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# 城市導向永續發展中的知識鴻溝：高雄市先導型研究

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## 摘　要

在聯合國永續發展目標宣布後的階段，我們看到越來越多研究者和實務工作者協力來拓展他們過去忽略的永續指標測量方式，並將更多重點放在如何在地化這些永續發展目標，並朝實務及政策應用方向規劃。但因為此國際目標才剛於 2015 年訂定，還有更多的議題需要被提出、專有名詞需要被定義、理論或實證及應用上需要投入更多研究，這樣巨大的知識鴻溝，特別是如何在地化永續發展目標引起此研究的注意及投入。此論文透過設計一個城市導向的永續發展評估先導型研究方法，先以高雄為城市個案範例，企圖了解以下兩個面向: 第一、被選定的城市在既有的永續指標是如何被監督? 第二、在該城市，研究社群是如何投過知識的提供來支援 17 個聯合國永續發展目標的城市導向規劃? 其中存在那些研究與政策間的知識鴻溝?

以方法論上來說，此研究先設計一個台灣六都永續發展委員會及永續指標設置的政策背景比較框架，爾後再提議產出一個以永續發展目標為分類的電腦化文獻導圖，但還不是一個系統性的詳細文獻內容探討，以便在此先導型研究中先初略呈現文獻分佈樣貌。透過這兩組資料的交叉比對，關於高雄永續發展的政策與科學間知識鴻溝可以被點出，特別是此研究發現既有文獻中，與 SDG12 負責任消費與生產、SDG10 減少不平等及 SDG17 夥伴關係的高雄相關論文相當有限。此外，本研究也指出多個在高雄市府永續工作小組實務及既有文獻創造集體知識的連結缺口，並建議未來可往補齊這些科學與政策連結缺口做跨界與跨領域合作推廣。

**關鍵字:永續發展目標、知識鴻溝、在地化永續發展目標、科學與政策連結、台灣**

# Knowledge Gap in City-Based Sustainable Development： A Pilot Study of Kaohsiung, Taiwan

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## Abstract

In the post-Sustainable Development Goal (post-SDG) era, we see how scholars started to join with practitioners to expand their attention to indicators that were not emphasized previously and to give priority to how to localize SDGs towards more practical and policy relevant approach. However, given the newness of this sustainable development trend since 2015, there are more to be explored, issues unsettled, terms undefined and blackbox unraveled theoretically, empirically and practically. This immense knowledge gap in localizing sustainable development led to the endeavor of this research. By conducting a city-based sustainable development evaluation pilot study in Kaohsiung city, Taiwan as a demonstrative case, the study sought to understand 1) how the chosen city was evaluated in the existing sustainability indicator monitoring; and 2) how scientific community supported the knowledge provisioning in terms of the 17 SDG dimensions and what is the science-policy knowledge gap in between.

Methodologically speaking, this research first launched a comparative effort to analyze the policy setting of sustainable development committee and sustainable development indicators designed by all six metropolises in Taiwan. Next the study proposed to conduct a SDGs-oriented computerized literature mapping, rather than a qualitative reading of systematic literature review, to produce a cursory literature landscape. Cross-checking these two sets of data, the knowledge gap between policy and science can be initially identified for Kaohsiung city where extent research on SDG 12 for responsible consumption and production, SDG 10 for reduced inequalities and SDG 17 for partnership was relatively scarce. Beyond that, this study also pointed out several

missing linkages between the focus of Kaohsiung City government sustainable working groups in practice and the collective knowledge produced by the existing literature before recommending future transdisciplinary and interdisciplinary cooperation to bridge these science-policy linkage gaps.

**Keywords: sustainable development goals, knowledge gap, localizing SDGs, science-policy linkage, Taiwan**

## 1. Introduction

Is reaching sustainability a global challenge or a city level game of the year for the 21st century? If the latter is the basic aggregate unit for sustaining *Our Common Future* (World Commission on Environment and Development, 1987) in the Anthropocene, are cities ready for THE challenge and what are the associated opportunities and barriers? How scientific community is supportive of the urban planning and sustainability-centric policymaking in all 17 dimensions guided by the United Nations Sustainable Development Goals (SDGs)? These are puzzles that this research aims to tackle with or at least begins to reflect upon at this pilot study stage – by conducting a preliminary review to evaluate feasibility of future steps needed to be taken for cities.

Prior to the worldwide introduction of SDGs in 2015, cities were already under multidimensional indicator scrutiny since the Rio Earth conference in 1992 adopting Agenda 21 and confirming role of local government as indispensable agent for pushing sustainability. In chapter 28 of Agenda 21, Local Agenda 21 (LA 21) was particularly conceptualized to provide documented legitimacy calling for municipalities to consult with local community for the purpose of co-devising sustainable strategies (Evans & Theobald, 2003; Lafferty, Eckerberg, & Eckerberg, 2013; Selman, 1998). Thereafter, several urban monitoring indicators were released, including UN Habitats Urban indicator programme since 1996 used by more than 200 cities, European Common Indicators (2000-2004) tested by 42 cities, ISO 37 120 indicators since 2014 with at least 30 cities reporting some of the data (Zinkernagel, Evans, & Neij, 2018). However, these seemingly comprehensive urban indicator, according to some researchers (Keirstead & Leach, 2008; L.-Y. Shen, Jorge Ochoa, Shah, & Zhang, 2011), is far from objective or in many circumstances is more political whereas impact of indicators on policy is limited and indirect. In the work of Lehtonen, Sébastien and Bauler (2016), the authors showed how Indicators of Sustainable Development (SDIs) were often preoccupied with the technical quality and we knew less about why certain indicators were chosen and for what purpose.

In the post-SDG era, we see how scholars started to join with practitioners to expand their attention to indicators that were not emphasized previously (Barnett & Parnell, 2016; Graute, 2016; Kharrazi et al., 2016) and to give priority to how to localize SDGs towards more practical and policy relevant approach. SDGs working book for local policymakers also became available such as *The Sustainable Development Goals: What Local Governments Need to Know* published by a Spain based city coalition– United Cities and Local Governments (UCLG) (2015) and *Getting Started with the SDGs in Cities* provided by Sustainable Development Solutions Network (SDSN) (2016) – an operation under the

UN Secretary-General to promote practical and integrated solutions. Both of these materials focused on translating global goals into local actions and the above-mentioned emerging researches pointed out the fact that this field is still in its early stages of development (Bibri & Krogstie, 2017). In other words, there are more to be explored, issues unsettled, terms undefined and blackbox unraveled theoretically, empirically and practically.

This immense knowledge gap in localizing sustainable development led to the endeavor of this paper. By conducting a city-based sustainable development evaluation pilot study, the study sought to understand 1) how the chosen city was evaluated in the existing indicator monitoring; 2) how scientific community supported the knowledge provisioning in terms of the 17 SDG dimensions and what is the knowledge gap in between. For the purpose of demonstration, Kaohsiung metropolis locating in southern Taiwan was selected to be the exemplary case of this city-based pilot study mainly due to its current leading role in promoting city level sustainable development in Taiwan via the installation of an international organization promoting urban sustainability training - Local Governments for Sustainability Kaohsiung Capacity Center (ICLEI KCC[1]) affiliated with Kaohsiung City government since 2012. The next section begins with Kaohsiung city background introduction, followed by a review of prior SDIs conducted for Kaohsiung and a computerized scientific knowledge mapping for supporting Kaohsiung to implement SDGs. In the findings and concluding part, the author discussed opportunities and barriers of cities to implement SDGs and suggested future research direction to fill in the research gap critical to provide cities the background knowledge and alternative perspective to move on to a more sustainable future. Again, this research is designed as a pilot study. It does not provide full scale of systematic review but more serves as a starting point to think about where cities were and could be in the future.

## 2. Kaohsiung – the Chosen City Background

The City of Kaohsiung with 277 million population (Table 1) can be best characterized by three major economic components of this metropolis constitutive of both urban and rural territory- 1) Kaohsiung Port; 2) oil refining and petrochemical industry; 3) agricultural and fishing industry.

[1] Visit ICLEI KCC website for more information http://kcc.iclei.org/tw/home.html (accessed on May 11, 2020). On September 5, 2019, ICLEI KCC celebrated its seventh anniversary by inviting all Taiwan ICLEI city members to Kaohsiung City government to review their performance. See September 6, 2019 news on the *Storm Media* https://www.storm.mg/localarticle/1681012 (accessed on May 11, 2020)

Table 1. Kaohsiung City Basic Information

| | |
|---|---|
| Population | Approx. 2,770,000 |
| Area | Approx. 2947.6159 km 2 |
| Population density | 941 people/km2 |
| Climate | Tropical Monsoon climate |
| The average month temperature | 25.1°C |
| The average annual rainfall | 2549.4mm |
| Co-ordinates | 120°10'29"～121°02'55 East longitude and 22°28'32"～23°28'17" N latitude. |

Source: Information Bureau, Kaohsiung City Government
https://www.kcg.gov.tw/EN/cp.aspx?n=E5AA72D4F35F91D0 (accessed on May 12, 2019)

## 2.1 Kaohsiung Port

City of Kaohsiung in the 17th century was a fishery village. Its historical port expansion begun with consecutive colonial governance first by the Dutch (1626-61) (Andrade, 2006), later Japanese (1895-1945) and Han (Dawley, 2010) in between and thereafter. When the Dutch East India Company (Verenigde Oost-Indische Compagnie, VOC) reached the island of *Formosa* in 1624 (van Veen, 1996), they came to the southern Taiwan to occupy the coastal plains and invested in developing several harbors. What is named Kaohsiung port area today began to have more active fishing vessel activities since the Dutch era (Lin-Liao, 2013, p22). In 1858, Kaohsiung was decided to develop into an international commercial port and Kaohsiung Customs Authority was established in 1863 under the Tianjin Treaty, ending Second Opium War[2].

The modern avatar of Kaohsiung Port today is the 14th largest world container port, preceded by Rotterdam and followed by Antwerp according to global trade monitoring data provided by World Shipping Council[3] and Taiwan's largest international commercial harbor[4] witnessing Taiwan's industrial transition from service-intensive industry to knowledge-based economy (Chen & Lee, 2004; Masuyama & Vandenbrink, 2003). The port was certified as EcoPort in 2014, complying to ISO 14001 environmental

[2] History of Kaohsiung Port, Port of Kaohsiung, Taiwan International Ports Corporation, Ltd. https://kh.twport.com.tw/en/cp.aspx?n=91D96D48707133B3 (accessed on May 12, 2019)

[3] Top 50 World Container Ports data provided by World Shipping Council http://www.worldshipping.org/about-the-industry/global-trade/top-50-world-container-ports (accessed on May 10, 2020)

[4] Port of Kaohsiung 2040 Master Plan Executive https://kh.twport.com.tw/en/cp.aspx?n=F115CF1524D6C059 (accessed on May 12, 2019)

quality management system and other port related regulations while actively participating Green Port Award System (GPAS) pilot project hosted by APEC Port Service Network[5].

## 2.2 Oil-Refining and Petrochemical Industry in Kaohsiung

The name of Taiwan was globally recognized with association of post-war transition growth of East Asian economic miracle(Gold, 1986; Ranis, 1995) or the four East Asian Tiger states (Birdsall et al., 1993), namely Taiwan, South Korea, Singapore and Hong Kong. To realize this "miraculous" social-economic transition, role of Kaohsiung City is indispensable with four out of seven major oil refining factories islandwide and two out of four petrochemical industrial complexes (Figure 1) were established in Kaohsiung metropolis since 1970s. This important infrastructure had driven the rapid economic growth of Taiwan for decades leaving immeasurable environmental pollution and cost of human life to this harbor city. In other words, this city landscape entailed an archetypical environment development trade-off (Wesseh & Lin, 2016; Zhao et al., 2016). Whereas petroleum and coal product manufacturing demonstrated a fast production increase from a record low of 8,943,607,000 NTD in 1990 to a record high of 147,040,827,000 NTD in July 2008[6], Kaohsiung resident's health (Lin et al., 2001; Pan et al., 1994; Yang, Tseng, & Chang, 2003) was greatly impacted by the manufacturing pollution from the non-stop toxic chemicals released to air and water.

[5] Green port policy updated March 20, 2018 https://www.twport.com.tw/en/cp.aspx?n=922F1EE5FE261804 (accessed on May 12, 2019)

[6] Taiwan IP: Mfg: Petroleum & Coal Production Manufacturing https://www.ceicdata.com/en/taiwan/production-by-industry/ip-mfg-petroleum--coal-product-manufacturing (accessed on May 12, 2019)

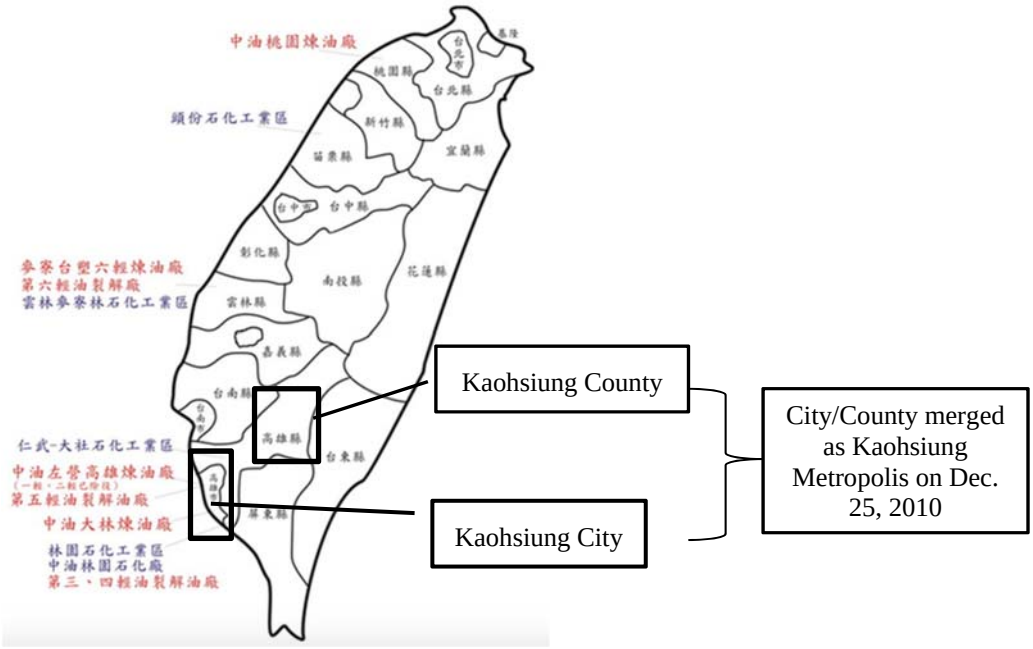



Figure 1. Oil Refining & Petrochemical Industry Distribution in Taiwan
*Red – oil refining factories; blue - petrochemical industrial park
Source: National Science and Technology Museum research
https://iht.nstm.gov.tw/form/index-1.asp?m=2&m1=3&m2=76&gp=21&id=7 (accessed on May 12, 2019)

## 2.3 Kaohsiung Agricultural and Fishing Industry

The most notable agricultural produce of Kaohsiung city since Japanese colonial period was banana. Taiwan's banana used to monopolize the Japanese market until liberalization of import was introduced in 1963 (Koseki, 2006, p.216) and Kaohsiung was the largest banana-growing sites in Taiwan with 60,000 acres of banana farm, followed by Taichung with 50,000 acres of slope lands. Historical data showed that banana crop yielded US$8 million of revenue in 1963. From 1965 to 1966 that number increased to US$107 million which is around ten percent of total exports and 90% of banana exported to Japan market[7]. Today, Kaohsiung's agricultural capability is still number one among the six metropolises in Taiwan[8].

What is more is that the agricultural production growth was coupled by recent years' local governmental effort to attract young farmers returning to hometown for joining the farming related activities, enable new Kaohsiung Farmers League[9] and trigger other

[7] Big Business in Bananas published on June 1, 1967.
https://taiwantoday.tw/news.php?unit=8,8,29,32,32,45&post=13830
[8] Liberty Times Net news on Oct. 17, 2018 https://news.ltn.com.tw/news/life/breakingnews/2582958
[9] Kaohsiung Farmers League https://www.kaofarmers.tw/farmer

youth farmer led creations such as agrotourism[10]. Similar story can be depicted in fishing industry in Kaohsiung. Among all Taiwan's distant water fishing fleets, 80% of the 524,000 mt of fish landed at oversea ports in 2007 was from Kaohsiung deep sea port. In terms of seafood trade, squid is the largest caught, representing 20% of total output and frozen and cold storage tuna is the second with 14% share[11]. Administratively speaking, there are 16 fishing ports regulated under Marine Bureau, Kaohsiung City government (Figure 2), making this coastal city home of thousands of fishermen's descendant.

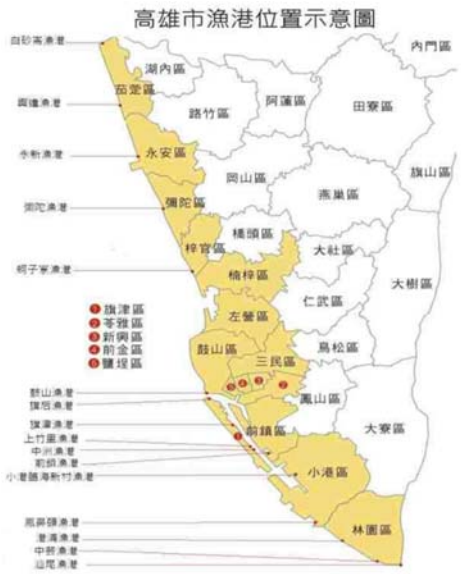



Figure 2. Fishing Harbors in Kaohsiung
Source: Marine Bureau, Kaohsiung City Government

## 3. SDIs Review on Kaohsiung

Indicator of Sustainable Development in Kaohsiung was closely related to the establishment of sustainable development related committee at the municipality level. In those committee meetings, that is where Kaohsiung city-based SDIs were proposed, debated, drafted. Historically speaking, 2003 marked the founding year of Taiwan's national sustainable development action by establishing National Sustainable Development Committee[12]. Furthermore, in response to Local Agenda 21, one of the major tasks of the national committee was to assist local government to devise sustainable

[10] Agriculture Bureau, Kaohsiung City Government received funding from central government to organize One Day Happy Farm programs for years. This program is featured with theme farm and agrotourism. https://www.odfkcg.com/index.php/zh-tw/ (accessed on May 13, 2019)

[11] World Fishing and Aquaculture https://www.worldfishing.net/news101/regional-focus/taiwan

[12] Introduction of National Sustainable Development Network in Taiwan https://nsdn.epa.gov.tw/ (accessed on May 10, 2020)

development action plan at local level. Going beyond the local level committee establishment accordingly, Kaohsiung City, Kaohsiung County and Pintung (the KKP area) pursued a trans-regional approach by jointly creating a consultancy oriented KKP Sustainable Development Committee in 2005 (Figure 3) as platform for regional information exchange, rather than specific action co-implementation. The common vision of the three cities were "Kind Life", "King Place" and "Prosperity"[13].

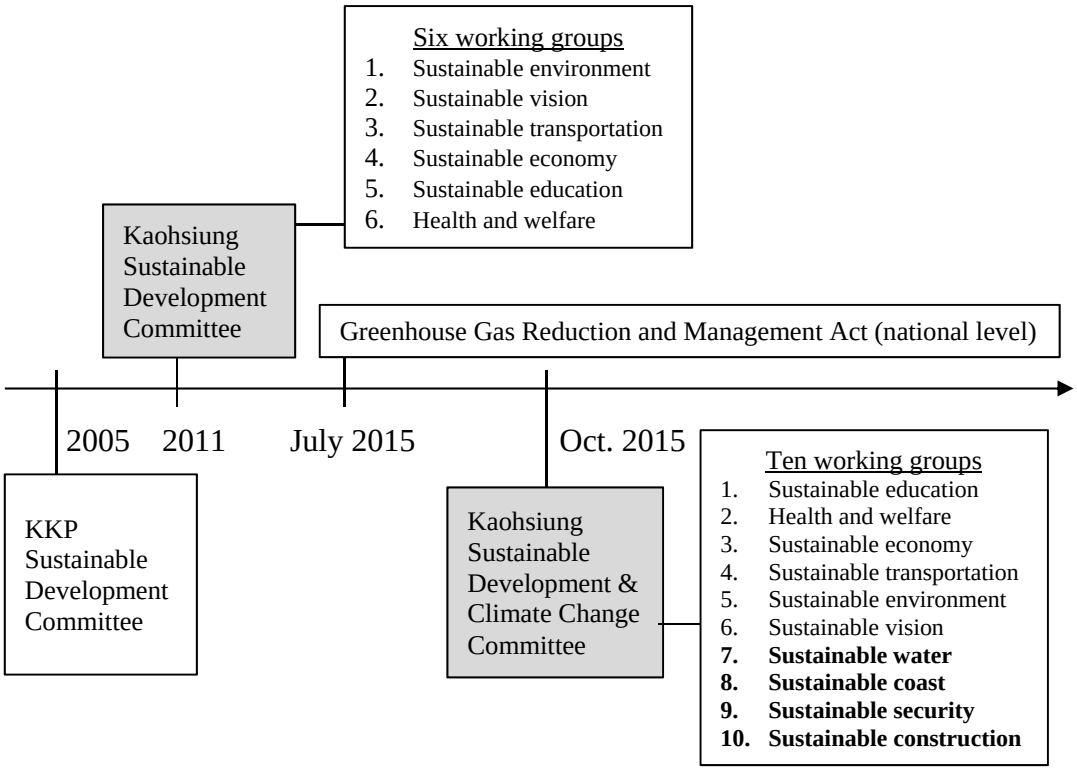



Figure 3. History of Kaohsiung Sustainable Committee Development
Source: compiled by author in reference to related government documents

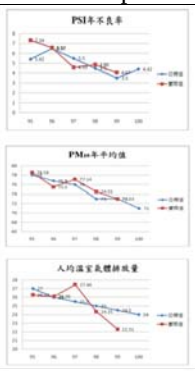
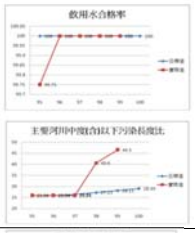
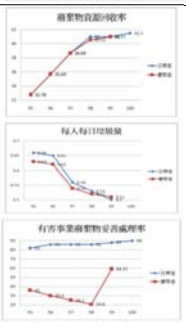
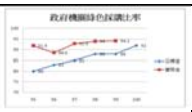
In 2011, after the administrative merge of Kaohsiung City and Kaohsiung County[14], "Kaohsiung Sustainable Development Committee" was established to better coordinate the overall urban planning for crafting a sustainable eco-city. Under this committee, six working groups were set up: 1) sustainable development; 2) sustainable vision; 3) sustainable transportation; 4) sustainable economy; 5) sustainable education; 6) health and welfare. In July 2013, a comprehensive analysis on Kaohsiung's sustainable

[13] *Kaohsiung City, Kaohsiung County, Pintung City Strategic Planning for Local Sustainable Development Report* commissioned by KKP local governments. July 2004. National Sun Yat-sen University. http://ir.lib.nsysu.edu.tw:8080/bitstream/987654321/39679/1/RRPG930900.pdf (accessed May 12, 2019)

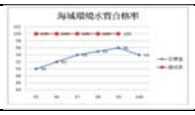
[14] By order of Executive Yuan, Republic of China, Kaohsiung city government merged with Kaohsiung county on December 25, 2010. See more in the legal documents released by Kaohsiung City government Bureau of Legal Affairs https://law.kcg.gov.tw/merge1.aspx (accessed on May 11, 2020)

environment indicator and performance was released by Environmental Protection Bureau, Kaohsiung City Government[15]. The report showed the overall environmental improvement in air, water, waste management, green procurement and marine environment, except that toxic waste water recycled rate fell far from the anticipated target. In particular, the performance on length of medium polluted river, percentage of green procurement and ocean water qualified rate (see the underlined item in Table 2) had not only reached the target but exceeded the target expectation.

Table 2. 2006-2011 Kaohsiung Sustainable Environment Indicator and Performance

| Topic | indicator | 2006-2011 performance |
|---|---|---|
| air | -PSI, polluted days per year<br>-$PM_{10,}$ the lower the better air quality<br>-GHG emission per resident |  |
| water | -drinking water qualified rate<br>-<u>length of medium polluted river</u>, the longer the more sustainable |  |
| waste | -waste recycling rate<br>-average trash per day per person<br>-toxic waste recycled rate |  |
| green procurement | -<u>Percentage of green procurement</u> in public agency |  |

[15] 高雄市永續環境指標之達成統計與優劣勢分析
Kaohsiung City Sustainable Environment Indicator Performance Evaluation and SWOT Analysis, Environmental Protection Bureau, Kaohsiung City Government.
https://orgws.kcg.gov.tw/Download.ashx?u=LzAwMS9LY2dPcmdVcGxvYWRGaWxlcy8yNTcvY2tmaWxlLzJiYjM4MTAzLWVjYjAtNDFiOC04NGM3LTUyMjA4MDkzOWNhNC5wZGY%3D&n=57ac6KiILemrmOmbhOW4guawuOe6jOeSsOWig%2BaMh%2BaomeS5i%2BmBlOaIkOe1seioiOiIh%2BWEquWKo%2BWLouWIhuaekC5wZGY%3D&Icon=.pdf (accessed May 10, 2020)

| | | |
|---|---|---|
| marine environment | -Ocean water qualified rate |  |

Source: 2013 Report by Environmental Protection Bureau, Kaohsiung City Government
*In performance, blue line = target; red line = actual performance

In July 2015, Republic of China, Taiwan (Taiwan, R.O.C.) central government promulgated "Greenhouse Gas Reduction and Management Act", preparing for an islandwide greenhouse emission reduction endeavor. The national long-term goal was set to reduce greenhouse emission to 50% of 2005 emission level by 2050 with medium term of Intended Nationally Determined Contribution (INDC) as 20% reduction of 2005 baseline (266.038 Mt) business as usual (BAU) by 2030 (see Figure 4) and specify the duty of central government to promote green financial scheme and devise incentive mechanism. Three month later, Kaohsiung City Government re-organized the 2011 "Kaohsiung Sustainable Development Committee" and re-named it as "Kaohsiung Sustainable and Climate Change Committee" to strengthen the mitigation and adaptation future monitoring and implementation effort. The new committee also expanded the original six working groups to ten working groups, adding four new sections – 7) sustainable water; 8) sustainable coast; 9) sustainable security and 10) sustainable construction.


Figure 4. Taiwan (R.O.C.) National GHG Emission Target

Source: 2017 Public Hearing for GHG Emission Monitoring Target, Environmental Protection Administration, Executive Yuan, Republic of China.

With the expanding working groups, it means that the city-wide sustainability monitoring indicators have expanded as well. For instance, the monitoring effort did not focus on only the conventional environmental dimension, Urban Development Bureau of Kaohsiung City Government which is the chair for Sustainable Vision Working Group established ten sustainable monitoring indicators up to December 2017 to reach three visions: regional balance, industrial advance and innovative governance. Among them, three indicators (see Figure 3 Item 1, 5, 10 in bold) are target oriented whereas the other 7 are observation index.

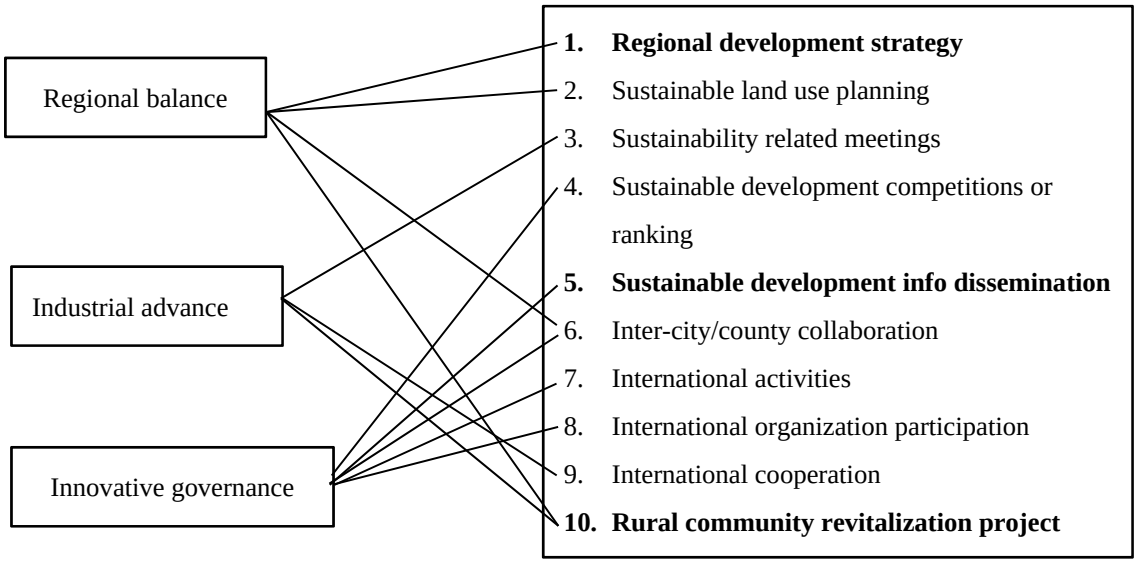



Figure 5. Sustainable Indicator

Source: 2018 Report by Kaohsiung Urban Development Bureau, Kaohsiung City Government to Kaohsiung Sustainable Development and Climate Change Committee

*indicators in **bold** style are "target" based indicator, indicator 1,5,10; otherwise "observation" based indicator.

Under this setting, the indicator monitoring agencies were also diversified: regional development strategy indicator was monitored by Urban Development Bureau; sustainable development information dissemination was monitored by Environmental Protection Bureau; rural community revitalization project was under the overseeing of Agricultural Bureau. Similar to Sustainable Vision Working Group, the other nine working groups under "Kaohsiung Sustainable Development and Climate Change Committee" had created different sustainability indicators. However so far it was not yet aggregated into a Kaohsiung city-wide indicator for all ten working group perspective on a single mapping with visual aid for non-governmental organizations, researchers or

citizen to easily monitoring sustainable progress of their city. Even if sustainable development indicators were aggregated internally among the Kaohsiung City Government, this information was not yet widely disseminated to the public as open and easily accessible data representation yet.

On the other hand, these sustainability indicators were Kaohsiung City Government context specific and have not yet coordinate with other cities in Taiwan to facilitate future cross-city sustainable indicator annual comparison. For instance, in Taipei city which is the Capital of Taiwan (R.O.C.), Taipei Sustainable Development Committee created only seven working groups, namely 1) sustainable vision; 2) water/land resource; 3) energy/ecology; 4) sustainable transportation; 5) sustainable community; 6) sustainable education; 7) livable environment, with 25 city-wide monitoring indicators (Table 3) announced on the website of Environmental Protection Bureau of Taipei City Government[16].

Table 3. Indicators Released by Taipei Sustainable Development Committee

| 7 working group | 25 local sustainability indicators |
|---|---|
| 1.Sustainable vision | - non-urban regional development<br>- survival rate of tree in urbanized area |
| 2.Land/water resource | - sediment rate in dam<br>- biochemical oxygen demand rate in river<br>- area of permeable pavement |
| 3.Energy/ecology | - energy usage per household<br>- solar energy generation capacity<br>- correction area of illegal usage of sloped land<br>- improved management of sloped land<br>- area of threaten ecological area<br>- biodiversity indicator<br>- area of urban farming |
| 4.Sustainable transportation | - green transportation rate<br>- rate of motorcycle non-occupying pedestrian lane<br>- setting of pedestrian lane over 1.12 meter<br>setting of pedestrian lane, sign under 12 meter |
| 5.Sustainable community | - growth rate of child care service<br>- rate of cancer screening<br>- participation rate of artistic activity<br>- confirmed rate of dementia<br>- rate of elderly society participation<br>- number of activities in “Cultural in Alley” |
| 6.Sustainable education | - ratio of student health<br>- area of small farm school participation<br>- amount of energy/water reduction in school |
| 7.Livable environment | - days of AQI less than 50 |

[16] Taipei Sustainable Development Committee Indicator table https://www.dep.gov.taipei/News_Content.aspx?n=5AF3A0B5D419CC8C&sms=9EF3B1109364454C&s=9B44BE6BD658B265 (accessed on May 13, 2019)

Source: in reference to data released by Climate Change Division, Environmental Protection Bureau, Taipei City Government website.
*the underlying working groups are different grouping and terminology used compared to Kaohsiung city.

This seven-working group Taipei committee with 25 indicators composition is different from the ten-working groups organization of Kaohsiung City Government with unknown number of indicators from all ten working groups. In fact, all six metropolises in Taiwan devised their city sustainable, climate change or low carbon strategy and indicators variably (see Table 4). Up to now, only Taipei City created 1) a publicly assessible city-wide sustainability 25 indicator to facilitate monitoring effort and 2) went beyond the traditional environmental approach of analyzing sustainability issues whereas the other five metropolises in Taiwan did not release a city-wide sustainability assessment indicator as open data and still on their way to expand the scope of sustainability evaluation. Moreover, by tracking the organizational history of sustainable development committee in different local governments also revealed the organizational inconsistency or mismatch between comprehensive citywide sustainability effort and focus of newly elected mayors for each new administrative period. From the sustainability related committee development comparison analysis in Table 4, Taipei City Government exhibits the highest institutional continuity since the creation of committee in 2003 (+++). New Taipei City Government and Kaohsiung City Government only made minor adjustment to the composition or focus of the committee (++) whereas Taoyuan, Taichung and Tainan City Government did not follow the conventional form of establishing local sustainable development committee. Instead, new sustainability committees were created to tackle specific aspect of city sustainability challenge such as the establishment of Coastal Management Committee in Taoyuan city in 2017 or Taichung City Urban Regeneration and Development Committee created by the elected Mayor Chia-lung Lin in 2015 immediately after election to fulfill one of his major election campaign's promises – to regenerate central district of Taichung city[17].

The above mentioned analyses could provide sustainability committee and indicator reform direction for Kaohsiung City Government in collaboration with other cities in Taiwan to invest in the next few years: 1) to re-devise a shorter set of city-based monitoring indicator in order to facilitate monitoring effectiveness and enable easier sustainable development information dissemination to citizen; 2) to synchronize city-based sustainable development monitoring indicator island wide to induce competition

[17] Liberty News Jan. 22, 2015. https://news.ltn.com.tw/news/local/paper/849465 (accessed on May 13, 2019)

among cities and compare city-based sustainable endeavor annually to provide stronger incentive and better monitoring institutional mechanism for policymaker, mayors and voters to scrutinize city scale sustainable development progress; 3) to de-couple city level sustainable development committee from political term of major in order to maintain continuous functioning of the committee and ensure the committee's capacity to produce longitudinal data for long term monitoring and improvement tracking purpose.

Table 4. Comparison of Sustainable Indicator in Taiwan's Six Metropolises

| Metropolis *by geographic north to south | Creation of city-wide wholistic sustainable development committee | | # of working group | Open data city-based indicator development |
|---|---|---|---|---|
| Taipei City | +++ | **Taipei Sustainable Development Committee** since 2003 | 7 | City wide 25 indicator on city website (2018. 12 version) |
| New Taipei City | ++ | -**New Taipei City Healthy City and Sustainable Development Committee** since 2010<br>-Taipei County Sustainable Development Committee created in 2005 | 10 | No citywide indicator open data on city website<br><br>July 26, 2018. 1st indicator meeting of 2018 Committee: discussed future revision of indicator in accordance to UN SDGs |
| Taoyuan City | + | -Taoyuan County Sustainable Development Committee under Education Bureau + Environmental Education Consultancy Group in 2004<br>-Education Bureau led **Sustainable Development and Environmental Education Consultancy Group** since 2005<br>-**Costal Management Committee** created in Oct. 2018 to promote costal sustainability | 5 working groups under Environmental Education Consultancy Group | No citywide indicator open data on city website |
| Taichung City | + | -Taichung City Government Sustainable Development Committee 2004-2010<br>-Taichung City Sustainable Development Committee since 2011.2015 ceased.<br>-**Taichung Economic Development Consultancy Committee** (2015 - )<br>-**Taichung City Urban Regeneration and Development Committee** (2017- ) | | No citywide indicator open data on city website<br><br>57 indicators (2004 data)<br>Life 30<br>Production. 21<br>Ecology. 6 |
| Tainan City | + | -**Low Carbon Adaptation and Sustainable Development Committee** since 2012<br>-**Low Carbon Sustainability Office** created in 2017 | | No citywide indicator open data on city website |
| Kaohsiung City | ++ | Kaohsiung City Sustainable Development Committee (2005-2011)<br>Kaohsiung City Sustainable Development Committee (2012 - 2015)<br>**Kaohsiung City Government Sustainable Development and Climate Change/Adaptation Committee** (2015 Oct) | 10 | No citywide indicator open data on city website |

Source: compiled by authors in reference to data archive from local governments
**committee +++ = high institutional continuity; + = less institutional continuity
*committee name in **bold** = incumbent committee up to May 2019.

# 4. SDGs-Oriented Scientific Knowledge Distribution on Kaohsiung

The second research puzzle of this study is to explore how scientific community was supportive of all 17 SDGs dimension for providing a city the scientific knowledge to reflect local problems before policy recommendations could be drawn upon to induce city-wide sustainability improvement. For approaching this aim, this study designed a systematic literature review method to evaluate SDGs categorized city specific scientific knowledge and used Kaohsiung city as showcase exemplary of this method. Doing so, it implies that cities in other part of the world could also follow this SDGs based literature mapping method to explore how SDG related socio-economic problems were studied in the extant literature before matching the scientific effort with sustainability policy for further science-policy interface analysis (Hinkel, 2011; Wesselink, Buchanan, Georgiadou, & Esther Turnhout, 2013) or try to turn “science” into “policy” (Watson, 2005).

## 4.1 SDGs-Oriented Computerized Literature Mapping Method

Given the large quantity of literature yield from all 17 SDGs categories, this study proposed a SDGs-oriented computerized literature “mapping” method, rather than a literature “review” or “meta-analysis”, to produce a cursory literature landscape snapshot for future more detailed reading and analysis of literature under each SDG category. In other words, the major difference between a standard systematic literature review flow with “identification”, “screening”, “eligibility” and “included” steps(Valentine, Hedges, & Cooper, 2009) and the proposed computerized literature mapping method lies on the omission steps on “screening” and “eligibility” for unavailability of integrated technical tool to remove duplicated copies or unrelated papers from different literature databases given the manually unmanageable number of literatures identified by the literature search engines. Nevertheless, the mapping is still considered useful and worthwhile to be recommended by this research for its ability to provide researchers or policymakers to identify research gap or surplus in the extant SDGs related scientific knowledge. Once the research gap is identified by this literature mapping effort, future researches can narrow the literature search to conduct standard systematic literature review or literature meta-analysis (Ernst & Resch, 1993; Tonmukayakul, Calache, Clark, Wasiak, & Faggion, 2015). In short, this study recognizes the limitation of this literature mapping design and its constrained ability to explain further the causal relation behind the identified research gap based on quantitative mapping, rather than detailed qualitative readings.

To proceed with the literature mapping analysis, this study selected four citation databases: Scopus, Science Direct, Taiwan Journal Index System (臺灣期刊論文索引系統) and Taiwan Thesis Knowledge Database（臺灣博碩論文知識加值系統）. The former focused on searches of English only peer-review papers published before 2018; the latter was used to search journal or PhD thesis published in Taiwan before 2018 (See Figure 6).

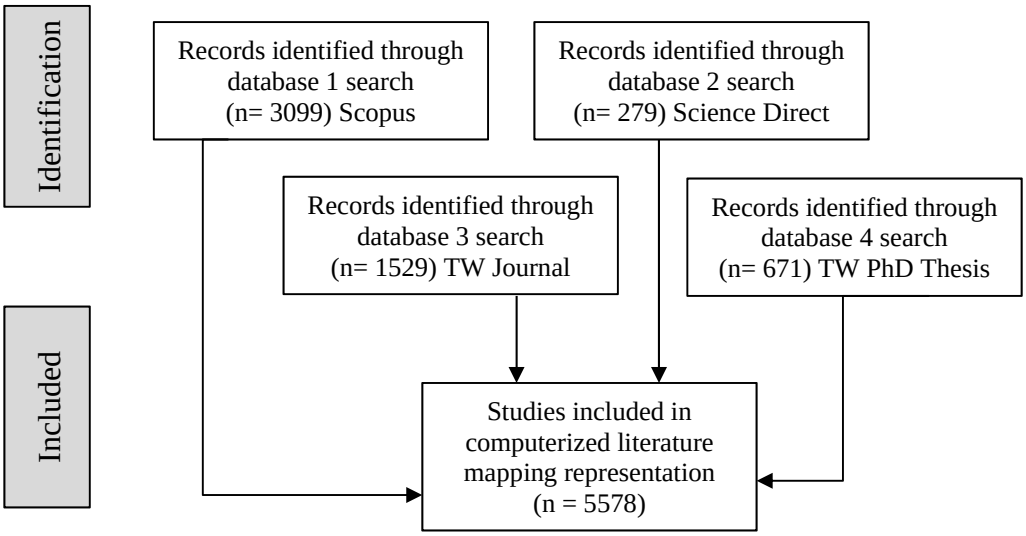



Figure 6. Computerized Literature Mapping Flow Diagram (search keywords see Table 5)

Keywords used were designed according to the description of each SDG. Some SDGs only used one keyword but the other might use up to four keywords to approximate the scope of the SDG. For instance, SDG 1 on poverty used “poverty” as the only keyword applied in all four citation database searches. SDG 8 on decent work and economic growth required at least three keywords in search. Table 5 listed all keywords used by this research. As mentioned at the beginning of this study, this research is designed as a pilot research to conduct a preliminary review to evaluate feasibility of future steps needed to be taken for cities. Therefore, the list of keywords used in this study for analyzing SDGs categorized literature might not be exhausted. In other words, other keywords could be also used by future studies to capture the scope of SDGs. Those keywords that were used in this computerized literature search is for the purpose of demonstrating the potential usefulness of SDG based literature mapping.

Table 5 Keywords Used in Computerized Literature Search

| SDG 1 | SDG 2 | SDG3 | SDG4 | SDG 5 | SDG6 | SDG7 | SDG8 | SDG9 |
|---|---|---|---|---|---|---|---|---|
| “poverty”<br>貧窮 | “hunger”<br>“food security”<br>“food waste”<br>飢餓<br>糧食 | “health”<br>健康 | “education”<br>教育 | “gender”<br>性別 | “clean water”<br>“water”<br>“sanitation”<br>水資源<br>衛生設備 | “energy”<br>能源 | “economic growth”<br>“employment”<br>“job”<br>經濟發展<br>就業 | “industry”<br>“innovation”<br>“infrastructure”<br>工業/創新<br>建設 |
| SDG10 | SDG11 | SDG12 | SDG13 | SDG14 | SDG15 | SDG16 | SDG17 | |
| “inequality”<br>平等 | “sustainable city”<br>“sustainability”<br>永續城市<br>永續 | “responsible consumption”<br>“responsible production”<br>“green consumption”<br>“green production”<br>負責任消費<br>負責任生產<br>綠色消費<br>綠色生產 | “climate change”<br>“climate action”<br>氣候變遷<br>氣候變遷行動 | “ocean”<br>“marine life”<br>“marine”<br>海洋<br>地洋生物 | “forest”<br>“ecosystem”<br>“biodiversity”<br>“land degradation”<br>森林<br>生態系統<br>生物多樣性<br>環境退化 | “inclusive society”<br>“inclusion”<br>“peace”<br>“justice”<br>“accountable institution”<br>“strong institution”<br>“accountability”<br>社會融合/融合/和平/正義<br>課責 | “international partnership”<br>“international cooperation”<br>“global partnership”<br>“United Nations”<br>國際夥伴<br>國際合作<br>全球夥伴<br>聯合國 | |

*all search begins with “Kaohsiung” as keywords first, then narrow literature by using SDGs categorized related keywords/record up to 2018 only.

## 4.2 SDG based Computerized Literature Mapping Analysis

In this computerized literature search effort on Kaohsiung’s SDG based scientific knowledge exploration, a total of 5,578 literatures were identified from four citation database search (Table 5). The citation database of Scopus generated the largest number of research results, followed by Taiwan journal citation database and Taiwan PhD dissertation database. Among all 17 SDGs, SDG 3 on good health and well-being attracted the most attention from researchers conducting medical experimentation or discussing disease pattern in Kaohsiung city. One reason for this high number of literature concentrated in SDG 3 might be the advanced medical research field in Taiwan and especially from Kaohsiung Medical University which is fairly productive in terms of publishing medical researches by using data in Kaohsiung, writing in English (total of 944 SDG 3 related journal written in English identified) and publishing in international journals. The second most affluent scientific knowledge in Kaohsiung is on SDG 4 for quality education. The issue of education draws a disproportional attention from Taiwan scholars and PhD students resulting 502 identified journal articles published in Taiwan journals and 195 PhD theses identified by the computerized search before manual excluding irrelevant researches. Although among the combined 697 researches potentially engaging in the discussion of education issue in Kaohsiung, there might include studies that only briefly mention about Kaohsiung or even are unrelated to Kaohsiung’s educational system due to the lack of manual screening for literature

excluding process. The field of SDG 4 is still relatively over-researched compared to other SDGs, such as SDG 12 on responsible consumption and production or SDG 1 on poverty which both yielded only a combined 7 computer identified studies respectively in the search of Taiwan journal and PhD dissertation archive.

Table 5. SDG Categorized Scientific Knowledge on Kaohsiung

| | SDG 1 | SDG 2 | SDG 3 | SDG 4 | SDG 5 | SDG 6 | SDG 7 | SDG 8 | SDG 9 | SDG 10 | SDG 11 | SDG 12 | SDG 13 | SDG 14 | SDG 15 | SDG 16 | SDG 17 | **Total** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scopus | 5 | 5 | **876** | 315 | 163 | 348 | 148 | *199* | 321 | 12 | 37 | 3 | 63 | 408 | 119 | 60 | 17 | **3099** |
| Sci Dire | 1 | 0 | **68** | 27 | 10 | 51 | 14 | 9 | 29 | 1 | 17 | 0 | 6 | 28 | 8 | 8 | 2 | **279** |
| TW Journal | 5 | 4 | 211 | **502** | 240 | 19 | 20 | 89 | 233 | 14 | 72 | **5** | 13 | 60 | 15 | 23 | 4 | **1529** |
| TW PhD Dissertation | 2 | 5 | 73 | 195 | 82 | 7 | 10 | 34 | 147 | 6 | 39 | **2** | 7 | 16 | 14 | 23 | 9 | **671** |
| Total | 13 | 14 | 1228 | 1039 | 495 | 425 | 192 | 331 | 730 | 33 | 165 | 10 | 89 | 512 | 156 | 114 | 32 | **5578** |

Source: compiled by author

Similarly, Figure 7 below depicts the ranking of SDGs in terms of Kaohsiung's scientific knowledge provisioning for potential policymaking reference. Six SDGs with less than 100 combined researches identified from the computerized literature search in four citation databases: SDG 13 (89) on climate change; SDG 10 (33) on reduced inequalities; SDG 17 (32) on partnerships for the goals; SDG 2 (14) on zero hunger; SDG 1 (13) on poverty and SDG 12 (10) on responsible consumption and production.

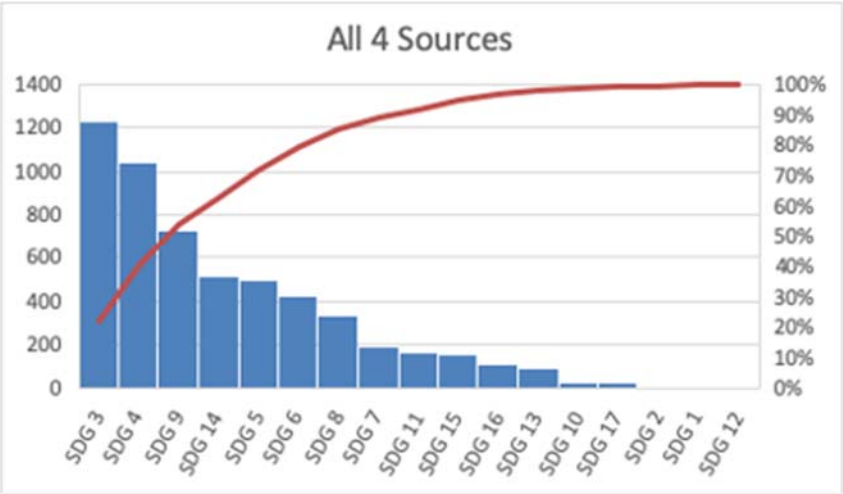



Figure 7 All Four Literature Source Comparison

If we compare four citation sources, interestingly Kaohsiung studies published in journal written in English focused mostly on four SDGs: SDG 3 on good health and well-being; SDG 6 on clean water and sanitation; SDG 14 on life below water and SDG 9 on industry, innovation and infrastructure (See Figure 8). In the Taiwan literature however, SDG 4 on quality education, especially at primary or secondary level of education and SDG 9 on industry, innovation and infrastructure were most researched.

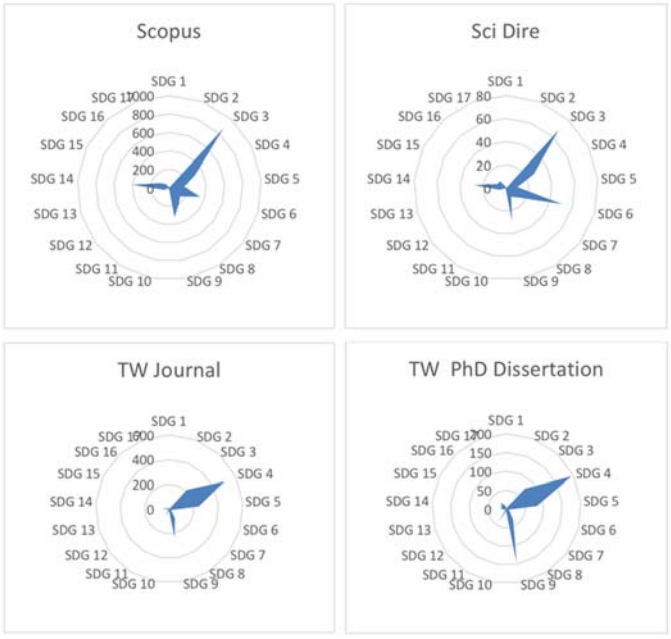



Figure 8. Literature Type and SDG Comparison

## 5. Discussion of Research Findings

In this discussion of findings, this research first suggested that more scientific knowledge should be strengthened in the three least researched SDGs area for Kaohsiung city. Then, the author discussed opportunities and barriers for cities to implement SDGs based on the SDIs review and recommended future research direction to fill in the gap between science and policy which is critical to move forward cities onto a sustainable pathway.

### 5.1 Scientific Knowledge Promotion in the Least Studied Three SDGs

Through the computerized literature mapping exercise, this study was able to identify the six least studied SDGs aspects about Kaohsiung city: SDG 13 (89) on climate change;

SDG 10 (33) on reduced inequalities; SDG 17 (32) on partnerships for the goals; SDG 2 (14) on zero hunger; SDG 1 (13) on poverty and SDG 12 (10) on responsible consumption and production. However, SDG 1 and SDG 2 which are comparatively more important policy concern for least developing nations can be excluded for now considering the present developmental stage of Taiwan.

Taiwan (R.O.C.) as a highly industrial developed economy with US$ 25,000 GDP per capita according to International Monetary Fund (IMF)[18] and score of 0.88 (2014), ranking 21th in the world (2014) on Human Development Index (HDI) based on Taiwan government's calculation following methodology used by the UN study[19] might not need to list SDG 1 and 2 as sustainable development priority for Kaohsiung city at least in the SDG comparative scope of this study. Although poverty, hunger or food security are still issues of concern for minority groups such as marriage migrant women (Jones & Ramdas, 2004; Tsai & Sun, 2013), migrant worker (Lan, 2003; Lindio-McGovern, 2004) or elderly in solitary lifestyle (Hsu, 2007; Lan, 2003) in southern Taiwan, these problems might find its structural root in other SDGs such as SDG 10 on reduced inequalities.

Excluding SDG 1 and 2, it leaves the other three least researched SDGs - 1) SDG 12 on responsible consumption and production; 2) SDG 17 on partnerships for the goals and 3) SDG 10 on reduced inequalities as the three recommended sustainability concerns of further scientific knowledge strengthening effort for Kaohsiung City. In regard to SDG 12, ten researches were identified by the computerized literature search, all of them were results of "green consumption" keywork search and no study was yielded under "green production" keyword. In the context of Kaohsiung, green restaurant (Shen, Chung, & Lin, 2014), organic agricultural produce promotion(Long, Deng, Jian, & lan, 2014) or eco port (Sheu, Hu, Lin, Chi, & Hou, 2014) were the most relevant studies to SDG 12. The former two studies showed a preference on researching daily consumption such as green consumption preference in picking restaurant or popularized trend of purchasing agricultural produce from small organic farmers in Kaohsiung. Eco port is also a recurrent theme throughout the searches and it might link indirectly to "material footprint". Nevertheless, eco port is more related to sustainable infrastructure (SDG 9) rather than SDG 12 responsible production and consumption.

As for SDG 17, this is an area that very few studies were conducted in the context of Kaohsiung city. Although there were 32 papers identified, not many of these papers

[18] IMF GDP per capita data for Taiwan in 2019 data is 25.45 thousand. https://www.imf.org/external/datamapper/NGDPDPC@WEO/OEMDC/ADVEC/WEOWORLD/TWN (accessed on May 13, 2019)

[19] Focus Taiwan News Channel September 18, 2014 Taiwan ranks 21st in world human development index http://focustaiwan.tw/news/asoc/201409180039.aspx (accessed on May 14, 2019)

directly investigated international cooperation between Kaohsiung and other entities. One of the few exceptions is a study on how Port of Kaohsiung (PoK) played a key role in collaboration with other ports or airports to prevent the transmission of international public health risks (Chiu, Hsieh, Wu, Chou, & Chang, 2014). Lastly, SDG 10 on reducing inequalities is the third areas in which scientific knowledge should be strengthened for Kaohsiung. Six researches were identified with keyword "equality" within search of "Kaohsiung" in Taiwan's PhD dissertation archive. Only two dissertations specifically focused on Kaohsiung as case studies – one explored offset-expenditure of government/self-management urban land (Chang, 2016); the other investigated the women empowerment process from projects generated by Kaohsiung County Women Center (Wu, 2007). In short, with the extant literature, our understanding about the three least studied SDGs area in Kaohsiung is scarce and fragmented. We also lack systemic empirical and theoretical understanding on the practices and potentials of responsible consumption or production models, typology of inequality forms practicing in Kaohsiung and barriers and opportunities of Kaohsiung to promote international cooperation development.

## 5.2 Bridging Science-Policy Gap

The core challenge of sustainability is on how to make good uses of scientific knowledge and translate that knowledge into making policy-relevant impact to transform the business as usual (BAU) and society as a whole. That is why numerous scholars emphasize the importance of "science-policy-practice interface"(Weichselgartner & Kasperson, 2010; White, Corley, & White, 2008) or "transdisciplinary"(Brandt et al., 2013; Hirsch Hadorn, Bradley, Pohl, Rist, & Wiesmann, 2006) in sustainability science. There are growing consensus on how we need new form of knowledge production and decision making (Lang et al., 2012) in order to tackle THE biggest challenge in the Anthropocene. Some scholars named this new form of knowledge production as "co-creation" of knowledge (Mauser et al., 2013), engaging both social and natural science and forming partnership between science and society. To be more specific, role of scientific knowledge in sustainability science is to solve sustainability problem based on needs and preference of users, namely human and nonhuman(Hanna, Johnson, Stenner, & Adams, 2015; Hiedanpää, Jokinen, & Jokinen, 2012) in the city. Therefore, what kind of knowledge we need in this new era in order to support the policymaking of sustainable indicators for cities is a critical and new question to ask for future researches.

In the case of Kaohsiung city, to link science with policy, we need to first try matching the policy with scientific knowledge and identify the science-policy gap or de-linkage. In

Figure 9 below, it showed the linkage pattern between the ten working groups of Kaohsiung Sustainable Development and Climate Change Adaptation Committee" and extant knowledge about Kaohsiung city on 17 SDGs.

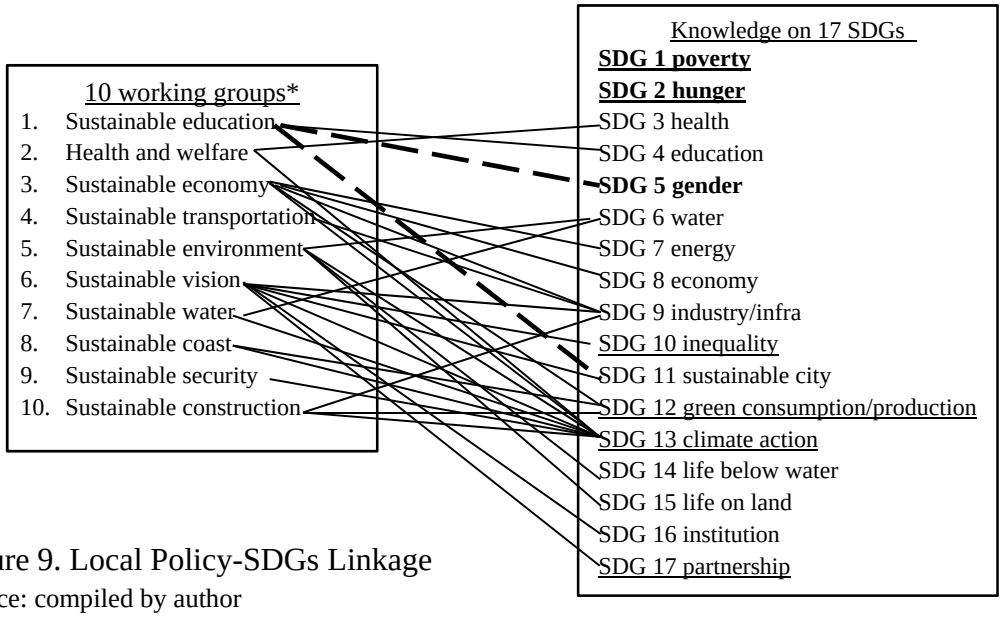



Figure 9. Local Policy-SDGs Linkage

Source: compiled by author

*10 working groups are the organizational composition of "Kaohsiung Sustainable Development and Climate Change Adaptation Committee". Each group developed SDIs.

** underlying SDGs refer to the least studied based on computerized literature mapping

*** SDGs in bold refer to those cannot find corresponding working group to be in charge of.

It is interesting how eight out of ten working groups emphasized the important missions to promote "climate change and adaptation mechanism"[20] which resulting in an intense linkage to SDG 13 on climate action. However, SDG 13 was identified by this study as one of the least studied area in the extant literature both in papers written in English or Chinese. Other noticeable de-linkage lies on SDG 1, SDG 2 and especially SDG 5 on gender issues which failed to trace back to a working group in sustainable committee to be in charge of its monitoring and implementation. Elsewhere, international partnership was heavily emphasized by Sustainable Vision working group yet it was not well supported by academic researches according to the computerized literature mapping results. Beyond that, more missing links such as the exemplified two dashed lines between sustainable education working group and SDG 5 on gender and SDG 11 on sustainable

[20] Details refers to regulation (last revision on Oct. 19, 2017) on "Kaohsiung Sustainable Development and Climate Change Adaptation Committee) https://orgws.kcg.gov.tw/001/KcgOrgUploadFiles/258/relfile/15352/55925/45fbed19-7f13-499f-ae85-e475a1f11b05.pdf (accessed on May 13, 2019)

city represent the future potential areas of transdisciplinary between policy and science and interdisciplinary cooperation within the academic community that Kaohsiung city could invest more public resources and research attentions.

## 6. Conclusion

With the rising imminent threat of climate change, our planet Earth has arrived to a pivotal time for major drift apart from the BAU scenario. This new reality not only propels us to re-consider use of technological innovation (Brown & Sovacool, 2011; Peeters, Gossling, & Becken, 2006) and change of governance style to co-manage the human-nonhuman relation with multiple stakeholders (Bäckstrand, 2003; Lipper et al., 2014), there is a pressing need to create new sustainability indicator for monitoring and implementation purpose and to re-engage the scientific community to support policymaking and the society in general to make a collective leap forward in the next decades to come for a sustainable common future.

Such pressing need exhibits vividly in the international relation where UN led climate change negotiations or globally agreed SDGs are in action on a daily base. City is another important venue or “locality”(Sharp & Richardson, 2001; Warf, 1991) for sustainable development where what is the best form of human and nature relation is constantly contested. This study, by launching a pilot study of city-based sustainable development evaluation in Kaohsiung, Taiwan, demonstrated the potential sustainability gap between cities, between policy and science and within scientific disciplines. Especially in this post-SDG era, a number of sustainability monitoring indicators in cities require continuous update and new aggregating effort. Although this study has identified significant gap between SDGs and our existing scientific knowledge about all 17 goals in the city of Kaohsiung, this knowledge inefficiency problem implies future opportunities for encouraging the least studied SDG areas such as SDG 12, SDG 17 and SDG 10 to strengthen its knowledge acquisition capability for the context of Kaohsiung. Furthermore, more city-based sustainable development indicator and knowledge evaluation shall also be conducted in other cities around the world in order to better match future direction of sustainability science researches and policymaking while encouraging co-creation of knowledge (Mauser et al., 2013).

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