decision-making party of this case, the Taoyuan city government. Through policy interventions, it has a highly-relevant direct influence on the Taoyuan environmental protection park and the enterprises in the park.

As the core elements of the park, these enterprises, and the association are of high relevance to the evolution of the Taoyuan environmental protection park. The enterprises generate employment and the economic added value. The decision of further investment or leaving the park will have a great impact. As for the external relevant organizations, such as Environmental Protection Administration and Industrial Technology Research Institute (ITRI), play a moderately influential role in the development of the park. The influence of Environmental Protection Administration comes from conducting the environmental impact assessment and the supervision of the park development, while the ITRI contributed to the setup of the environmental science and

technology parks, and it has been continuously developing technologies regarding higher resource efficiency and reducing hazardous waste generation.

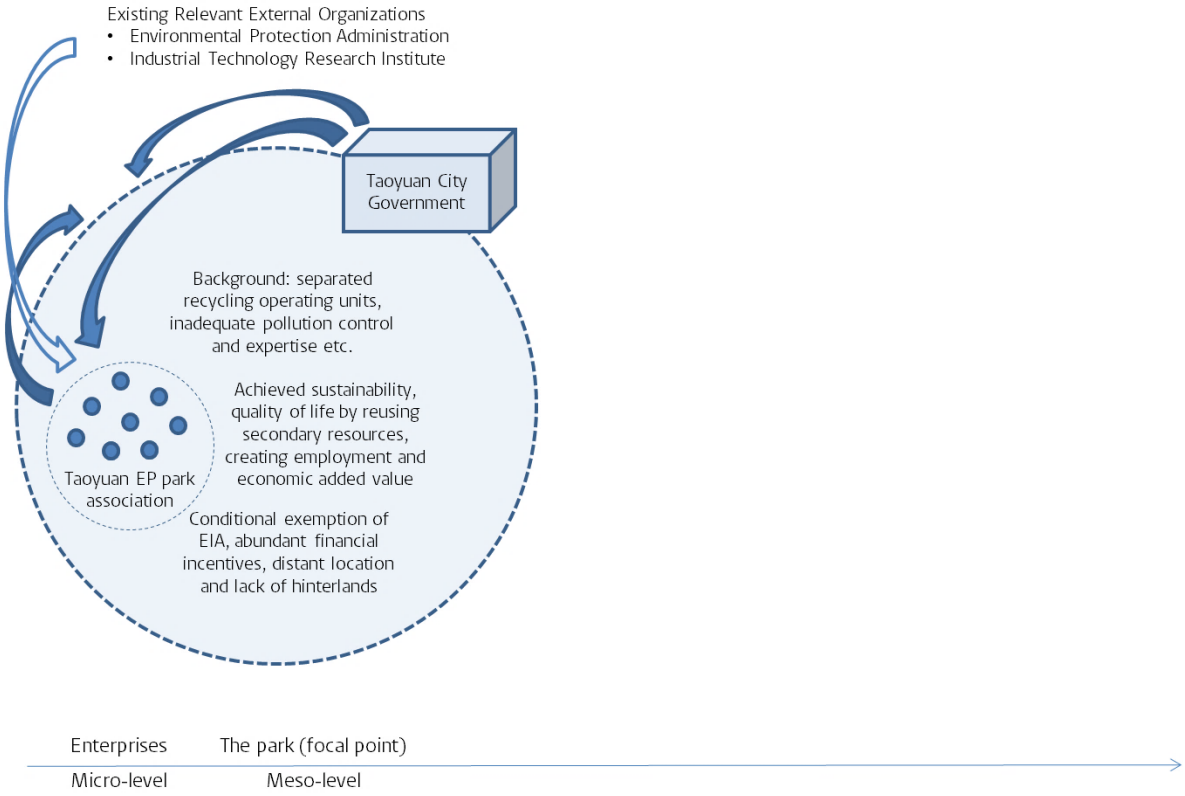


Figure 12 Internal Environment Analysis in Mixed-Level Analysis

3.2 Macro-Global Environment Analysis

Taiwan, officially known as the Republic of China, is a sovereign state with the independent government, legislature and judiciary. Other names include Formosa, Chinese Taipei due to the political reality. The native Taiwanese aboriginal tribes and the subsequent visitors, including the Dutch and Spanish, Qing Dynasty, the Japanese and the Chinese nationalist co-shaped the diverse historical and cultural context of Taiwan.

In the last hundred years, Taiwan has gone through the Japanese colonization, Chinese Nationalist one-party rule, the democratic process, and the Taiwan miracle — rapid industrialization and economic growth. Taiwan's geographical location and its attractive resources determine the heavy international influence of players on the global stage. This liberal, modern country with advanced

technology has also earned the title, the lighthouse of democracy in Asia. The following section describes the macro-global environment of Taiwan in political, economic, social and technological aspects.

It is universally a great challenge to tell the history objectively and correctly. The stories and the analysis are extremely prone to distortion or a biased perspective due to other powerful forces. The objectivity of this research comes partly from the neutral funding organization, European Commission. Moreover, the author is convinced of the quality and the objectivity of this analysis. Originated in Taiwan with over 20 years of exposure to diverse opinions from various information sources, the author is confident in the educated approach to the channel selection of information.

3.2.1 Political Aspect

Postwar Taiwan: From the Authoritarian One-Party Rule to Democratic Consolidation

After World War II, the control of Taiwan was replaced with the representative of the Allies, Republic of China (RoC), ending the Japanese colonization in Taiwan for three decades in 1945. During the subsequent four years, the political regime transformation was disastrous and caused a collapsing decrease in the standard of living for the inhabitants. Soon the 228 Incident broke out. With the violent suppression, thousands of inhabitants and elites vanished, died or were imprisoned. This tragic incident heavily divided the society, not only locked some civilians into unwavering ideologies but remained a taboo under white terror until 1995 and an unhealed wound until today.

In 1949, the Kuomingtang (KMT)-led RoC retreated to Taiwan after the defeat by the Communist Party of China, together with 2 million soldiers and a group of intellectuals, political and business elites. (J. Zhang & Peck, 2016) Since then, the Chinese Nationalist one-party (KMT) rule had lasted for 50 years in Taiwan, with the imperialistic ambition and development plan to ‘recover the lost lands’, including the entire China and Mongolia today. Following the 228 Incident, the martial law lasted for 38 years since 1949 to suppress political dissidents. On the other side of the strait, the Communist Party-led People’s Republic of China (PRC) has been seeing Taiwan as a breakaway province. The regime marginalizes and

downgrades the sovereignty of Taiwan with various measures in international occasions, expecting to 'free' the province and Taiwan's return.

In 1971, the United Nations expelled RoC and transferred the seat to PRC, which left Taiwan and its civilians in an awkward and disputed position on the global stage until today. Despite the diplomatic break-off with the U.S. in 1978, RoC has maintained close bonds with American political and economic establishment. (J. Zhang & Peck, 2016)

One landmark in the pursuit of freedom and democracy was built in 1986. The establishment of Democratic Progressive Party (DPP) has led Taiwan to the current two-party system, stemming from the democratic process with lots of blood, sweat, and tears.

Since the unprecedented DPP's presidency (2000-2008), there have been regular meetings between the officials from KMT and the PRC's regime. the relations between the two parties transformed from conflictive division into peaceful cooperation.

Taiwan Today: With Undefined Sovereignty but Functions Independently

Taiwan functions as an independent, democratic country under the rule of law. The president is directly elected by the citizens. There have been three party alternations in the central government between DPP (2000-2008, 2016-) and KMT (1949-2000, 2008-2016). However, the parliamentary party alternation just happened for the very first time in 2016. The new parliament with DPP majority takes the role of monitoring the central government for the first time, freeing the long-standing, KMT majority-led lawmaking since 1949. Taiwan has the multiple political party system, but in history, only DPP and KMT were capable of contending for the presidency. With the party alternations, the polarized ideologies of the two parties have gradually evolved towards the political-philosophical debate on pragmatic issues.

Reporters Without Boarders ranked Taiwan at 51st out of 180 countries worldwide in the latest 2016 World Press Freedom Index. Despite the resistance against the alliance of media capitalists and politicians, powerful forces utilize enormous resources to sabotage press freedom with media mergers and controversial journalistic practices. The structural and systemic impediments have limited the

individual reporters as well. (Wu & Lambert, 2016) Worth mentioning is the susceptible judicial independence in Taiwan. Doubts have been cast on several controversial cases; the corruption charges of the former president Chen, for instance. Goebel stated, "Although Chen had an incentive to obliterate the KMT's political machine, he was dealing with a legal system that was still in the grip of the KMT and its friends." (Goebel, 2016) Researchers in Amnesty International commented that the currently existing death penalty in Taiwan has also been executed with a political motive. ("Taiwan: Six executed in politically motivated decision" n.d.)

In the past hundred years, Taiwan has advanced substantially in the democratic progress. However, the fixed ideologies in the institution, the loyalty to previous regimes as well as the powerful forces still remain as rigid systemic challenges in the ongoing, continuous pursuit of democracy and freedom in this country.

3.2.2 Economic Aspect

From Agriculture to Manufacturing to Technology; Cautiously Entry to the Global Market Economy

Due to the hyperinflation of the Old Taiwan Dollar introduced in 1946 to support RoC regime's ambition in China, New Taiwan Dollar was issued in 1949 to stabilize the economy and remain in circulation until today. Foreign aid in the first two decades of the RoC in Taiwan period, especially from the U.S., exceeding one-third of total investment, played a crucial role in the economic development. (Berger & Lester, 2005)

The characteristics of the Taiwanese development mode are the political regime transformation, dependence on foreign investment, discretionary market economy and the abundant human resources. The autonomous state with interventionist industrial policies matches the characteristics of the East Asian developmental state (Fields, 2012), with the distinct growth in Japan (1953-1973), Taiwan (1960-1985) and Korea (1965-1989). The features of industry structure in Taiwan are the agriculture and consumer goods-oriented industries in 1950s, labor-intensive industries in 1960s, capital-intensive and heavy industries in 1970s, technology sectors in 1980s, institutional reform, the privatization of state-owned enterprises and market liberalization in 1990s,

information technology in 2000s, with various financial interventions to foster and guide the industrial development. (Berger & Lester, 2005; J. Zhang & Peck, 2016)

For political concerns, the ban on the investment in China was not lifted until 1990, which resulted in the mass relocation of the businesses in the 1990s. (J. Zhang & Peck, 2016) Taiwan used to play the role as a global manufacturing center, and it has been a trading hub in the global economy. With the privatization of state-owned enterprises and market liberalization, Taiwan entered the competitive global market economy, governed by the neo-liberal institutions and the international capitalism.

Tripartite Economy with Dynamic SMEs

Another characteristic of the Taiwanese economy is the tripartite structure of the upstream state-owned enterprises, midstream family-owned business groups and the downstream small to medium enterprises (SMEs). (Fields, 2012) The features of the SMEs are the abundant human resources, strong information networks with local and overseas counterparts, flexible and specialized manufacturing system and the broad supporting industries. One distinct feature of this structure is the unstable relationship between the suppliers and users. (Guerrieri & Pietrobelli, 2004; J. Zhang & Peck, 2016)

Some scholars see the SMEs-oriented industry structure as a competitive disadvantage. Berger & Lester argued that the interventions to support SMEs could lead to the incapability to compete with enormous enterprises on the global market. The scale of the customers would also limit the Taiwanese SMEs. (Berger & Lester, 2005) While Fields suggested that SMEs would secure Taiwan's position in the regional production in East Asia, strengthening the trade and investment among various industries. The complex and interdependent economy raised political concerns. One danger could be the state's attempt to retain control over the development of these connections. (Fields, 2012)

The vigorous SMEs, together with the privatization of state-owned enterprises, created a political/ economic environment where private business groups could contest the state authority. In the 2000s, the business groups continued to grow and increasingly influence the public policy, striking a new balance with business

actors and reduced the state capacity. (Fields, 2012) The new coalition of the government and the business groups not only fragmented the ruling elites but weakened their ideological cohesion as well, with the labor force remaining in a position to be sacrificed.

3.2.3 Social Aspect

Identity of the Immigrant Society

Taiwan is an immigrant society which constitutes the aboriginal tribes and the immigrants from different periods. With different political regimes, the institutional discrimination has been against various groups in history. The Taiwanese government has nevertheless been dedicated to creating equal chances for its citizens despite their origins and social status. Today, 2.3% of the permanent residents hold a non-Taiwanese nationality. Among them, residents from Indonesia (29%), Vietnam (18%), China including Hong Kong and Macau (16%), the Philippines (14%) and Thailand (13%) are the majority. (National Statistics, 2010) As for the identity, 60% of the Taiwanese identify themselves as Taiwanese, 33% see themselves as both Chinese and Taiwanese, while 3% of the people identify themselves as Chinese. (Figure 13) Compared to the result in 1992, 46% both Chinese and Taiwanese, 26% Chinese and 18% Taiwanese, the formation of Taiwanese identity has explicitly emerged.

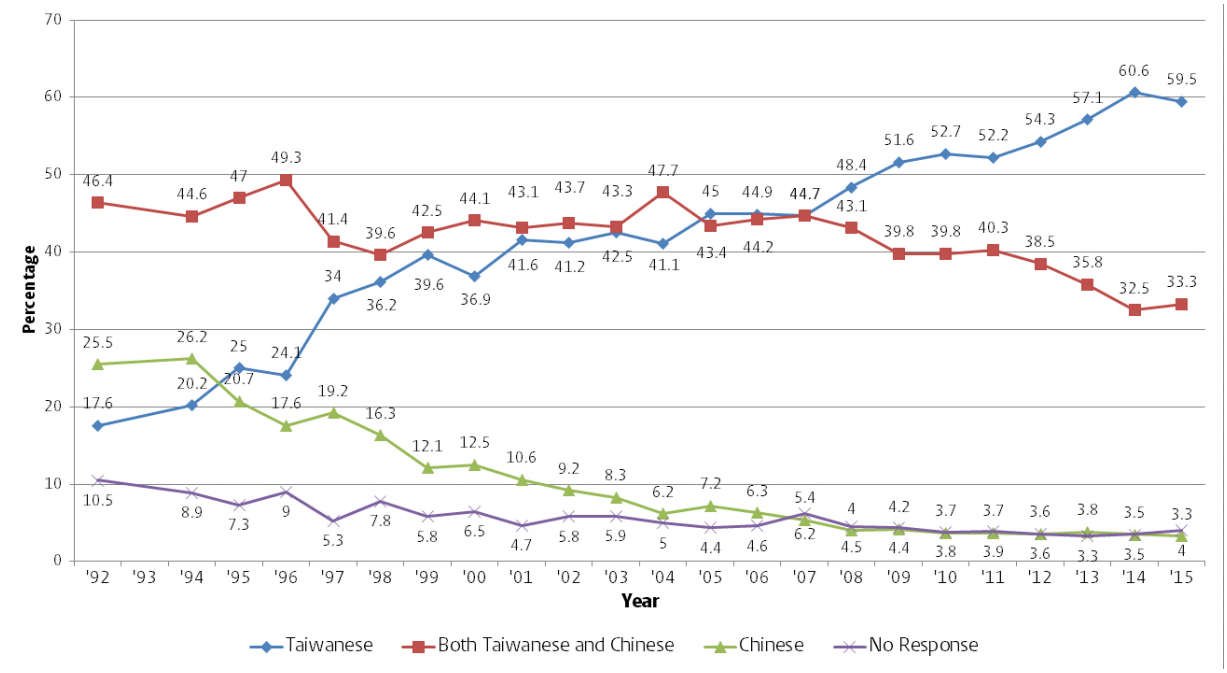


Figure 13 Changes in Taiwanese/ Chinese Identity of Taiwanese (NCCU Election Study Center, NCCU, 2015)

Environmental Awareness Reflected in Elections and Regulations

There have been various social movements in Taiwan, including the recent Sunflower Student Movement in 2014, and the regular elections reflect the political inclination in the country. The democratic process has drawn attention to the welfare, the environment, the labor force, the consumers and other essential issues, allowing all voices and opinions to be heard. (Fields, 2012)

The long list of hazardous environmental incidents can be traced back to the heavy industrial development in the 1970s, but only in 2002 did the Environment Fundamental Act come into force. Subsequently, the Environmental Impact Assessment Act in 2004 and the Environmental Education Act in 2010 both raised the awareness of environmental protection in the society.

3.2.4 Technological Aspect

The modernization and the rapid industrial development have equipped Taiwan with advanced technology. Following the U.S. model of Standford Research Institute and Stanford Industrial Park, the setup of the Industrial Technology Research Institute (ITRI) in 1973 and Hsinchu Science Technology Park in 1980 marked substantial progress in the technological aspect in Taiwan. (J. Zhang &

Peck, 2016) ITRI is a non-government organization, dedicated to upgrading the industries, research, and innovation.

The technology for material exchange and industrial symbiosis is also in place. The major efforts from the government lie in professionalizing the waste treatment and the recycling sector. Sustainable Environment Research Institute in ITRI takes the research and development role in the fields of low-carbon, resourcification technology, new and renewable energy, energy management and promotion. By introducing regulations and promoting resourcification certifications to prevent improper waste treatment, the development moves towards achieving higher resource efficiency and minimizing the generation of hazardous waste.

3.2.5 Influence of the Historical Development on Taiwan Today

Legacies in the Political Status and the Economy

Distinguished from the Anglo-American neo-liberal model, the development mode in Taiwan has the characteristics of managed opening and varying degrees of market adaptation, as the developmental paternalism in East Asia. What makes the Taiwan model unique is the recent democratization and party alternations. After World War II, Taiwan had followed the global trend of international cooperation, but the participation was limited and marginalized due to the political reality.

The influence of the tripartite structure of the upstream state-owned/ previously party-led enterprises, midstream family-owned business groups and the downstream small-to-medium enterprises (SMEs) can still be found in Taiwan. Until the 1980s, the authoritarian state had kept a tight leash on the enterprises to maintain the control over the country. (Berger & Lester, 2005) Fields indicated that the growth of SMEs was limited by the state, and the upstream capital-intensive state-owned enterprises were supported, leaving the downstream labor-intensive industries to the local Taiwanese. The KMT's integration into Taiwan and the democratization of the regime fostered a partnership between the state and the island's diversified family business groups. (Fields, 2012)

With the historical and global influence, Taiwan' co-governed capitalism is led collectively by the growing industry leaders, large business groups, and the adaptive state. The experiences have shown that the government interventions are prone to limit the long-term economic growth due to the distortions created by allocating capital, leaving the future government great challenges to develop new industries and services. (Mueller, 2012, p. 121) The party alternations have challenged the industrial policy and strategic development. (Fields, 2012) However, the capital supply in the economy remains a critical factor, simply because it can be political beyond the national boundary.

Legacies in the Society

In the last hundred years, there have been progressive voices and actions pursuing reforms in the KMT, in the institution and in the society. However, under the one-party regime, progressive voices and actions could be suppressed, or even expelled from the party. The separation of power and justice could not be well-implemented under the one-party institution. The martial law had stabilized the turmoil for 38 years, but the write terror had also suppressed diverse opinions for 38 years. In the society, the solidarity level is not high. Due to the previous authoritarian state and the initial disparity in origins, Taiwanese citizens was divided into subcategories according to their attitude towards reforms and their positions in this institution. (Figure 14) The influence of imposing a government institution to the society has been enormous, and the institution is still evolving. The progressive political elites were eager to initiate reforms in the country, while the citizens outside the institution searched for flexible solutions to facilitate the prosperity of the country, and some, inevitably for themselves. On the other hand, the conservative public servants developed loyalty to the institution and became resistant to changes, while the obedient social group remained being suppressed by the institution, partly due to the fear and learned helplessness tackling the previous authoritarian state. The progressive actions could only be initiated under this institutional structure.

The legacy of the previous one-party rule still remains in the society. For instance, this division of social groups and ideologies has caused misunderstandings and inherited political leanings in the generations. It has also

resulted in the resistance to changes, even if they are positive progressive for the entire society and beneficial in the long run.

Taiwan has encountered great challenges in the formation of the country as well as building the institution. In 1971, Taiwan was replaced by the People's Republic of China in the United Nation due to the majority vote of the member countries. The sovereign state has been marginalized and interfered by the powerful forces until today. Within the country, the first party alternation in the parliament just recently happened in 2016. The increasing separation of power in the institution can be expected. Together with the liberation from the origins, gender, social class, education, labor force, the environment and so forth, the wider range of progression in the institution just started to emerge.

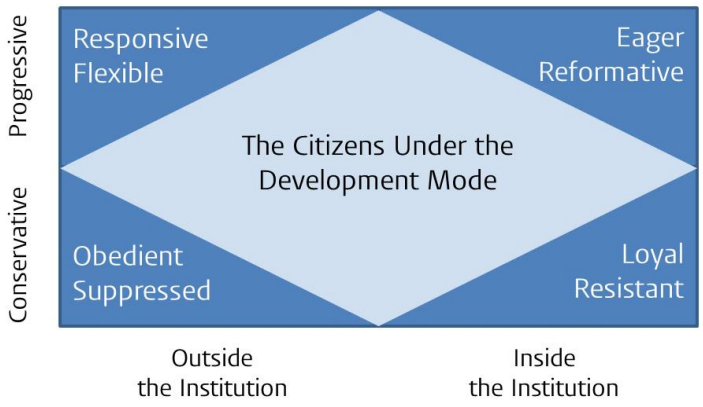


Figure 14 Subgroups of Taiwanese Citizens

3.2.6 Summary

This section analyzed the macro-global environment in the aspects of PEST, political, economic, social and technological. A great deal of information from multiple sources, including the existing literature and the media, are processed with the author's ample understanding in the socio-historical aspect of Taiwan and its connection to the global political and economic environment.

In the recent hundred years, Taiwan has gone through multiple power transfers from Japanese colonization, Chinese Nationalist's one-party authoritarian rule, and the recent democratization process. The power transfer has been smooth for over 20 years, but what cannot be ignored is the political reality, economic legacies, the impact on the society and people's ideologies. For instance, the

economic development was once led by the short-term and aggressive national development plans, and the low tolerance for different opinions still remains in the society nowadays, partly due to the previous one-party authoritarian rule of the martial law. The long-lasted suppression could shape the general social tendency to pursue stability, resist changes or even the progression, which can benefit the public such as the circular economy. These facts and the socio-historical development do not cause a direct influence on the Taoyuan environmental park, but it is crucial to address the macro-global environment where the enterprises and the park operate. (Figure 15) To develop the circular economy in a particular place, especially for the city government, a holistic consideration of both the opportunities and threats, as well as the potential uncertainties is very important to provide sound strategies and recommendations.

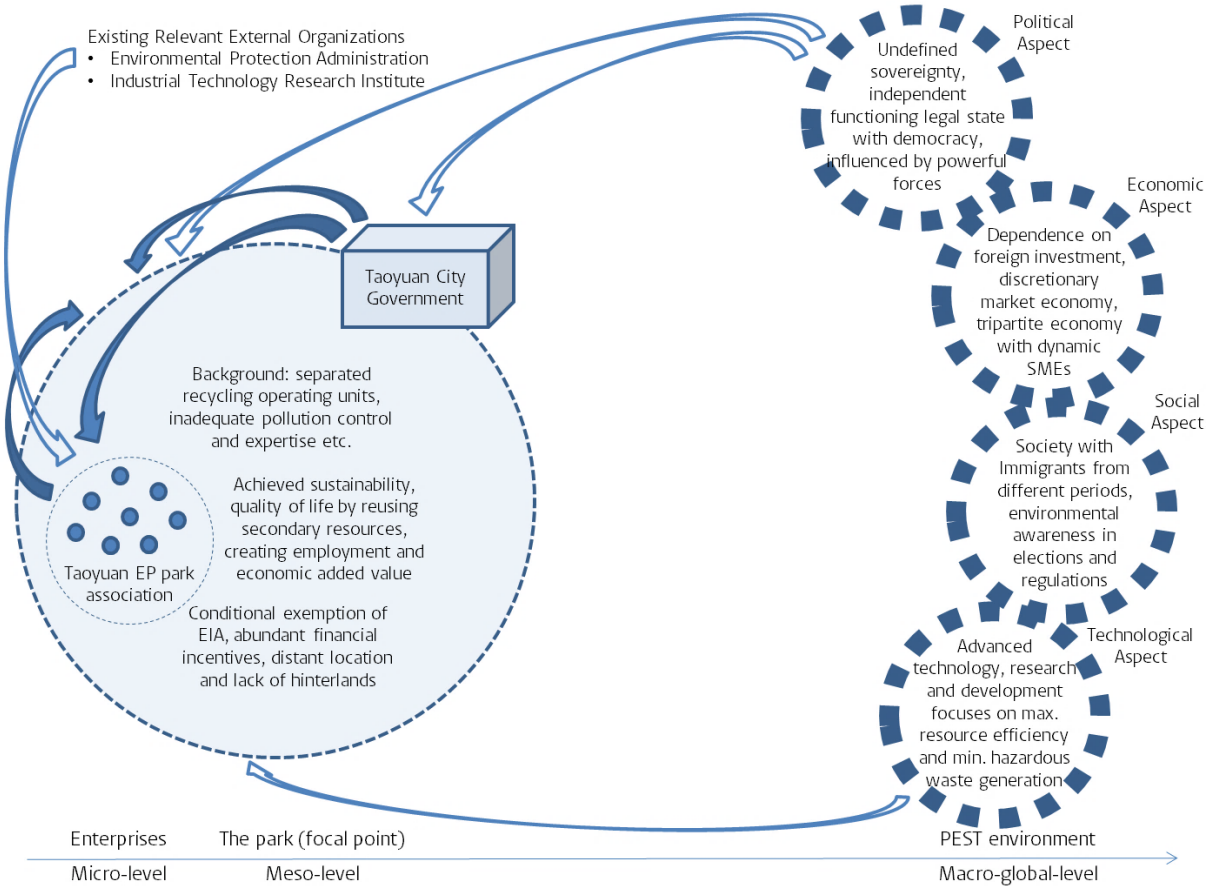


Figure 15 Integration of Macro-Global Environment Analysis to Mixed-Level Analysis

3.3 The Taiwanese Development Mode

3.3.1 National Development Plans

Rapid Industrial Development and Emergence of Sustainability

From the published national development plans over the years, more knowledge and insights can be acquired regarding the recent historical and economic development. In 2013, National Development Council was founded, integrating the departments related to national development under the obsolete organizational structure. The first national development plan was published in 1953. The plans reflect the situation and show the priorities at the corresponding time periods. The transition of industries and the traces of modernization can be observed in Figure 16.

It is clear that the emphasis of national development was in exports and industrial development to pursue economic growth with the abundant human resources. Starting from 1975, the rapid transition from agriculture-based to industrial-based economy called attention to striking a balance between the economy and the society. The issues of industrial development also arose in the late 1980s, compelling the government to prioritize pollution control and environmental protection. While the social welfare and the quality of life were incorporated into the national development plans in the 1990s, the term "sustainable development" appeared for the first time in 1995 and has remained a fundamental objective until today.

Policies in Long-Term Resource Management and Circular Economy

With the trend of sustainable material management, the policy planning of resource circularity was formulated in 2011. The promotion plan of sustainable resource management was approved by the Executive Yuan in 2013. The planning compared the policies in OECD, EU, Japan, the Netherlands and extracted the applicable policies for the Taiwanese context. The resources and waste are within the management scope of the policy planning, and natural resources will be incorporated in the long run. The vision is to circulate the resources and preserve natural resources, while maximizing the resource efficiency and minimizing the environmental impact.

The recent inaugural speech of the president can be seen as an early signal of the national development plan. In May 2016, Tsai Ing-Wen mentioned circular economy in the inaugural speech and the ambition of transition from the previous unsustainable policies. More long-term development plans are expected to emerge in Taiwan, regarding sustainable resource and energy planning, climate change, land conservation and disaster prevention.

"We must not endlessly expend natural resources and the health of our citizens as we have done in the past. Therefore, we will strictly monitor and control all sources of pollution. We will also bring Taiwan into an age of circular economy, turning waste into renewable resources. We will gradually adjust our energy options based on the concepts of sustainability. The new administration will seriously address issues related to climate change, land conservation, and disaster prevention. After all, we only have one earth, and we only have one Taiwan." ("Full text of President Tsai's inaugural address," 2016)

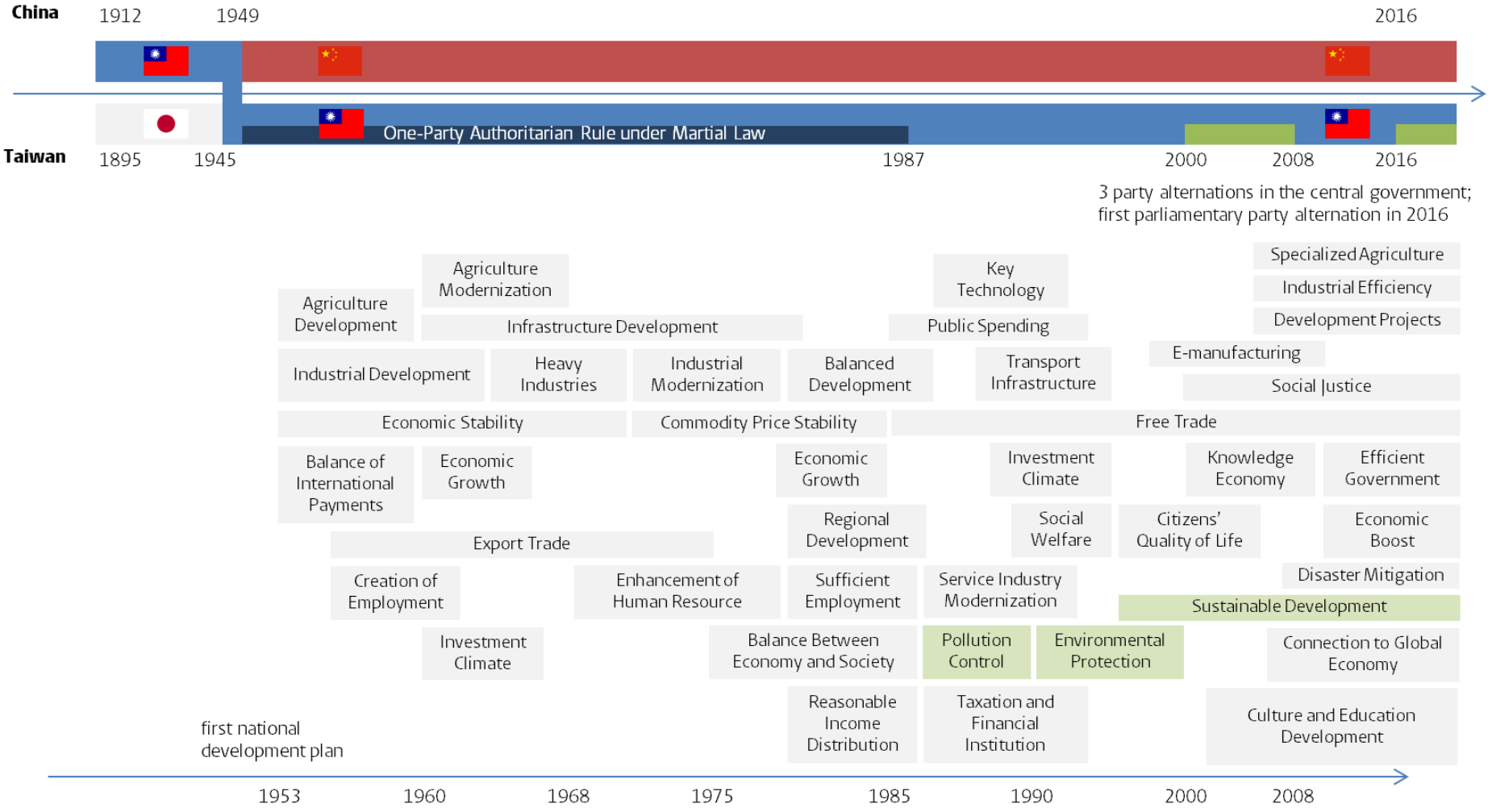


Figure 16 National Development Plans of Taiwan (1953-)

3.3.2 Organizational Structure and Existing Initiatives

Existing Initiatives Promoting Resource Efficiency

Outside of the promotional plan of environmental science and technology parks, there are various initiatives and organizations existing to enhance the resource efficiency. Note that the promotion scope of these initiatives and organizations is within Taiwan, still in the national boundary.

In 2014, Taiwan Circular Economy Network first started to advocate circular economy and resource circularity from a non-governmental perspective. It is currently a member of the CE100 project initiated by Ellen MacArthur Foundation, devoted to discovering the potential of the circular economy with the major stakeholders involved. The current vision of the organization is to create an economic development model with the basis of resource circularity. The current mission statement is to promote the concept of circularity and to facilitate the implementation plan of the effective resource use. At the initial stage, the scope of circular economy planning is the entire Taiwan, but the network is optimistic about the potential regional integration into ASEAN countries, mainland China, and other international systems in the future. (Taiwan Circular Economy Network, personal communication, 2016)

To increase the energy and resource efficiency in Taiwan, the energy and resource information integration platform was formed in one of the projects from Industrial Development Bureau, Ministry of Economic Affairs. (Industrial Development Bureau, Ministry of Economic Affairs, n.d.) The main function of the platform is to integrate the relevant information of energy and resources. The platform started the operation in 2009. More than 60 enterprises joined the platform, and the 3 industrial parks in Taoyuan are key participants. (Shangwen Chan, e-mail correspondence, 2016) By 2015, there are 250 planned potential linkages in Taiwan, and over 100 linkages have been achieved. The linkages are monitored every year and adjusted with the updated information and rolling plans.

Apart from the integration platform, Industrial Development Bureau, Ministry of Economic Affairs has been promoting industrial symbiosis (industrial waste resourcification) in the following aspects, developing regulations and the

management system, advising industries, disseminating information and promoting. (Figure 17) The bureau amended Regulations Governing Industrial Waste and Regulations Governing Renewable Resources to enhance regulations and the management systems. The management together with the monitoring system was built to institutionalize the operations. To advise the industries, the resourcification platform was built to match the industries and the academia. Subsidies can be applied for this collaboration. To effectively spread information, several websites are built to spread the information of events, services, regulations, rewards and so forth. The technical manuals were issued, currently 6 manuals in composting and related industries and 18 manuals in PCB industry and related. Conferences and training are also organized regularly. As for the promotion, exhibitions, and large-scale conferences are held to stimulate collaboration. (Industrial Development Bureau, Ministry of Economic Affairs, 2015)

Last but not least, Environmental Protection Administration continued to design policies to facilitate resource circulation and the development towards zero-waste. (Environmental Protection Administration, 2014) Figure 18 shows the key policies under the current national development plan. It is clear that resource circulation policy is a major development category. In the upcoming organizational restructuring, Environmental Protection Administration will be upgraded as Ministry of the Environment and Resources, combining several departments in the current Ministry of Economic Affairs and the state-owned Taiwan Water Corporation. The ex-director of Environmental Protection Administration stated the transformation of policies from end-op-pipe measures into zero-waste, circular economy. Therefore, adjustments have to be made in resource management structure, environmental impact reduction, resource efficiency increase, scientific management tools, supporting measures and the partnership with private sectors. (Environmental Protection Administration, 2015) Worth noticing is the frequent replacement during the presidency of the former president Chen; the total of 6 ministers served the 8-year presidency.

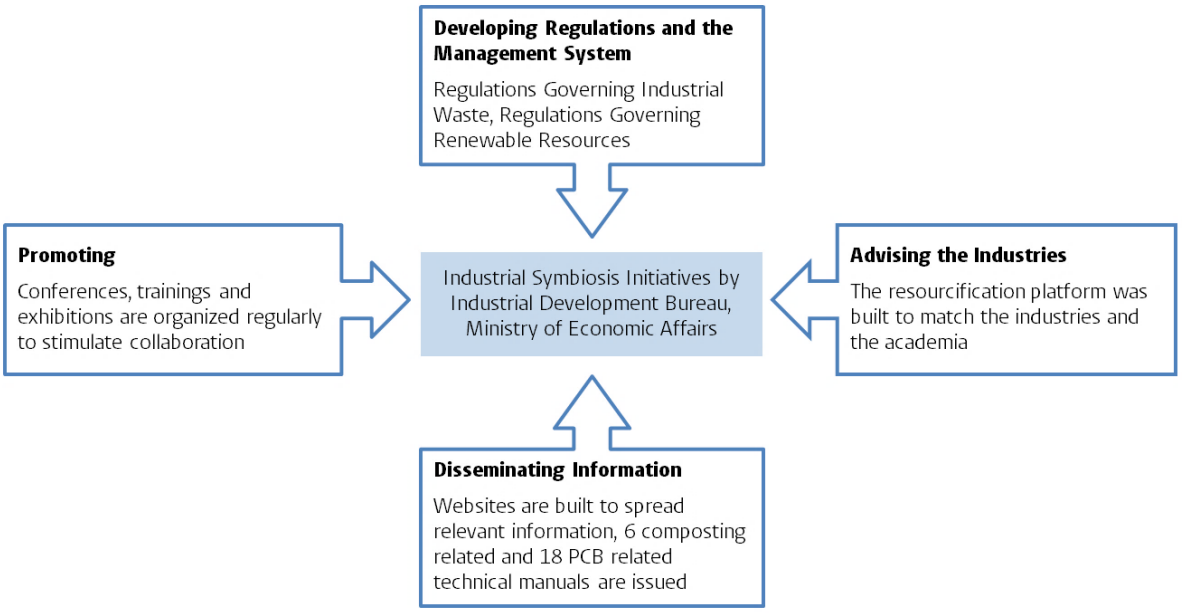


Figure 17 Industrial Symbiosis Initiatives by Industrial Development Bureau (Industrial Development Bureau, Ministry of Economic Affairs, 2015)

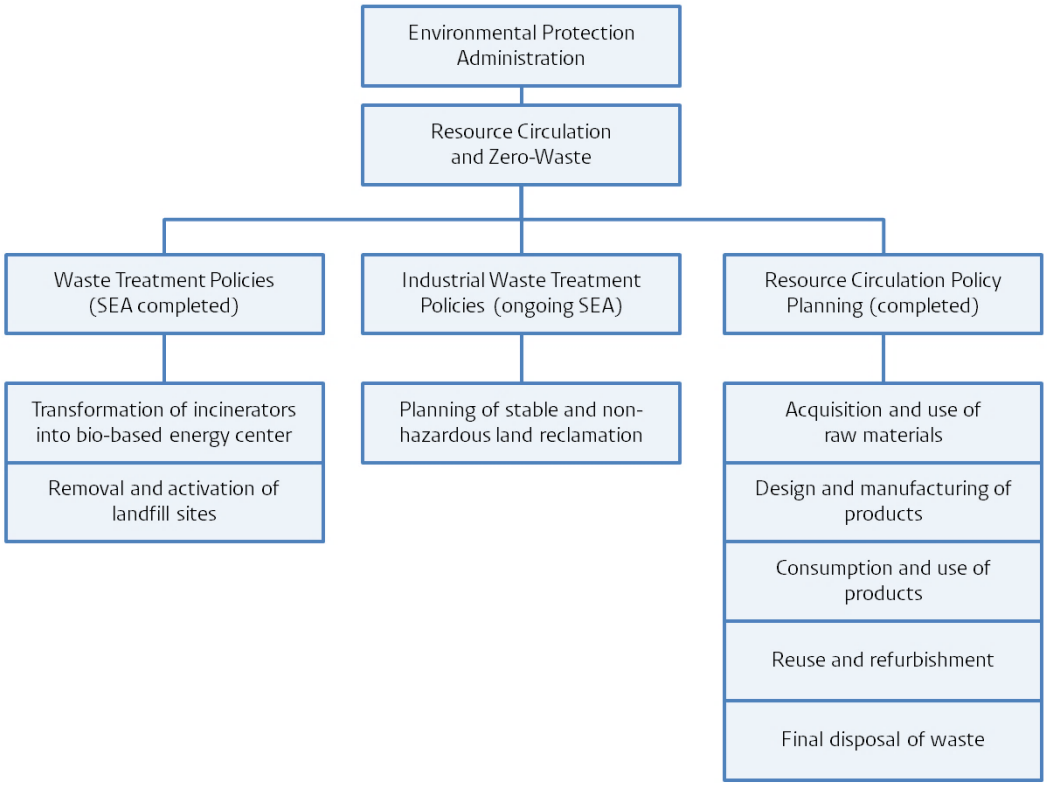


Figure 18 Key Policies of Environmental Protection Administration (Environmental Protection Administration, 2014)

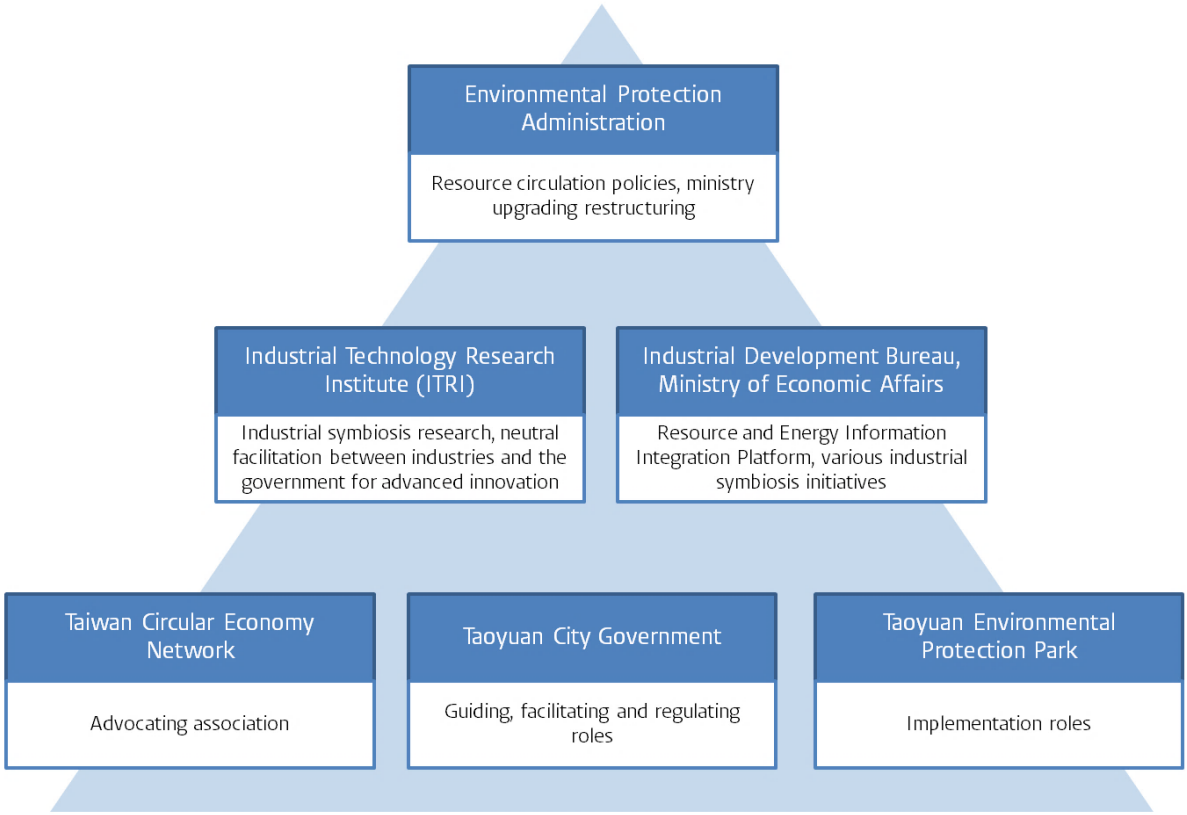


Figure 19 Organizational Structure of the Existing Industrial Symbiosis Facilitators

Beyond the Taoyuan environmental protection park, there are various initiatives and measures aiming to increase the energy and resource efficiency. For instance, Taiwan Circular Economy Network is currently the only CE-related civil group in Taiwan, and it takes the role as an advocator, sharing information with relevant stakeholders. Furthermore, Industrial Development Bureau and Energy Bureau from Ministry of Economic Affairs are responsible for facilitating green industrial development, Bureau of Foreign Trade in the same ministry explores the international market, while Environmental Protection Administration formulates the resource circulation policies and implements environmental monitoring. Figure 19 illustrates the related organizations and the nested structure of the existing industrial symbiosis facilitators. Currently, different projects from various organizations only collaborate through project websites and conference participation. The implementing organizations are occasionally invited

to the conferences to share the progress. (Shangwen Chan, e-mail correspondence, 2016)

According to Industrial Development Bureau, Ministry of Economic Affairs, the reuse rate of industrial waste has risen from 56% to 80%, from 2012 to 2015. The economic added value has also increased from 25 billion to 68 billion NTD from 2002 to 2015. (Industrial Development Bureau, Ministry of Economic Affairs, 2015) The indirect benefits are calculated as the CO_2 reduction of 8 million tons per year and the environmental depreciation of 38 billion NTD per year. The 2020 goal is set by the Industrial Development Bureau, aiming to reach 87 billion NTD economic added value and 85% reuse rate of industrial waste.

3.3.3 Summary

This section analyzed the Taiwanese development mode and the existing relevant external organizations through the research into official reports, existing literature, official websites, personal interviews and the media. In the recent hundred years, Taiwan has been through enormous transitions also in its industries, and many short-term, immediate industrial development goals were set. This has brought Taiwan great economic achievements and a huge improvement in the quality of life, but inevitably the stress on the environment and the society as well. With the attention emergence of sustainability, several long-term resource management plans have been outlined, together with the commitment of the recently-elected president to develop the circular economy in Taiwan.

The existing relevant external organizations, including the energy and resource information integration platform, Taiwan Circular Economy Network, will continue to promote resource efficiency and circular economy in the scope of Taiwan. These development plans at the national level have a moderate impact on the Taoyuan environmental protection park, given that the key industries are already described in the plans. The Taoyuan city government is a regional government which takes the implementation role, and it should govern according to the national development plans. Though being directly influenced by the plans, the city government could also report to the central government regarding the regional implementation, thus, adjust the national development plans.

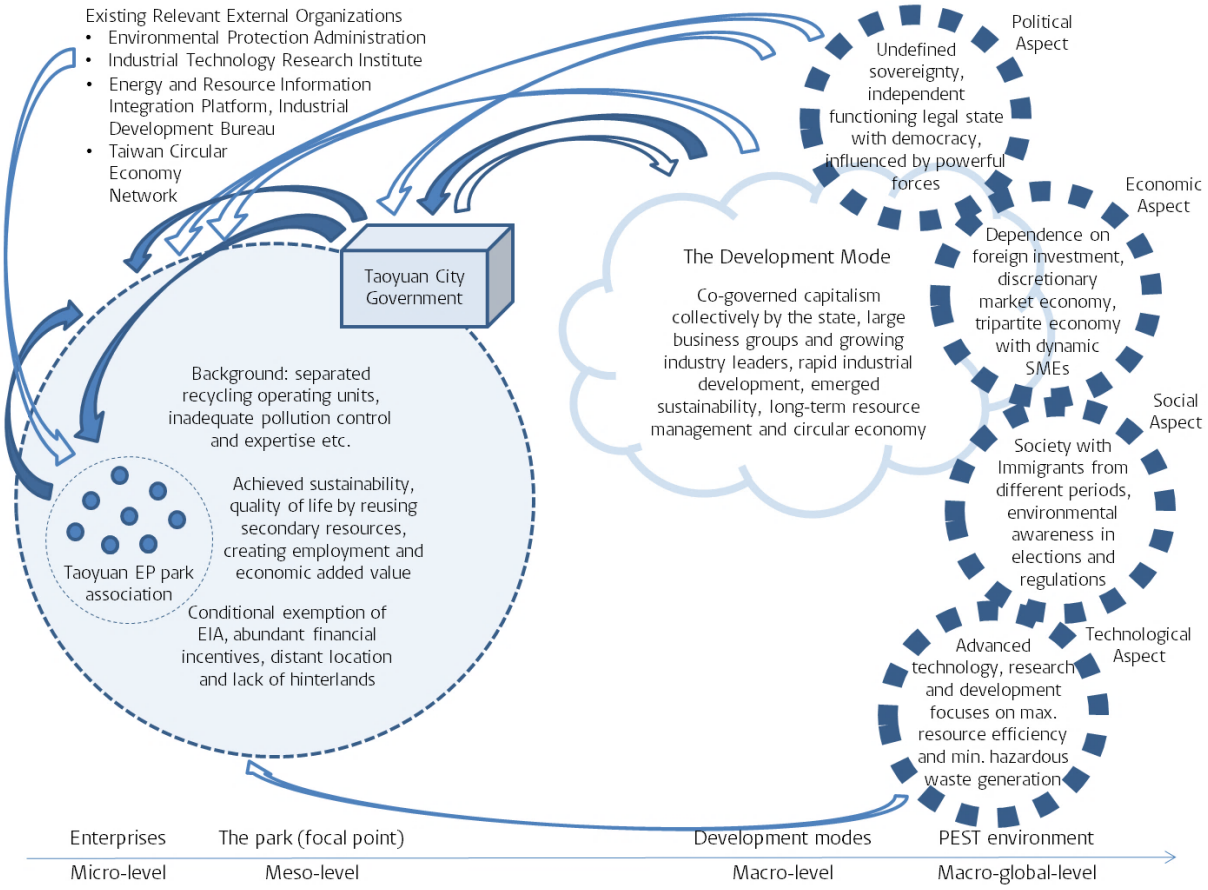


Figure 20 Integration of Development Mode Analysis to Mixed-Level Analysis

3.4 SWOT Analysis

In the SWOT analysis, internal and external factors are divided according to the focal point of the research. The strength and the weakness are internal factors which the decisions made at the focal point can have an influence on. While the opportunity and threat are external factors which affect the focal point and describe the environment at a larger scale. Furthermore, depending on the whether the factors are advantageous to the development, the division between the strength and weakness; between the opportunity and threat can be made.

Unlike the common examples of SWOT analysis in the business sector, in this case, the scope of influence is much larger than one corporation or one single enterprise. The Taoyuan city government can influence not only the Taoyuan environmental protection park but also the context where the park operates, through the policy interventions in specific industries, in the civil society, in the mechanisms, in many aspects of the city development and so forth. Note that

the factors in the context belong to neither the internal environment nor the external environment. A contextual analysis needs to be conducted separately. The detailed analysis comes in the next section. (section 3.5)

3.4.1 Strength and Weakness

The strength and weakness describe the enablers and barriers to circular economy development in the internal environment, within the scope below the meso level of the Taoyuan environmental protection park. These are factors which the city government can have the direct influence, turning the weakness into the strength.

The evident strength of this case is the achieved progress of sustainability. The park has enhanced the environmental performance by utilizing secondary resources, and it has created employment and economic added value, which are the achievement in social and economic aspects. There remains a debate concerning whether it counts as environmental, social and economic sustainability, given the unstable nature of the waste treatment industry. In this research, a more pragmatic view is taken to define the sustainability in this case, since it has indeed improved the environmental, social and economic standards. The other point of strength is the centralization of the recycling operating units. With the historical background of having separated recycling units, the Taoyuan environmental protection park contributes to the efforts of centralizing those separated units in the park.

The barriers, the weakness in the analysis, in the internal environment to the circular economy development are the conditional exemption of EIA and the ambiguous current state, the enterprise dependence on financial incentives, the distant location of the park and the lack of hinterlands.

3.4.2 Opportunity and Threat

In the external environment at the macro-global level, there are many uncontrollable factors which the city government has no control over, but they can be hugely influential when it comes to the circular economy development or the development in general.

The undefined status of Taiwan's sovereignty can be both the opportunity and threat for the circular economy development. It gives Taiwan the flexibility to be adapted and incorporated into various regional systems, such as the great China system, the pan-Asia system with ASEAN countries, the U.S. system and so forth. The downside of this undefined sovereignty is the uncertainty and instability. The tripartite economic structure of the upstream state-owned enterprises, midstream family-owned business groups and the downstream small to medium enterprises is also a distinct fact of the external environment.

There are several opportunities in the external environment, including the reality as an independently-functioning democratic country, liberty, the transparent legal system and the rule of law, the emerging Taiwanese identity, the emerging environmental awareness reflected in elections, policies and regulations, the advanced technology and the existing organizations, initiatives, research and development in maximizing resource efficiency and minimizing hazardous waste generation.

The main threats are the dependence on foreign investment and the interference from the foreign investors and other powerful forces, which may threaten the sovereignty and reduce the decision-making to the provincial level. This reduction will affect or even cancel the national development plan, and it may influence the implementation of the determined circular economy strategies. The legacies and long-lasting influence from the previous authority and one-party rule remain to be a threat to the external environment as well.

3.4.3 Summary

The SWOT analysis is conducted at the focal point of the Taoyuan Environmental Protection park, with multiple sources of information by the author, for the Taoyuan city government as policy advice. Depending on whether the factors are enablers to the circular economy development, the strength/ opportunity and weakness/ threat division is made. The goal of the categorization is to identify which the enabling factors are, to foster the circular economy development. Regarding the barriers, the priority is to change them into enablers. If the factors are currently uncontrollable or even threatening, long-term strategies are suggested to avoid frontal attack at the current stage.

	Enablers	Barriers
Internal Factors	**Strength** - Achieved progress in sustainability - Centralizing the separated recycling operating units	**Weakness** - Conditional exemption and the ambiguous current state of EIA - Enterprise dependence on subsidies - Distant location of the park and the lack of hinterlands
External Factors	**Opportunity** - Undefined but flexible sovereignty status of Taiwan - Tripartite economic structure - Smooth power transfer for twenty years - Independently-functioning liberal reality with democracy - Transparent legal system under the rule of law - Emerging identity - Emerging environmental awareness and long-term plans - Advanced technology - Existing organizations and initiatives in max. resource efficiency and min. hazardous waste generation	**Threat** - Undefined but flexible sovereignty status of Taiwan - Tripartite economic structure - Influence and legacies from previous authority and one-party rule - Dependence on foreign investment - Interference from foreign investors and powerful forces

Table 13 SWOT Analysis of the Taoyuan Environmental Protection Park

In brief, the evolution and the development of the park are not solely dictated by the city government. In the current nested and interlinked organizational structure, the future of the Taoyuan environmental protection park is indeed directly influenced by the city government, but it is also affected directly by the decision made in the enterprises which are located in the park. (Figure 21)

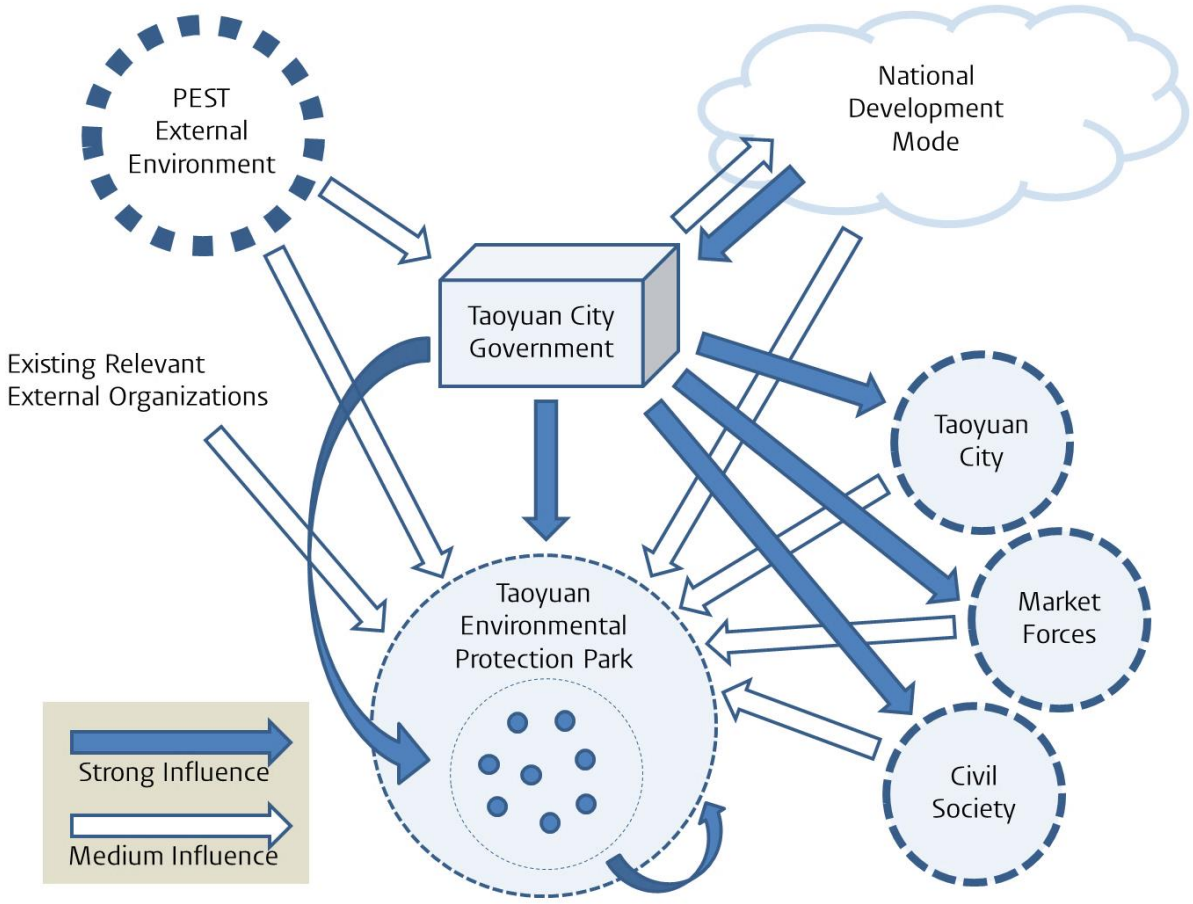


Figure 21 Relationship Between the Taoyuan City Government and the Park

This relationship again illustrates the importance of analyzing the context. Although the Taoyuan city government does not control the city, market forces and the civil society, it can influence its governing domain through policy interventions. These influences then apply to the park indirectly, facilitating the changes in the city, market forces and the civil society. Together with the indirect influence from the external PEST environment, the state and the above-mentioned influences, the Taoyuan environmental protection park co-evolves with all the stakeholders.

3.5 Context Analysis

What makes the context interesting is that it covers the socio-historical aspect, the state (the city), the specific market forces and the civil society of the focal point of this study. The analysis gives us an ample understanding of the particular environment where the park operates. Continuing the development history, the context is evolving, and the city government is able to influence the

evolution of the city, the specific market forces, and the civil society. The policy interventions can not only influence the internal environment but also turn the contextual hindrance into contextual convenience for circular economy development.

To complement the ample understanding of the Taoyuan environmental protection park, a closer examination of the context has to be taken. The context includes the enablers and barriers related to market factors, social practices, cultural norms, the regulatory regime and the actions of other actors. (Yap & Devlin, 2016) The actions of the enterprises are influenced by the context, but the contextual factors do not provide the predicting power of whether industrial symbiosis emerges and how it evolves. The decisions of an enterprise are influenced by a collection of factors including its macro-global environment, development mode, internal environment, context and randomness at the individual level. Therefore, this section describes the context (the city, market forces and civil society) where the Taoyuan environmental protection park operates, addressing the local characteristics and expecting to provide explanations for the phenomenon.

3.5.1 The City

Industrial City and Transportation Hub with Abundant Workforce

Taoyuan City, where the major international airport is located, is an industrial and service industry-based city with the abundant workforce and the population of over 2 million. Since the 1960s, Taoyuan has played a crucial role in the industrial development history with its abundant population, from the state-led labor-intensive industries, rewarded investment in high-pollution industries, to the recent private science and technology industry development. However, this transition process was not immune to severe environmental hazards. (Sung et al., 2009) The available industrial land is over 6800 hectares, and there are currently 29 industrial parks, creating the highest industrial added value among the cities in Taiwan of 3 trillion NTD.

The city mayor has been directly elected by the citizens in Taoyuan since 1951. Despite the unresolved murder case of the mayor in 1996, the power transfer of the city government has been smooth and peaceful for over 60 years. The city

government has adapted to the national development goal of the country, and the role of the city government as a facilitator has also evolved accordingly. In the 1980s, the amount of scheduled industrial land decreased sharply, adapting to the promotion plan of "Taiwan as a manufacturing, research, and development hub in Asia Pacific" in 1990.

The city government takes the regulator role, regulating the state-led industrial sectors in early years to the recent private sectors. Most technological industrial parks are driven by the private sector, while there are still a few technology and research parks in Taoyuan led by Ministry of National Defense. The Taoyuan technological industrial park, which includes the Taoyuan environmental protection park, is developed by the appointed Yashuo Development Company and the Taoyuan City government. With the transition from labor-intensive industries to the current semiconductor, information, electronic industry structure, the city government continues to create incentives which reward the environmentally and socially productive activities of the enterprises.

Enlarged Scope of Symbiosis

The energy and environment research center of Industrial Technology Research Institute (ITRI) researched into the potential of industrial symbiosis in Taoyuan City and introduced four principles of resource planning considering the local context, industry structure and the recycling organizations in Taoyuan. First, prioritizing the planning of the most urgent types of waste (e.g. hazardous waste) in a larger amount. Second, reducing the transportation distance of the resourcification and waste treatment. Third, resourcification and recycling instead of incineration and landfill. Fourth, replacing the existing recycling measures with resourcification measures at a higher level. (Industrial Technology Research Institute, 2007) ITRI pointed out that the main difference in the industrial symbiosis in Taoyuan from other cities, Kaohsiung Linhai industrial park, for example, is the symbiosis scope. For Taoyuan City, the objective of the industrial symbiosis is to create linkages with the enterprises in the park or those in neighboring industrial parks, rather than creating internal linkages in the industrial park. The concrete initiative is to examine the waste treatment plans and the waste reports, centralizing and concentrating the resourcification

treatment of the hazardous waste in large amounts in the city. (Industrial Technology Research Institute, 2007)

3.5.2 Market Forces

Vulnerable SMEs to the Five Forces in the Waste Treatment Industry

When analyzing the Taoyuan environmental protection park, there are several factors to consider in the context of market forces. The shareholders are the first factor. In Taiwan, the enterprises in the waste treatment sector all belong to SMEs, which do not have the enormous capital for research and development but the flexible manufacturing system. (Chang & Lu, 2012; Guerrieri & Pietrobelli, 2004) These SMEs are mostly family-owned, small-scale but agile to shift their manufacturing capacity.

It is worthwhile to examine Porter's Five Forces in the waste treatment industry. Due to the diversity of waste treatment subcategories and the research limitations, the analysis could only be done at the general level to reflect the situation of the park. The industry rivalry and the competition within the industry are high. Apart from the resourcification of fluorescent lamps and waste solvent (pH < 2) industries, the expertise in the remaining subcategories (e-waste and the waste liquid processing, waste solvent, the cutting fluid of solar panels, waste tires, medical waste and so forth) is relatively common, and the enterprises could not stay competitive in the price war. The bargaining power of the suppliers is high as well. Reports showed that the amount processed is much smaller than the amount of waste produced due to the strict emission standards, and the enterprises in the market compete to place higher bids to get the waste for further processing. (Taoyuan City government, 2015) This indicates that in the waste treatment sector, the supply of enterprises is larger than the demand, which gives the suppliers both the abundant waste as their resources and bargaining power. The bargaining power of the customers is unclear. Depending on the various sources of income of the operating enterprises, the market can be either domestic, abroad or both. (Table 11) More information has to be collected to address the market structure individually, but inevitably it is influenced by the price volatility of the resources on the international market. The threat of the new entry is generally huge due to the prevalence of the expertise except for few

specific industries. The threat of substitutes is minor because this segment constitutes an irreplaceable linkage in the circular economy.

Unstable Waste Treatment Industry

With the above analysis, it is clear that the waste treatment industry is quite vulnerable. It is faced with severe industry rivalry, high bargaining power from the suppliers, price volatility on the international material market and the huge threat of the new entry. With these obstacles, one enterprise has left the park, terminated the business and found the investment not profitable. (Chung-Tai Resource Technology, e-mail correspondence, 2016) One distinct characteristic of the SMEs in Taiwan is that it never implies a stable relationship between its suppliers and customers. (Guerrieri & Pietrobelli, 2004; J. Zhang & Peck, 2016) The stability of the waste treatment industry is definitely low.

The international consensus has formed with the Basel Convention to reduce hazardous waste and to advocate localized waste treatment, ethically and properly. There still remain issues in the technological disparity, policy and regulations transfer. While the efforts in the more developed countries are made to innovate and design new products which are easier to dismantle for recycling, the value of the previously-manufactured obsolete product models and second-hand products which are closer to the end of life still has to be extracted in the less developed countries. At the same time, these countries struggle with the less mature democratic and economic status, but with the same competition in the global market economy.

3.5.3 Civil Society

Due to the industrialization and the severe environmental hazards, the environmental movement started to evolve in the mid-1980s. Early formations such as Taiwan Environmental Protection Union and Homemakers United Foundation were founded in 1987, immediately after the martial law was terminated. With the social trend and the protest against negative environmental externalities of industrial development, Environmental Protection Administration was formed in the central government in the same year. Today, there are many organizations pursuing environmental justice and guarding the environmental quality. Taiwan Environmental Information Association is an organization which

builds a database collecting environmental news and relevant information. It promotes environmental trust and reasonable conservation to secure the welfare of the public.

In September 2015, a forum was organized in collaboration between the Taoyuan City government and Taiwan Circular Economy Network to promote circular economy development. Over 150 participants seeking potential collaboration came from diverse fields, including the city government officials, the industry representatives and the professionals from Germany and the Netherlands. (Taiwan Circular Economy Network, n.d.) Approximately 60% of participates were governmental employees, and 20% were business representatives. Nearly half of the participants were managers, executives or directors in their organizations. (Taiwan Circular Economy Network, personal communication, 2016)

Apart from these forces, the enterprises within the Taoyuan environmental protection park also influence the civil society through providing employment and environmental education. The measures include building a sight-seeing and educational plant (Chung-Tai Resource Technology, e-mail correspondence, 2016) and creating artworks with recycled materials from e-waste to raise awareness. (Chung-Tai Resource Technology, e-mail correspondence, 2016)

3.5.4 Convenience and Hindrance

The division of the contextual factors to contextual convergence and hindrance depends on whether the factors are enablers to the circular economy development. The convenience and hindrance address the characteristics of the context where the park operates. To some extent, through both direct and indirect measures, the city government can influence the context and transform the barriers into enablers.

The convenience of the context includes the prosperity of the diverse industries, the abundant workforce, the actions and regular contact with circular economy professionals.

The hindrance factors of the context are the powerful five forces in the unstable waste treatment industry and the existing mindset and sub-regulations

(underlying mechanisms) of pollution control, waste treatment rather than maximizing resource efficiency.

Flexible but unstable small-to-medium businesses can be both convenience and hindrance, depending on the industries they are in. Positive chances are the suitable allocation of the flexible and vigorous SMEs to encourage circular economy with their dynamic capacity.

	Enablers	Barriers
Contextual Factors	**Convenience** - Prosperous, diverse industries - Abundant workforce - Regular actions and contact with CE professionals - Flexible SMEs	**Hindrance** - Powerful five forces in the waste treatment industry - Existing mindset and sub-regulations of pollution control - Unstable SMEs

Table 14 Contextual Convenience and Hindrance

3.5.5 Summary

Due to the multi- and mixed-level relevance of this case, the SWOT plus the contextual analytical framework is used in combination with the mixed-level analysis, and most importantly, to structure the complex mixed-level analysis. (Table 13 and Table 14)

An overview of the context is provided in this section, the analysis is conducted with the information from sources including official reports, existing literature, official websites and personal interviews. What makes the contexts unique is position in the mixed-level analysis. Taoyuan city is the context where the Taoyuan environmental protection park operates, and the park is influenced by the contextual factors to some extent. While the decision-making entity, the Taoyuan city government, has the governance over the city. It can affect the city directly in many aspects, market forces and the civil society with various measures and policy interventions. The understanding of the contextual convenience and hindrance in the circular economy development helps to identify the leverage points where the city government can influence, adjust and facilitate the circular economy.

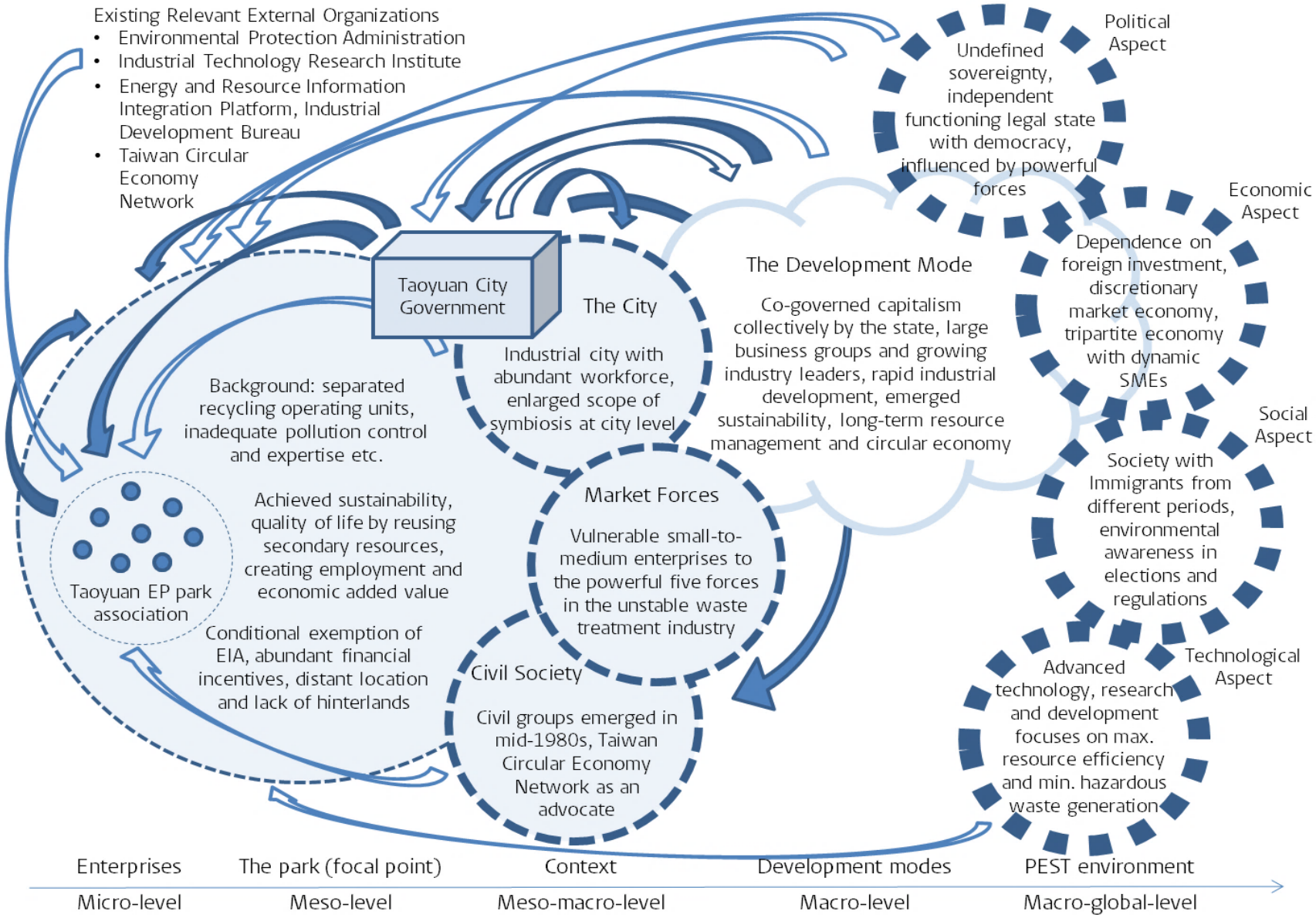


Figure 22 Completed Mixed-Level Analysis Canvas

3.6 Checklist for the Mixed-Level Analysis

An overview of the key points analyzed in the mixed-level analysis with the corresponding information sources is provided in Table 15. The knowledge level of the analysis is rated on a scale of 1-5. With the maximum efforts in the limited duration, this research is dedicated to providing objective findings with high reliability from multiple information sources. In the internal environment, more input from the city government and more production details from the enterprises in the park can help to even more specifically describe the city government's goals and the industrial symbiosis potential. In the macro-global environment, some limitation lies in the economic development and structure, technical knowledge and infrastructure, but no further investigation is needed to conclude the key findings which answer the research question. In the context, more business insights from specific industries can help to describe the waste industry better due to the various types of industrial waste treated in the park.

Key points	Information Sources					Knowledge Level in the Analysis (1-5, max. 5)
	Official Reports	Existing Literature	Official Websites	Personal Interviews	The Media	
Internal Environment						
City government's goals			x	x		4
History of the park and firms	x		x	x		5
Development objectives	x		x			5
Current state and participants	x		x	x		5
Industrial symbiosis potential	x			x		4
Inter-firm relations			x	x		3
Connection to the context	x	x		x		5
Connection to the global economy	x	x		x		5
Macro-Global Environment						
History in the recent 100 years		x				5
Political and international relations		x			x	5

Economic development and structure		x				4
Position in the neo-liberal global economy		x				5
Culture, awareness, and identity	x	x				5
Technical knowledge and infrastructure		x				3
Legacy from the previous authority		x				5
Development Mode						
National development plans	x	x				5
East-Asian developmental state model		x				5
Existing organizations and initiatives	x	x		x		5
Context						
The city and its industrial characteristics	x	x	x	x		5
Five forces of the waste treatment industry	x	x		x		4
Civil regulations from informal authorities			x	x		5

Table 15 Completed Checklist for the Mixed-Level Analysis

4 Discussion

After collecting the valuable and abundant information in chapter 3, there are several issues which merit discussion before the preliminary findings can be outlined. This chapter intends to provide arguments to support the outcome of this research and key findings in the form of policy advice to the city government regarding mainly the possible future of the Taoyuan environmental protection park, as the revisit of the research question below.

What can be the possible future of the Taoyuan Environmental Protection Park, an eco-industrial park or a normal industrial park?

- *What is the largest and feasible scope of cooperation/ symbiosis which can be achieved from the city government's perspective?*
- *How would the development help to facilitate the circular economy in Taoyuan City?*

It is crucial to compare the reality of the park with the original plan, to examine the situation in the past and whether the objectives are achieved. The disparity between what was envisioned and the reality can also come from different interpretation of terms. Furthermore, are the individuals and the involved entities in cooperation or in competition? What is the largest scope of integration or symbiosis/ cooperation we can achieve from the city government's perspective?

The discussion supplements the mixed-level analysis, attempts to explain the phenomena and most importantly provides valuable insights and reflections from the analysis.

4.1 Policy Gap Examination

Many insights and details about the park and the internal environment can be found in section 3.1, as well as the objectives of Environmental Protection Administration's promotional plan of environmental science and technology parks and the Taoyuan city government's translated objectives of the Taoyuan environmental protection park. (Table 8 and Table 9) This section compares Administration's original objectives, the city government's translated objectives

and the achieved outcome in the reality of the Taoyuan environmental protection park, aiming to identify the linkage and the gap between the policy development.

<table>
<tr><td colspan="2">Environmental Protection Administration's Objectives of The 4 Environmental Science and Technology Parks in Taiwan</td><td>Policy Translation</td></tr>
<tr><td colspan="2">1/ Reduce pollution & Facilitate resource circulation</td><td rowspan="5">All well translated</td></tr>
<tr><td colspan="2">2/ Activate the unused lands & Provide employment</td></tr>
<tr><td colspan="2">3/ Attract foreign investment & Advance the resourcification expertise</td></tr>
<tr><td colspan="2">4/ Stimulate the waste treatment industry & Encourage environmental protection practices in industries</td></tr>
<tr><td colspan="2">5/ Create circular cities & Enhance the quality of life</td></tr>
<tr><td>City Government's Translated Objectives of Taoyuan Environmental Protection Park</td><td>Linkages to Objectives Above</td><td>Achievement in Reality</td></tr>
<tr><td>Solve the existing pollution issues in lands, rivers, groundwater, and so forth</td><td>1, 5</td><td>Medium</td></tr>
<tr><td>Facilitate the circular linkages in industries, preventing resources from entering the waste treatment system</td><td>1, 4</td><td>High</td></tr>
<tr><td>Pull the domestic and foreign, expertise and human resources in environmental protection industries</td><td>3, 4</td><td>Low-Medium</td></tr>
<tr><td>Implement actively the long-term sustainability goals and maintaining sustainability</td><td>5</td><td>Medium</td></tr>
</table>

Table 16 Examination of the Objectives of Taoyuan Environmental Protection Parks

From the comparison Table 16, it is evident that all objectives from Environmental Protection Administration for the larger promotional plan of all the 4 environmental science and technology parks are considered in the city government's translated, actionable objectives. The objective 2 is not linked to the translated objectives, but the unused industrial lands and employment would be inherently covered in the development of the Taoyuan environmental protection park.

The examination of the gap between the translated objectives from the city government and the reality is much more complicated due to the co-evolution as well as the difficulties to assign the contribution. Therefore, this part of the examination is conducted with a simplified qualitative scale of high, medium and low achievement.

4.1.1 Examination of the Objectives

Solve the Existing Pollution

The park contributed to the centralization of the previously separated recycling operating units. This effectively allows the government to monitor and prevent the potential pollution at various locations. Moreover, the content of the wastewater generated can be examined and processed to recover the highest resource residual value. According to the department of environmental protection of Taoyuan city government, half of the results from the quarterly water quality examination conducted on Dajueh creek, which receives the wastewater generated in the Taoyuan environmental park, were moderately polluted in the past five years with the measures of river pollution index (RPI). For the achieved standards and the potential improvement, this item is assigned with medium achievement.

Facilitate Circular Linkages

Currently, all enterprises in the park play the recycling role in the circular economy. They facilitate the circular linkages and enhance the most efficient resource use by processing the industrial waste, driven by profits and limited to environmental standards. From the personal interviews conducted, the industrial symbiosis linkages are found to be limited within the Taoyuan environmental protection park. (Chung-Tai Resource Technology, e-mail correspondence, 2016; SDTI, personal communication, 2016; Taoyuan City government, personal communication, 2016) However, it does not mean that the industrial symbiosis linkages do not exist at a larger scale. It is therefore not a failure that the park does not operate in the form of an eco-industrial park, and the achievement is high.

Pull the Expertise in Environmental Protection Industries

The team of the promotional plan has organized and attended various international events, but only Taiwanese enterprises and expertise were pulled in the Taoyuan environmental protection park in the end. Environmental Protection Administration listed 6 key industries to reward the business participation. These focal industries are cleaner production, resourcification (waste or byproducts turning into raw materials), recycling (waste or byproducts turning into other use), advanced and strategic environmental technology, renewable energy and systemic production, other expertise and developing other key components. (Environmental Protection Administration, 2013). The definition of "environmental protection industries" limits the possibilities and potential of the environmentally-innovative practices and the imagination of collaboration with diverse existing industries. The achievement is low to medium. The synergy and environmentally-innovative practices come from the business side, and the public sector can design mechanisms to encourage those initiatives.

Implement Long-Term Sustainability Goals

The operating enterprises in the Taoyuan environmental protection park have created environmental benefits by recycling and circulating the resources, social benefits by providing employment and economic added value. The medium achievement of the initial stage has been made. The upcoming challenges to extend the sustainability achievement to a longer term remain in dealing with the powerful Porter's five forces in the waste treatment industry.

4.1.2 Interpretation of Terms

In the policy gap examination of the objectives of the Taoyuan environmental protection park, the implementation is found to have at least achieved the medium level. It proves that there are no major issues in the policy translation and implementation. The key does not lie in the objective setting and implementation, but is the definition of terms really an issue?

The Necessity to Assign Strict Definitions?

Different terms were used during the planning stage of the environmental science and technology parks, including eco-industrial parks, industrial symbiosis,

and environmental protection. (Environmental Protection Administration, 2013) To enhance the readers' understanding, the definition of terms adopted in this research is explained in section 1.6. These concepts raised and freshened the awareness of the seemingly innovative measures. New opportunities were anticipated by stakeholders in diverse geographical regions, correspondingly facing the diverse reality. Due to the observation of different contexts, researchers have also concluded diverse success factors and barriers of industrial symbiosis, eco-industrial parks, and circular economy development. (Deutz & Lyons, 2015; Ghisellini et al., 2015; Yap & Devlin, 2016) This leads to a debate, whether it makes a contribution to generalize and assign strict definitions to the success or failure of industrial symbiosis, eco-industrial park, and circular economy development. After all, the pragmatic contribution is to achieve the improvement of environmental standards and regulations in different geographical regions.

Vision Translation and the Enlarged Industrial Symbiosis Zone

Several questions still remain. First, how did the eco-industrial park vision turn into the promotional plan of the 4 environmental science and technology parks? Further, how did the promotional plan of environmental science and technology parks turn into the Taoyuan environmental protection park, a park whose enterprises process the industrial waste?

The answer lies in the background and the observation scope. Even though Environmental Protection Administration had the vision of creating eco-industrial parks, they were facing the background of severe pollution problems and decentralized recycling operating units in Taiwan. The immediate urgency was to centralize the recycling units, to reduce the existing pollution, and to better monitor the discharge through end-of-pipe measures. The other explanation comes from the observation scope. The Taoyuan environmental protection park and the other three corresponding environmental science and technology parks play the role of researching and developing 6 key industries in cleaner production and resourcification. (Environmental Protection Administration, 2013) With the clustered operation, the enterprises contribute to the centralization of the recycling operating units. Due to the processing of industrial waste from diverse industries, the industrial symbiosis potential within this specific park is limited.

However, it does not mean the industrial symbiosis linkages do not exist at a larger scope, in the city, a region, or the country for example. Furthermore, the Industrial Technology Research Institute indicated that in Taoyuan city, the observation scope should be enlarged to the entire city. (Industrial Technology Research Institute, 2007)

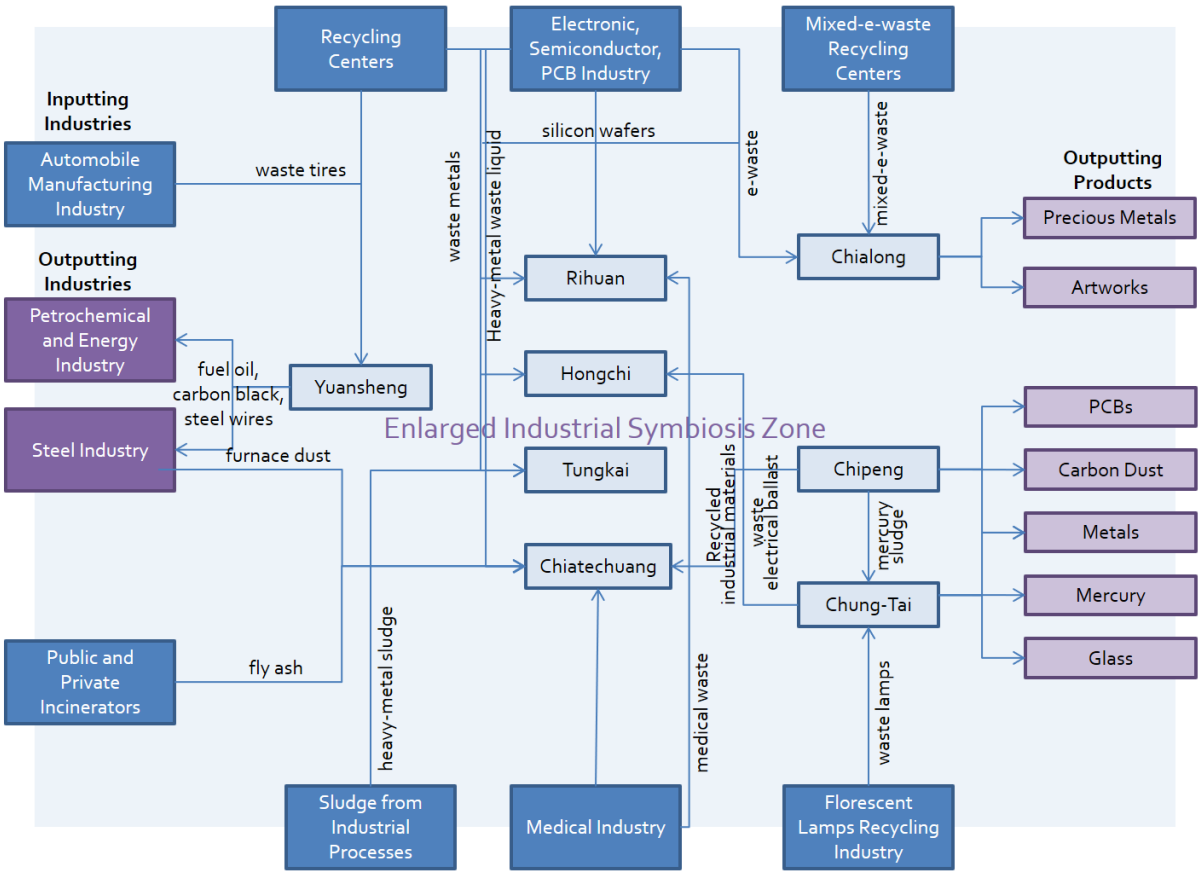


Figure 23 Enlarged Industrial Symbiosis Zone from Taoyuan Environmental Protection Park (adapted from Figure 9)

Figure 23 shows the switch of the observation scope and the formation of the enlarged industrial symbiosis zone, including the immediate inputting and outputting industries. Within the enlarged scope of observation, it is crucial to pose the emphasis on forming smallest possible clusters to minimize the environmental impact. However, the enlargement of the observation scope always has boundaries due to the business, political, and economic reality. While planning the smallest possible clusters for the environmental performance remains a challenge in the neoliberal, globalized market economy.

4.2 Scope of Integration

4.2.1 Globalized Neo-Liberal Economy

Despite the market protection strategies adopted in various locations, all the entities are operating and integrated into the global and globalizing economy. This is the reality of the dominating neo-liberal economy which we are facing. The countries, territories, and regions with separate customs have been forming trade agreements with one another, theoretically with the aim to achieve the maximum economic efficiency. The international, inter-territorial, and inter-regional integration can cause both benefits and drawbacks for different industries, but it is still not comparable to the disadvantage of the great economic inefficiency caused by the exclusion of trade unions, especially when the majority participates.

Taiwan has been struggling to position itself in the international integration. In section 3.2.1, several barriers and exclusions to the trade unions can still be observed nowadays due to the political reality in the Taiwanese case. Because of the long economic dependence on foreign investments, the previous short-term development plans, and the divided society influenced by historical events, it is a challenge for Taiwan and other countries with similar development paths to create new competitive advantages apart from the looser environmental standards and less protected labor forces in earlier years. (section 3.2.5 and 3.3)

4.2.2 Localized Circular Economy and Industrial Symbiosis

On the other side of the spectrum, the concepts of industrial symbiosis and circular economy attempt to shift the focus back to the more localized measures with the consideration of environmental efficiency, under the overwhelming neo-liberal economic institution. In fact, most actions of the enterprises are already both economically and environmentally efficient. The economically-optimized resource use can be freely interpreted as an environmentally-efficient practice. The cleaner production can also mean a minor improvement from the "dirty" production processes. An interesting question arises here, to which side do the practices lean? Under the existing neo-liberal economic institution, the consideration of environmental performance has an informal but indestructible boundary. With the reflected price of resource scarcity and environmental

pressure in some regions, the enterprises can conduct a more environmentally-oriented optimization research, but in the end, these analysis efforts are inevitably profit-oriented.

Broken industrial symbiosis linkages have been found in the existing literature as well as the Taoyuan environmental protection park, partly due to higher economic efficiency or the entry to the global economy. (Envirolink Corporation, e-mail correspondence, 2016; Yap & Devlin, 2016) Furthermore, it can become an ethical debate in a global context. Is it fair to limit the relocation, which can result in the survival of enterprises in severe crisis, to places with more attractive conditions, such as looser environmental standards and poorer labor regulations? Or, can the integration under the neo-liberalism ever be a fair deal? The debate is addressed in the next section.

4.3 Scope of Symbiosis

4.3.1 Types of Symbiosis at Multiple Levels

There is a variety of symbiosis at different levels. The symbiosis, the "living together" activities are already found existing within a plant or an enterprise at the micro-organizational level, within the same industry, in the supply chain, in a city, a nation, a region, or globally in the neo-liberal market economy. Apart from the research focuses of industrial symbiosis at the meso level and cross-level circular economy (Figure 4), the symbiosis from the business side can be within a multi-national enterprise or a strategic business alliance which consists of many enterprises. There is a large collection of the economic terms to describe the phenomena, but the symbiosis activities at the highest possible level observed in the reality are more intriguing in this research.

4.3.2 Symbiosis in Reality

Observed Contradictions

Many studies have researched into achieving a more transparent supply chain or business alliances. Even with the business contracts, the disclosure is always somewhat limited to complex factors in reality, unless there are mergers and acquisitions, which forcefully and effectively create transparency and integrate

the enterprises into one. This example explains the bonding change, from by only trust or business agreements to a united entity.

Another example observed is the Taiwanese case in this research. With the industrial and technological development, the industries in Taiwan, as well as the Taoyuan environmental protection park, generate a large amount of hazardous waste. However, when this country attempts to participate in the international organizations related to hazardous waste management or sustainable resource integration, the participation is often limited or hindered due to the political reality. The uncertain sovereignty status hinders Taiwan and other ambiguous regions in the world as an evident contradiction to cooperate in an official system which promotes sustainable resource integration and other critical issues that can benefit the general public and the environment.

Following the research question, what is the largest and feasible scope of cooperation/ symbiosis which can be achieved *from the city government's perspective?* These observed contradictions of Taiwan's largest feasible scope of symbiosis discussed in this section are indeed beyond this thesis research boundary, but it is crucial to consider the reality above, at the macro-global level. Despite the high autonomy level of the Taoyuan city government as one of the six special municipalities in Taiwan, the decision-making and the policies designed by the city government are still significantly influenced by the national development plans and the international relations maintained at a higher level.

Multi-Faceted Industrial Symbiosis in Taiwan

A multi-faceted industrial symbiosis system is developed in Taiwan according to the actual governance area of the entities, facing the political and economic reality described in section 3.2. Figure 19 shows the existing entities and their corresponding initiatives which promote the higher resource efficiency. (Page 69) With the ambiguous sovereignty status, Environmental Protection Administration still has governance over its territories regarding the national circulation policies. The Industrial Development Bureau promotes the resource and energy information integration platform and various industrial symbiosis initiatives in the Ministry of Economic Affairs. While the Industrial Technology Research Institute (ITRI) takes a non-governmental position to facilitate advanced innovation and resource efficiency in industries. Taiwan Circular Economy Network and other

civil groups continue to advocate circular economy and stimulate information sharing from the society. (Taiwan Circular Economy Network, personal communication, 2016)

In reality, this multi-faceted symbiosis is perhaps the optimal basic organizational structure which can be achieved in Taiwan, though the organizational structure has the potential to be further improved with cross-departmental and cross-organizational collaboration. (Shangwen Chan, e-mail correspondence, 2016; Taiwan Circular Economy Network, personal communication, 2016; Taoyuan City government, personal communication, 2016) The future of Taiwan can be operating as an internationally-recognized, independent country with reasonable and normal participation international occasions; it can also be officially integrated into the Chinese system as a province or a special district. While developing the national resource circulation policies, Taiwan may, at a certain point comply with the Chinese central law. Influenced by another powerful force, there is also the possibility to accept the conditions from the U.S. side. Dealing with its own system, restrictions from other systems and the international system, the contraction in the sustainable resource management is very likely to emerge and become difficult to resolve.

Beyond National Boundaries

Other opportunities of the symbiosis beyond national boundaries lie in the business actions. A large amount of multi-national enterprises has already integrated the global resources effectively, and many of them are members of Ellen MacArthur foundation, an organization with the mission to accelerate the transition to a circular economy. The consensus is gradually forming, but without drastic changes in market mechanisms, it is still not beyond the economic integration as a strategic business alliance.

So, if the current global market economy is unwavering without drastic changes in market mechanisms, how to not exclusively integrate all the resources, materials, water, energy at a global scale, meanwhile achieving the smallest scale of clusters for the environmental efficiency?

The answer to this question can be clear, creating a global state, not leaving any country or any entity behind, and meanwhile having a realistic shared vision of

implementing the global sustainable resource management. However, the immediate barriers will emerge in order to incorporate all countries and literally everyone. In the interconnected world, individual countries are ruled by the corresponding national governments. Moreover, almost all countries and all entities are incorporated and governed by the neo-liberal economic institution with an individual vision to make a living. These visions are both distinct and distant from the global sustainable resource management. Furthermore, a large number of the current international and transnational organizations is not more than the purposes of strategic integration among nations instead of symbiosis at a global scale. The world comprises regions with highly varied standards of living and a huge disparity in levels of resource consumption. How to both fairly distribute and consume the resources will remain a critical global issue.

The inconvenient truth is, that the international politics and economic policies nowadays still have higher weights than the environmental issues. The international cooperation initiatives continue to incorporate the majority but still not everyone, which leaves the excluded entities great disadvantages. In this research, Taiwan is proved to be a vivid example. Nevertheless, the globalization and the neo-liberal economy is leading us to achieve the shared vision. The globalization and the global migration could reduce the differences among the regions, while the scarcity of resources will gradually emerge in the neo-liberal economy. Perhaps not until we face the next environmental hazard at a sufficiently large scale, which causes enormous inconvenience for a critical number of people, will we start to realize the necessity of solidarity, with everybody, the practitioners in all industries, the city governments, all countries, and regions altogether to fairly manage, distribute, and consume the global resources sustainably.

4.4 Preliminary Findings

In previous sections, the objectives of the Taoyuan environmental protection park and the corresponding larger plans were examined. Various terms were interpreted, but it is not necessary to assign strict definitions. The purpose of this research is to achieve pragmatic improvement in the environmental standards, regulations, and sustainability in different geographical regions.

Further discussion regarding the scope of integration and the scope of symbiosis is conducted in 4.2 and 4.3. The debate covers the influence of the globalized neo-liberal market economy on the circular economy development, different types of symbiosis at multiple levels, and the symbiosis in reality under the current international relations. It not only emphasizes the mixed-level factors in reality and how Taiwan can achieve the largest scope of symbiosis, but also raises insights for other cases to consider these common but realistic issues.

With the basis of the mixed-level and SWOT analysis plus the C-H factors from the context analysis, and the critical issues in reality mentioned in previous discussion sections, 7 preliminary findings are outlined. They are concrete policy interventions designed for the Taoyuan city government, and these findings were sent to all the interviewees for validation in early June 2016. (Appendix 3) Their feedback is presented in section 4.5 as the validation for this research.

Despite the small scope of the Taoyuan environmental protection park, the observation at the micro level can also be the insights for the Taoyuan city government as policy advice and the recommendations of management strategies at a larger scale.

- *Keep the existing enterprises in the park; maintain the achieved environmental, social, and economic progress*
  Facing the powerful five forces in the waste treatment market, the efforts should continue to support the environmental education and sightseeing plant in the park to maintain the achieved sustainability. The coverage of the function can be extended to the separated recycling operating units, so that both the public and the operating units can be educated with the appropriate knowledge of recycling and processing. As for the regulations regarding greening and ecological engineering, the principle of maximum connecting ecological habitats and green lands can be adopted to simplify the complicated regulations.

- *Participate actively in the existing initiatives, projects, and organizations; Join the multi-faceted industrial symbiosis system*
  Assess and participate in the existing projects from Industrial Technology Research Institute, the energy and resource integration platform from the

Industrial Bureau, Ministry of Economic Affairs, and other initiatives or organizations which promote a higher resource efficiency. As a participant and an implementer, report actively the insufficiency of the platforms and projects to other organizations. The goal is to enlarge the observation scope and the scheduling area to the largest, while achieving the highest environmental efficiency with the smallest scale of clusters within the observation scope from the city government's perspective.

- *Report the complicated and distorted details of the environmental impact assessment; recommend to introduce ISO standards*
  Due to the previous conditional exemption of environmental impact assessment (not exceeding the regulated total pollution amount with the consent of the department of environmental protection and the department of business development) (Taoyuan Environmental Protection Park Preparation Office, 2005), currently, the environmental impact assessment of new enterprise entry to the park is conducted in the form of deviation EIA. To simplify and clarify this ambiguous current state and the long-standing environmental impact assessment, the introduction of ISO standards is recommended.

- *Transform the attitude in policies and regulations to "Everything is a resource."*
  Assess the sub-regulations existing in current regulations. Replace the attitude of "Removing/ excluding the waste" with "Everything is resource" and implement it in new policies.

- *Create cross-departmental and cross-organizational cooperation*
  Continue to facilitate the circular economy in this multi-faceted structure, but clarify the responsibilities of the authorities concerned and reduce potential bureaucracy.

- *Help the small-and-medium enterprises (SMEs) to shift the capacities or to other industries*

Guide the SMEs which are in trouble and help them shift the capacities according to new management strategies, the implementation plan in Taoyuan city, and the national development plan.

- *Encourage the collaboration among diverse industries in smaller projects; remove non-financial barriers*

  Learn from the Green Deal, collectively introduced by several Dutch ministries, Economic Affairs, Infrastructure and the Environment, and the Interior and Kingdom Relations. Apart from the previous financial support, this project requests innovative proposals which have the potential to enhance environmental standards from the businesses and the interest groups. The business side is responsible for listing the environmental contribution, action plans, and concrete key points which need the governmental support. The ministries then can gradually adjust the regulations and market mechanisms, or create other incentives which encourage innovation. The Green Deal is usually a mutual agreement between a coalition of enterprises, civil groups and society, local and regional government.

4.5 Validation

As the validation of this research, the preliminary findings were sent to all the interviewees in early June 2016, including city government officials, enterprise representatives, and the practitioners in the field. (listed in section 0) The feedback, questions, and recommendations are reflected in this section. The results will be incorporated into the key findings in chapter 5. Two feedbacks from Chung-Tai Resource Technology and Taiwan Circular Economy Network are received, but the reply from the city government is not yet received. Further attempts will be made for the officials' feedback and opinions.

4.5.1 Chung-Tai Resource Technology

Jack Wang from Chung-Tai Resource Technology Corporation gave recommendations to one of the preliminary findings, "Report the complicated and distorted details of the environmental impact assessment; recommend to introduce ISO standards".

He mentioned that there is no distortion in the environmental impact assessment of the Taoyuan environmental protection park and asked for corrections in the findings. There are several reasons in his argument. First, the entire park has passed the EIA in the initial setup stage, and the new enterprises should apply to the service center of the park for the certified share of pollution discharge. The originally promised (from the city government) mechanism was to monitor the total pollution discharge. Moreover, according to Title 34 of the regulations on the qualification, descriptions, and standards of EIA in the Environmental Impact Assessment Act, the EIA is exempt in two conditions. The industry types match the originally approved industries, and the development does not exceed the approved total pollution amount with the confirmation of the supervision organizations. He also showed the interest in more concrete ISO standards.

The author replied with reiterating the research question. The research intends to provide valuable and pragmatic insights for the city government as implementation advice. As for the complicated and distorted details of the environmental impact assessment reporting, it refers to the long-lasting but still ambiguous EIA state of the Taoyuan technology industrial Park, which partly consists of the Taoyuan environmental protection park. (Figure 11 ,Table 12) To enhance the ambiguousness will reduce redundancy, and ISO principles can be helpful for the Ministry to amend the regulations.

With the reply from the author, Jack Chang gave thanks for the insights into the past and the future of the park. From the perspective of the enterprises in the park, he said that the expectation is to save time and get the certification. Through the long-term collaboration and communication, the enterprises and the service center have reached the consensus and a balance to some extent. He looks forward to the future efforts on the three pillars of sustainability.

4.5.2 Taiwan Circular Economy Network

Shadow Chen from Taiwan Circular Economy Network complimented the preliminary 3-page report (Appendix 3) and questioned the EIPs in Taiwan and doubted the leap to the conclusion. She suggested to investigate the objectives and the problems of the current approach, so either the objectives or the approach can be adjusted. If the objectives are unclear, the focal point and the research question of the SWOT analysis is difficult to define. She gave several

examples of the focal questions, including a successful EIP which shares the energy and resource, a profitable industrial park, the role of waste treatment in Taoyuan city, or the initial objectives of the development.

The author re-illustrated in the reply that the 7 preliminary findings were based on the observation of the Taoyuan environmental protection park. Keeping the existing enterprises in the park and treating as a normal industrial park does not mean not to promote EIP development in other locations in Taiwan.

Due to the limited 3 pages of the preliminary report, which focused on the analysis results and key findings, the literature review, research scope, and the deductive process were briefly covered. Two sets of objectives of the promotional plan and the Taoyuan environmental protection park were forwarded and examined. (section 4.1) The existing problems are shown in the S-W internal environment. While the SWOT analysis with the C-H factors from the context analysis takes the park as the focal point and analyzes from the city government's perspective. The classification of whether the elements are advantages or disadvantages depends on the benefits to the circular economy development. Because the Taoyuan environmental protection park only accounts for a small part of the governance coverage of the city government, the influence on the C-H contextual environment and the background is also what the city government can adjust to create a positive impact on the park.

In the author's opinion, there are no problems with the EIPs in Taiwan. The measures are meant to be different at different levels. The industrial symbiosis and EIP may not be evident in the Taoyuan environmental protection park given the small scope, but it does not mean that the EIP or industrial symbiosis linkages do not exist among the industries in the entire city or nation. As one of the preliminary findings suggested, the goal is to enlarge the observation scope and the scheduling area to the largest, while achieving the highest environmental efficiency with the smallest scale of clusters within the observation scope from the city government's perspective.

After further explanation, Shadow validates the key findings of this research with compliments, and she thinks that it is worthwhile to evaluate the role of EIP in a broader context.

5 Conclusion

The final chapter of this thesis report includes the key findings, the relevance to the academia and the implementation in reality, as well as recommendations for future research. Note that the deduction has gone through an integrated mixed-level in-depth analysis with extensive information from multiple sources. Critical issues in reality are reviewed in chapter 4, and the preliminary findings were sent to all the interviewees for validation. The results above are all incorporated into this conclusion chapter.

5.1 Key Findings

Based on the solid understanding of the mixed-level environment in this case (chapter 3 and section 4.1) and the critical issues in global reality (section 4.2 and section 4.3), preliminary findings were outlined and sent to all the interviewees for comments as the validation of this qualitative research. (section 4.4 and section 4.5) The feedback from the interviewees is treated also as an examination of the preliminary findings as well as the analysis. With their questions, doubts, and corrections to the preliminary findings, minor adjustments and further specification are made to further clarify the findings. The final key findings and the validation from the interviewees will be sent to the city government officials as policy advice.

Several concrete questions were formulated to help explore the mixed-level environment. What are the city governmental goals for the environmental protection park? (section 3.1.2, Taoyuan City Government's Pursuit of Circular Economy) What is the organizational structure of the environmental protection park? (section 3.3.2) What are the macro environment and the context which the actors of the park operate in? (section 3.2 to 3.4) What insights for the Taoyuan City government can be drawn from the Taoyuan environmental protection park development for the future CE development project? (section 4.4) Is industrial symbiosis an indispensable part of the circular economy development? (section 5.1.2)

7 key findings are formulated based on the SWOT analysis with the C-H factors from the context analysis, an analytical framework to structure mixed-level analysis. The following key findings are adjusted according to the expert validation with minor specifications to avoid misunderstandings.

The factors concluded from the mixed-level analysis are labeled with the corresponding key findings. The numbers inside brackets represent the relations between the factors and the findings, which explains which main factors are considered in the formulation of the findings.

	Enablers	Barriers
Internal Factors	**Strength** - Achieved progress in sustainability (1) - Centralizing the separated recycling operating units (1)	**Weakness** - Conditional exemption and the ambiguous current state of EIA (3) - Enterprise dependence on subsidies (7) - Distant location of the park and the lack of hinterlands (1)
External Factors	**Opportunity** - Undefined but flexible sovereignty status of Taiwan (2) - Tripartite economic structure - Smooth power transfer for twenty years - Independently-functioning liberal reality with democracy (2) - Transparent legal system under the rule of law (3) - Emerging identity (7) - Emerging environmental awareness and long-term plans (4, 5) - Advanced technology (2)	**Threat** - Undefined but flexible sovereignty status of Taiwan (2) - Tripartite economic structure - Influence and legacies from previous authority and one-party rule (5) - Dependence on foreign investment (7) - Interference from foreign investors and powerful forces (2)

	- Existing organizations and initiatives in max. resource efficiency and min. hazardous waste generation (2, 5)	
Contextual Factors	**Convenience** - Prosperous, diverse industries (1) - Abundant workforce (6) - Regular actions and contact with CE professionals (2, 3) - Flexible SMEs (6)	**Hindrance** - Powerful five forces in the waste treatment industry (1, 6) - Existing mindset and sub-regulations of pollution control (4) - Unstable SMEs (6)

Table 17 SWOT Analysis plus C-H Factors from Context Analysis (with Policy Advice Labels)

5.1.1 Policy Advice for the City Government

The intention is to answer the research questions with the key findings. Consequently, the research questions and the key findings are presented in an interlinked manner.

What can be the possible future of the Taoyuan Environmental Protection Park, an eco-industrial park or a normal industrial park?

1/ Keep the existing enterprises in the park; maintain the achieved environmental, social, and economic progress

Facing the powerful five forces in the waste treatment industry with the distant location of the park and the lack of hinterlands, it is suggested to keep the current state of the park and the sustainability achievements. The 9 currently operating enterprises in Taoyuan environmental protection park have created the economic added value of 1.1 billion NTD and the employment of 350 people. (Taoyuan City government, 2015) The park also plays the role of centralizing the separated recycling operating units. The Taoyuan environmental protection park is the overlapping subset of the two larger projects, the promotional plan of environmental science and technology park and Taoyuan technology industrial park. Given the small scope of the focal point, studies have shown that the industrial symbiosis planning should be considered with the diverse industries at

the city level. (Industrial Technology Research Institute, 2007) Note that keeping the park as it is currently, does not mean there should not be EIP development in other locations. The main arguments for this suggestion come from the scope, the type of industry, and the inherently weak geographical location of the park.

The coverage of the function can be extended to the separated recycling operating units, so that both the public and the operating units can be educated with the appropriate knowledge of recycling and processing. As for the regulations regarding greening and ecological engineering, the principle of maximum connecting ecological habitats and green lands can be adopted to simplify the complicated regulations.

- ***What is the largest and feasible scope of cooperation/ symbiosis which can be achieved from the city government's perspective?***

No specified key finding is formulated to address this question, but there are critical factors from the macro-global environment which merit attention. It is evident that the global sustainable resource management requires the non-exclusive participation worldwide, but it is outside the city government's boundary.

This research takes the perspective of the city government. In the mixed-level environment, the city government is located at a tricky position between the macro and meso level. Empowered by the general democracy, the city government governs the city and could directly influence the industrial park, while it has to comply with the national development plan and is affected by the global PEST environment. (Figure 21) An ample introduction of Taiwan's political and economy reality is provided in this research. (section 3.2.1 and 3.2.2) The intention is not to raise a dispute among different political standpoints, but rather to show how the development towards a circular economy could be affected by the undefined and flexible sovereignty status, as well as the rapid industrial and democratic development in the recent hundred years. Due the ambiguous sovereignty status, Taiwan has been maneuvering among the powerful forces internationally. Taiwan's participation in international occasions has been active but with numerous titles of different political implications. The current status of this undefined but flexible sovereignty can be seen as both an opportunity and

threat. This fact may limit the official international cooperation, but it creates the potential for various regional integration.

- ***How would the development help to facilitate the circular economy in Taoyuan City?***

2/ Participate actively in the existing initiatives, projects, and organizations; Join the multi-faceted industrial symbiosis system

With the consideration of Taiwan's political and economic reality, suggestions are for the city government to participate actively in the existing initiatives, projects, and organizations which promote a higher resource efficiency. Figure 8 and Figure 19 show the relations and the structure of these organizations in this multi-faceted industrial symbiosis system. These organizations all take different approaches and have been coping with the political and economic reality.

Environmental Protection Administration and Industrial Development Bureau in Ministry of Economic Affairs take the role of the central government to promote the industrial symbiosis, sustainable resource and energy management, within the scope of Taiwan's independently functioning territories. Industrial Technology Research Institute was developed during the one-party rule and has secured a non-government standpoint to conduct innovative research and to facilitate a higher resource efficiency. (J. Zhang & Peck, 2016) Taiwan Circular Economy Network is formed as an advocate for the circular economy. Currently, the scope is the entire Taiwan, but the organization is optimistic about the potential regional integration into ASEAN countries, mainland China, and other international systems. (Taiwan Circular Economy Network, personal communication, 2016) The pursuit of these organizations earns the title and constitutes the multi-faceted industrial symbiosis system.

As a participant and an implementer, it is suggested for the city government to report actively the insufficiency of these platforms and projects to other organizations. The goal is to enlarge the observation scope and the scheduling area to the largest, while achieving the highest environmental efficiency with the smallest scale of clusters within the observation scope from the city government's perspective.

3/ Report the complicated details of the environmental impact assessment; recommend to introduce ISO standards

Due to the previous EIA exemption in the Taoyuan environmental protection park, with the condition of not exceeding the regulated total pollution amount and the consent of the department of environmental protection and the department of business development (Taoyuan Environmental Protection Park Preparation Office, 2005), several deviation EIAs of the Taoyuan technology industrial park are then conducted to enhance the environmental standards. The complicated current state is shown in Table 12 with the unfinished and long-standing EIA over 10 years.

A major opportunity for Taiwan is its transparent legal system under the rule of law and its established EIA system. The proper implementation can thus be enforced with a well-designed system. It is recommended to report the EIA complexity to Environmental Protection Administration and to introduce ISO standards to the EIA system, in order to simplify and clarify this ambiguous situation. Taoyuan city government's regular contact with CE professionals could also help to introduce the ISO standards.

4/ Transform the attitude in policies and regulations to "Everything is a resource."

It is reported that the reuse and re-inclusion of certain output items are only possible after a lengthy application process. (Taiwan Circular Economy Network, personal communication, 2016) With the reorganization of Environmental Protection Administration into Ministry of Environment and Resources, a better approach for the city government is to examine the current regulations and replace the remaining mindset and sub-regulations of pollution control with circular resource management.

5/ Create cross-departmental and cross-organizational cooperation

In the multi-faceted industrial symbiosis system, there are several organizations taking different entry perspectives towards the goal of a higher resource efficiency, ranging from civil advocates, non-government organizations, to governmental administrations. This used to be a necessity to secure the political independence during the one-party rule, but it is not the case anymore under the

current democracy. (J. Zhang & Peck, 2016) (section 3.2.4) One interview mentioned that the cross-organizational cooperation could be further improved. (Shangwen Chan, e-mail correspondence, 2016) With the planned reorganization to form Ministry of Environment and Resources, it not only symbolizes the emerging environmental awareness and long-term plans but also creates cross-departmental and cross-organizational collaboration.

6/ Help the small-and-medium enterprises (SMEs) to shift the capacities or to other industries

One feature of the Taiwanese economy is the abundant workforce, flexible and unstable SMEs. Once the enterprises in the Taoyuan environmental protection park are confronted with severe problems due to the powerful five forces in the waste treatment industry, it is recommended for the city government to guide the flexible and unstable SMEs to shift their capacities according to new development plans of the city or the national development plans.

7/ Encourage the collaboration among diverse industries in smaller projects; remove non-financial barriers

The definition of "environmental protection industries" limits the possibilities and potential of the environmentally-innovative practices and the imagination of collaboration with diverse existing industries. One challenge which Taiwan has encountered is the dependence on foreign investment. Previous competitive advantages which attracted investment were the abundant and inexpensive labor forces with the unimproved environmental standards. An increasing amount of people stopped to see Taiwan as a development base where resources could be insatiably extracted. Instead, an emerging Taiwanese identity which encourages collaboration among different actors is developed. (section 3.2.3) The synergy and environmentally-innovative practices can come from the business side, and the public sector can design mechanisms to encourage those initiatives.

It is suggested to learn from the Green Deal, a collective project introduced by several Dutch ministries, Economic Affairs, Infrastructure and the Environment, and the Interior and Kingdom Relations. Apart from the previous financial support, this project requests innovative proposals which have the potential to enhance environmental standards from the businesses and the interest groups,

which reduces enterprise dependence on subsidies. The Green Deal is usually a mutual agreement between a coalition of enterprises, civil groups and society, local and regional government.

The key findings are sent to the Taoyuan city government as policy advice and the implementation part of this research.

5.1.2 Interpreted Relationship of Research Focuses

After conducting and presenting the key findings from the mixed-level analysis, the holistic understanding of the Taoyuan environmental protection park could help to enhance the knowledge on the relationship between the two research focuses, industrial symbiosis and the circular economy.

Revisiting Figure 4 and the section 1.6, it is evident that the two research questions mapped on the lower part of the figure have been answered. (Figure 24)

Firstly, a key learning from the case is that it is not necessary to promote the industrial symbiosis which internally restricted to the park boundary, especially when the scope of the park is small. Neither should the industrial symbiosis be coercively formed when facing inherent disadvantages, such as the homogenous industry type and the weak geographical location observed in this case. However, it does not mean eco-industrial parks should not be promoted in other regions or planned in new development projects. A more realistic perspective of enlarging the observation scope, while optimizing the resource use and maximizing the resource efficiency is recommended to be taken.

The second key learning is, even if the park is not developed into an eco-industrial park, it can still take the role as a facilitator of a circular economy very well. The six realistic recommendations proposed in section 5.1.1 have shown that it is attainable to facilitate a circular economy as a normal industrial park.

Last but not least, this research on this case also adds insights to the knowledge between industrial symbiosis and circular economy. Whether industrial symbiosis forms an indispensable part of a circular economy depends on the scope defined. Despite the fact that industrial symbiosis can be seen as a subordinate to the circular economy implementation at the meso level, a coercively formed

industrial symbiosis linkage at an infeasible scope would not sustain due to the economic reality, which in turn has limited contribution to a circular economy. It is suggested to consider the economic and political reality while determining the feasible scope of industrial symbiosis, the greater Taoyuan City in this case, in order to contribute the self-sustaining industrial symbiosis linkages to the circular economy development.

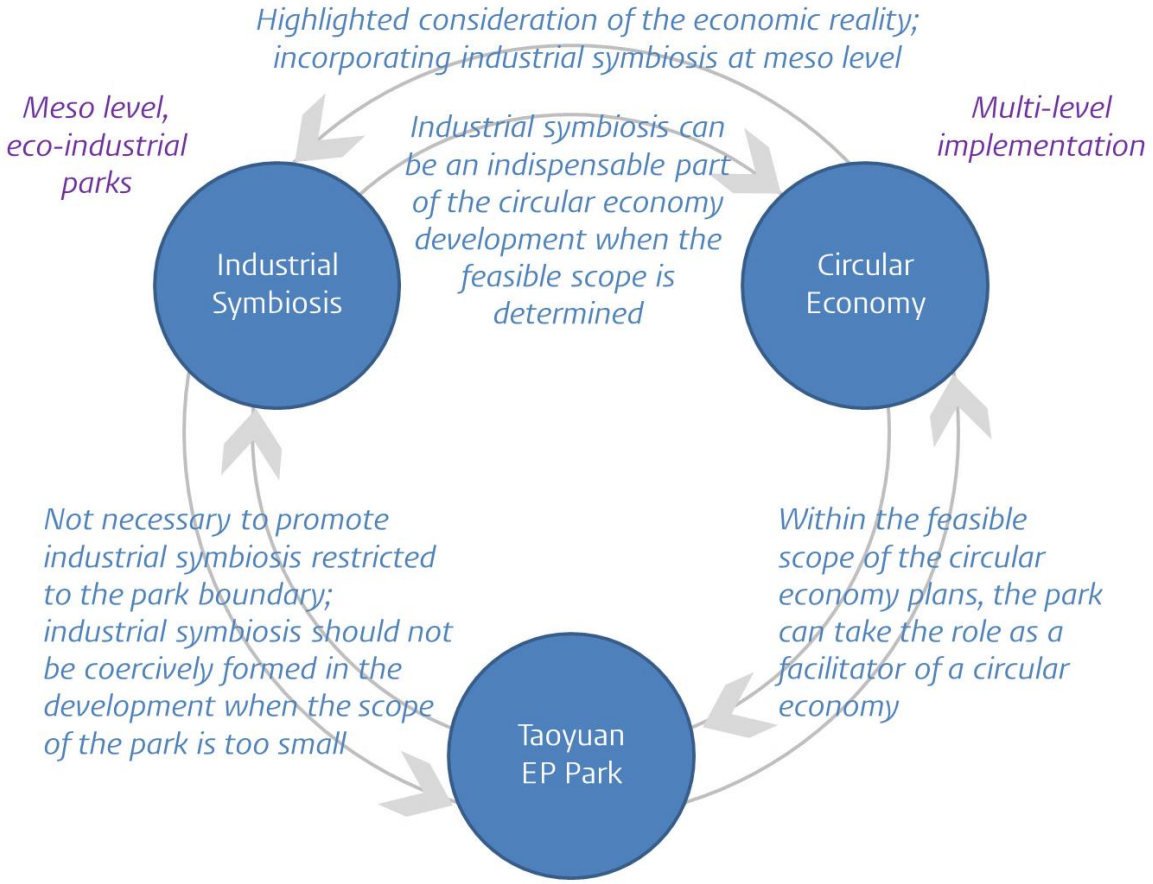


Figure 24 Relationship between Industrial Symbiosis, Circular Economy, and the Taoyuan Environmental Protection Park

5.2 Relevance

The relevance of this research to both the academia and the field lies in analysis, design, and implementation. The contribution is threefold, including the analytical framework, the multi-faceted Taiwan model, and the policy advice to the city government for potential implementation.

Integrated Mixed-Level Analysis, SWOT Analysis with C-H Factors from Context Analysis

In order to provide valuable insights into particularly how the political, economic, and socio-historical development mode have a huge influence on a specific place, an integrated mixed-level analysis is conducted to describe the internal environment, the macro-global environment, the Taiwanese development mode, and the context in detail. A checklist is created to examine whether the key points are covered, the information sources, and the knowledge level in the analysis. Furthermore, the SWOT analysis with C-H factors from context analysis is used to structure the complex findings of a mixed-level analysis in internal factors, external factors, and contextual factors. This integrated approach of combining results from the analysis helps the decision makers to observe what specific pragmatic changes can be made for the interest of the people and the environment, as well as what external opportunities and threats there are to cope with. The existing theories are analyzed and improved in this research, and an analytical framework is designed with a combined set of analysis to provide the mixed-level answer to the research question.

Taiwan Model: Multi-faceted Industrial Symbiosis System

Conducted with the extensive sources of information, this research contributes the objective and ample knowledge of a particular place for future comparative research. Given the distinct socio-historical development mode, and the political and economic limitation, many organizations and initiatives in Taiwan are dedicated to achieving a higher resource efficiency and sustainability within the largest actual scope governed. The design in practice lies in proposing improvements to the organizational structure, more collaboration among the existing organizations for instance. To be both realistic and pragmatic facing the macro-global environment, this multi-faceted system in Taiwan is currently a suitable industrial symbiosis model to promote a circular economy within the largest feasible scope.

Implementation as Policy Advice to Taoyuan City Government

A major integral part of this research is the interviews with several practitioners in the field and city government officials. The preliminary findings were sent to

the interviewees for validation. With the feedback and the supplementary information incorporated, the key findings are properly validated with these expert interviewees. In the end, the key findings of this research contribute to the Taoyuan city government as policy advice. To facilitate a circular economy in both Taoyuan city and in Taiwan, it accounts for the implementation of a sound and realistic qualitative analysis.

5.3 Further Research

Enormous efforts have been dedicated to conducting an objective research from a broad perspective as well as the close collaboration with the stakeholders involved. Several aspects for future research include the continuous observation of this case and other applications in other locations to the analytical framework proposed in this research.

Continuous Observation of the Development

In Taiwan, a new president and the new government just started the term in May 2016. The term "circular economy" was mentioned in the inaugural speech, but the continuous observation is needed to trace the following actions in the long-term planning. The interaction with the powerful forces also merits attention, especially to the potential political and economic integration.

Other Applications to the Analytical Framework in Comparative Study

Other research use of the analytical framework proposed in the research, the integrated mixed-level analysis, and the SWOT analysis with C-H factors from context analysis, can enhance this methodology for the qualitative analysis in other locations. As long as the decision-making entity and the focal point are well-defined at the corresponding levels, the applicability is clear in other systems. The valuable insights of how particular cases are influenced by their environment and context can be systemically analyzed in detail. As a comparative study of this research, it is interesting to observe the largest scope of pragmatic environmental integration and symbiosis in other locations, especially in other types of systems, a planned economy for instance. The transparency and validity of the information sources arise from the system nature as another intriguing aspect for the future research.

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Appendix 1: Interview Transcriptions

(in both English and Mandarin Chinese)

Cosmas Lu (SDTI)

Participants:
Cosmas Lu, spokesperson/ strategy advisor
Ian Chu, legal commissioner

Date and Time:
17/ 2/ 2016 13:30-14:30

Location:
Huanke Road 323, Datan Li, Guanyin Districht, Taoyuan City (SDTI, Taoyuan Environmental Protection Park)

Q: As far as I know, the original plan of the industrial park is to include diverse industries and create an eco-industrial park. Could you briefly introduce the Taoyuan environmental protection park and the company?

A: SDTI built the plant on this polluted land from decades ago in order to set the benchmark and strengthen the connection (among companies in the park). Currently the company profits from the material refinery, but hoping to transform into an advisory actor and provide the expertise in environmental protection (and e-waste treatment). It anticipates further, and active collaboration with the department of environmental protection of the city government. There have not been huge changes since the establishment 20 years ago. Just more people discovered the value of e-waste. In early years of establishment, the founding team was not 'mainstream' and seen as mafia gangsters, but the CEO and the chairman saw the environmental, social and economic value of the recycling (e-waste treatment).

Q: What about the shared resources and shared information in the park? Are there waste/ water/ gas emissions from the companies which are processed collectively?

A: There has been a discussion panel organized by Academia Sinica, Ministry of Economic Affairs and Taiwan Rare Earth Association. Several companies in the park participated in the discussion panel. While the waste/ water/ gas emissions are processed separately, and monitored by the government.

Q: What about the Taoyuan Environmental Protection Park Association?

A: The chairman knows better, and we cannot speak for other companies. The key issue is to discover the value of the recycling process together with other companies. Refining precious metals from e-waste processing as the original business model will not sustain.

Q: What about the shared investment and shared facilities?

A: The facilities such as electricity are shared, but the incentives are lacking to attract diverse industries, the distant location, inconvenience in traffic and the limited hinterland, for instance.

Q: Is the e-waste from abroad also processed here?

A: No, there are regulations on e-waste import.

Q: How does the e-waste supply fluctuate?

A: More e-waste comes from the north (of Taiwan), and little from the south. It depends on the attitude (of the people) and how the government supports. There must be demand for artworks and building materials from e-waste recycling, but what incentives can create this demand?

Q: What are the main barriers of industrial symbiosis? Is it technical, institutional, economic or too disruptive to the current business models?

A: The companies at the front end of the supply chain should make an e-waste treatment plan and consider easy disassembly during the product design. The incentives can be from the profit, brand image, the request from the government, customers or shareholders. The (manufacturing) companies should collaborate with the e-waste treatment companies. It is crucial how the e-waste is processed, especially the choice between the low-cost offers and e-waste treatment companies with good reputation. The key relevant regulations are about the e-waste import (with strong opposition from environmental NGOs) and the government procurement law about green (recycled) building materials.

Q: Who is the suitable facilitator fo industrial symbiosis?

A: The facilitator can be the government, the private sector or the third party. However, what is the leading (guiding) role of the government? Is it supporting the leading businesses, and how to be fair in this? The neutrality of the scholars is also questionable, and they could be too theoretical for the reality. How different sectors identify industrial symbiosis also varies, and who are the professional? SDTI's role is clear, being responsible for the profit and the brand, but what are the roles of other parties? The key point is the implementation plans in the next steps, either discovering new business opportunities or identifying the common goals which everyone approves. Another option is to collaborate with the capital (of Taiwan), Taipei (city government), on a demonstration project.

陸怡豪顧問 佳龍科技

17/ 2/ 2016 13:30-14:30

桃園市觀音區大潭里環科路 323 號 桃園環科園區

Q: 就我瞭解，市府原先對於環科園區的規劃是引進多樣產業的工廠，打造資源與能源循環再生的工業生態園區。是否能簡述環科園區與公司背景？

A: 佳龍在十多年前污染過的土地設廠，目的是增強連結，作為標竿。目前靠貴金屬獲利，但希望能轉型，提供環保 know-how，advisory，期待與環保局的積極雙向連結。佳龍與二十年前創立時沒有太大改變，只是更多人發現電子廢材的價值。創立回收業時被當流氓看待，不入流，吳家的總裁與董事長（在二十年前）看出回收的環境，社會，經濟價值。

Q: 共享的資源？共享的資訊？工廠間是否有共同處理的物質流，如廢棄物/ 廢水/ 廢氣排放？

A: 園區外的，中研院與經濟部相關機構，台灣稀土協會，曾舉辦過一場相關討論，數家園區廠商有參加。而廢棄物/ 廢水/ 廢氣排放則由個單位分別交由政府監控。

Q: 廠協會？

A: 董事長比較清楚，無法為其他公司發聲。但無法繼續停留在過去的處理廢棄物，提煉貴金屬的方式獲利，而是與其他廠商一起發現回收過程的價值。

Q: 共享的資金？共享的設備？

A: 基礎設施如電力等共享，但地理位置，交通便利性有落差，腹地不廣闊，沒有誘因將多樣的廠商拉入。

Q: 是否處理國外輸入廢電子產品？

A: 無，仍有法規限制進口。

Q: 廢電子產品供給變動情況？

A: 北部電子垃圾比較多，南部少數。看大家的心態，看政府如何支持，回收藝品，環保建材等一定有需求，但什麼誘因能創造需求？

Q: 產業循環鏈結的障礙？科技面：鏈結設備不足使物質流流通？制度面：法規？合約（多長？）所致無法引進新廠商？經濟面：無利可圖？破壞利益結構？

A: 源頭廠商應從產品設計完善廢料處理計畫，與處理商協調，製造誘因（profit/ cost & brand/ image 政府要求、顧客要求、股東要求）。是否設計容易拆解的產品，公司廢棄物該如何處理，而不是找 licensed 處理廠，選低價處理廠商還是選評價高的處理廠。重要相關法規：廢五金進口法規（環團阻擋）與關於綠色建材的政府採購法。

Q: 誰來推動？

A: 政府或民間或第三方。然而政府的領導角色是什麼，是扶持企業龍頭？可能有失偏頗？而學者的公正性也受質疑，理論大於實際？認同度歧異，認同的人專業度。佳龍的角色清楚，對 profit & brand 交代，而其他單位的角色又是甚麼？重點是下一步的執行計畫：either 發現商機 or 政府，找出全民能認同的目標，或與首都台北合作，做示範。

Mingte Wang, Jhihsiou Shen, Chang-Tsair Chang and other representatives (Taoyuan City government)

Participants:
Mingte Wang, deputy mayor
Jhihsiou Shen, director of the department of environmental protection
Chang-Tsair Chang, director of the department of economic development
An-Pi Chang, Ph.D. secretary, deputy mayor's office
Hsi-Tsung Lin, chief of department of environmental protection
Chih Ping Chiu, manager of marketing and investment department, Taoyuan Aerotropolis Co.

Date and Time:
18/ 2/ 2016 14:00-15:00

Location:
Shienfu Road 1, Taoyuan District, Taoyuan City (Taoyuan City government)

Current State of Taoyuan Environmental Protection Park

Director Shen:

The formation of the industrial parks is coordinated by Industrial Development Bureau, Ministry of Economic Affairs. The companies from the same industry gather, using the class-A waste (hazardous waste) as the raw materials for the class-B waste, saving the processing and transportation costs. The Hualien environmental protection park did not recruit businesses successfully and is currently not operating. The entire Taoyuan environmental protection park has passed the environmental impact assessment (EIA); therefore, the companies are exempt from the complicated EIA procedures. Some companies have resold the property in the park, but the companies are still related to environmental protection and waste regeneration (refinery). There is an educational plant in the Chung-Tai Resource Technology Corporation.

Are there goals of creating industrial symbiosis or eco-industrial parks in 4-8 years?

Director Chang:

The basis of the industry in Taiwan is agriculture. 29 industrial parks in Taiwan were formed according to the trend of (global) economic development and the national (domestic) needs, such as the textile industry and electronic industry. The (Taoyuan) environmental protection park is full and is functioning as a waste treatment industrial park. The circular economy requires the collaboration from all parties and supporting policy interventions. The industrial clusters in the (Taoyuan) Aerotropolis can be designed with the concept of industrial symbiosis.

deputy mayor Wang:

There are many industrial districts with diverse waste flows in Taoyuan, and also with symbiosis potential. As for the industrial clusters in Taoyuan Aerotropolis and the established environmental protection park, the experience can be learned from the successful examples in Amsterdam, especially how to link the industries and how to overcome the challenges in finance and the institution. The government can introduce the incentivizing structures, but in principle, it is the private sector that implements (the industrial symbiosis). For example, (the government) can connect the competing companies which are both in crisis and turn the structure into upstream and downstream firms, which may lead to the survival of both companies utilizing their manufacturing capacity. The government can manage to create the environment, but the key is still to establish/ facilitate the communication platform among companies, inducing companies to collaborate and form a symbiosis. The next steps would be to design policies and institution about the environmental protection, logistics and so on.

Who should be the leader/ facilitator? the government or the leading businesses?

deputy mayor Wang:

We are creating an ideal Aerotropolis from scratch, but the common goals are still unclear. The incentives should be designed with leverage points and the arguments for every sector to meet its objectives. The collaboration platform with the industry, the public sector and the academic can be established, starting from small projects and attracting the financier (Tungho Steel is one example). Currently, the circular economy is at an initial stage, and the sectors still see the profit separately. The government stands for the public interest. It is crucial how to secure the interest of the public while maintaining the trust with companies.

Director Chang:

We search for the experts for the public interest to solve public issues. The rules are made to secure (public) safety, health, and justice.

The reaction from the e-waste treatment companies: the monitoring is too strict

Director Shen:

The companies are monitored because they are paid with the e-waste processing fund to prevent few companies from simplifying the e-waste treatment process or 'dumping' without internalizing the high cost of waste processing.

What happened after the circular economy forum in October 2015?

deputy mayor Wang:

Currently, we are still advocating. What are the incentives for the businesses (to create symbiosis)? How to incorporate the advantages of the circular economy into the development of Taoyuan Aerotropolis?

Ph.D. secretary Chang:

The water and electricity are important issues. The low price of water and electricity does not provide an incentive for adopting renewable energies and reclaimed water.

王明德副市長 沈志修環保局長 張昌財經濟發展局長 張岸巒秘書 桃園市政府

18/ 2/ 2016 14:00-15:00

桃園市桃園區縣府路 1 號 桃園市政府

環科園區現況

沈局長：

工業區成立由經濟部工業局輔導設置，同業群聚，甲類廢棄物作為乙類廢棄物的原料，省下處理費用與運輸成本。花蓮環保科技園區招商不順，停擺中。桃園環科園區整區已通過環評，廠商能免除複雜環評程序，園區內廠商曾經過轉手，但仍是環保相關產業，廢棄物再生，中台有觀光綠色教育工廠。

四年內或八年內是否有產業鏈結工業區的目標？

張經發局長：

台灣農業為本，二十九個工業園區為了經濟發展趨勢與國家需求而成立，如紡織業，電子業。環科園區已滿，作為事業廢棄物處理廠區，循環經濟必須有各單位與政策配合。未來航空城的產業群聚可以用產業鏈結的概念。

王副市長：

桃園的工業區多，廢棄物種類多，也有鏈結潛能。桃園航空城的產業群聚，或是已設立之環科園區，空間規劃能參考前人經驗如阿姆斯特丹，產業如何鏈結，財務，政策制度的困難，並且如何克服？政府能提供誘導機制，但原則上還是民間廠商執行，例如將遭遇困境的兩家同業轉為上下游關係，而能發揮產能一起生存下來，政府能試著創造環境，重點還是塑造促進廠商間溝通平台，誘導廠商共生合作，再來設計政策制度環保交通的配合。

領導者是誰？政府或產業領頭羊？

王副市長：

從無到有，創造一個理想的航空城，但共同目標仍不明確。設計誘因，找出槓桿點與說詞，令各界都能滿足各界目標，建立產官學平台，從小個案合作起。（找金主投入：東和鋼鐵）目前循環經濟剛起步，各單位還是以設法獲利的方式在處理。政府為了公共利益而存在，如何保障無辜第三人的權益又不破壞廠商的信任。

經發局長：

為了公共目的找專家，解決公共的問題，訂出公平正義維護安全健康。

廠商反應監控太嚴謹

環保局長：

領取物品回收清除處理基金才受監控，防止少數不肖廠商簡化處理。或是少數廠商未內化高環保成本，低價傾銷。

循環經濟論壇後續

王副市長：

目前只有宣導，設計誘因，令各界都能滿足各界目標，建立產官學平台，從小個案合作起。什麼誘因能讓企業界做這件事？CE 的好處在桃園航空城該如何做？

張博士/ 秘書：

電無法自己生產，水電供給，水費電費便宜，沒有誘因做再生水或再生能源。

Jack Wang (Chung-Tai Resource Technology)

Participant:
Jack Wang, deputy manager of Chung-Tai Resource Technology (in Taoyuan Environmental Protection Park)

Date:
22/ 4/ 2016 e-mail correspondence

Q: What are the main incentives of Taoyuan EP park for Chung-Tai Resource Technology? Does it currently own or rent the land? Has it enjoyed the benefits and subsidies?

A: The sponsorship and the fund from the environmental protection administration ended in 2011. The subsidies and rewards include 1) subsidies in renting the property 2) subsidies in manufacturing 3) subsidies in research and development. We have applied for all (three) types, but the project has ended. We own the land. Please visit http://estp.epa.gov.tw/big5/invitation2.htm for more reference on the subsidy project.

Q: Is Chung-Tai in the Taoyuan EP park association? Is the symbiosis potential and information sharing developed in the association?

A: Most of the companies in the park are in the association. Managers meet regularly, and the information sharing is currently the main function. Of course, there are symbiosis opportunities, but the similarity of the factories is high, mostly in the waste treatment sector.

Q: Apart from the EP park guiding committee, what are the other participating departments from the central government and regional government?

A: Currently we have less contact with the committee. The park may be governed by Taoyuan City government.

Q: Apart from Academia Sinica, what are the other research and coordinating organizations? What are their roles and responsibility?

A: As far as I know, we are not in contact with any other of them.

Q: What is the influence on the EP park after Taoyuan was 'upgraded' to a special county in 2014? What are the continuing participants (departments, private organizations) from the previous government to the current government?

A: There is no tangible influence after the upgrade, but the service center of the EP park became quite active after the new mayor entered the city government. Additionally, the department of environmental protection outsources a consultancy firm to monitor and examine regularly.

Q: What is the history and statistics of the Chung-Tai sightseeing and educational factory?

A: At the establishment in 2008, the pathway was also built for visitors and environmental education. In 2012, the certificate of environmental education facilities was rewarded by the environmental protection administration. In 2015, we obtained the certificate of the industrial and cultural center from Taoyuan City government. Annually, there are 400-600 visitors to the center.

王嘉慶副理 中台資源科技

22/ 4/ 2016 電子郵件通聯

Q: 環科園區對於中台的主要誘因？目前土地自有或承租？是否享有租地、量產、研究補助？

A: 過去環保署推動園區 經費至民國 100 年底

優惠及獎勵措施 包括 一、土地租金補助費、二、生產補助費、三、研究補助費

皆有申請過，但補計畫已結束 土地是自有的

過去推動補助計畫說明 http://estp.epa.gov.tw/big5/invitation2.htm

Q: 是否參與環科園區廠協會？廠協會是否發展資源鏈結、資訊互通潛能？

A: 園區大多廠商都有加入廠協會，高階主管定期聚會，以交流聯誼資訊互通為目前功能

當然有機會也是可以進行資源鏈結，只是環保科技園區內大多廢棄物處理工廠，同質性較高一些

Q: 除了環科園區指導委員會外，環科園區推動與產業鏈結計畫有那些中央部會、地方局處參與？

A: 本公司目前比較少與環科園區指導委員會有所接觸，園區目前可能是由桃園市政府管轄

Q: 除了中研院之外，其他研究單位與民間協調機構參與？其角色與相關職責？

A: 具我了解 未接觸到 其他研究單位與民間協調機構參與

Q: (2014-2016) 桃園時升格後對環科園區的影響？

前任政府之環科園區計畫，延續至現任政府之參與局處與民間機構？

A: 桃園時升格後對環科園區 無特別的感覺 但在園區管理中心部分

在新市長上任後 是有明顯的活躍起來

另外 環保局 是有委託顧問公司 定期來訪查核

Q: 中台觀光工廠發展歷史與統計資料？

A: 中台在 2008 年環科成立以來 即設有環保參觀走道 2012 年取得環保署 環境教育設施場所資格

2015 年取得 桃園市政府產業文化館資格 ，目前每年約有 400-600 人次來訪

Shangwen Chan (Energy and Resource Information Integration Platform)

Participant:

Shangwen Chan, consultant and contact person of Energy and Resource Information Integration Platform, Industrial Development Bureau, Ministry of Economic Affairs

Date:
25/ 4/ 2016 e-mail correspondence

Q: What are the main difficulties and challenges in developing the energy/ resource information integration platform? How does the matching process work?

A: The platform provides mainly the energy/ resource related information, and the matching is the side function. The main issue is the small number of business members in applying for matching. Therefore, the matched cases are also limited. The conferences, promotional meetings, discussion panels and such events are organized every year to introduce this platform, in order to attract business users with the needs of energy/ resource integration.

The matching process starts from the free membership application to the online platform. After getting the confirmation, username, and passwords, the business users can fill in basic information and publish the energy or resource subject to integration (item, supply or demand, amount and so forth). If there is a match, the system will automatically send notification emails to both sides with contact information.

Q: Apart from the 13 cases on the website, what are other successful examples? Do you also track the development in the long run, including stopping the exchange or the linkage?

A: The listed cases are large-scale examples, only as a representation. By 2015, there are 250 items of potential linkage up for regional planning. There are 180 tangible linkages achieved, and 124 items still need promotion. Every year we track and monitor the linkages with the adoption of rolling plans to adjust and update changes.

Q: What is the participation statistics of the platform? and the business users in Taoyuan City?

A: Since the start in 2009 of the platform/ project, Chungli, Guanyin, and Dayuan industrial parks are our focal point. There are over 60 business users in these three industrial parks.

Q: Is there collaboration between this platform from the Industrial Development Bureau, Ministry of Economic Affairs and the EP park project from the Environmental protection Administration?

A: The information sharing is through the project websites and conferences. At the discussion panel, different departments (implementation role) would be invited to present and share the experience.

Q: Other industrial symbiosis research or subsidy from the central government?

A: Currently no.

Q: What's the role of Academia Sinica in this project? What are the responsible research institutes or coordinating organizations?

A: This project is from the Industrial Development Bureau, Ministry of Economic Affairs. Academia Sinica does not participate.

詹尚文顧問 中興工程顧問公司 經濟部工業局 能資源整合平台

25/ 4/ 2016 電子郵件通聯

Q:推動經濟部工業局能資源整合平台（以下簡稱平台）之困難與挑戰？與媒合流程？

A:該平台目前以提供廠商能資源整合相關資訊為主，媒合為輔，目前面臨最大之問題為申請能資源媒合之會員廠商較少，故相對於網站上直接促成能資源媒合案例較少，故每年皆會藉由辦理研討會、宣導會議、推動說明會..等會議於會中介紹本網站之媒合功能，藉以提升有能資源媒合需求廠商之會員加入。

另該網站媒合流程為廠商先申請加入該網站會員(完全免費)，待取得系統所核發之帳號及密碼後再登錄進去網站建立基本資料、能資源之需求(包括項目、需求方或供給方、可提供媒合或需求量...等)，後續倘有其他廠商有相同項目之能球或供給，則系統會自動發信給雙方進行通知，再由雙方進行直接聯繫。

Q:除網站上 13 個案例，平台之整合成功案例資料？是否追蹤鏈結後續發展，例如鏈結中斷等情況？

A:目前網站上所述案例為成效較大之案例，但僅為部分非代表全部，截至 104 年底止，歷年重點推動區域規劃潛勢鏈結共計 250 項，已促成累計達成 108 項能資源實質鏈結，其中計有 124 項屬持續推動中，針對所促成或未達成之鏈結項目，每年皆會持續追蹤鏈結情況並作滾動式鏈結情況(數據)修正。

Q:平台之企業參與統計，桃園市內工業參與狀況？

A: 產業園區能資源整合推動計畫(以下簡稱本計畫)自 98 年度開始執行以來，針對桃園地區已選定及推動中壢、觀音、大園等 3 座工業區做為推動對象，3 座工業區參與本計畫之廠商超過 60 家以上。

Q:經濟部工業局能資源整合平台，環保署環科園區推動計畫與不同部會計畫之間是否有交流？

A:不同部會計畫目前皆透過計畫網站所架設之資訊平台參考他人之作法與成果，另於辦理如研討會時亦會邀請其他部會(如環保署環保園區推動計畫)之執行單位(如工研院)於會中以簡報方式作經驗交流分享，以互相參考彼此間之作法及成效。

Q:其他來自中央部會的產業鏈結研究參與或補助？

A:目前無

Q:中研院在此計畫的角色是什麼？中央部會的專責研究機構與協調機構？

A:產業園區能資源整合推動計畫為經濟部工業局之科專計畫，中研院並無參與本計畫。

Yuansheng Renewable Energy and Technology

Participant:

Representative at: service@envirolink.com.tw, the reply email was cc'd to the chairperson Charlie Hsu and John Lee

Yuansheng Renewable Energy and Technology, Envirolink Corporation (previously in the Taoyuan environmental protection park)

Date:

3/ 5 / 2016 e-mail correspondence

Q: What were the main incentives of Taoyuan EP park for Yuansheng Technology? Did it own or rent the land? Has it enjoyed the benefits and subsidies?

A: The benefit was the exemption of environmental impact assessment. Yuansheng owned the land and got no subsidies.

Q: What was the main reason for Yuansheng Technology to shut down the plant? Was it related to internal issues, regulatory factors, economic factors or technological factors?

A: There are lots of regulations in the environmental protection industry (waste treatment industry). The examination period is very lengthy. There is no case-by-case consideration for specific industries. The investment is not profitable with the one-fits-all policy.

The policy focuses on one specific profession, and it is not helpful in the industrial development.

Q: What is the current status of Yuansheng Technology?

A: Yuansheng Technology has stopped the operations, and the facilities have been demolished and applied for the shutting down (canceling the plant for being regulated). Currently, the land and the remaining buildings are planned for sale.

Q: Was Yuansheng in the Taoyuan EP park association? What was the reaction from the association with Yuansheng's exit?

A: (Yuansheng) had the membership and took part in the decision making. The disturbance from the association and the park would be reduced because of the peculiar smell from the tire treatment.

Q: What is the influence on the EP park after Taoyuan was 'upgraded' to a special county in 2014?

A: We applied for shutting down right after the upgrade; therefore, it was with barely any influence.

Q: What are the continuing participants (departments, private organizations) from the previous government to the current government?

A: None.

源昇科技代表於 service@envirolink.com.tw 電子郵件回復

同時 cc 至董事長徐志宏與 John Lee

源昇科技 環盟國際企業

3/ 5/ 2016 電子郵件通聯

Q: 環科園區對於源昇科技的主要誘因？先前土地自有或承租？是否享有租地、量產、研究補助？

A: 環科園區具有免環評優勢；源昇為自有土地；無任何補助。

Q: 源昇科技退出環科園區的主要原因？是否受到公司內部、政策面、經濟面、科技面等阻礙及衝擊？

1. 環保事業規範甚多，審查期曠日廢時，對特殊尺葉(產業)並未專案考量，一視同仁造成不具投資效益

2. 不具通盤性政策，鑽研於某一學術專業，無法協助產業發展

Q: 源昇科技/ 環盟國際的現況？

A: 源昇科技目前已處停工，設備皆已拆除，並報請解除列管核可，目前預計針對土地及廠房做銷售處置

Q: 是否參與環科園區廠協會？廠協會對於源昇退出園區的反應？

1. 具廠協會理事及會員資格

2. 因產業製程特殊易造成異味(輪胎)，停工將減少園區困擾

Q: (2014-2016) 桃園時升格後對環科園區的影響？

A: 升格即報請停工，故較無感

Q: 環科園區推動與產業鏈結計畫中曾與哪些中央部會、地方局處、研究單位、民間協調單位接觸？前任政府之環科園區計畫，延續至現任政府之參與局處與民間機構？

A: 無

Shadow Chen (Taiwan Circular Economy Network)

Participant:

Shadow Chen, deputy CEO at Taiwan Circular Economy Network

Date:

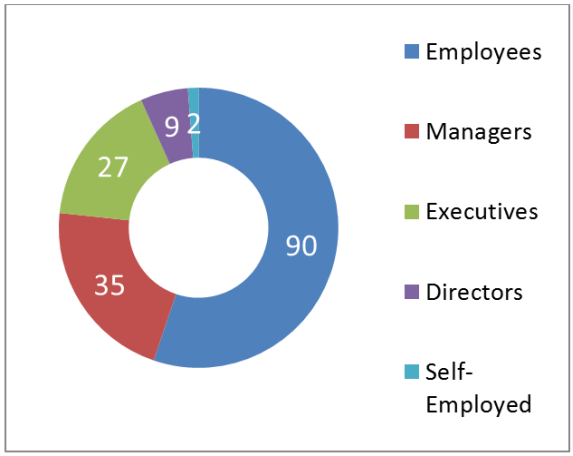
23/ 5/ 2016 Skype conference call

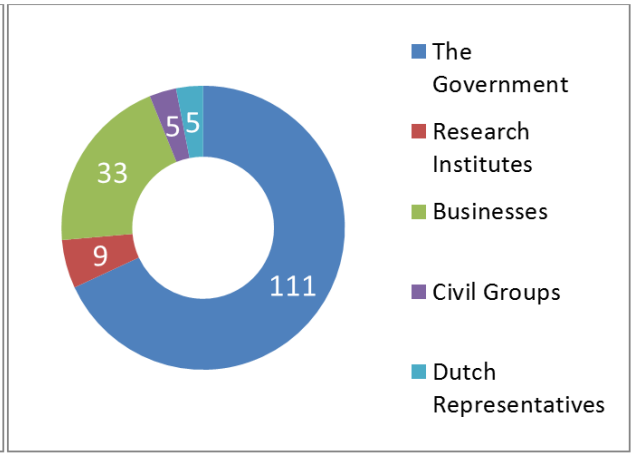
(translation of an interview in Mandarin Chinese)

In the forum: Circular Economy in Taoyuan, which took place in September 2015, how was the participation from the government, research institutes, businesses and civil groups?

Professionals from various fields were invited to the forum, including Dutch experts Mr. Douwe Jan Joustra, Ms. Eva Gladek, Ms. Sanderine van Odijk, Dr. Marc de Wit, and Dr. Olaf Blaauw, as well as Charles Wang, the chairperson of Taiwan Circular Economy Network (TCEN). Every one of them possesses extensive knowledge and experience in the environment, the fields of renewable energy, resourcification, recycling and so forth.

More than 150 participants were registered in the system, with the majority of governmental employees (~=60%) and business representatives (~=20%). About half of the participants were managers, executives or directors. The statistics are shown in the charts below.





What are the current operations/ projects in Taoyuan with TCEN?

In April 2016, Taoyuan and Kaohsiung City government attended Netherlands Circular Hotspot—3-day Trade Mission. The delegation from Taoyuan City government included the deputy mayor, the director of the department of economic development, the chief secretary of the department of environmental protection and the general manager of Taoyuan Aerotropolis Corporation. The mayor will also visit circular economy cases in end-June 2016, but apart from the above-mentioned cooperation, there are no other ongoing projects between Taoyuan City government and TCEN.

What is the definition of circular economy adopted by TCEN?

The vision of TCEN is to create an economic development model with the basis of resource circularity. The current mission statement is to promote the concept of circularity and to facilitate the implementation plan of the effective resource use. However, there is currently neither a universal definition nor a universal vision for all the participating organizations. In the implementation, what's more feasible for the city government is to continue the policies of the central government. There is not a clear framework, but in principle, the fundamentals of Industrial Ecology are adopted. The integration of the scientific analytical methods, such as MFA and input/output analysis, is a good way to plan the optimal circular use of energy, water, and materials.

At this stage, the scope of circular economy planning is still the entire Taiwan. We anticipate that Taiwan becomes a model of the circular economy, and we are optimistic about the potential regional integration into ASEAN countries, mainland China, and other international systems.

What are the main difficulties and challenges in the operation of TCEN and the implementation of circular economy?

TCEN takes the role as an advocator and shares information with relevant stakeholders, and it is currently the only CE-related civil group in Taiwan. From the society, lots of interests have been shown, and there has always been a larger demand when we promote the CE concept. Since TCEN is, there is a larger demand. There are many requests from the government, research institutes, businesses and civil groups. We work with projects from Council of Agriculture, Environmental Protection Administration, Taipei city government. We also discuss CE research projects with Ministry of Science and Technology. From the business side, the association of semiconductor industry and Taiwan Chemical Industry Association have also brought the CE concept into the industries, hoping for new opportunities.

As for the implementation of circular economy in Taiwan, the difficulties and challenges include the current economic model, the interconnection of governmental operations, the long-existing mindset of seeking immediate solutions, the lack of long-term planning and other fundamental issues. After the forum in September 2015, the awareness has been in the departments of the city government. However, the clear action plans have not (cannot/ will not) been formed without the order from top management.

It required both the top-down implementation and the bottom-up participation to transition to a circular economy. The current economic model cannot fully include the environmental externalities. A better approach is to use "the stick" and "carrots" wisely and create mechanisms which are circular economy friendly. For instance, the low electricity price causes the inefficient use of the bio-waste, such as direct burning or illegal disposal. The potential of biogas generation cannot fully be discovered. Another example is the manifestation of the "exclusion" of waste in the regulations. The output items which are not listed on the operating certificate would normally be considered waste. Then, it would be sold to the certified waste treatment companies for further processing, resulting in the waste treatment of the resources with reuse potential. The reuse and "re-inclusion" of those output items is only possible after the lengthy application process. For these challenges, TCEN expects to collect feedbacks from the businesses and reports to the government regarding appropriate policy intervention.

Appendix 2: Wastewater Standards

Standard of Wastewater Inflow to the Wastewater Treatment Plant in Taoyuan Technology Industrial Park

Item	Limit	Item	Limit
Temperature (°C)	35	Copper (mg/L)	3
pH	5-10	Zinc (mg/L)	5
Sulfide (mg/L)	1	Soluble Iron (mg/L)	10
COD (mg/L)	350	Soluble Manganese (mg/L)	10
BOD (mg/L)	200	Nickel (mg/L)	1
Suspended Solids (mg/L)	200	Silver (mg/L)	0.5
Grease (mg/L)	10	Anionic Surfactant (mg/L)	1
Phenols (mg/L)	1	Boron (mg/L)	1
Cyanide (mg/L)	1	Selenium (mg/L)	0.5
Total Murcury(mg/L)	0.005	Fluoride (mg/L)	15
Cadmium (mg/L)	0.03	Total Organic Phosphorus Compounds (mg/L)	0.5
Lead (mg/L)	1	Total Carbamate (mg/L)	0.5
Total Chromium (mg/L)	2	Herbicide (mg/L)	1
Hexavalent Chromium (mg/L)	0.5	Endosulfan (mg/L)	0.03
Arsenic (mg/L)	0.5	Not Detected Items*	-

* Exception of indium, gallium, molybdenum concentration for optoelectronic and photovoltaic industries, following another standard of optoelectronic and photovoltaic component manufacturing

Standard of Wastewater Discharge (Effluent) from the Wastewater Treatment Plant and Recent Results in Taoyuan Technology Industrial Park

Item	2012	2013	2014	Standard
pH	7.5	7.5	7.8	6-9
Temperature (°C)	19.8	24.3	28.8	< 38 (May-Sep) < 35(Oct-Apr)
Anionic Surfactant (mg/L)	0.03	0.11	< 0.1	10
BOD (mg/L)	2.0	< 1.0	< 1.0	30
Cadmium (mg/L)	ND < 0.001	ND < 0.001	ND < 0.001	0.03
COD (mg/L)	9.3	22	10.6	100
Coliform (CFU/100mL)	< 10	4500	360	200000
Copper (mg/L)	0.021	< 0.02	< 0.02	3
Fluoride (mg/L)	2.49	3.85	10.2	15.0
Nickel (mg/L)	0.008	< 0.02	< 0.02	1
Grease (mg/L)	< 1.0	< 1.0	< 1.0	10.0
Lead (mg/L)	ND < 0.004	ND < 0.006	ND < 0.006	1
Suspended Solids (mg/L)	1.6	29.6	3.2	30
Zinc (mg/L)	0.017	0.048	< 0.02	5

Appendix 3: Report with the Preliminary Findings for Expert Validation

(in Mandarin Chinese)

循環經濟在桃園/ 循環經濟在台灣

※此簡報包含初步研究摘要與初步結論，研究全文將在 2016 九月後以英文公開發表於 TU Delft 碩士論文資料庫

文獻探討

學術新領域，許多研究試著解釋產業共生，但並沒有通則。任何觀點都能找到相對應的單一量化資料佐證，產業共生與循環經濟都是特別的社會經濟現象，在不同發展歷史、背景、國情、系統之下，產業共生需要不同的因素組合而成，此研究議題正進入比較研究，公共政策與決策者仍扮演相當具有影響力的角色。至於對「產業共生」、「循環經濟」等新穎名詞的使用，寬鬆定義，甚至濫用也在此領域之學術研究中常見。

研究問題

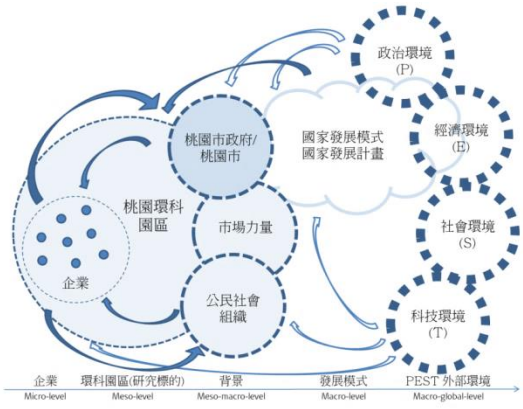
桃園環科園區的未來經營策略，視為生態工業園區或是一般工業區？

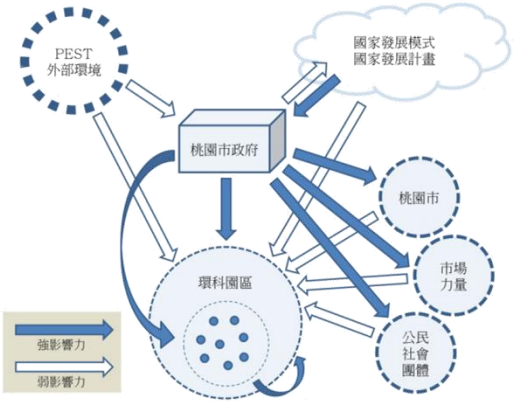
此經營策略將如何促進桃園的循環經濟？從市府角度思考，這樣的整合/ 共生能達到多高的可行層級？

資源整合層級		專有名詞
micro	公司內部 同業之間 供應鏈上廠商	最佳化企業資源配置 水平整合 垂直整合
meso	工業區或聚落內	產業共生
macro	城市內 國家級 區域間	循環經濟
global	全球	新自由主義市場經濟

方法架構

1/ 複合層級分析





2/ SWOTCH 綜合背景分析

本研究提出的 SWOTCH 綜合分析，採用著名的 SWOT 分析加上了 Convenience/ Hindrance 正反兩項背景因素。在 SWOT 中，個案能直接影響系統層級較低的 SW 內部因素（環科園區），同時受到系統層級較高的外部因素 OT 影響（外部環境、國家發展模式）。而 CH 背景因素雖然層級較高，但桃園市政府的政策能在個案背景上（桃園市、市場力量、公民社會團體）發揮強影響力。

3/ 多方資料蒐集：官方報告、網站與資料庫、現存文獻、訪談與電子郵件通聯、媒體報導

系統分析

這些內部、外部、背景因素以對於循環經濟發展有利或不利做分類，目標是將可能的阻礙轉化成循環經濟發展的推動力，若部分不利因素已造成威脅、或難以控制，將納入長程規劃避免直接衝突。

	優勢	劣勢
內部因素 (環科園區)	**Strength** - 已達之環境、社會、經濟成果 - 集中化先前分散之回收商	**Weakness** - 有條件式的環評豁免、繁複的環境影響差異報告、模糊現況（環評長期審查中） - 企業對於補助的依賴 - 偏遠地理位置、腹地缺乏
外部因素 (PEST 環境、國家發展計畫)	**Opportunity** - 未定而彈性的台灣主權狀態 - 三重經濟結構（上層國營企業、中層家族企業集團、下層中小企業） - 近二十年之政權和平轉移 - 獨立運作之民主自由國家現況 - 透明法制、法治國家現況 - 逐漸形成的台灣認同 - 逐漸形成之環境與永續經營意識與國家長期經營計畫 - 先進的科技 - 現有之多管齊下組織結構與計劃，促進最大化資源效率與最小化有害廢棄物產生	**Threat** - 未定而彈性的台灣主權狀態 - 三重經濟結構（上層國營企業、中層家族企業集團、下層中小企業） - 一黨專政的後續影響 - 對於外資的依賴 - 外資、其他強大力量的影響或干預
背景因素 (桃園市、市場力量、公民社會團體)	**Convenience** - 有彈性的中小企業 - 活力繁榮的多樣化工業 - 豐富的勞動生產力 - 與循環經濟專家的聯繫與定期活動規劃	**Hindrance** - 不穩定的中小企業 - 廢棄物處理市場中強大的五力（供應商、消費者、競爭者、新進者、替代品） - 現存的污染防治與對於廢棄物的「去化」態度，現存法令中的潛規範

初步結論

桃園環科園區範圍雖小，但能見微知著。以下七點初步結論提供給桃園市政府做為政策、經營策略建議。研究生聯絡方式[1]在本頁末附上，任何疑問、改正、意見都歡迎聯絡交流，也敬請指教！

- *維持園區現況，維持已達之環境、社會、經濟成果*
  面對廢棄物處理市場中強大五力，持續扶持園區中環境教育館/ 觀光工廠、也發展廢棄物處理教育中心，教育「酒矸倘賣無」業者與民眾正確回收觀念；至於綠美化設計、其餘生態工程之繁複規定能稍作簡化，以最大可延續綠地/ 生態棲地作為規劃原則。

- *積極參與現存計畫與部會/ 機構，加入多管齊下工業生態系統運作*
  評估並參與現存之工研院計畫、經濟部工業局之能資源整合平台等，促進資源效率的計畫與機構，積極向其他機構回報平台不足之處。目標是以市府角度、盡可能擴大視野與規劃範圍，而在視野中做微觀、資源效率最高的規劃。

- *向上回報繁複/ 扭曲之環評細節，建議引進 ISO 國際標準*
  由於先前有條件式（不超過規範之汙染總量、經本府環保局與工商發展局同意[2]）的環評豁免，目前園區新進廠商之環評以環境影響差異分析進行。針對此模糊現況與環評長期審查狀態，建議引進 ISO 國際標準，將環評細節與流程簡明化。

- *轉變政策與法令中的實質態度：萬物皆資源*
  評估現存法令中的潛規範，將「萬物皆資源」取代「去化廢棄物」的態度並落實新政策中。

- *建立跨部門、跨組織合作*
  持續多管齊下推動循環經濟，與相關部會釐清責任歸屬，減少重複職責與繁文縟節。

- *協助中小企業轉型、調整產能*
  引導陷入困境的中小企業，根據新經營策略、桃園市發展計畫、國家發展計畫調整產能。

- *鼓勵不同產業間的小個案合作，移除非財務障礙*
  可參考荷蘭中央政府由經濟部、環境與基礎設施部、內政部共同推行的 Green Deal[3]，有別以往的經濟援助，此計畫向企業與利益團體徵求提升環境品質的創新提案，由企業提出需要政府協助的項目、明確的環境貢獻與明確的行動計劃，中央政府負責漸進式調整法規、市場機制與提供其他引發創新的誘因，Green Deal 通常是包含中央/ 地方政府、聯合企業、民間團體、公民組織的多方協議。

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[1] 高以德 理學碩士 工業生態學 歐盟碩士學程
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[2] 桃園市環保科技園區土地出售手冊完整版
http://estp.epa.gov.tw/Document/DownloadDoc42.pdf

[3] Green Deal http://www.greendeals.nl/english/