臺灣建築學會「建築學報」第 106 期增刊（創新低碳與綠建築專刊），41~54 頁，2018 年 12 月
JOURNAL OF ARCHITECTURE, No. 106, Special Issue onInnovative Low-carbon and Green Building, pp. 41~54, Dec.2018
DOI:10.3966/101632122018120106017

Smart and Ecological Community Assessment Indicator System of Taipei City

Chen-Yi Sun [1*] Te-Chuan Li [2] You-Yu Chen [3] Tsun-Chin Wu [4]

[1]Professor, Department of Land Economics, National Chengchi University, Taiwan
[2]Deputy Secretary General, Taipei City Government, Taiwan
[3]Master Student, Department of Land Economics, National Chengchi University,Taiwan
[4]Ph. D Student, Department of Land Economics, National Chengchi University, Taiwan
*Corresponding author Email: justin.sun.tw@gmail.com

ABSTRACT

In recent years, urban issues such as climate change, aged society, declining birthrate, energy efficiency and carbon reduction have been receiving tremendous attention. In response to these issues, governments all over the world have proposed innovative planning concepts such as ecological and smart planning. As the capital city of Taiwan, Taipei City takes the responsibility of leading Taiwan to deal with the issues worldwide.

Since the planning of city levels were implemented on the scale of communities, local residents, as the core of community development will be the critical factor in determining whether the planning would be successful. Thus, this research established a “Smart and Ecological Community Index System” of Taipei, selected three current urban readjustment sites in Taipei City to conduct trials, and developed strategies for promoting Taipei City’s smart and ecological community assessment index.

KEYWORDS: Sustainable Development, Eco-city, Smart City, Green Community, Green Building

1 Introduction

The sustainable development of the earth has become an important international issue. From the Kyoto Protocol to the Paris Agreement, all countries in the world are actively formulating greenhouse gas reduction targets and promoting the development of energy conservation and low-carbon energy industries. Among these trends, energy consumption has become an essential element of urban development. Energy consumption around the world has been increasing over the past few decades and has led to an energy crisis (Madan, et al., 2012; Sunak, 2011; Shukla, 1995; Fengetal., 2013; Rees and Wackernagel, 1996; Wittig, 2008). In the 2016 Paris Agreement, more than 100 countries have agreed and committed to comply with greenhouse gas reduction measures and take concrete actions to mitigate climate change.

With this international trend, it is inevitable for Taiwan to stay out of the way. Therefore, sustainable development, eco-city, low-carbon city or sustainable smart city concept have become important policies for government administration. Over the past two decades, the world's major metropolitan areas have been working to improve the infrastructure and services of existing cities and to improve environmental, social and economic conditions to enhance the attractiveness and competitiveness of cities (Lee, et al., 2008; Jong, et al., 2015). After centuries of development, Taipei City has become the political, economic and cultural center of Taiwan. Smart and ecological development are international trends, and of course the focus of the Taipei City Government.

Vertical and horizontal governance strategies across scales and networks must be developed for the successful eco-city governance (Li, 2014; Seymoar, et al., 2010). Urban-level planning must be implemented in the community. The development of ecological communities and smart communities will be the key to the sustainable planning of cities. However, at present, Taiwan has inadequate policy to implement smart and ecological concepts in the community, which is also a major obstacle to the promotion of Taipei City into an excellent city. Therefore, the purpose of this study is to establish a smart ecological community assessment indicator system for Taipei City to help the government of Taipei in carrying out urbanization and community planning.

In order to effectively use the limited resources of the government, this study adopts the established intelligent ecological community indicator system as the evaluation standard for improving urban environment. The main research objectives are as follows:

(1) Establish indicators for the evaluation of smart and ecological communities in Taipei City with reference to domestic and foreign smart communities and ecological community assessment indicators.

(2) Propose the promotion strategy for the development of smart and ecological community in Taipei City to help promoting the sustainable development of Taipei.

2 Methodology and Research Areas

In order to construct the evaluation index of the smart and ecological community in Taipei City, this study first developed a smart and ecological community assessment system suitable for Taipei City through the collection and analysis of related literatures, and invited scholars and experts to provide suggestions for the indicators of smart and ecological communities. In the end, a set of objective assessment criteria for the smart and ecological community of Taipei City was established to help Taipei in pursuing the international trend of sustainable development.

2.1 Literature review

Literature review is the basis of research and the preparation for data collection. Itis also called the “library research method”, which includes relevant research reports, papers and periodicals. Content analysis, also known as information analysis or document analysis, is a quantitative research method. Document analysis is a method of transforming qualitative research data into quantitative data. It is an objective and systematic research method for the special attributes of articles or media, extracted themes, words, characters and other parts, exploring the true meaning and influence behind the content.

2.1.1 Smart City

The smart city is a brand-new concept, and its definition and connotation continue to evolve. At present, the academic community and the industry still have no consensus on this. In general, smart cities can be understood as making full use of new technologies and the inspiration they bring, transforming and upgrading their systems, operations and services, compared to traditional cities. In other words, smart cities provide citizens and governments with the infrastructure they need to make more informed decisions. It plays a crucial role in addressing the challenges associated with ecological, social, cultural and economic sustainability (Caragliu, et al., 2011).

2.1.2 Eco-city

In addition to comprehensive consideration of land use patterns in cities, eco-cities should include comprehensive discussions on areas such as transportation, energy, public space, urban design, and popular participation (Kenworthy, 2006). It can be seen that the vision of the eco-city is to create a healthy, sustainable and prosperous urban space that coexists with nature and has a minimal impact on the natural environment. The current international practice uses the concept of sustainability as a planning direction, or “ecological city”, “sustainable city”, “low carbon city”, “green energy community”, “ecological community”, etc.

2.1.3 Smart community

Smart Community is a community that uses digital technology to enhance the living and working environment (Bardalen, 2017), and effectively carry out the integration and utilization of various next generation technologies and advanced social systems, including the efficient use of energy, the utilization of heat and unused energy, local improvements in transportation systems and the transformation of residents' daily lives (Hisatsugu, 2015). Smarter communities begin to miniaturize and scale smart solutions, and then connect multiple systems to form a smart city (Black & Veatch Corporation, 2015). Therefore, the construction of a smart community could be the basis for the development of a smart city.

2.1.4 Ecological community

In the face of global environmental protection issues, such as global warming and climate anomalies, and with the promotion of eco-planning design and sustainable development concepts, “ecological city” and “ecological community” have become important planning trends. In 1998, the ecological community was listed for the first time in one of the 100 best practices of the United Nations Model for Sustainable Living. An ecological community is an urban or rural human community in which community residents strive to combine a supportive social environment with a low-environmentally impacted lifestyle. In order to achieve this goal, the ecological community combines various aspects of ecological design, ecological construction, sustainable cultivation, green products, alternative energy and community building practices.

On the other hand, Beatley proposed the basic principles of a sustainable community: (1) recognizing the basic limitations of ecology and improving the soundness of ecosystems; (2) establishing a close relationship with the natural environment; (3) reducing the consumption of land and resources; (4) recognizing the social, economic, and environmental goals of each other; (5) supporting the overall planning strategy; (6) constructing new moral attitudes; (7) strengthening resources, fair distribution of opportunities and environmental risks (Beatley, 1998). Relevant research also shows that the definition and theoretical meaning of ecological communities are not fixed. They should be defined by residents and planners as the regional environment changes. The real ecological community should be a dynamically balanced community. (Roseland, 1998)

2.2 Case study analysis

The case study method is a survey method based on experience and in-depth study of current social phenomena and real life. Case study is a practical way of investigation. When the boundary between the phenomenon being studied and real life is not clear, the status quo is investigated through various source evidences. At present, there is no standard for the evaluation of intelligent ecological communities in China. However, this study will use the case analysis method as the basis for formulating the indicators for the intelligent community evaluation of Taipei City. Through the success of the smart community case at home and abroad and the analysis of the key items worthy of the opportunity, the integrity and suitability of the follow-up “Taipei Smart Eco-Community Assessment Indicators” was established to benefit the promotion of “Taipei Smart Community Evaluation Indicators”.

2.3 Expert consultation meeting

This study invites experts and scholars in six major fields, such as transportation and tourism, environmental ecology, green energy industry, safety and disaster prevention, healthy living and humanities and art, as well as relevant departments of the municipal government to make recommendations on the data and indicators collected in this study. The results of the research can be made more concrete and feasible through expert consultation in various fields. The integrity, richness and correctness of this evaluation indicator system can be enhanced through the expertise and opinions of experts. In the end, the researcher integrated the opinions of the experts and the research results of this project, and proposed the smart and ecological community promotion policy to help the Taipei City government in promoting the smart and ecological community evaluation indicators.

3 Domestic and foreign smart and ecological community indicator system integration and case analysis

This study collected a number of international smart and ecological community indicator systems, such as OECD Green Growth Indicators, Smart city wheel, Asia Pacific Smart City Awards (SCAPA), US ICF Smart Community Assessment Indicators, China Smart City Evaluation Index System, LEED-ND, BREEAM-Communities, CASBEE-UD, Green Mark for Districts, EEWH-EC, and Shenzhen Smart Community Construction Guidelines. Some indicators which are suitable for Taipei City can be incorporated into the Taipei Smart Eco-Community Assessment Indicators.

In order to establish a rating system for intelligent ecological communities, the domestic and international indicators of intelligent ecological communities was classified into three types according to the design of relevant indicators at home and abroad, and were classified into international, urban and regional types according to the indicators. The international smart and ecological indicators have a national policy framework, focusing on national scale evaluation projects such as economic activities, policy measures, and smart government, mainly based on cross-international evaluation indicators; urban smart ecological indicators are focus on countries. The urban service is between cities. The evaluation project mainly covers the infrastructure, management services, information integration and other service projects in the city; the scale scope of the regional smart and ecological indicators considers different architectural design, type and other projects, and the evaluation projects emphasize more within the community. Categories such as architectural design, construction, and neighborhood environment.

4 Taipei Smart Eco-Community Assessment Indicators

Based on the analysis of the above-mentioned domestic and international smart ecological community cases, this paper analyzes the smart ecological indicators of three different scales in the international, urban and regional areas, and organizes them in different aspects, as a source for the follow-up of the exclusive intelligent ecological community indicators in Taipei.

This study uses the relevant literature analysis and case integration of the smart ecological community, and cooperates with questionnaires, expert consultation meetings, and actual case trial evaluation to verify the applicability of the “Taipei Smart Community Evaluation Indicators”. The indicators are divided into seven major areas: “Overall Development”, “Environment and ecology”, “Security and Disaster Prevention“, “ Healthy and Lifestyle”, “Transportation and Tourism”, “Green Energy and Industry” and “Culture and Art”.

Table 1 Induction of various intelligent ecological community indicators

Category	Indicator system
International Indicators	OECD Green Growth Indicators
	Smart city wheel
	Asia Pacific Smart City Awards (SCAPA)
City indicator	US ICF Smart Community Assessment Indicators
	China Smart City Evaluation Index System
Regional indicator	LEED-ND
	BREEAM-Communities
	CASBEE-UD
	Green Mark for Districts
	EEWH-EC
	Shenzhen Smart Community Construction Guidelines

4.1 Overall development

In order to improve the development foundation of the smart ecological community, this study screened two indicators (A1. free Wi-Fi access coverageandA2. smart street lamp setting rate) as the basic indicators. Designs of smart ecological communities: (1) have perfect Wi-Fi network connectivity, which is sufficient to increase the penetration rate and usage level. This is the basic requirement for the development of digital age areas; (2) can increase energy efficiency through smart street lamps, and monitor systems instead of traditional manpower inspection, which reduces maintenance costs and improves maintenance efficiency.

4.2 Environmental Ecology

In this study, three indicators of “B1. Effective water storage per unit area of rainwater recycling system, B2. Green area density, and B3. Air quality index (AQI) excellent day-to-day ratio” were selected in the evaluation index of smart and ecological community in Taipei. To ensure that smart communities have sufficient environmental and ecological standards. These three indicators have the following functions: (1) To solve the problems caused by insufficient water resources and reduce heavy rainfall, improve surface runoff and improve water use efficiency through good base water and rainwater recovery mechanisms. (2) Establishing parks and green spaces to alleviate the urban heat island effect, adjust the urban microclimate, and enhance outdoor thermal comfort. (3) Air quality will affect human health. Therefore, it is essential to improve air quality to protect people's health.

4.3 Security and Disaster Prevention

This study lists five indicators included in the “Safety and Disaster Prevention Indicators Group”: “C1. 1,500-meter reach coverage for emergency shelters, C2. Public monitor density per unit area, C3. Disaster potential density, C4 . The water retention area density of the construction base and the C5. AED site setting certification rate."

The purpose of each indicator is to ensure that: (1) There should be sufficient emergency shelters in the community to provide emergency evacuation of the community in the event of a disaster to improve the safety of the public space. (2) In order to reduce the unsafe space inside the community, the community needs to set up a public monitoring system to avoid the occurrence of security blind spots. (3) Take measures against the distribution of disaster potential areas in the community to respond to future disaster prevention measures. (4) In order to achieve the water retention performance of the base, the community is able to retain rainwater and retain rainwater in the natural soil layer and hardware facilities in the building base. (5) In addition to AED (automated external cardiac defibrillator), all kinds of public places should also strengthen the first-aid skills training and promotion to increase the rescue survival rate after accidents.

4.4 Healthy and Lifestyle

This study screened three indicators: D1. Open space 500 meters reach coverage, D2. Health care coverage, and D3. Community care coverage. The main goal is to ensure a healthy and comfortable environment for smart communities: (1) The community has a good open space plan to provide residents with activities, entertainment and social gatherings, and to bring together community awareness and improve the overall quality of urban life. (2) The community has access to good health care facilities, including clinics, medical facilities, health service centers, and activity centers. By organizing community activities and providing simple exercise equipment to enhance the physical and mental health of community residents. (3) The community has access to community care services, including community care site, elderly care mechanisms, child care systems, and kindergartens.

4.5 Transportation and Tourism

Regarding to transportation and tourism, this study includes three indicators: E1. Public bicycle system penetration rate, E2. Electric vehicle charging pile 500 meters reachable range coverage, and E3. Smart station setting rate. The aim is to strengthen the functions of the intelligent ecological community in transportation and tourism: (1) Maintaining a good bicycle system and environmentally friendly green transportation characteristics, and enhance the scope and convenience of mass transportation services. (2) Promote a friendly environment for electric vehicles by setting up electric vehicle related infrastructure. (3) Set up smart station signs to help passengers in knowing the traffic transfer information clearly and quickly.

4.6 Green Energy and Industry

In order to ensure that the intelligent ecological community is in the “Green Energy and Industry” aspect, this study selected two indicators to be included in the “Green Energy and Industry” indicator group: F1. Renewable energy capacity increase, F2. Participation in the Taiwan Power Company Electronic demand bidding system. Specific reasons and objectives: (1) Minimizing the depletion of non-renewable energy through the use of renewable energy (such as solar energy, wind power, tidal energy, thermal energy, etc.) should be promoted by the smart ecological community. (2) Applying electricity incentives to encourage people to save energy and save money, creating environmental benefits.

4.7 Culture and Art

In order to construct a smart and ecological community, the study included two indicators into the “Cultural and Art Indicators Group”: G1. Number of cultural events held, and G2. Cultural and educational facilities coverage of 500 meters. The intention is to highlight: (1) The smart and ecological community must include art and cultural activities and the development of community art and culture. The energy of culture and art can unite the overall consciousness of the community and shape the sense of community identity. (2) Provide cultural and educational platforms for community residents through community workshops, community colleges, libraries, art exhibition space, and art galleries, and promote smart and ecological community development of community culture education.

5 Discussions

In 1999, based on the energy-saving design regulations, Taiwan developed the “Green Building Evaluation System”, which uses the four major evaluation criteria of “Ecology, Energy Saving, Waste Reduction and Health” (Lin, 2006). Therefore, it is referred to as EEWH system. In 2012, the "Green Building Assessment System - Eco-Community (EEWH-EC)" version was updated to implement ecological community assessments in communities, rural settlements, aboriginal tribes, science parks, industrial areas, and university towns (Lin, 2014). In this way, the idea of sustainable development can be promoted from the building to the community. The evaluation system of EEWH-EC includes five categories of ecology, energy saving and waste reduction, health and comfort, community function and public security, which focus on the ecological quality of the community and community function. Ecological quality includes animal and plant ecology, global environmental protection and sustainable human survival; community function includes the most basic convenience, health, comfort, efficiency, safety and cultural function in life. It is emphasized that the development of ecological communities should maintain a balance between "human needs" and "ecological environment".

Table 2 Taipei City Smart Eco-Community Assessment Indicators

Category	Indicators	Indicator content description	Reference
A. Overall	A1.free Wi-Fi access coverage	Having perfect Wi-Fi network connectivity, which is sufficient to increase the penetration rate and usage level, which is the basic condition for the development of digital age areas.	Zanella et al., 2014
	A2.smart street lamp setting rate	It can increase energy efficiency through smart street lamps, and monitor systems instead of traditional manpower inspection, which reduces maintenance costs and improves maintenance efficiency.	Zanellaetal., 2014; Müllner, R., Riener, A., 2011
B. Environment andecology	B1. Effective water storage per unit area of rainwater recycling system	To solve the problems caused by insufficient water resources and reduce heavy rainfall, improve surface runoff and improve water use efficiency through good base water and rainwater recovery mechanisms.	Oh, Kim, & Jeong, 2005.
	B2. Green area density	Establishing parks and green spaces to alleviate the urban heat island effect, adjust the urban microclimate, and enhance outdoor thermal comfort.	Kong & Nakagoshi, 2006
	B3. Air quality index (AQI) excellent day-to-day ratio	Air quality will affect human health. Therefore, it is essential to improve air quality to protect people's health.	Frasera et al., 2006
C. Security and Disaster Prevention	C1. 1,500-meter reach coverage for emergency shelters	There should be sufficient emergency shelters in the community to provide emergency evacuation for the community in the event of a disaster to improve the safety of the public space.	Satterthwaite, 1997
	C2. Public monitor density per unit area	In order to reduce the unsafe space inside the community, the community needs to set up a public monitor system to avoid the occurrence of security blind spots.	Su et al., 2011
	C3. Disaster potential density	Take measures against the distribution of disaster potential areas in the community to respond to future disaster prevention measures.	Norris et al., 2008
	C4. The water retention area density of the construction base	In order to achieve the water retention performance of the base, the community is ableto retain rainwater and retain rainwater in the natural soil layer and hardware facilities in the building base.	Norris et al., 2008
	C5. AED site setting certification rate	In addition to AED (Automated External Defibrillator), all kinds of public places should also strengthen the first-aid skills training and promotion to increase the rescue survival rate after accidents.	Louis et al., 2014

(Continued) Table 2 Taipei City Smart Eco-Community Assessment Indicators

Category	Indicators	Indicator content description	Reference
D. Healthy and Lifestyle	D1. Open space 500 meters reach coverage	The community has a good open space plan to provide residents with activities, entertainment and social gatherings, and to bring together community awareness and improve the overall quality of urban life.	Saldivar-tanaka & Krasn, 2004
	D2. Health care coverage	The community has access to good health care facilities, including clinics, medical facilities, health service centers, and activity centers. By organizing community activities and providing simple exercise equipment to enhance the physical and mental health of community residents.	Weinehall et al., 2001
	D3. Community care coverage	of the community has access to community care services, including community care site, elderly care mechanisms, child care systems, and kindergartens.	Department of Health, 2006
E. Transportation and tourism	E1. Public bicycle system penetration rate	Maintaining a good bicycle system and environmentally friendly green transportation characteristics, and enhance the scope and convenience of mass transportation services	Midgley, 2011; Fishman et al., 2015
	E2. Electric vehicle charging pile 500 meters reachable range coverage	Promote a friendly environment for electric vehicles by setting up electric vehicle related infrastructure.	Bradley & Frank, 2009 Rahman et al., 2016
	E3. Smart station setting rate	Set up smart station signs to help passengers in knowing the traffic transfer information clearly and quickly.	Ning et al., 2017
F. Green Energy and Industry	F1. Renewable energy capacity increase	Minimizing the depletion of non-renewable energy through the use of renewable energy (such as solar energy, wind power, tidal energy, thermal energy, etc.) should be promoted by the smart ecological community.	Walker & Devine-Wright, 2008
	F2. Participation in the Taiwan Power Company Electronic demand bidding system	Applying electricity incentives to encourage people to save energy and save money, creating environmental benefits.	Palensky & Dietrich, 2011

(Continued) Table 2 Taipei City Smart Eco-Community Assessment Indicators

Category	Indicators	Indicator content description	Reference
G. Culture and Art	G1. Number of cultural events held	The smart and ecological community must include art and cultural activities and the development of community art and culture. The energy of culture and art can unite the overall consciousness of the community and shape the sense of community identity.	Schulenkorf, 2012
	G2. Cultural and educational facilities coverage of 500 meters	Provide cultural and educational platforms for community residents through community workshops, community colleges, libraries, art exhibition space, and art galleries, and promote smart and ecological community development of community culture education.	Bachleitner & Zins, 1999

The "Taipei Smart and Ecological Community Assessment Indicators" is similar to "EEWH-EC" since it maintains the balance between "environmental ecology" and "residence health and safety" and incorporates many important indicators into the system; culture, art, disaster prevention, transportation, and green energy.

The difference is that the "Taipei Smart and Ecological Community Assessment Indicators" have included the "Industry" and "Tourism" indicators to promote sustainable development of the community. Meanwhile, in setting the evaluation indicators, the "Taipei Smart and Eco-Community Assessment Indicators" must fully comply with the policy of the Taipei City, which is different from the basic considerations of "EEWH-EC" which is applicable to Taiwan.

This study is based on "Documentation Analysis", "Reference to Existing Smart and Ecological Community Assessment Indicators", "Case Analysis", "Expert Questionnaire", "Expert Discussion" and "Executive Conference" as the important tools for developing "Taipei Smart Eco-Community Assessment Indicators". Besides, this study also targets three experimental areas: one residential district, one commercial district, and one industrial park district. The actual index system is used to carry out calculation and evaluation, and the applicability of the indicator system is confirmed. At the same time, based on the trial results, the required adjustment for the indicator system is performed.

6 Conclusion and Suggestion

In response to the trend of climate change and urban competition, Taipei City has been promoting smart eco-community demonstration projects since 2015 with the combination of smart cities, rural cities and communities to achieve the goal of low-carbon green energy and ecological sustainability. In order to effectively use the limited governmental resources, the established indicator system for the smart ecological community in Taipei will be adopted as a standard for improving the regional environment and the allocation of municipal resources effectively.

In order to establish the indicator system of the intelligent community in Taipei, this study will first analyze and integrate relevant literature and cases related to the intelligent ecological community through literature collection and case analysis. The results from studying national cases and literature will serve as important reference for the establishment of evaluation indicators of the smart ecological community in Taipei.

Base on the results of two expert consultation meetings, this study summarizes six major indicators: transportation, environmental ecology, green energy industry, safety and disaster prevention, healthy living and humanities. It is suggested that the follow-up study can carry out trial calculation and adjustment of the content of this indicator, and update the data and content every 3-5 years.

ACKNOWLEDGMENTS

The support of Ministry of Science and Technology of Republic of China (Taiwan)(project MOST 105-2410-H-004-194 -)and the support of Department of Land Administration of Taipei City Government are gratefully acknowledged.

REFERENCES

Bachleitner, R., & Zins, A. H. (1999). Cultural tourism in rural communities: The residents' perspective. *Journal of Business Research*, *44*(3), 199-209. DOI: 10.1016/S0148-2963(97)00201-4

Bardalen, O. (2017). *Smart Communities: An Area of Opportunities, Norway Grants– Bilateral Experience Sharing Oslo*.

Beatley, T. (1998). *The Vision of Sustainable Communities*. Washington, DC: Joseph Henry Press.

Bradley, T. H., & Frank, A. A. (2009). Design, demonstrations and sustainability impact assessments for plug-in hybrid electric vehicles. *Renewable and Sustainable Energy Reviews*, *13*(1), 115-128. DOI: 10.1016/j.rser.2007.05.003

Caragliu, C. B., & Nijkamp, P. (2011). Smart Cities in European. *Journal of Urban Technology*, *18*(2), 65-82.

Department of Health (2006). *Our Health, Our Care, Our Say*. Department of Health, London.

Feng, Y. Y., Chen, S. Q., & Zhang, L. X. (2013). System dynamics modeling for urban energy consumption and CO_2 emissions: A case study of Beijing, China. *Ecological Modelling*, *252*, 44-52. DOI: 10.1016/j.ecolmodel.2012.09.008

Fishman, E., Washington, S., Haworth, N., & Watson, A. (2015). Factors influencing bike share membership: An analysis of Melbourne and Brisbane. *Transportation Research Part A: Policy and Practice*, *71*, 17-30. DOI: 10.1016/j.tra.2014.10.021

Frasera, E. D. G., Dougilla, A. J., Mabeeb, W. E., Reeda, M., & McAlpinec, P. (2006). Bottom up and top down: Analysis of participatory processes for sustainability indicator identification as a pathway to community empowerment and sustainable environmental management. *Journal of Environmental Management*, *78*(2), 114-127.
DOI: 10.1016/j.jenvman.2005.04.009

Hisatsugu, T. (2015). *Fujitsu's Approach to Smart Cities*. Retrieved January 25, 2015 from www.fujitsu.com/downloads/MAG/vol50-2/paper01.pdf.

Kenworthy, J. R. (2006). The eco-city: ten key transport and planning dimensions for sustainable city development. *Environment and Urbanization*, *18*(1), 67-85. DOI: 10.1177/0956247806063947

Kong, F., & Nakagoshi, N. (2006). Spatial-temporal gradient analysis of urban green spaces in Jinan, China. *Landscape and Urban Planning*, *78*(3), 147-164. DOI: 10.1016/j.landurbplan.2005.07.006

Lee, S. H., Han, J. H., Leem, Y. T., & Yigitcanlar, T. (2008). Towards ubiquitous city: Concept, planning, and experiences. *Igi Global*, *2*, 148-169.

Li, T. C. (2014). *Toward Eco-city Planning and*

Governance: A Multi-Scalar Empirical Comparative Study. PhD thesis. Graduate Institute of Urban Planning, National Taipei University, New Taipei City. (in Chinese)

Lin, H. T. (2006). *Good to Be Green*. Architecture and Building Research Institute, Ministry of the Interior, Taipei.

Lin, H. T. (2014). *Green Building Evaluation Manual for Eco-Community: EEWH-EC 2015 Edition*. Architecture and Building Research Institute, Ministry of the Interior, New Taipei City. (in Chinese)

Madan, D., Pant, A., Kumar, S., & Arora, A. (2012). E-learning based on cloud computing. *International Journal of Advanced Research in Computer Science and Software Engineering, 2*(2).

Madlener, R., & Sunak, Y. (2011). Impacts of urbanization on urban structures and energy demand: What can we learn for urban energy planning and urbanization management?. *Sustainable Cities and Society, 1*(1), 45-53. DOI: 10.1016/j.scs.2010.08.006

Midgley, P. (2011). *Bicycle-Sharing Schemes: Enhancing Sustainable Mobility in Urban Areas*. United Nations, New York.

Müllner, R., & Riener, A. (2011). An energy efficient pedestrian aware Smart Street Lighting system. *International Journal of Pervasive Computing and Communications, 7*(2), 147-161. DOI: 10.1108/17427371111146437

Ning, Z., Xia, F., Ullah, N., Kong, X., & Hu, X. (2017). Vehicular Social Networks: Enabling smart mobility. *IEEE Communications Magazine, 55*(5), 49-55. DOI: 10.1109/MCOM.2017.1600263

Norris, F. H., Stevens, S. P., Pfefferbaum, B., Wyche, K. F., & Pfefferbaum, R. L. (2008). Community Resilience as a Metaphor, Theory, Set of Capacities, and Strategy for Disaster Readiness. *American Journal of Community Psychology, 41*(1-2), 127-150. DOI 10.1007/s10464-007-9156-6

Oh, D. S., Kim, K. B., & Jeong, S. Y. (2005). Eco-Industrial Park Design: a Daedeok Technovalley case study. *Habitat International, 29*(2), 269-284. DOI: 10.1016/j.habitatint.2003.09.006

Palensky, P., & Dietrich, D. (2011). Demand Side Management: Demand Response, Intelligent Energy Systems, and Smart Loads. *IEEE Transactions on Industrial Informatics, 7*(3), 381-388. DOI: 10.1109/TII.2011.2158841

Parikha, J., & Shukla, V. (1995). Urbanization, energy use and greenhouse effects in economic development: Results from a cross-national study of developing countries. *Global Environmental Change, 5*(2), 87-103. DOI: 10.1016/0959-3780(95)00015-G

Rahman, I., Vasant, P. M., Singh, B. S. M., Abdullah-Al-Wadud, M., & Adnan, N. (2016). Review of recent trends in optimization techniques for plug-in hybrid, and electric vehicle charging infrastructures. *Renewable and Sustainable Energy Reviews, 58*, 1039-1047. DOI: 10.1016/j.rser.2015.12.353

Rees, W., & Wackernagel, M. (1996). Urban ecological footprints: why cities cannot be sustainable—and why they are a key to sustainability. *Environmental Impact Assessment Review, 16*(4-6), 223 -248.

Roseland, M. (1998). *Toward Sustainable Communities: Resource for Citizens and Their Governments*. Canada: New Society Publishers.

Saldivar-tanaka, L., & Krasn, M. E. (2004). Culturing community development, neighborhood open space, and civic agriculture: The case of Latino community gardens in New York City. *Agriculture and Human Values, 21*(4), 399-412. DOI: 10.1007/s10460-003-1248-9

Satterthwaite, D. (1997). Sustainable cities or cities that contribute to sustainable development?. *International Institute for Environment and Development, 34*(10), 1667-1691. DOI: 10.1080/0042098975394

Schulenkorf, N. (2012). Sustainable community development through sport and events: A conceptual framework for Sport-for-Development projects. *Sport Management Review, 15*(1), 1-12. DOI: 10.1016/j.smr.2011.06.001

Seymoar, N., Ballantyne, E., & Pearson, C. J. (2010). Empowering residents and improving governance in low income communities through urban greening. *International Journal of Agricultural Sustainability*, *8*(1-2), 26-39.

Su, K., Li, J., & Fu, H. (2011). Smart city and the applications. *2011 International Conference on Electronics, Communications and Control (ICECC).* DOI: 10.1109/ICECC.2011.6066743

Walker, G., & Devine-Wright, P. (2008). Community renewable energy: What should it mean?. *Energy Policy, 36*(2), 497-500. DOI: 10.1016/j.enpol.2007.10.019

Wittig, R. (2008). *Principles for Guiding Eco-City Development., Ecology, Planning, and Management of Urban Forests* (pp. 29-34). (Edited by Margaret M. Carreiro, Yong-Chang Song, Jianguo Wu)

Zanella, A., Bui, N., Castellani, A., Vangelista L., & Zorzi, M. (2014). Internet of things for smart cities. *IEEE Internet of Things Journal, 1*(1), 22-32. DOI: 10.1109/JIOT.2014.2306328

臺灣建築學會「建築學報」第 106 期增刊（創新低碳與綠建築專刊）
JOURNAL OF ARCHITECTURE, No. 106, Special Issue on Innovative Low-carbon and Green Building

臺北市智慧生態社區評估指標體系

孫振義 [1*]　李得全 [2]　陳宥羽 [3]　吳存金 [4]

[1] 國立政治大學地政學系教授
[2] 臺北市政府副秘書長
[3] 國立政治大學地政學系碩士生
[4] 國立政治大學地政學系博士生
[*] 通訊作者 Email: justin.sun.tw@gmail.com

摘 要

近年來，氣候變遷、老齡化社會、出生率下降、能源效率和降低碳排放等城市問題受到了極大的關注。為了對應這些問題，世界各國政府都提出了創新的規劃概念，如：生態和智慧規劃。作為臺灣的首都，臺北市負有引領臺灣眾多城市面對這些課題之責任。由於城市規劃的基礎單元是社區，因此社區居民作為社區發展的核心，其將是決定規劃成功與否的關鍵因素。本研究建立了「臺北市智慧生態社區指標體系」，並且以臺北市既有的三個「市地重劃區」進行指標試評估，最終提出了推動「臺北市智慧生態社區評估指標」的策略。

關鍵字：永續發展，生態城市，智慧城市，綠色社區，綠色建築