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A Study on the Inter–Korean Cooperation for Establishing the Oriental Stork Ecology Network

Young–Sun Yoon* · Young–Sook Nam**

Abstract: The purpose of this study is to explore avenues for inter–Korean cooperation to establish an ecological network for Oriental Storks on the Korean Peninsula. There were no more Oriental Storks in ROK in about 25 years ago. However the reintroduction of Oriental Storks has been successful. Their release back into the wild is now at the experimental stage. In the DPRK, Oriental Storks are a rare bird. Subsequently, the DPRK has also recognized the need for their protection and is focusing upon the protection of the wetlands along its western coast.

Taking these individual efforts by the ROK and the DPRK as a common task to establish an ecological network for Oriental Storks on the Korean Peninsula, this study proposes a plan for cooperation in three stages such as EXPERT EXCHANGE AND BASIC RESEARCH, HABITAT RESTORATION AND DATA SHARING, and THE REINTRODUCTION OF THE SPECIES ON THE KOREAN PENINSULA.

To achieve this, the Korean government, local governments and private organizations will need to provide legal, political, and economic support to promote exchange, cooperation and active human interactions with experts.

Key Words: Oriental Stork Reintroduction, Oriental Stork Ecological Network, Inter–Korean Cooperation

I. Introduction

The ecosystems that have interrelationships are also connected spatially. Based on this, Korea is aware of the problem of the populations reduction due to habitat fragmentation and the consequent deterioration of species diversity and has a rising interest

* First Author, Graduate student, Korea National University of Education
** Corresponding Author, Professor, Korea National University of Education
in habitat connectivity and wildlife movement (Jeon et al., 2008). Amid this issue, some of the Oriental Storks that have been successfully restored and released into the wild in ROK have stayed back in DPRK for the past four years (Eco-Institute for Oriental Stork: ECOIOS, 2019).

Restoring Oriental Stork means not only the restoration of the species but also the habitat for the Oriental Stork to live in. Furthermore, the restoration of Oriental Storks, located at the top of the ecological pyramid, means that all of the layers below have been restored (Bae and Kim, 2018). That is, it is a restoration of a healthy ecosystem and, moreover, a restoration of harmonious life between nature and man.

A total of seven Oriental Storks have been to the DPRK since 2015. In particular, the ‘A81’ Oriental Stork has been staying in DPRK for about two months since September 2018 (ECOIOS, 2019). The fact that the habitats along the migration route of the restored Oriental Stork continue not only to ROK but also to DPRK, shows the connectivity of the spatially continuous ecosystems. It also raises the need for the two Koreas to cooperate to secure a stable habitat for the restored Oriental Storks. However, previous research on Oriental Storks, which used to be the nation’s resident bird, is mainly about the significance of the restoration of Oriental Storks in terms of its extinction and sustainable development. Since 2008, research has been conducted on the characteristics and habitat analysis of Oriental Stork habitats in ROK (Kim et al., 2008). Recently, however, the migration routes of the restored Oriental Stork have been expanding to DPRK, but related research is insufficient. To ensure the stable return to the wild of the Oriental Storks reintroduction in ROK,
research on the spatially connected habitats of DPRK is necessary. Moreover cooperation for the conservation and expansion of the Oriental Stork habitats in DPRK is essential.

Therefore, the purpose of this study is to explore the ways of how ROK and DPRK should cooperate in the future to establish an ecological network on the Korean Peninsula along the migration pathway of the Oriental Stork. The research questions were created to achieve the objectives of the study and are as follows.

First, it analyzes the history and the current status of Oriental Stork restoration in ROK.

Second, DPRK’s environmental trends are analyzed through meaningful data related to Oriental Storks.

Third, based on the results of the analysis, it will draw up measures for inter-Korean cooperation to establish the Oriental Stork ecology network on the Korean Peninsula.

II. Theoretical Background

1. Overview of Endangered Species

Established to secure biodiversity and conserve nature and natural resources, the International Union for Conservation of Nature (IUCN) publishes the Red Data Book, which evaluates endangered species. Oriental Storks are classified as endangered species that is the fourth phase of the nine-stage category, which indicates a very high risk of extinction in the near future.
2. Designation of Endangered Wildlife in ROK

Endangered wildlife is a species that are protected, and managed by law. Endangered species of wildlife are classified into species 1 and species 2. Class 1 endangered wildlife\(^1\) refers to endangered wildlife whose populations are greatly reduced due to natural and artificial threats. Endangered wildlife class \(^2\) refers to wildlife whose population is greatly reduced due to natural and artificial threats, and thus which is at risk of becoming endangered soon if current threats are not eliminated or mitigated (Article 2, Law on the Protection and Management of Wildlife). The designation of endangered wildlife by law is intended to promote biodiversity in order to balance ecosystems and to protect and manage them more efficiently.

3. Laws Related to Natural Monuments

Oriental Storks are designated as a Natural Monument in ROK and DPRK respectively\(^3\), and are recognized for the need of protection. The legal basis for the conservation of Oriental Stork is shown in (\(<\text{Table 1}>\)).

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1) Oriental Stork et al., 13 species.
2) Black-headed Gull et al., 48 species.
3) Natural Monument No. 99 in ROK and No. 303 in DPRK (nm.nktech.net/).
## III. Research Method

In order to achieve the purpose of this study, a literature survey was conducted as follows. First, the relevant contents are extracted mainly from thesis and academic journals searched by keywords such as 'Oriental Stork' and 'Inter-Korean Cooperation' from thesis search engines such as RISS and DBPIA. Second, Oriental Stork restoration data of 'ECOIOS' is analyzed. Third, the DPRK environmental trend data related to Oriental Storks is analyzed.

## IV. Results and Discussion

### 1. Steps and Prospects of Oriental Stork Restoration in ROK

The Oriental Stork was a common bird in early 1900’s, and lived mainly in Gyeonggido, Chungcheongdo, and Hwanghaedo, but...
declined rapidly during the industrialization process (Park, 2004). Accordingly, the Cultural Heritage Administration designated Oriental Stork as Natural Monument No.199 in 1968 under the Protection of Cultural Properties Act. In 1971, the last Oriental Stork couple was found in Eumseonggun, Chungbuk. But the male Oriental Stork was shot by a hunter the female Oriental Stork lived alone until 1983 when she fell to pesticide poisoning and was moved to Seoul Grand Park. After her death in 1994, it was reported that the Oriental Stork, the resident bird of ROK, became extinct in the country (Park, 2004).

ECOIOS have started the reintroduction program for Oriental Storks breeding population disappeared in ROK since 1971 with importing captive Oriental Storks from Germany and Russia in 1996 and succeeded in artificial breeding for the first time in 2002. Oriental Storks were designated as endangered wildlife class 1 by the Ministry of Environment according to the ‘Wildlife Protection and Management Act’ (https://species.nibr.go.kr/). ECOIOS, ROK’s only Oriental Stork restoration institute, was designated as a ‘Habitat Exterior Protection Agency’ in 2001 (Nam, 2018).

Following the restoration of the Oriental Stork species, the Cultural Heritage Administration established 'Yesan Stork Park' in Yesan district of Chungcheongnamdo in 2015. Eight Oriental Storks were released near the Yesan Stork Park in 2015, and first released breeding pair produced two chicks successfully in 2016. Three breeding pairs continued to breed successfully from 2017 to 2019. In addition, Oriental Storks released or born in Yesan, have widely inhabited mainly Gyeonggido, Chungcheongdo and Jeollado, and some of them have been confirmed to have traveled to DPRK, China and Japan.
A total of seven Oriental Storks have been to DPRK since 2015, four of which have been there for two consecutive years. In 2016, an Oriental Stork stayed around Hwanghaedo for ten days. In particular, the 'A81' Oriental Stork stayed for about two months from September 26 to December 6, 2018, in Oncheoneup (Pyeongannamdo), Kwaksangun and Cheolsangun (Pyeonganbugdo), and Jangyeongun (Hwanghaenamdo). As of October 2018, the number of Oriental Storks is about 200, with 83 in ECOIOS, 77 in Yesan Stork Park, and 39 Oriental Storks being released and monitored (ECOIOS, 2019).

Captive breeding program, first step among the endangered Oriental Storks reintroduction program has been successful since the first breeding in captivity in 2002. The Oriental Stork is now in the process of expanding its wild habitats to ensure a stable reintroduction to the wild. To this end, the ECOIOS has established a 'Vision 2.0' plan to monitor the distribution of Oriental Storks nationwide, and based on the data, is implementing a mid- to long-term roadmap for habitat analysis, habitat assessment models, and international cooperation (ECOIOS, 2019).

Monitoring results so far show that the unique characteristics of the Oriental Storks looking for food in wetlands or farmland, and nesting on high trees are well represented, indicating that stable management and protection of wetlands, farmland, and forests are closely linked to the releasing to the wild of the Oriental Storks.

2. Environmental Trend Analysis for Oriental Storks in DPRK

DPRK’s environmental trends related to Oriental Storks are as follows.

First, in DPRK, the Oriental Storks are protected under the
Environmental Protection Law as natural monument No. 303 (Park, 2003), and is responsible for environmental protection work at the Ministry of Land, Infrastructure and Transport (Lee, 2002). The Ibis and Seabird Habitats are designated as natural monuments in Pyongannamdo and Pyonganbukdo where the Oriental Stork 'A81', which was restored by the ECOIOS, resided (nm.nktech.net/).

Second, according to the '2003 Inter-Korean Environment Forum’ Environmental Impact Assessment Survey of KEDO Nuclear Power Plants (Jung, 2003, p.96), One or two Oriental Storks were seen moving in Sinpo (Hamgyongnamdo).

Third, according to the ‘2017 DPRK Environmental Trends’ (Choo and Jung, 2017, p.143), DPRK’s west coast is becoming a safe route habitat for many migratory birds, and is conducting joint research with the ‘New Zealand Miranda Natural Fund Delegation’. It also emphasizes the need for international cooperation to protect migratory birds, that is closely linked to human survival and development.

Fourth, in April 2018, it joined the EAAFP (East Asia-Daeyang Migratory Bird Pathway Partnership), and Mundeok (Pyonganbukdo) and Geumya (Hamgyongnamdo) Migratory Bird Sanctuary in were listed as International Migratory Habitats (https://www.eaaflyway.net/). In May, Mundeok and Rason (Hamgyongbukdo) Migratory Bird Protection Area in were registered as Ramsar Wetlands. In July, the ROK and the DPRK met at the East Asia Ramsar Regional Center and promised to share information on wetland management and conservation along the west coast and to cooperate through regular meetings. In addition, DPRK is actively engaged in international exchanges and cooperation by working with Suncheon City and the
International Crane Foundation to push for the restoration of the habitat of the cranes (KOEM, 2019).

3. Inter-Korean Cooperation for ‘Establishing the Oriental Stork Ecology Network on the Korean Peninsula’

Oriental Storks breeding population disappeared in ROK since 1971, but its species reintroduction has succeeded, and its release to wild is under way. DPRK is also aware of the need for protection of rare birds, and thus paying attention to the protection of wetlands along the West Coast. Taking these individual efforts as a common task of ‘Establishing the Oriental Stork Ecology Network on the Korean Peninsula’, I would like to propose three stages of cooperation based on the history of the reintroduction of Oriental Storks in the ROK.

(Figure 1) Strategies for cooperation by step

<table>
<thead>
<tr>
<th>Step. 1</th>
<th>Step. 2</th>
<th>Step. 3</th>
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<tbody>
<tr>
<td>(Ensure Genetic Diversity)</td>
<td>(Ensure Habitat Diversity)</td>
<td>(Released Population Increased)</td>
</tr>
<tr>
<td>Expert Exchange And Basic Research</td>
<td>Habitat Restoration And Data Sharing</td>
<td>Reintroduction On The Korean Peninsula</td>
</tr>
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</table>

The first step is expert exchange and basic research between the two Koreas. ROK achieved success in reintroduction the Oriental Stork about 20 years after its disappeared. DPRK has a record of Oriental Stork being mentioned in the 2003 ’Environmental Effects
Assessment Report of KEDO Nuclear Power Plant’, but it is difficult to determine the existence of the Oriental Stork just by press releases and records related to the subsequent migratory birds.

Therefore, based on the accumulated experience of ROK, which successfully reintroduced the Oriental Stork, a basic survey should be conducted to determine the number of Oriental Storks at the site believed to be habitat to DPRK Oriental Storks. Before reunification, Germany engaged in various exchanges and cooperations to overcome environmental, economical, social and cultural differences, and problems derived from the different systems (Nam, 2008). ROK and DPRK, likewise, need time, cost and expert exchanges at the civilian and governmental levels to conduct a joint survey of the Oriental Storks.

In addition, the ‘ROK and DPRK Forest Cooperation Research Center’ of Kangwon National University will conduct a three-way joint study with the ‘Urban and Environmental Ecology Research Institute’ at Yanbian University in China and ‘Kim Il Sung University’ (Lee, 2016). And Suncheon City and the ‘International Crane Foundation’ will cooperate with DPRK to restore the habitat of black-crowned cranes (KOEM, 2019). In this way, with ECOIOS at the center, it could also push for three-way cooperation involving DPRK universities and organizations such as the Korean Federation for the Protection of Nature or international organizations such as the EAAFP.

The second step is habitate restoration and data sharing of the Oriental Stork. Currently, ROK has released the Oriental Stork into the wild since 2016 and is monitoring their natural adaptation (ECOIIOS, 2019). In the process, seven Oriental Storks were confirmed
to have traveled to DPRK.

Therefore, after a joint survey of the Oriental Storks and habitats is conducted, we will be able to try to release the ROK Oriental Stork into the nature, especially around Jangyeongun (Hwanghaenamdo), Oncheoneup (Pyeongannamdo), and Gwaksan- gun and Cheolsangun (Pyonganbukdo), where the Oriental Stork ‘A81’ has stayed.

According to Lee et al. (2004), the area of Yeonbaek Plain in Hwanghaenamdo is located in the northern part of the Han River estuary in northern Gyeonggi Bay. Most of these are small streams flowing into the sea, and that habitats are suitable foraging site for Oriental Stork.

If the Oriental Stork restored in the ROK, can be naturally released and successfully inhabited in the DPRK, the reintroduction of the Oriental Stork on the Korean Peninsula can be effectively completed. Furthermore, sharing data on the migratory routes of Oriental Storks will be the basis for the establishment of an ecological network for Oriental Storks on the Korean Peninsula.
Finally, The third step is the reintroduction of the Oriental Stork on the Korean peninsula. Once a stable habitat has been secured through the first and second stages, the Oriental Stork can be successfully released into their natural habitat. The Oriental Stork ecological network can be established along the Oriental Stork’s migration path on the west coast and plains of the Korean Peninsula and further to the east and south coasts.

Also, if the reintroduced Oriental Stork can reliably inhabit the two Koreas, the possibility of pairing with the Oriental Storks from Russia, China and Japan in order to secure genetic diversity will increase. To achieve this, the ROK and the DPRK could conclude a bilateral Oriental Stork protection agreement and further expand into multilateral Oriental Stork protection agreements with neighboring countries such as Russia, China, and Japan.

V. Conclusions

The purpose of the study is to explore ways of inter-Korean cooperation to establish Oriental Stork ecological network on the Korean Peninsula. To achieve this goal, it examined the status of the restoration of Oriental Storks in ROK, analyzed the DPRK environment related to Oriental Storks, and suggested three steps for inter-Korean cooperation: Expert exchange and Basic Research, Habitate Restoration and Data Sharing, Reintroduction on the Korean Peninsula.

ROK has now reached the second stage of monitoring the Oriental Stork after releasing them into their natural habitats, but DPRK must
first confirm their existence. In particular, the severe deforestation in DPRK is expected to damage Oriental Stork habitats. However, due to the limited data on the DPRK Oriental Storks, it is difficult to understand the situation.

As the Oriental Storks reintroduced in ROK are already expanding their route to DPRK, the two Koreas should actively cooperate to release the Oriental Stork back into the wild through the conservation and expansion of its habitats, and to create a healthy ecosystem in which humans and Oriental Storks coexist through the establishment of an ecological network.

Therefore, the government, local governments and private organizations should first provide legal, political and economical support so that they can pursue exchanges and cooperation in various ways. And, active human exchanges focusing on experts should be started.

Furthermore, multilateral exchanges with Russia, China, and Japan will be necessary, including various cooperation between the ROK and DPRK, and the establishment of an ‘East Asian Oriental Stork Ecological Network’ that will lead through Russia, China, the Korean Peninsula, and Japan in the future. Also, sharing awareness among the locals for the conservation of wetlands, farmland, and forests, which are the foundation of the Oriental Stork’s life, should be extended.

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Natural Monument in North and South Korea, 2019, nm.nktech.net/.

Young Sun Yoon: She worked at Soryong Elementary School, a member of the Jeollabukdo Office of Education, and is a student at the Graduate School of Environmental Education, Korea National University of Education. The area of interest is an environmental education based on Oriental Stork (culpig1@hanmail.net).

Young Sook Nam: She is professor at the department of environmental education in Korea National University of Education, and currently serves as the director of the Eco-Institute for Oriental Stork. Her interest areas include environmental policy, environmental impact assessment, climate change, women, environment, culture, and sustainable development theory. In particular, the restoration and preservation of the Oriental Stork, which is the first class of endangered wildlife, and sustainable development models with Oriental Storks. In 1993, she received her Ph.D. degree(Environmental Policy and Evaluation) from the Department of Landscape Planning at Technical University of Berlin, Germany and served as a senior researcher at Korea Environment Institute (ysnam@knue.ac.kr).

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Are Smart Cities Growing Smartly and Sustainably?: Smart and Sustainable Growth Evaluation of Each Plan of Two Smart Cities in South Korea*

Jiyong Park** · Sihyeon Kim*** · Sunmin Jun**** · Juchul Jung*****

Abstract: A smart city (SC) should be planned and constructed based on Urban Growth Management. There is insufficient research to assess whether projects designed for the creation of SCs are in-line with both Smart Growth and Sustainable Growth practices, which are the foundation of Urban Growth Management. The purpose of this study is to assess whether the projects designed for the creation of SCs in Korea have been conducted using Smart Growth and Sustainable Growth practices. We selected the Sejong 5-1 Neighborhood and Busan Eco Delta City as case study areas. We evaluated the SC plans based on both Smart Growth principles and Sustainable Growth indices. As a result, we found that SC plans in both case study areas have primarily focused on economic growth opportunities that have followed some technological indicators. The indicators for equitable approval processes, efficient development patterns, and resiliency to hazards, but, were all found to be lacking in the urban planning considerations for these cities. This article proposed that Urban Growth Management such as Smart Growth and Sustainable Growth is important for environmental policy.

Key Words: Smart City, Smart Growth, Sustainable Growth, Plan Evaluation

I. Introduction

The era of smart cities (SCs) has arrived. Over the past few years,
global SC development projects have flourished, such as the United States’ (U.S.) SC Team Challenge Project, India’s SC 100 Construction Project, and so on (Lee and Lim, 2017). In January 2018, the Korean government selected Sejong 5-1 Neighborhood (Sejong 5-1N) and Busan Eco Delta City (Busan EDC) as the locations for pilot SCs. This project is a prototype for SCs in Korea to create a leading model for future SC-building businesses.

For a long time, urban planners agonized over Urban Growth Management to solve problems caused by indiscriminate development and urban sprawl. Among the proposed solutions, Smart Growth became a major agenda in the field of urban planning in the late 1980s and is still a growth management ideology and strategy adopted by many cities today. SCs and Smart Growth are similar in that they both stem from the need to solve urban problems, but Smart Growth is largely rooted in Urban Growth Management, while SC is an urban planning concept that have emerged as opportunities to incorporate new innovations in modern technologies like information and communication technology (ICT).

The trajectory of changes in Urban Growth Management reveals the values and planning/design elements that should be oriented toward sustainable urban development. However, while SCs seem to be following the direction of Urban Growth Management, it is not certain whether they should be included in the trajectory of Urban Growth Management. The reason we question this is because SCs emerged among a tendency to solve urban problems with modern technology like ICT.

Are SCs growing smartly and sustainably? This study sought to find answers to this question by evaluating two plans for pilot SCs in terms
of smart and Sustainable Growth. We conducted this research in the following order. First, we explored the links between Urban Growth Management and SCs through a literature review, and then we formulated the research questions. Second, we compared the basic characteristics of the two pilot SCs in Korea and analyzed the evaluation results and the SCs’ planned self-evaluation methods. Finally, based on the results of the analysis, we argue that Urban Growth Management, such as smart and Sustainable Growth, is a priority for SCs.

II. Smart Growth and Sustainable Growth on the Trajectory of Urban Growth Management

Modern metropolises suffer from a lot of urban problems such as traffic congestion, environmental pollution, lack of open spaces, housing supply imbalances due to polarization between classes, urban decline, and natural disasters due to climate change. Urban Growth Management has developed in different ways. U.S. local, regional, and state growth management policies can be largely divided into four major waves from the 1950s to the present, which can be represented by a single trajectory. Capitalist countries with institutionalized urban planning can be said to follow this trajectory, even if the timing and indicators vary slightly between countries. The main theoretical background of this study is Chapin’s (2012) discussion of the waves of Urban Growth Management.

The trajectory of Urban Growth Management has been formed through four waves. The first wave on the trajectory of Urban Growth
Management is the era of growth control in which suppressed urban growth or planned expansion such as urban growth boundary development stop lines, the rate of growth ordinance, growth caps, and so on. The second wave is the era of comprehensive planning, in which urban growth and development are managed rather than merely suppressed or planned expansion. In the 1980s and 1990s, communities across the U.S. began campaigns against urban sprawl that is related to above problems, focusing policies and programs on creating a more compact and livable community. At the same time, the New Urbanism movement took place, and city landscape design was incorporated into Urban Growth Management programs (Chapin, 2012).

<table>
<thead>
<tr>
<th>Defining issues</th>
<th>Era of growth controls</th>
<th>Era of comprehensive planning</th>
<th>Era of smart growth</th>
<th>Era of sustainable growth</th>
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<tr>
<td></td>
<td>Environmental degradation, loss of pristine lands, exurban development</td>
<td>Environmental degradation, infrastructure costs, infrastructure provision, professionalization of planning</td>
<td>Environmental degradation, infrastructure provision, placemaking, urban economic development</td>
<td>Economic development, environmental degradation, climate change, energy demand and supply</td>
</tr>
<tr>
<td>Basic approach</td>
<td>Strict limits on the amount of growth, boundaries delineating the preferred locations of new development, planned expansion</td>
<td>Regulation of development, comprehensive planning, infrastructure planning</td>
<td>Incentives and public infrastructure investments to support desirable development outcomes</td>
<td>A combination of incentives and regulations that promote development outcomes appropriate to urban, suburban, and rural locations</td>
</tr>
<tr>
<td>Era’s implied motto</td>
<td>Growth needs to be managed aggressively</td>
<td>Plans, regulations, and budgets are the solution to the problem of growth</td>
<td>Growth is an opportunity for strengthening urban communities</td>
<td>Growth is inevitable and essential, but must be balanced against the long-term goal of sustainability</td>
</tr>
</tbody>
</table>

Source: Chapin, 2012
While private participation in the public sector is expanding, the era of Smart Growth, a third wave, has emerged due to the recognition of the limitations of comprehensive planning-oriented Urban Growth Management and discussion of ways to improve it. With the Smart Growth movement, numerous cities have embraced many of the core concepts of the movement and are incorporating these ideas into their plans (Chapin, 2012; Ye, Mandpe and Meyer, 2005). In the era of Smart Growth, urban growth is regarded as an opportunity to improve the community rather than a matter of controlling and managing it. The U.S. state of Maryland, which institutionalized Smart Growth in its urban planning, established the Smart Growth Act in 1997 to facilitate new developments in priority funding areas (PFAs). In this way, the state tried to revitalize existing communities by creating landscape designs that incorporated activity centers and high-density architecture. Unlike UGBs and USAs, local governments could receive compensation for most of the state infrastructure costs and were offered various incentives for brownfield maintenance, redevelopment, and job creation through PFA tax credits (Cohen, 2002).

Smart Growth models aim to develop placemaking, streetscape design, and lively activity centers in the community as well as emphasize the importance of image and landscaping in Urban Growth Management. In addition, Smart Growth models enhance partnerships between public, private, and non-profit organizations for existing comprehensive planning models (Crane, 2008).

The fourth wave is the era of Sustainable Growth, which incorporates and advances the concept of Smart Growth in every city that has adopted Urban Growth Management. In the era of
Sustainable Growth, planners should deal with the issues that the Urban Growth Management of Smart Growth has failed to address or neglected (Chapin, 2012):

1. Local economic and community issues, such as the recession and high unemployment rate, housing problems such as plummeting housing prices and redevelopment demolition workers, and the lack of new development in many states that rely on real estate development;

2. Climate change issues that have a significant impact on communities in coastal areas, such as rising sea levels and changes in ecosystems;

3. Growing energy demand and associated problems; and

4. Sustainable and self-sufficient food systems for healthy communities.

Planners should take a close look at Smart Growth and Sustainable Growth, which views growth and development as an opportunity and takes into account long-term issues such as economic recovery, community restoration, climate change, and energy supply. Cooperation among major institutions is paramount for Sustainable Growth.

Urban Growth Management has evolved forming a single trajectory rather than staying at a certain time. The concepts that distinguish 'Urban Growth Management' longitudinally are the era of Urban Growth Control, the era of Comprehensive planning, the era of Smart Growth, and the era of Sustainable Growth. For example, in the era of Sustainable Growth, urban planners would manage urban growth with perspective of Sustainable Growth. They would focus on issues
such as adapt to climate change, energy demand and supply. But, they could manage growth using urban growth boundary with perspective of Sustainable Growth. The eras of them are not the concepts of disconnection, but dominant.

III. ICT: Distinguishing SCs from Other Cities

The acronym SC was first introduced in 1994 (Dameri and Cocchia, 2013), but it still does not have a clear definition (Angelidou, 2015; Caragliu, Del Bo and Nijkamp, 2011; Chourabi et al., 2012; Hollands, 2008; Marsal-Llacuna, Colomer-Llinàs and Meléndez-Frigola, 2015; Wall and Stravropoulos, 2016). However, a comprehensive definition of SC can be built by distinguishing between the technology component (ICT), which combines various features derived from SCs, and the methods and scope of its use. <Table 2> explores the various definitions of SCs.

As shown in <Table 2>, the definition of an SC varies between researchers and institutes. Keywords found in SC definitions include ICT, communication, intelligence, and information (26%); environment and sustainability (17%); infrastructure and services (17%); and people, citizens, and society (12%; Lee and Yoon, 2018). The environment and sustainability are the second most important factors behind ICT and intelligence. But even before the emergence of the concept of SCs (including digital cities, Ubiquitous-cities, etc.), there was interest in the environment and sustainable development. The same is true of infrastructure, services, people, and society. In other words, what distinguishes SCs from previous urban concepts is whether ICT is used.
SCs can be divided into hard smartness and soft smartness depending on the degree of smartness, which is deeply related to the utilization of ICT. Hard smartness refers to actively utilizing ICT to improve the physical parts of cities, such as offices and residential buildings, infrastructure, etc., most of which are tangible assets. In soft smartness, ICT plays a more passive and limited role in driving urban change. For example, intangible assets, such as encouraging communication between local governments and citizens through...
e-governance, exchanging instant feedback between users and providers in the development of a product, or creating a living lab that allows multiple stakeholders to participate in the urban planning process, all belong to soft smartness.

Different countries and regions have different perspectives and approaches to SCs. Even cities that solve problems smartly without using digital science, digital technology, or ICT can be referred to as SCs. But SC technologies must be deeply embedded and integrated into the urban fabric. To do this, the planner must take full advantage of the technological factors and demonstrate concern for community problems, creative thinking, thorough research, good planning, and persistence to achieve bold action (Barlow and Levy-Bencheton, 2018). In other words, technology is not the only requirement for an SC, but SCs would not be possible without modern science and technology.

IV. Links Between Urban Growth Management and Smart Cities

Are SCs an extension of the trajectory of Urban Growth Management? There have been quite a few studies directly comparing SCs with the concept of sustainable development. These studies focused on how the diverse concept of the SC embraces the agenda of sustainable development. In other words, rather than utilizing a diachronic understanding of the apparent background of SCs according to the trajectory of changes in Urban Growth Management, most of these studies viewed SCs and the concept of sustainable development as synchronous.
Some scholars have sought to combine sustainable development with the definition of SCs to achieve various urban planning goals. Global institutions emphasize sustainable development and smart urban transformation to fix urban problems (D’Auria, Tregua and Vallejo-Martos, 2018). As such, there has been lively discussion on how SCs can secure sustainability, which has recently emerged as a new concept called the smart sustainable city (Ahvenniemi, Huovila, Pinto-Seppä and Airaksinen, 2017; Akande, Cabral, Gomes and Casteleyn, 2019; Bibri and Krogstie, 2017; Bifulco, Tregua, Amitrano and D’Auria, 2016; Houvila et al., 2019; Yigitcanlar and Kamruzzaman, 2018). Smart sustainable cities are innovative urban areas that meet the economic, social, environmental, and cultural needs of current and future generations, while utilizing ICT and other means to improve efficiency, competitiveness, and quality of life in terms of urban services (ITU, 2016).

Cities change as they respond to opportunities provided by new tools and technologies such as ICT as well as new challenges arising
from the needs of society (Zhang et al., 2016). Digitalization processes are inherently based on technology infrastructure and innovation systems. The smarting process, however, considers all aspects of regional growth and daily life, from the support of sustainability to ICT (Caragliu et al., 2011).

Previous studies on the link between SCs and sustainable development have often simply compared the two concepts without considering the trajectory of Urban Growth Management. Some scholars have defined SCs as an umbrella concept that includes numerous sub-topics, such as smart urbanism, smart environment, sustainable and smart technology, smart energy, smart mobility, and smart health (Gudes et al., 2010; Lara et al., 2016). Other researchers have viewed the smarting process as a means of sustainable development (Lytras et al., 2018; Trindade et al., 2017).

Park et al. (2017) stated that smart city has an urban management function that effectively solves urban problems using information and communication technology. Developing countries, in particular, have the potential to create a variety of urban problems due to rapid population growth and urbanization. In developing countries, the need for planned urban development is greater than that of developed countries, and growth management is more directly included in the smart city concept. This is the same context in which the need for growth management was raised in the United States to prevent sprawl in the 1980s. Growth management plays an especially important role in resolving spatial inequality, which is in line with the importance of providing housing type and community in consideration of various incomes and classes in Smart Growth. Smart cities are related to growth management in the sense that growth management based on
Smart Growth eventually creates a sustainable city.

There is still a lack of research on what the relationship between the two concepts is and what should be prioritized in the planning and policy-making process. The following research questions were created based on the literature review:

RQ1: In terms of Urban Growth Management, is the region in Korea currently being developed as an SC planning for smart and Sustainable Growth?

RQ2: Is the concept of an SC located on the trajectory of Urban Growth Management? If it is not, how can the relationship between SC planning and Urban Growth Management be explained?

V. Methods and Results

1. Basic Conditions of the Two Case Study Areas

We selected Sejong 5-1N and Busan EDC, which are pilot SCs, as the case study areas and assessed their SC plans. The two cities announced their plans to implement SC projects in February 2019 (Korean Ministry of Land, Infrastructure and Transport, 2019). Busan EDC has determined indicators for managing its performance to create a continuously “new smart growing city (Busan Metropolitan City, 2019, p.21).” In addition, the city includes plans for improved quality of life, economic security, sustainable urban space models, and energy self-reliance. Sejong 5-1N has set the goal of creating a sustainable city for future generations by focusing on sustainable development, including eco-friendly energy, data-based innovation ecosystems, and citizen-centered participation systems.
Busan EDC is part of Gangseo-gu, Busan. The Busan EDC SC plan was designed to fit the concept of a future waterfront city where innovative ecosystems will be created by fostering industries such as robotics. The 10 main themes were water management, utilization of robotics, learning-day play, intelligent urban management, smart water, zero energy, smart education and living, health, mobility, smart safety, and smart parks. Sejong 5-1N is in Sejong City (also known as Sejong-si). The Sejong 5-1N SC plan is an artificial intelligence-based city with seven major innovation elements, including mobility and health care, education, environment, governance, culture and shopping, and jobs.

Gangseo-gu, Busan has long been one of the least developed area in Busan Metropolitan City due to its low population density and geographical features, such as the Nakdong River Estuary Bank, which is a migratory bird habitat. However, Gangseo-gu recently received attention as a new growth engine of Busan, and the Busan Metropolitan City (2019) plans to develop western Busan into a global city with EDC in mind. Currently, various developments have been made in EDC, such as in the Busan-Jinhae Free Economic Zone, Sinpyeong-Jangrim Industrial Complex, National Industrial Complex in Noksan, and Smart Valley in Sasang. Also, developments in the selected area are expected to continue because it has good access to Gimhae International Airport, the second South Sea Expressway, Busan Station, and the Busan New Port (Busan Metropolitan City, 2019).
Sejong City was constructed in July 2012 as a single-story metropolitan government that does not have a basic local government. Sejong City has been carrying out its administrative-centered multi-city project since 2005, which is intended to create a sustainable model city that leads to balanced national development. The relocation of central government agencies and the establishment of an early growth hub have been completed, and it is currently in the process of expanding its self-sufficiency function and improving
its urban infrastructure. Sejong City also has the advantage of access to the Korean Train Express (Osong Station), various highways, and Cheongju Airport, as well as being within two hours of the country’s major cities (Sejong City, 2019). The pilot SC of Sejong 5-1N is linked to other neighborhoods in the administrative city, including the central administrative region, cultural and international exchange areas, and high-tech industrial function areas. There are plans to implement future high-tech technologies in to the SC by taking advantage of the site’s blank status.

<table>
<thead>
<tr>
<th>Table 3</th>
<th>General characteristics of Sejong-si and Busan Gangseo-gu</th>
</tr>
</thead>
<tbody>
<tr>
<td>Characteristic</td>
<td>Sejong-si</td>
</tr>
<tr>
<td>Area (km²)</td>
<td>464.89</td>
</tr>
<tr>
<td>Population (persons)</td>
<td>284,225</td>
</tr>
<tr>
<td>Open space as a percentage of total land use (%)</td>
<td>69.01</td>
</tr>
<tr>
<td>Number of development permits</td>
<td>2,777</td>
</tr>
<tr>
<td>Local tax per capita (million won/population)</td>
<td>2.34</td>
</tr>
<tr>
<td>Number of people employed (persons)</td>
<td>99,827</td>
</tr>
<tr>
<td>R&amp;D expense (million won)¹</td>
<td>7,553</td>
</tr>
<tr>
<td>Number of patents</td>
<td>307</td>
</tr>
<tr>
<td>Disaster damage (million won)</td>
<td>3.24</td>
</tr>
<tr>
<td>Working age population (persons)</td>
<td>194,460</td>
</tr>
</tbody>
</table>

Sejong City has a higher population density and more development than Busan City’s Gangseo-gu, with a larger per capita local tax, research and development (R&D) spending budget, and number of people available for production. However, Gangseo-gu has more employees in business than Sejong City. Knowledge and information-related economic data, such as R&D expenditure and the number of patents, is important for estimating the growth potential.

¹ Note: R&D = research and development. According to the Gangseo-gu Statistical Yearbook (2019, p. 209), the R&D of this area was 0 won.
of SCs. Although Sejong City has greater potential to implement SC development compared to Gangseo-gu, the latter has contact with numerous existing communities in Busan.

2. Plan Evaluation Based on the Smart Growth Principles and the Sustaining Places Scoring Matrix

According to Sun-Ho Park, the vice minister of the Ministry of Land, Infrastructure and Transport, the pilot SC plans are the results of project developers’, ministries’, and experts’ efforts (Korean Ministry of Science and ICT, 2018). The pilot SC plan serves as the basic framework of the city.

In order to determine whether the SC plans contain adequate Urban Growth Management categories, Smart Growth principles and the Sustaining Places scoring matrix were used in this research (Godschalk and Rouse, 2015; Smart Growth Network and International City/County Management Association, 2003). The Smart Growth principle serves as a guideline used by many cities in the U.S. The Sustaining Places scoring matrix was developed to assess the sustainable development of an urban comprehensive plan, but we used this as an evaluation index because the SC plan is a master plan. Indicators that were not covered by the Smart Growth principles were supplemented by the Sustaining Places scoring matrix. In Table 4, Categories 1 to 10 are Smart Growth indicators (based on Smart Growth principles), and 11 to 14 are Sustainable Growth indicators (based on the Sustaining Places scoring matrix). It is expected that the Smart Growth rate of the SC plan and the level of Sustainable Growth can be evaluated separately. Since Smart Growth principles are more elaborate than the Sustaining Places scoring matrix, the two
indicators were integrated to establish a new index.

Compared to Sustainable Growth, Smart Growth focuses on issues related to land use in cities and surrounding areas. For that reason, Smart Growth oriented toward placemaking and streetscape design neglected to deal with 4 issues that were mentioned upfront, local economic and community issues, climate change issues, growing energy demand problems and self-sufficient food systems for healthy communities. To consider these issues, indicators that were not covered by the Smart Growth principles were supplemented by the Sustaining Places scoring matrix. In addition, indicators that are deemed inappropriate or unnecessary to evaluate and analyze the two smart city implementation plans were excluded. Categories from 1 to 10 in (Table 4) are selected to evaluate Smart Growth in each plan. We excluded indicators that are not proper for evaluating plans especially in South Korea and reconstituted them that are close or sharing similar values. Smart Growth indicators were used as the main content of our evaluation indicators because they are more specific in terms of urban planning compared to sustainable ones. Sustainable Growth indicators are categories 11 to 14, and the indicators to be used in the evaluation have been selected and reconstructed from Sustaining Places scoring matrix.

The plan evaluation methodology has been used extensively in urban planning since the late 1990s (Kang, Hyun and Park, 2014). The plan evaluation methodology was used in this study to derive the indicators for evaluation and then provide scores on a sequential scale (Baker, Peterson, Brown and McAlpine, 2012; Kang et al., 2014; Tang and Brody, 2009). Quantitative scoring systems derived from these methods can help facilitate communication between different
stakeholders as well as between-plan comparisons (Berke et al., 2000; Kang et al., 2014).

We reconstructed evaluation criteria except for the contents that are not covered by the master plan (e.g., policy content), which are not suitable to the actual conditions of Korean cities. Smart Growth principle has various policies, concepts, and goals, so it is difficult for all of this to converge on the plan. For example, real estate industry education is not suitable for entering the contents of Korean cities’ master plan, even if it is a necessary principle for Smart Growth. Therefore, we reconstructed the indicators with focus on the planned contents and values for the purpose of assessing smart city plans regarded as the master plans.

To increase reliability in plan evaluation, the protocol was pretested as follows. Members of the research team (the four authors) reviewed all indicators and independently applied the protocol to the same plan and compared results. The team evaluated the plans, each time comparing results, resolving differences in interpretations, and refining the protocol. This process was continued until the team was satisfied that interpretations of results could be evaluated consistently (Berke et al., 2000).

Specific details on how the plans were assessed are as follows. The evaluation results were analyzed using two aspects, the coverage score and the depth score (Brody, 2003a, 2003b; Fu and Tang, 2013; Kang et al., 2014; Tang and Brody, 2009). The coverage score was calculated to determine if the plan addressed a particular indicator. If an indicator was not addressed, a score of 0 was given, and if it was addressed, a score of 1 was given. The depth score was assessed using a three-point ordinal scale to determine how detailed the plan
was regarding the indicator in question (0 points if the indicator was not included, 1 point if the indicator was included but not specified, and 2 points if the indicator was specified for implementation in the region; Kang et al., 2014).

<table>
<thead>
<tr>
<th>Category</th>
<th>Evaluation criteria (Indicators)</th>
</tr>
</thead>
</table>
| 1. Housing choice                 | 1.1 Secure housing for below-median-income households  
1.2 Variety of housing opportunities for home buyers to choose from |
| 2. Walkable neighborhoods         | 2.1 Creating space for walkable communities  
2.2 Safety and mobility for bicycle users and pedestrians  
2.3 Public services near jobs and transit  
2.4 Providing seniors and people with disabilities easy access to public and private services  
2.5 Connections between walkways, parking lots, greenways, and waterways |
| 3. Participatory planning         | 3.1 Education and promotion that stimulate participation of various stakeholders  
3.2 Various materials and programs that activate citizen participation  
3.3 Cultivation of relationships with schools, universities, and colleges  
3.4 Establishing collaborative relationships with non-governmental organizations |
| 4. Community image                | 4.1 Planning that encourages adaptive reuse of historic or architecturally significant buildings  
4.2 Active and secure open spaces  
4.3 Programs for interchange between community residents  
4.4 Programs for streets, buildings, and public spaces that coincide to create a sense of place |
| 5. Equitable approval process     | 5.1 Rational and cost-effective urban development guidelines  
5.2 Development of a self-evaluation program for Smart Growth projects  
5.3 Use of specific means of expression to visualize the results of developments |
| 6. Integrated land use            | 6.1 Programs that create a balance between jobs and housing  
6.2 Mixed-use development |
| 7. Resource conservation         | 7.1 Programs that preserve open spaces  
7.2 Planning for green infrastructure  
7.3 A network of trails and greenways |
| 8. Multi-model transportation     | 8.1 Variety of transportation choices  
8.2 Connection between transportation modes  
8.3 Transit-oriented development  
8.4 Programs that address parking needs and opportunities |
### Results and Analysis

Certain smart and Sustainable Growth indicators were well-addressed in both regions, while others were given insufficient attention. This is because the two regional SC plans focused on SC themes, such as artificial intelligence, robotics, smart education, smart energy, and smart mobility. In other words, the plan was developed based on various SC indicators rather than developing an Urban Growth Management strategy after fully analyzing the environmental and topographical characteristics of the case area and the conditions in the surrounding area.

In both areas, high depth scores and coverage scores were obtained.
for the categories of walkable neighborhoods, integrated land use, and multi-modal transportation. These specific categories are primarily related to transportation, which is the easiest ICT to utilize in the urban planning approach. For example, transit-oriented development in the field of multi-modal transportation is related to job-housing proximity and integrated land use. It is also very closely related to the walkable neighborhood environment in terms of reducing reliance on cars.

Additionally, both regions achieved high depth scores and coverage scores in the Sustainable Growth categories of reasonable energy consumption and healthy community. The Sejong 5-1N presented specific alternatives, including smart energy structure and strategies, with the aim of creating a “sustainable eco-friendly future energy city (Sejong City, 2019).” The Busan EDC pilot city set a target of “production of 100% of the energy consumed with renewable energy to create a sustainable energy self-reliance city (Busan Metropolitan City, 2019).” Thus, unlike Sejong 5-1N, Busan EDC has included a rational energy consumption strategy within the specific category of renewable energy. Both areas received high overall scores for healthy community by including plans to create spaces that promote a safe neighborhood environments, healthy lifestyles, and healthy local food. However, Sejong 5-1N designated indicators such as culture, shopping, and healthcare among the seven major innovation elements of pilot cities and described the related information in more detail than the Busan EDC plan.

The two regional SC plans lacked detailed proposals in two major Urban Growth Management areas. First, there was a lack of consideration for the categories of equitable approval process,
efficient development patterns, and resilience to hazards. An equitable approval process is a rational and cost-effective urban development program that uses a self-assessment system to facilitate Smart Growth projects and evaluate the development results. Although the Busan EDC SC plan provided details for the creation of a cost-effective urban development program (including the application of a regulation sandbox), its plan to develop key performance indicators to “ensure the sustainability of cities (Busan Metropolitan City, 2019)” did not include specific sustainability considerations, details regarding the 27 key performance indicators, or an assessment system for Smart Growth projects.

<table>
<thead>
<tr>
<th>Category</th>
<th>Sejong 5-1N</th>
<th>Busan EDC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coverage</td>
<td>Depth</td>
</tr>
<tr>
<td>1. Housing choice</td>
<td>0.50</td>
<td>1.00</td>
</tr>
<tr>
<td>2. Walkable neighborhoods</td>
<td>1.00</td>
<td>1.20</td>
</tr>
<tr>
<td>3. Participatory planning</td>
<td>0.75</td>
<td>1.25</td>
</tr>
<tr>
<td>4. Community image</td>
<td>0.60</td>
<td>0.8</td>
</tr>
<tr>
<td>5. Equitable approval process</td>
<td>0.33</td>
<td>0.67</td>
</tr>
<tr>
<td>6. Integrated land use</td>
<td>1.00</td>
<td>1.50</td>
</tr>
<tr>
<td>7. Resource conservation</td>
<td>0.75</td>
<td>0.75</td>
</tr>
<tr>
<td>8. Multi-modal transportation</td>
<td>1.00</td>
<td>1.75</td>
</tr>
<tr>
<td>9. Efficient urban infrastructure</td>
<td>0.67</td>
<td>1.00</td>
</tr>
<tr>
<td>10. Efficient development patterns</td>
<td>0.33</td>
<td>0.33</td>
</tr>
<tr>
<td>11. Responses to climate change</td>
<td>0.50</td>
<td>0.50</td>
</tr>
<tr>
<td>12. Reasonable energy consumption</td>
<td>1.00</td>
<td>2.00</td>
</tr>
<tr>
<td>13. Resilience to hazards</td>
<td>0.20</td>
<td>0.20</td>
</tr>
<tr>
<td>14. Healthy community</td>
<td>1.00</td>
<td>2.00</td>
</tr>
</tbody>
</table>

If the Busan EDC SC plan had laid out specific strategies for Sustainable Growth, there would have to be strategies for responding to natural disasters due to climate change, strategies for reducing
energy consumption, strategies for improving community rigidity that occur after disasters, and strategies for self-sufficient, and healthy community. The Sejong 5-1N SC plan contained the categories of the regulatory sandbox, but it was hard to say that it was only for urban development programs especially in terms of Urban Growth Management. The Sejong 5-1N SC plan introduced these regulatory sandbox for using test-bed of new technologies and easing the data-related regulations. However, Sejong 5-1N contained some indirect details on cost-effective urban development by describing the progression of laws pertaining to innovative cities as well as regulations for each category.

Second, both regions lacked plans to protect their legacy against hazards. There were no plans for natural disaster response or economic recovery after a disaster. The Busan EDC included details on the prevention of development in hazard zones and protections for floodplains, watersheds, and streams, but these lacked specificities. The Sejong 5-1N SC plan only focused on climate resilience improvement, which is aimed at protecting the environment from pollutants.
The category of efficient development patterns has a total of three detailed indicators. Both case areas lacked details on strengthening the link between the width and size of buildings to improve the landscape and the walking environment (Indicator 10.2). In the case of Busan EDC, efficient development patterns primarily focused on the development of public open space, and in the case of Sejong 5-1N, the only programs that fell in this category were those designed to encourage high-density development. It seems that the Busan EDC SC strategy is to secure the skyline by limiting the number of floors. This could be the result of the limitation of Smart Growth indicators, since high-density development is not the best choice for all regions.

Next, there was a lack of detailed strategies for urban planning alternatives in terms of Smart Growth. The Busan EDC pilot city presented a “New Smart Growing City (Busan Metropolitan City, 2019)” space plan and expressed an awareness of urban issues such as urban sprawl, downtown decline, and inequality. However, the suggested solutions did not utilize enough urban planning. For example, they said, “instead of simple zoning in existing communities
there should be creative complex land use and minimum area for location regulation in SC,” but the details of the plan fell. The Sejong 5-1N SC plan tended to focus more on indicators than the Busan EDC plan, but it did not formulate sufficient strategies that fully considered the characteristics of the space, and surrounding areas. The layout of Sejong 5-1N was built around the transportation infrastructure. there simply wasn’t enough room in the proposal to discuss all indicators of growth management.

Public officials of the Busan Metropolitan City created a pilot SC plan that classified the urban model into distinct industrial revolutions, with smartness separate from sustainability (Figure 5). This demonstrates that an SC is an advanced form of sustainable city and not a separate concept. (Figure 5) also demonstrates that they view a physical approach as a requirement of urban planning. They even show urban planning as a lower-level concept than urban construction and urban management. Urban management (not growth management) and urban construction are not higher concepts than urban planning. Urban planning should be the top priority when addressing urban issues, unless these are not relevant to national security or national land planning.
VI. Conclusion: Urban Growth Management as a Priority for SC Planning

The concept of SCs does not fully include all indicators of Urban Growth Management and is thus a separate entity from the Urban Growth Management trajectory. Urban Growth Management has a priority about SC planning. Simply put, Sustainable Growth is an ideology and goal that all cities should pursue, but not all cities need to be planned SCs. SCs are not the extension of the trajectory of Urban Growth Management. Therefore, Smart City planning should be discussed based on Urban Growth Management.

Some SCs are planned and constructed sustainably, even if planners don’t recognize the global paradigm of sustainable development. Sustainable Growth is a concept based on the popular trend of sustainable development. Many scholars have sought to find the links
between sustainable development and SCs and to create an integrated concept, like smart sustainable cities. However, sustainable development and SCs do not have a horizontal relationship and should not be used as an alternative to urban planning.

If SCs are not discussed in terms of urban planning access and Urban Growth Management, only sustainable development will be incorporated into SC planning, which could result in the risk of missing out on the numerous solutions addressed by Urban Growth Management. For example, from the perspective of Sustainable Growth, coastal and lowland development should be planned very carefully, with special attention given to the issues of the environment, climate change, and disasters. For example, Busan EDC belongs to a cultural heritage area with migratory bird-watching sites and special coastal control sea areas that are in decline or predicted to collapse. Nearby, there is a wetland protected area that is deemed to be particularly valuable for conservation.

The planners who created the Busan EDC SC need to focus on this situation more carefully. If the city continues to increase its housing development in the form of suburbs to unnecessarily fill open spaces and stabilize the housing market, the costs of building public facilities will be higher in the long run and the city will have failed to maintain Sustainable Growth.
Sustainable Growth, as described in Urban Growth Management, was established based on the trend of sustainable development. Sustainable development that is especially significant to environmental policy can be found in general corporate management philosophy, comprehensive urban plans, civic group slogans, and so on. Sustainable development is an ideology but not an alternative to urban planning programs. However, there is no such thing as sustainable zoning. In other words, sustainable development only provides us with an ideology and a balanced view.

When planning SCs, all aspects of Urban Growth Management should be carefully examined. While the concept of sustainable development has been absorbed into SC planning, the impact of climate change also needs to be considered. There is a lack of planning that accounts for new zoning programs or compact
development that is specifically designed to reduce disasters, environmental protection and adapt to climate change. There are few specific urban planning alternatives, such as living lab contents. This is because the concept of an SC has absorbed the agenda of sustainable development while ignoring Urban Growth Management. Therefore, to create a sustainable SC, it is necessary to recognize the importance of Urban Growth Management and plan accordingly.

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Jiyong Park is a Ph.D student in Urban Planning & Engineering of Pusan National University. The fields of interest are communications in smart cities, planning theory, land use planning and so on (jyxng@daum.net).

Sihyeon Kim is a Master student in Urban Planning & Engineering of Pusan National University. The fields of interest are hazard mitigation planning in smart cities, sustainable development and so on (minjeong205@gmail.com).

Sunmin Jun received a master’s degree in landscape architecture from Seoul National University Graduate School of Environmental Studies and completed a Ph.D in Urban Planning & Engineering from Pusan National University. The field of interest are sustainable land use planning, urban disaster prevention design and urban regeneration according to climate change (sunminjun2011@gmail.com).

Juchul Jung is a professor of Pusan National University in South Korea. He received a PhD. in Community and Regional Planning from The University of Texas at Austin. The main areas of interest are land use planning, hazard mitigation, environmental policy and planning, smart urban growth management and so on (jcjung@pusan.ac.kr).

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The Economic Valuation of Water Quality Degradation from River Algae Blooms: Evidence from the Han River*

Yoon Lee** · June-Mo Woo*** · Yongsuk Hong****

Abstract: Amid a range of growing environmental concerns, water quality degradation coupled with excess concentrations of nutrients in regulated rivers and streams have become problematic at not only the local but a national level. Aiming to revitalize a healthy and self-sustaining river system, the Korean government implemented a massive river restoration project, approximately USD 71.3 billion, and ironically exacerbated algae blooms. The Han River is a restoration project river and the only drinking water source for almost the half the Korean population, including the capital, Seoul, thus impacts of algae blooms were severe. To elicit aggregate economic cost of algae blooms in the Han River, ex-ante and ex-post economic assessment was applied to survey data from 2012 and 2015, using a Spike model and difference-in-differences (DID) analysis. The aggregated cost of algae blooms was estimated to be KRW 84.44 billion (USD 76.76 million). Based on the DID results, the pure aggregate economic cost of removing algae in the Han river were calculated to be KRW 2.56 billion (USD 2.33 million), annually. Although the initial river restoration plan to revitalize rivers was optimistic and promising, consequences might burden the nation.

Key Words: Economic Valuation, Spike Model, Difference-In-Differences Analysis, Aesthetic Value, Algae Bloom

I. Introduction

In recent decades, water quality degradation has become one of the problematic social issues for developed countries and for less developed
countries. Of several possible causes that aggravate water quality, anthropogenic activities have played a significant role in excess concentrations of nitrogen and phosphorus, causing eutrophication in many rivers and streams (Dodds, 2006). Excess nutrients impair water quality, causing negative externalities, including toxic algal blooms that reduce economic as well as aesthetic values for water (Nelson et al., 2015). Although eutrophication of surface waters can occur naturally, anthropogenic activities upstream coupled with climate change can accelerate algal blooms, because higher temperature drives physiological processes in phytoplankton, increasing the frequency and severity of algal blooms (Wells et al., 2015). Moreover, slowing water flow in rivers and streams by introducing dams and weirs that conventionally increase the availability and therefore the value of water can ironically worsen water quality and decrease the value of water, particularly due to a more frequent appearance of algal blooms. Man-made structures in rivers and streams require massive public expenditures to construct and maintain. Adding to these costs negative externalities that result from combining these structures with recent changes in hydrologic patterns due to climate change, suggests a need to carefully assess the net impact of water infrastructure investments. Unfortunately, in many parts of the world, most negative effects from eutrophication are non-stationary, so it can be easy to neglect the costs of nitrogen and phosphorus concentrations (Nelson et al., 2015).

Since the use of algaecides should be avoided so as not to compromise drinking water quality, there are limited number of management options to remove algae blooms in regulated rivers and streams. Biochemical removal of algae such as coagulation-
flocculation and dissolved air floatation are well-known and widely adopted options. However, those methods require labor-intensive and costly cleaning operations, imposing a capital burden on water service providers (MacArthur et al., 2009). Another method is mechanical removal using granular media filtration and intermittent sand filtration. As with the high-management schemes, the mechanical algae removal options may demand capital-intensive inputs, which burden water treatment facilities. Last but not least, flushing flows are a strategic option, in particular for sediment removal, and can eliminate algae blooms and potentially limit periphyton (Flinders and Hart, 2009). However, a hydraulic strategy for benthic algae removal is likely to decrease water availability in the short run and must be applied in a timely manner (Lee et al., 2011).

Of these algae removal schemes, it should be possible to select a feasible option with respect to cost effectiveness. In the absence of information on the benefits of algae removal in natural rivers and streams, applying a homogeneous management scheme may result in unexpected consequences, because benefits are affected by location and time constraints. It may be best for policy maker to begin from an economic perspective rather than a default management strategy.

However, the benefit from algae removal sometimes combine with increasing water quality and the aesthetic value of water. Lee et al. (2017) indicates that a heterogeneous value of water is a key element in identifying the success of water projects. In addition, the value of clean and safe water can change with seasons and differs according to user needs. Given these factors, the benefits of algae removal will vary with conditions, and when monitoring sites with periodically sever algae blooms decision makers seeking the best economic
solution need to understand how benefits change with conditions and with the removal method. A comprehensive cost-benefit analysis should be adopted wherever possible that respects site-specific constraints.

In 2008, the president of the Republic of Korea (Korea) implemented a national-level development strategy, called “Low-Carbon Green Growth”. This policy aimed to reform Korea’s economy from conventional development to an environmental-friendly approach. Sound natural resource management for water scarcity coupled with a climate change impact assessment emphasized a new growth pathway, with USD 17.3 billion dedicated to constructing 16 weirs on natural rivers and streams (Jones and Yoo, 2011). This mega-project intended to prevent flooding, water quality degradation, and water scarcity. In spite of its aspiration, critics including water resource experts and economists (e.g., Lee et al. (2015)) contended that the project neglected various stakeholder demands and disturbed natural interactions, possibly causing benthic algae development in those rivers. Although algae blooms were monitored intermittently at many sites in Korea, their density and intensity continued to accelerate after the mega-project began, becoming a problematic social issue recently in Korea. In this sense, exploring the cost and the benefits of algae has become a critical research questions relating to water availability and use.

Many economists have investigated methods to estimate the value of water and have conducted empirical analyses of overall water quality. For instance, Steinnes (1992) and Bergstrom et al. (2001) studied the value of water quality improvement by applying various valuation techniques in the U.S. However, the majority of prior economic literature has assessed the benefits of reducing overall
sources of water pollutants at different levels (e.g., Larson et al. (2001)). On the contrary, only a handful of studies have focused on nutrient concentrations, mainly concerning algae development at a state-level. This research motivated our work to estimate the value of reducing the nutrient concentration in Korea. Stumborg et al. (2001) applied the contingent valuation method (CVM) to calculate the public’s willingness to pay (WTP) to reduce the chance of algae blooms at Lake Mendota, Wisconsin. Recently, Van Houtven et al. (2014) and Nelson et al. (2015) introduced the cost of water quality impairment due to excess nutrients in southern U.S. lakes. Although the valuation methods used in those articles are applied to estimate the total economic value of water quality degradation or the economic cost of polluted water in an area, to our knowledge there is no economic literature investigating the value of nutrient reduction for the major fresh water source such as the Han River.

Our study investigates one of the four major rivers in Korea where severe water quality impairment has been frequently monitored following construction of new weirs, indicating a major failure in the hydraulic cycle. In addition, our analysis employs two national-level water value surveys, allowing us to conduct statistical analyses, e.g., a contingent valuation method and a difference-in-differences (DID) approach similar to those done in previous studies (e.g. Stumnorg et al. (2001) and Nelson et al. (2015)). The rest of the paper is organized as follows. Section 2 describes the background for our case study, i.e., the restoration project covering the Han River in Korea, with general water-related data, and the survey design for measuring the value of reducing nutrient concentrations in the Han River. Section 3 provides an overview of theoretical approaches for prioritizing and characterizing
water users’ behavior. Section 4 elaborates empirical results from the case study, and in the last section, we conclude with a summary of the main findings, and a brief suggestion for policy makers.

II. Case Study and Application

1. The Han River

On the Korean Peninsula, annual average precipitation is approximately four times greater than the world average, but about 70 percent of Korea’s rain falls during the rainy season (i.e., June to September). In this regard, Korea is categorized as a water-stressed country, and suffers frequent water-related disasters (e.g., droughts and floods) (Normile (2010). Furthermore, due to rapid industrialization coupled with a myopic river development project (i.e., the four major rivers restoration project), water quality degradation in the form of algae blooms has become a social concern. Initially, the “four major rivers restoration project” was implemented to enhance water security, flood control, and ecosystem vitality as a part of Korea’s “Green New Deal” policy. To achieve its river project objectives, the Korean government, with good intentions, constructed 16 consecutive weirs by dredging 570 million m³ of sediment and graveling almost 700 km of riverbed in the four major rivers (the Han River, the Nakdong River, the Yeongsan River, and the Geum River, in Figure 1) (Cha et al., 2011). The total cost of this mega-construction project was approximately USD 71.3 billion, but this investment failed to supply clean water to the greater population because it also caused an eutrophication. Lee et al. (2015, 2017) concluded that a myopic
view and ignoring various stakeholders’ demands may have resulted in the severe environmental damage in Korea that could last for decades.

2. Survey Design and Data Collection

Two separate but consecutive surveys were conducted to collect data on consumer welfare from river restoration projects. From August to November 2012 before the completion of the four major rivers restoration project, the first water demand and value survey was carried out, gathering information from 5 cities along the Han River and its major tributaries (Incheon, Seoul, Yangpyeong, Namyangju, and Yeoju). Since almost half of the Korean population lives near the Han River, a deterioration in water sourcing or quality may significantly impact consumers’ WTP for improvements. From July to August 2015, we conducted a second survey within the Han River watershed to compare how people’s perceptions changed with
changes in water quality and its aesthetic value after completion of the project, particularly focusing on effects from algal blooms. Adjusting for demographic characteristics, 500 and 301 responses were collected from the first and the second survey respectively, by a professional survey company (the Korea Environmental Economics Research Institute). Highly trained interviewers conducted face-to-face interview surveys during a designated time, informing interviewees about algae blooms and discussing relevant aesthetic values of water. Within two consecutive surveys, we introduced how the algae bloom happened and how it related with water quality degradation. In this sense, the willingness to pay for users will include not only direct use value but also option value and indirect use value.

Following Hanemann et al. (1991), double-bounded dichotomous choice questions were used to estimate WTP for the removal of algae bloom in the Han River across five different initial bids (KRW 250, KRW 500, KRW 1,000, KRW 2,000, KRW 4,000). The main questionnaire was consisted of three parts: (1) demographic information; (2) level of perception of water quality associated with algae blooms; and (3) WTP for water quality improvement, i.e., the removal of existing algae blooms caused by the four major rivers restoration project. Prior to executing each survey on the WTP for algae removal, we provided scientific information about current algae blooms in the Han River, and how this could deteriorate water quality and the aesthetic value of the river. To increase credibility of the research, the data of the first initial bids and responses can be used to estimate WTP from a single-bounded dichotomous choice model.

In our estimation model, we included as covariates: respondents’ age (all respondents were over 20), sex, years of formal education,
type of job, an apartment dummy, monthly household real income, and the number of members in the household. The mean and standard error of covariates are illustrated in (Table 1).

<table>
<thead>
<tr>
<th>Variables</th>
<th>Description</th>
<th>2012</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Rate</td>
<td>Mean water rate per month</td>
<td>17410.8</td>
<td>18803.32</td>
</tr>
<tr>
<td>Sex</td>
<td>1=male, 0 otherwise</td>
<td>0.53</td>
<td>0.408</td>
</tr>
<tr>
<td>Age</td>
<td>1 = 20’s, 2=30’s, 3=40’s, 4=50’s, 5=above 60’s</td>
<td>2.486</td>
<td>2.797</td>
</tr>
<tr>
<td>Job</td>
<td>1=white collar, 0 otherwis</td>
<td>0.286</td>
<td>0.388</td>
</tr>
<tr>
<td>Education</td>
<td>1= college educated or above, 0 = below college</td>
<td>0.654</td>
<td>0.093</td>
</tr>
<tr>
<td>Household Income (per month)</td>
<td>$2000 1, $3000 2, $4000 3, $5000 4, $6000 5, $7000 6, $8000 7, &gt;$8000 8, Otherwise 9</td>
<td>2.938</td>
<td>3.205</td>
</tr>
<tr>
<td># in Household</td>
<td>Number in household</td>
<td>3.222</td>
<td>3.488</td>
</tr>
<tr>
<td>Apartment</td>
<td>1 = apartment, 0 otherwise</td>
<td>0.50</td>
<td>0.388</td>
</tr>
<tr>
<td>Sample</td>
<td>1=Namyangju, 2=Yangpyeong, 3=Yeoju, 4=Seoul &amp; Incheon</td>
<td>101</td>
<td>53</td>
</tr>
</tbody>
</table>

III. Theoretical Model Specification

1. The State Preference Approach to Environmental Valuation

For more than four decades, economists have established numerous knowledge on certain goods and services that are unable to trade in
the market system. The CVM is a well-known standard valuation
method for estimating a conceptual demand curve for non-market
goods and services (Hanemann et al., 1991). Since this method was
developed by Ciriacy-Wantrup (1947), various statistical approaches
for eliciting individual preferences have been investigated by many
economists. Of those statistical methods, single-bounded (SBDC) and
double-bounded dichotomous choice (DBDC) models have been
widely applied (Venkatachalam, 2004). Both methods involve asking
an individual whether he or she would pay some given amount, $B$,
to secure given level of environmental quality. For a SBDC model, the
probability of obtaining a “no” or a “yes” response can be written,
respectively, as follows:

$$\pi^*(B) = G(B; \theta),$$

$$\pi^\neg(B) = 1 - G(B; \theta),$$

where $G(\bullet; \theta)$ is a cumulative distribution function (e.g. normal or
logistic) with parameter vector $\theta$ that is interpreted as the
individual’s true maximum WTP (Hanemann et al., 1991). Where $N$
number of respondents in a SBDC survey and $B_i^s$ is the bid offered
to the $i$th respondent, the log-likelihood function can be represented
as follows:

$$\ln L^s(\theta) = \sum_{i=1}^n \{d_i^s \ln [1 - G(B_i^s; \theta)] + d_i^n \ln G(B_i^s; \theta)\}$$

here $d_i^s$ is 1 if the $i$th response is “yes” and 0 otherwise, $d_i^n$ is 1
if the ith response is “no” and 0 otherwise. In this case, we can estimate the individual’s WTP as follows (Jeanty, 2007):

\[ WTP = \frac{-\bar{X} \beta'}{\beta_0} \]  

(4)

where \( \bar{X} \) is a row vector of sample means including 1 for the constant term, \( \beta'_k \) is a column vector of estimated coefficients, and \( \beta_0 \) is a coefficient on the bid variable.

Unlike the SBDC model, the DBDC format offers two sequential bids to respondents. An initial bid \( B^1 \) is acceptable or not, and \( B^2 \) (i.e., \( B^2 = 2B^1 \)) is asked on the condition that a respondent accepts \( B^1 \); otherwise \( B^3 \) (\( B^3 = 0.5B^1 \)) is offered. In this sense, there are four possible responses sets - “yes-yes”, “yes-no”, “no-yes”, “no-no”- with respective likelihoods of \( \pi^{yy} \), \( \pi^{yn} \), \( \pi^{ny} \), and \( \pi^{nn} \) (Hanemann et al., 1991). When there are \( N \) respondents, the log-likelihood can be illustrated as follows:

\[ \ln L(\theta) = \sum_{i=1}^{N} \left[ d_{i}^{yy} \ln \pi^{yy}(B_{i}, B_{i}) + d_{i}^{yn} \ln \pi^{yn}(B_{i}, B_{i}) + d_{i}^{ny} \ln \pi^{ny}(B_{i}, B_{i}) + d_{i}^{nn} \ln \pi^{nn}(B_{i}, B_{i}) \right] \]  

(5)

Following Hanemann (1984), the mean WTP with covariates can be rewritten as follows:

\[ WTP^* = \frac{a + X_i \beta}{b} \]  

(6)

where \( X_i \) is the covariate vector for respondents’ socio-economic
characteristics, and $\beta$ is the parameter vector to be estimated. In addition, WTP is directly derived from the maximum likelihood (ML) estimates which are asymptotically normal with variance-covariance matrices. We can apply the Krinsky and Robb (1986) simulation technique to obtain confidence intervals for the point estimates of WTP.

If there are a substantial number of “zero bid” responses, the Spike model is an appropriate method for estimating WTP (Kriström, 1997). “No-no” respondents are divided into two categories - those with a zero WTP, and those with a positive WTP less than $B$. Therefore, a third follow-up question was offered to “no-no” respondents. In this process, respondent subgroups are divided into five categories in order to distinguish true-zero WTP from “protest”-zero WTP. For each respondent $i$, therefore, a binary-value indicator that states where the individual belongs among those five subgroups can be written as follows:

$$d_i^{Y} = 1 \text{ (if } WTP \geq B_i^2, 0 \text{ otherwise)}$$

$$d_i^{Y} = 1 \text{ (if } B_i^1 \leq WTP \leq B_i^2, 0 \text{ otherwise)}$$

$$d_i^{N} = 1 \text{ (if } B_i^1 \leq WTP \leq B_i^2, 0 \text{ otherwise)}$$

$$d_i^{N} = 1 \text{ (if } B_i^3 \leq WTP \leq B_i^2, 0 \text{ otherwise)}$$

$$d_i^{N} = 1 \text{ (if } 0 \leq WTP \leq B_i^3, 0 \text{ otherwise)}$$

$$d_i^{N} = 1 \text{ (if } WTP \leq 0, 0 \text{ otherwise)}$$

(7)

The log-likelihood function of equation (7) can be represented for $n$ respondents as follows:
\[
\ln L(\theta) = \sum_{i=1}^{n} \left[ d_i^{TV} \ln[1 - G_i(B_i^e)] + d_i^{SN} \ln[G_i(B_i^c) - G_i(B_i^e)] + d_i^{TV} \ln[G_i(B_i^c) - G_i(B_i^e)] + d_i^{SN} \ln[G_i(B_i^c) - G_i(0)] + d_i^{SN} \ln[G_i(0)] \right]
\]

(8)

When the cumulative density function, \( G_i(B_i) \), is assumed to follow a logistic distribution, we have:

\[
G_i(B_i) = \begin{cases} 
0 & \text{if } B_i < 0 \\
\left[1 + \exp(\alpha + \beta X_i)\right]^{-1} & \text{if } B_i = 0 \\
\left[1 + \exp(\alpha - \beta_0 B_i + \beta X_i)\right]^{-1} & \text{if } B_i > 0 
\end{cases}
\]

(9)

By maximizing equation (8), parameters \( \alpha \) and \( \beta \) can be estimated and the share of true-zero WTP in the sample can be defined as follows:

\[
Spike = \frac{1}{1 + \exp(\alpha + \beta X_i)}
\]

(10)

Finally, the mean WTP under the Spike model can be rewritten as follows:

\[
WTP* = \frac{\ln[1 + \exp(\alpha + X_i'\beta)]}{b}
\]

(11)

2.. Difference-in-Differences Approach

The difference-in-differences (DID) estimator is one of the most well-known approaches for examining the effects of a policy when distinguishing two groups (i.e., pre-treatment and post-treatment
period, with and without public intervention). The DID framework applies in our analysis as follows. Let $Y(i, t)$ be the outcome (e.g., water quality improvement) of weir construction for individual $i$ at time $t$. Two samples are collected in a pre-construction of weir period $t = 0$, and in a post-construction of weir period $t = 1$. Between these time periods, a certain fraction of population experiences weir construction in its neighboring river. We denote $D(i, t) = 1$ if individual $i$ has a weir in his/her neighboring river at $t = 1$, $D(i, t) = 0$ otherwise. Therefore, of those individuals, we can rename $D(i, 1) = 1$ a “treated”, and $D(i, 1) = 0$ a “untreated”. Following Ashenfelter and Card (1984), the DID model can be written as follows:

$$Y(i, t) = \delta(t) + \alpha \cdot D(i, t) + \eta(i) + \nu(i, t)$$

(12)

where $\delta(t)$ is a time-specific component, $\alpha$ indicates the impact of weir construction, $\eta(i)$ is an socio-demographic component, and $\nu(i, t)$ is an individual-transitory shock ($\nu = 0$ at time $t$), correlated within individuals.

In this model, we only monitor $Y(i, t)$ and $D(i, t)$. Since the sufficient condition for selecting weir construction does not rely on $\nu(i, t)$, adding and subtracting $E[\eta(i)|D(i, 1)]$ in equation (12) we obtain:

$$Y(i, t) = \delta(t) + \alpha \cdot D(i, t) + E[\eta(i)|D(i, 1)] + \varepsilon(i, t)$$

(13)
where \( \varepsilon(i,t) = \eta(i) - E[\eta(i)\mid D(i,t)] + \nu(i,t) \)

We can modify equation (13) to produce the following equation:

\[
Y(i,t) = \mu + \tau \cdot D(i,1) + \delta \cdot t + \alpha \cdot D(i,t) + \varepsilon(i,t) \tag{14}
\]

where \( \mu = E[\eta(i)\mid D(i,1) = 0] + \delta(0) \), \( \tau = E[\eta(i)\mid D(i,1) = 1] - E[\eta(i)\mid D(i,1) = 0] \), and \( \delta = \delta(1) - \delta(0) \).

Since we have a sample with repeated pre- and post-weir construction, \( Y(i,1) \) and \( Y(i,0) \), the effect of weir construction, \( \alpha \), can be estimated as follows:

\[
\alpha = E[Y(i,1) - Y(i,0)\mid D(i,1) = 1] - E[Y(i,1) - Y(i,0)\mid D(i,1) = 0] \tag{15}
\]

In our DID analysis, we used individual’s WTP as a proxy for water quality improvement due to weir construction on the Han River. This analysis leads us to calculate the pure impacts of weir construction from the project, and allows us to verify any welfare loss to society.

### IV. Empirical Results

In the preliminary analysis, estimates from SDBC and DBDC models were not reliable due to a substantial number of “zero” responses. We therefore conducted the Spike model to adjust for this econometric problem. (Table 2) illustrates estimates from the Spike models across three different data sets: 2012, 2015, and aggregate (2012 and 2015).
data. Each model had two separate estimates (with and without explanatory variables). We checked the variance inflation factor (VIF) and correlation matrix, concluded that there are no multicollinearity problems in the dataset.

**Table 2** Spike model estimates across three different data sets

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>0.2250(0.0697)**</td>
<td>0.0283(0.0756)*</td>
<td>0.5683(0.1175)**</td>
</tr>
<tr>
<td>Bid</td>
<td>0.0015(0.0001)**</td>
<td>0.0016(0.0001)**</td>
<td>0.0014(0.0001)**</td>
</tr>
<tr>
<td>Mean rate</td>
<td>0.0000(0.0000)</td>
<td>0.0000(0.0000)</td>
<td>0.0000(0.0000)</td>
</tr>
<tr>
<td>Sex</td>
<td>0.0092(0.1370)</td>
<td>-0.0112(0.1777)</td>
<td>-0.0549(0.2365)</td>
</tr>
<tr>
<td>Age</td>
<td>-0.0317(0.0521)</td>
<td>-0.0367(0.0750)</td>
<td>-0.0202(0.0756)</td>
</tr>
<tr>
<td>Job</td>
<td>0.3388(0.1705)**</td>
<td>0.5616(0.2683)**</td>
<td>0.2042(0.2401)</td>
</tr>
<tr>
<td>Education</td>
<td>0.3441(0.1479)**</td>
<td>0.1587(0.1983)</td>
<td>0.2754(0.4175)</td>
</tr>
<tr>
<td>Income</td>
<td>0.0166(0.5799)</td>
<td>0.0353(0.0775)</td>
<td>-0.0542(0.1027)</td>
</tr>
<tr>
<td># in Household</td>
<td>0.1484(0.0621)**</td>
<td>0.0737(0.0766)</td>
<td>0.2381(0.1146)</td>
</tr>
<tr>
<td>Apartment</td>
<td>-0.3702(0.1982)**</td>
<td>-0.1796(0.2232)</td>
<td>-0.0687(0.2301)</td>
</tr>
<tr>
<td>Year dummy</td>
<td>-0.2102(0.1684)*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spike 2</td>
<td>0.4439(0.0172)**</td>
<td>0.4369(0.1739)**</td>
<td>0.4929(0.0219)**</td>
</tr>
<tr>
<td>Wald-x2</td>
<td>323.36</td>
<td>342.78</td>
<td>198.76</td>
</tr>
<tr>
<td>Prob. &gt; x2</td>
<td>= 0.0000**</td>
<td>0.0000**</td>
<td>0.0000**</td>
</tr>
<tr>
<td>LL</td>
<td>-851.776</td>
<td>-837.617</td>
<td>-523.060</td>
</tr>
<tr>
<td>Mean WTP</td>
<td>530.32(32.23)**</td>
<td>779.04(110.56)**</td>
<td>654.70(130.27)**</td>
</tr>
<tr>
<td># of Obs.</td>
<td>801</td>
<td>500</td>
<td>301</td>
</tr>
</tbody>
</table>

Note: ** and * indicate significance at the 1% and 5% level, respectively
Numbers in parentheses are standard errors

Although some explanatory variables (e.g., job, education, number in household, and apartment) are statistically significant at the 1% level, for all three data sets, model goodness-of-fit tests are better without explanatory variables. To elicit the WTP for algae removal in the Han River to increase water quality and its aesthetic value, we provided five different initial bids to each of five subgroups of respondents. The
estimation results of the Spike model based on Eqs. (8) to (11) indicates that respondents prefer low bid amounts for algae removal even though there are negative effects from water quality degradation. For two different surveys, the estimated constants are statistically significant and positive. This confirms a positive WTP across all models. The monthly mean WTP for algae removal in the 2012, 2015, and the aggregated model is estimated to be KRW 436.12 (USD 0.39), KRW 691.92 (USD 0.62), and KRW 530.32 (USD 0.47), respectively. As shown in Table 3, we conducted additional marginal analysis to capture respondent heterogeneity across socio-demographic characteristics.

<table>
<thead>
<tr>
<th>&lt;Table 3&gt; Marginal analysis results of explanatory variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variables</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Job</td>
</tr>
<tr>
<td>Education</td>
</tr>
<tr>
<td># in Household</td>
</tr>
<tr>
<td>Apartment</td>
</tr>
</tbody>
</table>

Note: elasticities are calculated at the mean value of each variable

Although the explanatory variables in Table 3 are statistically insignificant, variables capturing socio-demographic characteristics indicates meaningful results for policy makers. For instance, people with white-collar jobs and higher education indicate relatively higher WTP for algae removal. This implies that people more directly or frequently exposed to environmental problems are likely to pay more WTP to ameliorate water quality degradation. On the contrary, people who are provided clean water from public services and live relatively far from compromised water resources are less likely to pay WTP to improve water quality and its aesthetic value.
Since the four rivers restoration project was completed in 2013, we conducted the DID model to calculate WTP to remove algae in the Han River, temporally and spatially. Consequences from the project have accelerated algae bloom in the river, but Incheon, Seoul, and Yangpyeong are likely to be less affected from the weirs than Yeoju or Namyangju. Therefore, responses from these five different watersheds are categorized into four subgroups (pre-treatment, post-treatment, treatment, and control groups). To reflect temporal aspects, pre-treatment and post-treatment subgroups are separated as before or after 2013. Watersheds that are less likely to be affected by weir introduction are treated as a control subgroup (Incheon, Seoul, Yangpyeong). With these clarifications, the DID estimates of repeated cross-section analysis are illustrated in (Table 4).

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficient</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year dummy</td>
<td>247.7913 (91.1323)</td>
<td>2.72**</td>
</tr>
<tr>
<td>Control dummy</td>
<td>-260.9757 (86.6675)</td>
<td>-3.01**</td>
</tr>
<tr>
<td>DID dummy</td>
<td>20.7549 (136.2658)</td>
<td>0.15</td>
</tr>
<tr>
<td>Constant</td>
<td>791.4244 (51.1946)</td>
<td>15.46**</td>
</tr>
</tbody>
</table>

F-test 8.22
Prob. > F 0.0000**
Root MSE 935.54
# of Obs 801

Note: ** indicates the significance at the 1% and numbers in parentheses show the standard errors

According to DID estimates, respondents more affected by the four major rivers restoration project demonstrate a higher WTP, KRW 20.75, to address current algae blooms in the Han River. Although the DID dummy is not statistically significant, this result implies that people suffering a decrease in water quality and aesthetic water value
are willing to pay more for their monthly water bills. This amount is equivalent to approximately 0.25% of the average monthly water rate. Since this research employed representative sampling frame and had a high survey response rate, the estimated mean WTP can be expanded to analyze the aggregate benefit of algae removal in the Han River. Therefore, we multiplied the mean monthly per-household WTP by the total number of households in the Han watershed in 2017 (i.e., 10.17 million) and then annualized this result. For 2015 the aggregate economic benefit of removing algae from the Han River, to improve water quality and aesthetic value, is estimated to be approximately KRW 84.44 billion (USD 76.76 million). Based on the DID estimates, the aggregate economic cost of removing algae across the waters of the Han River is approximately KRW 2.56 billion (USD 2.33 million), annually.

V. Conclusions

Since the four major rivers restoration project in Korea, abnormal algae blooms much more frequently aggravate water quality and diminish the aesthetic value of water along these major rivers. Almost half of South Koreans live and rely on the Han River, so the negative impacts from algae blooms not only raise environmental concerns but may also degrade quality of life for millions of residents on the Han River water. Although the initial plan for the four major rivers restoration project was optimistic and promising, unintended consequences of the project lower water quality and burden or distress local populations.
This research investigates the aggregate economic cost of algae removal to partially restore water quality and regain the aesthetic value of the iconic Han River in Korea. Although methods for estimating non-market goods and services are limited mostly to the contingent valuation method, few other authors have attempted to elicit household willingness to pay for consequences of the mega-project in Korea. We jointly conducted a Spike model and a Difference-in-Differences (DID) approach, policy assessment tools, to elicit Korean households’ willingness to pay more for their water bills to correct water quality loss that followed the completion of weirs on the Han River in 2013. Based on results from the Spike model, we estimate per-household monthly WTP for algae removal in the Han River using 2012, 2015, and aggregate data (2012 and 2015) to be KRW 436.12 (USD 0.39), KRW 691.92 (USD 0.62), and KRW 530.32 (USD 0.47), respectively. The three Spike model estimates can be expanded to WTP across the entire Han River watershed: KRW 64.72 billion (USD 58.83 million), KRW 53.22 billion (USD 48.38 million), and KRW 84.44 billion (USD 76.76 million). To calculate the aggregate economic cost of cleaning algae in the Han River, we applied a DID approach and differences in WTP were estimated to be approximately KRW 2.56 billion (USD 2.33 million) annually. We also found that higher-educated residents are likely to pay more attention to environmental issues, while residents who live in apartments are less likely to attend to environmental issues than those in less urbanized areas. This implies that people directly exposed to environmental issues are likely to pay more WTP to ameliorate water quality degradation and recover aesthetic value of river. According to Cho et al. (2016), the effect of algal bloom is to be estimated as KRW 4,129
per household. This analysis carried out for all rivers in Korea, thus estimated WTP was higher than our research.

Results from this study can apply to water development policy perspectives in several ways. (1) A myopic and monotonic implementation plan may not only easily fail to achieve its stated objectives, but may also cause significant damage, as observed after the four major rivers restoration project. (2) Regulating and modifying natural rivers may have unintended consequences that are borne solely by later generation. (3) Although excess concentrations of nitrogen and phosphorus that cause an eutrophication may be recognized as local or temporal problems, people are willing to pay more to ameliorate water quality degradation. Results from this study show that the differences between upstream and downstream WTP for amelioration are relatively small. This implies that an upstream-downstream development agenda may not apply in the case of water quality degradation and aesthetic value of a river. (4) The value of algae removal appears to be meaningful to residents, but the high proportion of respondents claiming a zero WTP indicates that many households may prefer not to pay an additional charge for this on their water bills. Suffice to say that the Korean government should conducting further public outreach and continuing to investigate research on water quality degradation, with renewed attention to meeting national water quality standard.

Limitations of this study deserve mention for future research. First, the contingent valuation survey method can be improved by appreciating a potential bias due to correlation between the responses. Improving the question set used to elicit WTP will improve the quality of this type of research. Second, while this research
investigates household-level WTP for ameliorating water quality degradation and recovering aesthetic value of a river, additional cost–benefit analysis would be needed in order to calculate the economic value of the four major rivers restoration project in Korea.

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Yoon Lee: Professor Lee earned his doctorate in environmental and resource economics from the University of Connecticut and he is currently an associate professor at Sunmoon University and also a director of the Global Sustainable Development Economic Institute (GSEI). He has been conducted various environmental economics topics including water, climate change, and energy. He worked at the Korea Environmental Institute (KEI) as a team leader. He has also conducted various research projects with the World Bank Group, Water and Sanitation Program, and Global Green Growth Institute. He also served as a global reviewer editor in the process of the 6th Global Environmental Outlook with UNEP (lyoon21@sunmoon.ac.kr).

June-Mo Woo: Professor Woo earned his doctorate in politics from the Hankuk University of Foreign Studies and he is currently an associate professor at Sunmoon University and a member of steering committee at the Global Sustainable Development Economic Institute (GSEI). He worked at Tashkent State University of Oriental Studies as an assistant professor. He conducted various researches focused on international relationship, Russian politics, and territorial issues. In addition, he tries to investigate environmental concerns in the context of politics (ruswoo@sunmoon.ac.kr).

Yongsuk Hong: Professor Hong earned his doctorate in environmental engineering from the Lehigh University and his is currently an associate professor at Korea University Sejong Campus. He worked at the Korea Environmental Institute (KEI) as a associate researcher and University of California at Riverside as a post doctorate researcher. His major research areas include environmental policy assessment and water treatment with focusing on algae blooms at rivers and streams (yhong@korea.ac.kr).
Optimizing the Local Embedding of Renewable Energy Plants*

Michael Krug** · Dörte Ohlhorst***

Abstract: In this article we ask about the factors that promote acceptance of local renewable energy plants and about the specific role nature conservation plays in the concert of other acceptance factors. We explored to what extent trade-offs between climate protection, nature and species protection, protection of local residents and local value creation can be realigned. The article provides an overview of the key acceptance factors identified and derives a set of trust and acceptance building measures. It has a specific focus on wind energy.

Our findings suggest that nature conservation rationales have definitively a role to play as a local acceptance factor, but other acceptance factors are closely linked or more important. Particularly, economic factors, the attitudes towards the energy transition, trust in key actors and planning and development processes were identified as key preconditions for local acceptance.

Key Words: Renewable Energy Plants, Wind Energy, Acceptance Factors, Local and Regional Acceptance, Climate Protection, Nature Conservation, Trust

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** First author, Senior Researcher, Freie Universität Berlin, Environmental Policy Research Centre

*** Corresponding author, Lecturer, Bavarian School of Public Policy, Technical University Munich
I. Introduction

1. Setting the Scene – Renewable Energy Goals in the EU and Germany

In December 2018, the revised Renewable Energy Directive 2018/2001/EU (RED II) entered into force. It aims at keeping the EU a global leader in renewables and to meet its GHG emissions reduction commitments under the Paris Agreement. The RED II establishes a new binding renewable energy target for the EU for 2030 of at least 32%, with a clause for a possible upwards revision by 2023. In order to achieve the overall binding EU target, the Member states have to develop National Energy and Climate Plans (NECPs) by 31 December 2019.

In Germany, the share of renewables in final energy consumption across all sectors reached 16.6 percent in 2018 (UBA, 2019). In 2018, the share of renewables in gross electricity consumption reached 37.8 percent. Germany aims to cover 60 percent of final energy consumption and 80 percent of its electricity consumption from renewables by 2050. The government has goals for phasing out nuclear by 2022 and simultaneously decarbonising the economy by reducing GHG emissions by 80 to 95 percent of 1990 levels by 2050. A commission recently recommended to phase out coal by 2038. The implementation of local energy projects, in particular wind energy, plays a key role in this transformation.
2. Social Acceptance of Renewables as a Pre-Requisite for a Successful Energy Transition

Social acceptance of wind energy has become a subject of contested debates due to the visual impact on landscapes, noise annoyance (including infrasound), perceived health risks, local environmental disruption, risks for local fauna and flora, potentially negative impact on recreation and tourism, potential land and real property value loss, but also due to perceived procedural or distributional injustice and poor public involvement and participation (Petrova 2016). Wind turbines, ground-mounted photovoltaic systems or biogas plants require space and have an impact on habitats and landscapes. Thus, questions of nature and environmental compatibility are increasingly being put forward as arguments against the expansion of renewables.

In cities as well as in rural areas and across all educational, income and age groups, the population supports the overall goals of the energy transition and favours the expansion of RES. While solar energy on rooftops is widely accepted, conflicts increase when it comes to the construction of ground-mounted systems (solar parks), onshore and partly offshore wind turbines or biogas plants. Particularly, where wind turbines are planned, concerns about the visual impact, acoustic emissions including infrasound, nature and species conservation as well as other local resident interests are expressed (FA Wind, 2019). When asked about the conditions under which renewable energy plants (RE systems) are accepted, there are no easy answers. However, for the success of the energy transition, it is of pivotal importance that the further expansion of renewable energies is accepted and supported by the population.
3. The Interdisciplinary Research Project AcceptEE

The aim of the research project AcceptEE (see footnote 1) was to analyse whether an environmentally sound expansion of RES can lead to a higher level of local acceptance of renewable energy projects. We analysed the specific role of landscape as well as nature and species conservation rationales in the concert of other local acceptance factors. Furthermore we asked how trade-offs between climate protection, nature conservation, protection of local residents and local value creation can be re-aligned?

To answer these questions, the research team employed a combination of qualitative and quantitative research methods. In a first step, municipal and regional political leaders, representatives from regional planning and permitting authorities, nature conservation authorities, land owners, project developers, plant operators, citizen action groups opposing wind energy and nature and environmental protection associations have been interviewed in three different locations with installed capacities of wind, ground-mounted PV and biogas plants. In a second step, personal interviews and an online survey addressing local residents in the host communities have been carried out. In total, responses from 158 residents were collected. The quantitative analysis was mainly performed by the Institute of Psychology in Halle. It comprised bivariate and multivariate analyses.

4. Purpose, Concepts and Structure of the Paper

Referring to the broadly acknowledged framework developed by Wüstenhagen et al. (2007) who differentiate between three dimensions of social acceptance, in this paper we mainly concentrate on
community (or local) acceptance of renewable energy projects. The paper has a special, but not exclusive focus on wind energy and is structured as follows: Section 2 presents an overview of those acceptance factors which, based on the surveys of local residents and the quantitative analysis, were identified as key. Section 3 leads us to the question how wind farms and other renewable energy plants can be optimised in such a way that they are accepted as widely as possible by the local population. It has a special focus on trust and acceptance building measures. The findings are mainly based on qualitative research methods (desk research, expert interviews).

II. What influences Local Acceptance of Renewable Energy Plants?

This section provides an overview of key acceptance factors identified in the research project AcceptEE:

1. Social Norms

As social beings, people in almost all spheres of life use social norms (the opinions and behaviour of others) as a source of information and for orientation in their search for their own point of view. This is also the case when it comes to renewable energy projects: the more positive the local opinion is estimated by local

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1) Socio-political acceptance is defined as the general degree of support for technologies and policies, whereas market acceptance relates to the meso level, involving both consumers and investors and also includes an intra-firm dimension (Wüstehagen et al., 2007, p.2685).
residents, the higher the level of acceptance. Residents, however, tend to underestimate the local acceptance in their community. One of the reasons for this is that opponents are usually more active and more visible because they are concerned about public attention. Hence, protests against specific plants do not necessarily reflect the prevailing local opinion. Although the correlation of this factor with the local acceptance of the plants turned out to be weaker compared to the other acceptance factors, it was a constant size (Hübner et al., 2019).

2. Environmental Compatibility: Human, Nature and Landscape Protection

Our research suggests that nature and species protection play a significant role as acceptance factors, but economic factors, attitudes towards the energy transition and trust are even more important in influencing local acceptance (Hübner et al., 2019). Referring to the influence of wind power plants on humans, sound (noise) including infrasound plays a key role. In our study, cases of annoying noise from wind turbines were reported. However, most residents in our surveys perceive their living environment or health hardly as impaired (ibid.). Irritations are triggered through the visibility of the installations, the rotating blades and the navigation lights (in the night). In particular on mountain ridges or in sensitive landscape types, wind turbines have a great influence on the perception of the landscape scenery. Other related factors include a possible reduction of the recreational function or the loss of the “sense of home”.

Habitat disturbances or collisions can result from the land-use changes associated with the construction of the plants as well as from
their operation. In particular, the danger of birds and bats colliding with wind turbines is a matter of major concern. In Germany, questions of nature and species protection are addressed within the process of wind energy zoning in spatial planning and in the approval procedure. If negative effects for objects of protection are expected, compensatory measures are prescribed. Nevertheless, in the three regions surveyed, respondents estimate the consideration of nature and landscape protection aspects as rather critical. Interestingly, most of the respondents did neither know the expert opinions drawn up, nor the compensatory measures implemented to offset intrusions of nature and landscape. This means that in practice more is done in terms of nature and species protection than the local residents perceive.

Nature conservation as an acceptance factor is rather difficult to grasp, because trade-offs between energy production based on renewables in order to mitigate climate change and the protection of nature, biodiversity and landscape are almost inevitable. A low impact on biodiversity and the landscape seems to be crucial for community acceptance.

3. Economic Factors and Perceived Distribution of Costs and Benefits

The findings of the quantitative research indicate that the economic benefits of wind energy projects is the most important acceptance factor. This factor includes regional and local added value creation, local economic development and welfare effects. Municipalities hosting RES projects can benefit from local trade tax payments and compensatory measures and payments for the intrusion of nature and
landscape. Many developers offer further compensations, in-kind benefits or support the development of non-profit civic associations or foundations. There are also examples of developers offering other benefits including special electricity tariffs to the communities.

However, a critical acceptance factor is the distribution of costs and benefits. If only few actors benefit (land owners, investors), while many others have to bear the risks and negative impacts, local acceptance is likely to be low. Envy between different actors is a recurring phenomenon that also generates opposition. Local RES projects are more likely to be accepted if investors contribute to local welfare creation and the Common Good and if these contributions are perceived by the local people. Therefore, as many residents and local actors as possible should benefit economically from the installation of RES facilities. Community (co-)ownership and citizen energy companies are examples of direct financial participation, foundations or civic associations which disburse a certain percentage of the operating company’s revenues for social or charity purposes are examples of indirect financial participation of local communities.

In addition to a fair cost-benefit distribution between the beneficiaries and those affected by the projects, a fair spatial distribution of renewable energy plants should also be considered as an acceptance factor. The aspect of “interregional distributional fairness” became particularly clear in the expert interviews in the region of Dithmarschen with one of the highest wind turbine densities in Germany. Interviewees pointed out, that the region has fulfilled its contribution to the energy transition and that “the limits of what is tolerable have been reached”.

4. Plausibility, Stringency and Coherence of the Energy Transition

Both our qualitative and the quantitative results from our expert interviews and surveys with local residents reveal that the overall attitude towards the energy transition, the perceived plausibility and coherence of energy policy goals, strategies and measures at the various political and administrative levels had a relatively high impact on the local acceptance of renewable energy plants. The more local residents consider the energy system transformation and its implementation to be meaningful and consistent, the more likely they are to accept RES projects. This is also in line with other research findings (Eichenauer, 2016; Eichenauer, 2018; Devine-Wright et al., 2017). Many surveys including the recent Social Sustainability Barometer on the Energy Transition (Setton, 2019) indicate, that the vast majority of the population in Germany supports the energy transition and the expansion of RES. The actual implementation of the energy transition, however, is viewed more critically by the population. In particular, cost and equity issues play an important role, but also the perceived lack of coordination of the overall process.

5. Trust in Key Players

Trust in the procedures and in the responsible key actors, such as investors, project planners and employees of the authorities, is closely linked to the acceptance of local RES facilities. Those who consider the actors and institutions not trustworthy will have little confidence in the procedures and decision-making processes. Trust in the actors is strongly linked to personal qualities such as honesty, credibility, reputation, competence, fairness and orientation towards the Common
Good. If the actors cannot fulfill the respective expectations, the trust placed in them is rather low. Low trust in actors and institutions also influences trust in decision-making processes and procedures.

Land securing practices by project developers are often non-transparent. Often developers have acquired land or concluded option agreements with the landowners before the local authorities and decision-makers are informed. In many cases, information “flows behind closed doors”, local authorities are left with the role of observers. In the worst case, municipal decision-makers learn about a project only once the developer applies for approval. Aggressive or non-transparent land securing practices reduce the credibility and trustworthiness of investors and planners. Bias, role and interest conflicts of political-administrative decision-makers can also have a negative impact on their credibility and trustworthiness and the local acceptance of renewable energy expansion (Reuswig et al., 2016; Eichenauer, 2016).

III. How to Improve Trust?

1. Building Trust through Community and Citizen Energy Projects

Acceptance research shows that renewable energy communities and community ownership of renewable energy projects can be a main driver of community acceptance (cf. Jobert et al., 2007; Ruggiero et al., 2014; Warren and McFadyen, 2010; Zoellner et al., 2008; McLaren Loring, 2007; Sonnberger and Ruddat, 2017; Liebe et al., 2017; Wirth, 2014). At present, almost half of Germany’s electricity generation capacity benefitting from the financial support provided via the
Renewable Energies Act (EEG) (except for offshore wind) is in the hands of small private investors. These actors include farmers, landowners, individuals and private households, energy cooperatives, civil law partnerships, limited liability companies or limited partnerships. These diverse forms of citizen energy (Bürgerenergie) are an important driver for the dynamics of the energy transition. Moreover, citizen energy encourages more diverse acceptance and support for renewables and thus increases the stability of the German renewable energy sector (Bündnis Bürgerenergie, 2014; Debor, 2014; Müller and Holstenkamp, 2015; Ott and Wieg, 2014).

Community wind farms are widespread in several regions in Germany like e.g. in North Friesland where 90% of wind farms are in community ownership (Windcomm, 2012). Many of the wind farms were developed by bottom up grassroots initiatives. Minimum shares are usually low to enable as many residents as possible to benefit as limited partners or shareholders. Usually, persons living in the immediate vicinity of the wind farm enjoy privileged treatment. Often, the municipalities are involved as initiators/shareholders. These projects have become a cultural asset within the community. In many cases the community wind farms are accompanied by complementary benefit sharing measures including in-kind benefits, community foundations/trusts etc.

In East Germany (former GDR) local or community ownership of wind energy plants is less developed. In Thuringia, 80% of all wind turbines are owned by investors from outside Thuringia. There are only few community/citizen owned wind farms or wind energy co-operatives. This is at least partly related to different land ownership structures which emerged after the privatisation of
formerly state-owned agricultural and forestry areas in Eastern Germany (Gotchev, 2016). Often, the actual owners of the land are not local farmers, residents or communities. Municipalities only own a small fraction of land. For this reason, opportunities to develop citizen/community wind farms are constrained. Local/regional value creation from wind turbines has therefore been limited so far.

A key rationale of many community energy actors is to control and shape local or regional energy supply and to generate local added value. A study conducted by the Institute of Decentralized Energy Technologies showed that a wind farm developed by regional actors with the participation of municipal partners strengthens regional added value almost eight times as much as one built by external developers (Institut dezentrale Energietechnologien, 2016).

Active financial participation of citizens – as shareholders or lenders – can provide an opportunity for profitable investments. Forms of passive financial participation include special electricity tariffs, provision of in-kind benefits, payments for the compensation of landscape intrusion, contracting of local firms for construction works, or land lease payments for land owners and bonus payments for local residents. Municipalities hosting the wind farms benefit from local business tax revenues.

Citizen energy is not only characterised by its potential to create added value, but also by a high degree of identification of citizens with the energy supply in their own municipality or region. This is because most of the electricity generated by citizens’ power plants is produced regionally and close to consumption (Zuber, 2014). Furthermore, due to their proximity, initiators of community and citizen led initiatives and co-operatives often enjoy a relatively high
level of trust, an important pre-requisite of acceptance. Hence, supporting the development of community energy companies can definitively help to promote acceptance.

While in western and partly northern European countries the number of community energy projects has steadily increased over time, in most eastern and southern European countries community energy is still underdeveloped. This is related to a lack of enabling policy frameworks. New European legislation in the RES sector provides a framework which might spur the development of community energy. In its Clean Energy Package, the European Union acknowledged that renewable energy communities - such as co-operatives - have a major role to play in Europe’s energy transition.

Article 22 of the RED II obliges Member States to assess barriers to renewable energy communities (REC), as well as the potential for REC in their territories. Member States are obliged to provide enabling frameworks that can ensure that there are no unjustified regulatory barriers to community energy, that distribution system operators cooperate with energy communities, that participation is accessible to all consumers, and that regulatory and capacity-building support is provided to public authorities in enabling and setting up REC. Member States will also need to ensure that they take the specificities of REC into account when designing support schemes.

2. Improving Trust in Energy Policy

Our study showed that the overall attitude towards the energy transition on the one hand, and economic factors on the other one, had the strongest influence on local acceptance. A spatial distribution
of energy plants which is perceived as unfair, an energy policy coordination perceived as inconsistent, or wind turbines, that have to be temporarily shut down due to grid congestions lead to discontent and annoyance. The more positively the implementation of the energy system transformation is assessed, the higher is the acceptance of local renewable plants. Hence, local communities have to be better informed about the meaningfulness of renewable energy production, its socio-economic benefits and societal values. Embedding the expansion of RES locally in integrated regional or municipal energy or climate protection concepts which are developed bottom-up in a participatory process together with local communities can help to promote acceptance and reconcile renewable energy expansion and nature conservation. The goals and achievements of the energy transition as a whole and the municipal contribution should be actively communicated at all administrative levels. Energy and climate protection concepts can become part of the local identity. Examples of this in Germany are the numerous “100% renewable energy regions” or “bio-energy villages”. However, local actors and residents often do not know whether regional energy concepts exist and by whom or on what basis they were developed. For this reason, local energy and climate protection concepts should be developed in a participative manner and should be communicated to the public.

3. Improving Trust in Project Developers

Our research suggests that credibility and trustworthiness of the project initiators, developers and operators is of high relevance for community acceptance. If local actors are not trusted, opposition becomes more likely. External investors and project planners can
contribute to a smooth implementation of the projects through credibility, professionalism, open communication, public engagement and financial compensations for the local communities.

Particularly in regions where external developers dominate the market complementary benefit sharing mechanisms can turn out essential to ensure distributional justice and hence acceptance. This includes a fair distribution of benefits among developers, the host communities, landowners and local residents or foundations. It is essential to implement concepts that generate added value for the region. For instance, developers may contract local businesses or dedicate a certain percentage of their revenues to social or environmental projects (via foundations or civic associations).

Project developers can help to increase credibility and trustworthiness in many ways. They can voluntarily commit themselves to procedural participation and/or financial participation of local communities. Land procurement practices should be transparent and fair in order to avoid that land owners do not feel getting played off one against each other. The development of land lease pool models can help to reduce mistrust and envy among different types of land owners. Local decision-makers should be informed at an early stage of the planning process.

Developers can voluntarily opt to carry out an Environmental Impact Assessment, which automatically includes a formal participation of the public. Trust and acceptance building can also be enhanced if developers take over responsibility for local welfare and the Common Good including requirements of nature and species protection. Voluntary sustainability reporting (e.g. the publication of a Common Good Balance Sheet) also might help to increase trust.

Public actors can increase trust and acceptance by developing
voluntary quality labels for fair wind energy. Such labels can be effective, provided the issuing body is credible, the level of ambition is sufficiently high and control and sanctioning mechanisms are in place. In this context, studies in the field of product certification show that environmental and consumer associations or non-governmental organisations in particular are perceived as independent and trustworthy, whereas companies and private institutes are met with scepticism (Speck, 2018; Friedel and Spindler, 2016).

4. Improving Trust in Planning Procedures

The early provision of clear, transparent, and credible information is a key prerequisite for opinion-forming processes among the population. Local citizens and decision-makers wish to get informed about the planned sites, the investment costs and profits, the costs and benefits for the local community, the impact on people and the environment and opportunities for participation. Visualization methods can support planning processes and make information easier to grasp.

In Germany, the formal participation possibilities in the authorization process are rather limited. Only where the number of wind turbines reaches 20 or more, or where an environmental pre-assessment leads to the conclusion that an EIA needs to be carried out, a formal participation process is obligatory. This means that many projects are implemented without any formal public consultation. Therefore, informal dialogue and public engagement formats are of pivotal importance. However, dialogue and participation should not only be left to the commitment of the developers and operating companies, but additionally supported by local governments and authorities.

Well-designed, informal participation formats and processes can
help to increase the perceived fairness and justice in the planning process and thus increase the chances of trust and acceptance. Initiators of participation processes should offer dialogues at an early stage and at the same time inform about the actual possibilities of participation and influence. In addition, the citizens want to know how the results will flow into the further planning process. Creating an open participation culture can help to build acceptance - but participation alone does not necessarily lead to more acceptance.

Usually, expert appraisals for nature and species protection are commissioned and paid for by the project planners. Nature conservation organizations, but also wind energy opponents often criticize that due to this specific constellation, the experts conducting those appraisals are inherently biased and lack credibility. They sometimes also criticize the poor quality of those appraisals. The certification of experts could counteract any resentment. However, objective standards are difficult to set. It was also suggested that expert appraisals should be commissioned and paid by the permitting authorities. A third option is that the involved parties (developers, authorities, environmental organizations) jointly select the experts (Hübner et al., 2019).

5. The Role of Advisory and Intermediary Organizations for Building Trust

Studies illustrate that mayors can play a pivotal role in transitions to 100% RES (particularly in small municipalities) through building support, brokering deals, communicating visions, and ensuring implementation of projects (Busch and McCormick, 2014). Mayors can take over important integration and mediation functions in the event
of conflicting views. Particularly in small rural municipalities, however, mayors and local councillors work on a voluntary or honorary basis. They tend to be overloaded by complex planning and approval procedures. Here, professional, neutral, intermediary advisory and support organizations can help to create a more open, constructive communication culture, to organize dialogues, and reconcile between different interest groups. They can support local authorities to act on a level playing field with developers. National and international research on the social acceptance of renewable energies emphasize the role of enabling intermediaries as a critical factor in determining the success and degree of social support for wind energy (Huber and Horbaty, 2010; National Economic and Social Council, 2014; Devine-Wright, 2012; Devine-Wright et al., 2017).

The example of the wind energy service centre in Thuringia in Germany, which was set up in 2015 as a structural unit of the Thuringian Energy and GreenTech Agency (ThEGA), illustrates the function of intermediary actors in promoting acceptance: the centre acts as an information hub and advisory body and plays a mediating role between the four central groups of actors – project developers, municipalities, citizens, and land owners. The service centre offers free and neutral information, provides consulting and support measures for municipalities, citizens and project planners. This includes site visits, citizen consultation hours, legal advice for municipalities, support for regional dialogue events, as well as assistance in conflicts.

In addition, the service centre awards the label “Fair Wind Energy” to project developers and planners if they voluntarily comply with five guidelines for fair wind energy. Accordingly, project planners have to meet certain minimum requirements with regard to transparent
handling of information, the participation of interest groups, fair participation of the citizens, municipalities and companies concerned and the involvement of local banks and energy suppliers. The guidelines also address nature conservation aspects. The label is intended to enable a positive differentiation with regard to the credible implementation of procedural participation rights and financial participation, as well as the strengthening of local value creation. The service unit monitors compliance with the label on an annual basis.

The activities of the service centre in Thuringia helped to overcome informational asymmetries and create a level playing field between developers and municipal decision-makers (Di Nucci and Krug, 2018). It has become almost impossible for project developers to do business in Thuringia without having the label for fair wind energy (Notroff, 2017). Findings of the European research project WinWind suggest that the label increases transparency and trust (Themann et al., 2019), key pre-requisites for social acceptance. In addition, it helps to build up additional network structures and exchange between stakeholders. The label provides clear orientation for other initiatives and has a standard-setting function.

IV. Conclusions

Our quantitative research results derived from personal interviews and an online survey suggest that nature and species protection play a significant role as acceptance factors, but economic factors, the attitudes towards the energy transition and trust in actors and processes are likely even more important in influencing local acceptance.
Plants built in a way that is compatible with nature and landscape are more widely accepted.

Respondents estimated the consideration of nature and landscape protection aspects as rather critical despite comparatively strict permitting requirements and need of comprehensive expert assessments. Only few residents are aware of what is already being done to take nature conservation concerns into account in the planning and permitting process. Most of the respondents did neither know the expert opinions drawn up, nor the compensatory measures implemented to offset intrusions of nature and landscape. This means that in practice more is done in terms of nature and species protection than the local residents perceive. The nature conservation requirements should therefore be comprehensively and effectively communicated. This applies both to the investigations carried out and to the measures taken to avoid, reduce and compensate for impairments.

Several studies suggest that proximity and local embeddedness of key actors, project planners and shareholders can have a positive effect on local acceptance (Jobert et al., 2007; Enevoldsen and Sovacool, 2016). However, our research concludes that the crucial factor is personal trust in the people involved. Conversely, our findings suggest, that external developers and investors can contribute to an almost conflict-free implementation of projects through their credibility, professional appearance, open communication, engagement of local communities and financial compensations.

Besides economic factors, the overall attitude towards the energy transition had a significant influence on the local acceptance of renewable energy plants. Promoting a) participatory local energy concepts and b) community energy projects can be a particularly
promising strategies to enhance acceptance. The recently revised Renewable Energy Directive has the potential to spur the development of renewable energy communities across Europe.

The paper provided a brief overview of policies and measures helping to build trust and hence acceptance. Factors that contribute to this include transparent decision-making and planning processes, a fair distribution of costs and benefits, and keeping generated revenues in the region. Because trade-offs between climate protection through wind energy on the one hand and nature and landscape protection on the other hand are always necessary, it is of particular importance to optimise transparency, participation and trust in actors and the development processes.

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Dörte Ohlhorst: Dr. Doerte Ohlhorst has been a lecturer at the Bavarian School of Public Policy at the Technical University of Munich, Germany since 2017. She is a team member of the AcceptEE project. Her research focuses on energy, environmental and innovation policy, governance in the multilevel system, and participative decision-making processes. She was Managing Director of the Environmental Policy Research Center at the Freie Universität Berlin from 2016-2017. From 2012 to 2016, she led the project "ENERGY TRANS" at the Environmental Policy Research Center, which investigated different aspects of governance of the energy transition in Germany and Europe. She was a research associate at the German Advisory Council for the Environment and Head of the Climate and Energy Department of the Centre for Technology and Society of the Technical University of Berlin from 2009 to 2012. In 2011, she was co-founder of the Institute for Sustainable Use of Energy and Resources (iner e.V.). Recent publications are: Ohlhorst, D. 2019: Germany: from feed-in tariffs to auctions and the question of diverse actors. In: Christoph Burger, Antony Froggatt, Catherine Mitchell, Jens Weinmann (Editors): Decentralised Energy – a Global Game-Changer. pp.80-98.; Ohlhorst, D. 2016: Germany’s Energy Transition Policy between National Targets and Decentralized Responsibilities. Journal of Integrative Environmental Sciences, vol. 12, no. 4, 2016, pp.303-322 (doerte.ohlhorst@hfp.tum.de).

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Comparative Analysis of Green Productivity in Selected Asian Countries by AHP Method*

Jong-dall Kim**

Abstract: The research aims to assess the status of green productivity (GP) in six Asian countries for which we developed a framework of criteria covering the aspects of environmental sustainability, productivity, and social contribution. Under 3 major criteria, fourteen specific criteria were developed for GP. A total of 367 specialists, citizens and policy makers were participated in the survey from 6 countries. AHP was used in simulation for gaining weighting values. Respondents considered environmental sustainability (0.550) and productivity (0.246) as important elements in GP while social contribution (0.204) as less important. Among all 14 evaluation criteria, the most highly regarded elements were air quality (0.133), followed by water quality (0.111) and the use of renewable energy (0.095), while green label and customer complaints were considered the least important. Applied to the evaluation process were 89 companies that provided actual data for evaluation. These all data were combined with weighting values obtained in the previous survey. by which all companies could be ranked. The CC5 of the Republic of China was ranked as the best company and EC3 of Indonesia and CC15 of ROC were awarded as second and third companies. The research could actually evaluate companies over countries in terms of GP and expects to improve in measurement methodology for GP.

Key Words: Green Productivity, AHP, Multi Criteria Evaluation, Relative Importance, Rank

I. Introduction

Recently, Asian countries have experienced the most rapid economic growth of any region in the world, while they have intensively used energy and natural resources and are becoming the world's largest sources of "black" carbon emissions. The key question

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** Professor, School of Economics and Trade, Kyungpook National University
facing Asian countries is whether this increase will occur in a sustainable manner, or whether it will reproduce the patterns that industrialized countries witnessed in the past. Many researchers acknowledged the necessity of a new path of development, considering economic growth, resource conservation as well as environmental protection in Asia (Pan et al., 2015; Balist et al., 2016; Li and Lin, 2016; Krugman, 2016).

A green productivity (GP) can be generally defined as a business that strives to reduce its negative impact on the environment by incorporating green practices while maintaining a profit. The term Green Productivity was used by the Asian Productivity Organization (APO) (Macial and Freitas, 2019; Pineda-Henson and Culava, 2004; APO, 2006). The concept integrates productivity and quality improvements, in which productivity provides the framework for continuous improvement while environmental protection provides the foundation for sustainable development.

The trends of global environment pollution stemmed from the fast economic growth have highlighted the importance of intensifying the promotion of GP and enforced enterprise’s green productivity practices. Recently, APO initiated an award program for green companies for which national experts from Asian countries met and developed an evaluation framework and criteria for GP. Several meetings and intensive seminar for GP in Taipei and Seoul helped in developing the concept and two tiers of specific evaluation framework in the study. And two surveys across 6 Asian countries could be possible from them.

The study reviewed many literatures and developed Asian perspective with APO’s help, and finally adopted main framework
including environmental sustainability, productivity and social contribution, and specific criteria. The main objective of the paper is to develop an awarding framework of GP not for specific type but for energy and resource intensive type of manufacturing companies in Asia for which evaluation method and criteria were developed.

II. Literature Review

In the face of global environmental crisis, several authors and Asian countries have sought to find a new paradigm of sustainable manufacturing. The conservation of resources and minimization of waste were simultaneously linked to the strategy of better environmental performance and organizational productivity (Pineda-Henson and Culaba, 2004; Li and Lin, 2016). Tuttle and Heap (2007) also clarified the definition of GP with dual focus of business and its macro environment. And Sampattagul et al. and Pan et al. developed an comprehensive and integrated life cycle analysis of eco-impact of machine industries (Sampattgul et al., 2004; Pan et al., 2015).

In order to evaluate the organization as a whole, several authors have developed the Green Productivity Index (GI) and applied to in diverse industries such as oil production, car parts, pepper production etc. (Hur, Kim and Yamamoto, 2004; Gandhi et al., 2006; Cho et al., 2011; Sittichinnawing and Peerapattana, 2012; Marimin et al., 2014; Aprianto et al., 2016). Most of these analysis focused on the case of Asian countries such as Indonesia, Philippine, Pakistan and Republic of Korea, and Thailand.

Beyond the linkage of productivity with environment, the
framework of GP are expanded toward social dimensions. The social concern in the generation of products and processes contains the improvement in the quality of customers’ life (Macial and Freitas, 2019). The triple concept of GP contributed in the development of evaluation framework in the study. A wide range of criteria or attributes need to be taken into account, not simply focusing on the productivity or cost minimization.

Based on studies of Tangen (2002), Tuttle et al. (2007) and Saxena et. al. (2003), productivity can be defined as being the capacity to produce starting from a certain quantity of resources, where productivity is measured by the relation between the level of production and the resources applied to it, such as labor, energy, water and materials. These became the basic in the construction of indicators in the study.

Environmental impacts can be quantified and measured in terms of the minimum use of resource and the reduction of environmental impacts (Kim and Hur, 2003; APO, 2006). The concept was developed in the study as indicators for dematerialization and detoxification. The intensity of the consumption in raw materials, non-renewable energy, and water resources, and the recycled material, renewable energy and reclaimed water is developed as indicators of dematerailization. The reduction of the discharge of air, water and solid waste generated by the company is also developed as indicators of detoxification.

While corporates have focused on productivities and encouraged the technological innovation and/or cost minimization, societal perspectives require more than economic efficiency and environment and social welfares. The study widens its evaluation framework from
the business and the environmental orientations to “shareholders” perspective (Cho et al., 2011; Chavan, 2009). For this, the concept of corporate social responsibility (CSR) need to be integrated. Beyond the conventional approaches, the study integrated CSR in the framework such indicators of social contribution as social investment, safety, consumer and green labeling.

The evaluation of GP in the study are based on concept of productivity, environment and social responsibility. The study developed a metric framework of criteria and indicators to assess GP in the selected Asian countries, assuming the existence of diverse and conflicting values and points of views in the society (Munda, 2003; O’Connor et al., 1996).

Six national experts from six participating countries and staffs from APO have intensively helped together for the development of framework and the extraction of evaluation criteria through two seminars in Taipei and Seoul. Six countries are all of members of APO and experienced in the development of GP criteria. They also supported in conducting survey 1 and survey 2 in each country.

The paper could contribute in the construction GP indicators and framework for a comparison study in Asia by incorporating not only environmental pollution but also energy and social issues with economic growth, all of which are the essentials in Asia’s green development.

III. Evaluation Method and Framework

1. Evaluation Method

In evaluation of GP, multi-criteria evaluation is an appropriate tool
since it allows taking into account a wide range of evaluation criteria, not simply profit maximization but also other considerations (Munda, 2003). Different value and criteria can be conflicting, multidimensional, incomparable and incommensurable. As a tool for conflict management, multi criteria evaluation has demonstrated its usefulness in many green management policies.

Analytic Hierarchy Process (AHP) developed by Satty (1980, 1985) is a method to find an optimal alternative through hierarchical analysis and pairwise comparison of a wide range of criteria or attributes. Because of its simplicity and clearness in comparing companies in green productivity, AHP is appropriate in the study. The extraction of evaluation criteria related to green productivity and in the analysis of relative importance among evaluation criteria can be done. The method can help develop and articulate value judgment in a systematic way that can be used to rank alternatives in the case of development and environmental applications (Hobbs and Meier, 2000).

The research process begins with defining problems, planning goals and generating alternatives through literature review, data survey and expert meetings and interviews and with identifying and extracting hierarchical evaluation criteria: 3 implementing pairwise comparisons of each evaluation criteria with the scale of 7 points.

The surveys consisted of 2 stages: stage 1 to build evaluation framework, evaluation criteria and assessment indicators for GP. Stage 2 to assign the relative importance among the evaluation criteria selected in stage 1. It is anticipated that the respondents have and reveal various interests in GP in the survey response.

In the beginning of AHP, the larger system at upper hierarchy can
be developed to comprehend distinct pieces of information and interest, the number of entities. The large system is broken up into subsystems, almost as the schematic of a computer consists of blocks and their interconnections, with each block having a schematic of its own.

Through survey, opinions of respondents on the value of pairwise comparison matrix can be obtained. Analysis of survey data, calculate relative importance and consistency ratio on each alternative. If consistency is not secured, simulate again the 3th stage of analysis until consistency is secured. Finally, driving priorities among alternatives by composing the weights in the hierarchy (Kim et al., 2013).

When many pairwise comparisons are performed, some inconsistencies may typically arise. The AHP incorporates an effective technique for checking the consistency of the evaluations made by the decision maker when building each of the pairwise comparison matrices involved in the process. Consistency Ratio (CR) is important index representing consistency in judging and measuring of survey data. The deviation from consistency can be represented as the consistency index (CI).

\[
(CI) = (\lambda_{\text{max}} - n) / (n - 1)
\]
\[
(CR) = (CI / RI) \times 100% 
\]

<table>
<thead>
<tr>
<th>$n$</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>RI</td>
<td>0</td>
<td>0</td>
<td>0.58</td>
<td>0.90</td>
<td>1.12</td>
<td>1.24</td>
<td>1.32</td>
<td>1.41</td>
<td>1.45</td>
<td>1.49</td>
</tr>
</tbody>
</table>

Source: Saaty, T., 1980, p.20

The ratio of CI for the same order matrix is called the consistency
ratio (CR). A consistency ratio of 0.1 or less is considered acceptable. In particular, CR of 0.2 can be allowed in the case of difficulty in securing indifference among evaluation criteria unfamiliarity of respondents in AHP survey (Park et al., 2000; Ko, 2009).

2. Evaluation Framework

1) Environmental Sustainability

Environmental sustainability is to evaluate the extent to which the applicants reduce their environmental impacts yearly. This dimension has two aspects: dematerialization and detoxification. For the de-materialization aspect, raw material consumption, renewable energy and reclaimed water are important criteria. The discharge of toxic and hazardous materials or wastes are key concept in the detoxification aspect. Air and water quality, solid waste and hazardous waste materials are categorized in the 2nd trial of evaluation criteria. The reduction of GHG emissions is assumed to be included in the criteria of dematerialization.

The indicators for dematerialization and detoxification are expressed in detail in the table 2. The intensity of the consumption in raw materials, non-renewable energy, and water resources, and the recycled material, renewable energy and reclaimed water is developed as indicators of dematerialization. The reduction of the discharge of air, water and solid waste generated by the company is also developed as indicators of detoxification.
2) Productivity

Base on OECD suggestions (2001), the study includes general productivity and material productivity, in which labor productivity is included in the general productivity aspect, whereas energy and water productivities are included in each productivity aspect for analyzing how added value is created by workers, by the energy and by water consumed by the company. The idea behind these criteria is that profitability is the bottom line of a corporation, which thus needs to have high productivity to gain green competitiveness. Hence, all
indicators are translated into monetary units to represent a win-win of economic and energy and water efficiency.

Companies should disclose revenue growth for the most recent year, and any new capabilities/factors that demonstrate sustainable growth of the company. Companies should demonstrate continuous improvement in labor, energy, water and material productivity. In this survey, we asked for just one year performance in each element shown in the table 2, because it was difficult to have time series data. The unit of value added used in the following measurement is in US dollars.

3) Social Contribution

Social issues vary for different countries and are sometimes locality and community specific. Even though, the dimension has specific evaluation criteria in which applicants provide the amount of investment towards for contribution. The dimension of safety considering health also asks the enterprises to provide the number of industrial incidence inside and outside. The criteria of green label/certification and customer/consumer are related to current number of label/certification and any channel for customer/consumer number of complaints, each other.

Companies provide a description or explanation of their efforts for social contribution and sustainable development. The magnitude of positive impact on stakeholders of the issues listed in the table 2 is the main consideration for judgment: Data for each criterion in the CSR were not appropriately obtained, so the data for simulation were inputted as number 1 or 0. If a company has investment toward for social contributions, 1 was inputted. If not, 0 was inputted.
IV. Pairwise Comparisons among Evaluation Criteria and Company Survey

1. Pairwise Comparison

Based on the hierarchical evaluation criteria, the study developed two types of survey questionnaires. Survey 1 for diverse types of respondents is to check the relative importance of criteria by comparing each other in the case of 1st tier and 2nd tier of evaluation criteria each other. All weighting values in each tier could be derived through survey 1. In the survey, 367 respondents are classified as 4 groups of organization, i.e., education and research, company, government and others.

Survey 2 for companies is to fill out actual data for their performance in all questionaries including company’s general informations(4), environmental sustainability(13), productivity(4), social contribution(7). Their replied values on questions are integrated and calculated with weighting values that are gained from the survey 1. The final performance and ranking for all companies is determined by the combination of these two surveys.

Our survey for the research has been conducted through 6 countries and the numbers of respondents are as the table 3. Total numbers are 367 for survey 1 and 89 for survey 2.
Table 3: Number of respondents

<table>
<thead>
<tr>
<th>Country</th>
<th>Survey 1 for weighting</th>
<th>Survey 2 for company</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indonesia</td>
<td>35</td>
<td>8</td>
</tr>
<tr>
<td>India</td>
<td>50</td>
<td>30</td>
</tr>
<tr>
<td>Philippines</td>
<td>17</td>
<td>13</td>
</tr>
<tr>
<td>ROK</td>
<td>14</td>
<td>7</td>
</tr>
<tr>
<td>Thailand</td>
<td>25</td>
<td>16</td>
</tr>
<tr>
<td>ROC</td>
<td>226</td>
<td>15</td>
</tr>
<tr>
<td>Total</td>
<td>367</td>
<td>89</td>
</tr>
</tbody>
</table>

The table 4 shows the example of survey questions for evaluating relative importance among 1st tier criteria, and the table 5 shows the example of survey questions for evaluating relative importance among 2nd tier criteria in the case of productivity. Considering criteria, the scale of 7 points are used in pairwise comparisons of each evaluation criteria. Relative importance of evaluation criteria can be expressed in the matrix. Through survey 1, opinions of respondents on the value of pairwise comparison matrix can be obtained. Relative importance of the evaluation criteria for GP can be calculated from the pairwise comparison matrix which is obtained by the second survey. The weights of attributes can be derived by using eigen vector of the pairwise comparison matrices.
Comparative Analysis of Green Productivity in Selected Asian Countries by AHP Method

〈Table 4〉 Survey I questions for 1st tier evaluation criteria

<table>
<thead>
<tr>
<th>A</th>
<th>A is more important than B</th>
<th>Equal</th>
<th>B is more important than A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental sustainability</td>
<td>very strongly, strongly, slightly</td>
<td>7 6 5 4 3 2</td>
<td>1 2 3 4 5 6 7</td>
<td>Productivity</td>
</tr>
<tr>
<td>Environmental sustainability</td>
<td></td>
<td>7 6 5 4 3 2</td>
<td></td>
<td>Social contribution</td>
</tr>
<tr>
<td>Productivity</td>
<td></td>
<td>7 6 5 4 3 2</td>
<td></td>
<td>Social contribution</td>
</tr>
</tbody>
</table>

〈Table 5〉 Survey I questions for 2nd tier evaluation criteria (Case of productivity)

<table>
<thead>
<tr>
<th>A</th>
<th>A is more important than B</th>
<th>Equal</th>
<th>B is more important than A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labor productivity</td>
<td>very strongly, strongly, slightly</td>
<td>7 6 5 4 3 2</td>
<td>1 2 3 4 5 6 7</td>
<td>Energy productivity</td>
</tr>
<tr>
<td>Labor productivity</td>
<td></td>
<td>7 6 5 4 3 2</td>
<td></td>
<td>Water productivity</td>
</tr>
<tr>
<td>Labor productivity</td>
<td></td>
<td>7 6 5 4 3 2</td>
<td></td>
<td>Material productivity</td>
</tr>
<tr>
<td>Energy productivity</td>
<td></td>
<td>7 6 5 4 3 2</td>
<td></td>
<td>Water productivity</td>
</tr>
<tr>
<td>Energy productivity</td>
<td></td>
<td>7 6 5 4 3 2</td>
<td></td>
<td>Material productivity</td>
</tr>
<tr>
<td>Water productivity</td>
<td></td>
<td>7 6 5 4 3 2</td>
<td></td>
<td>Material productivity</td>
</tr>
</tbody>
</table>

The table 6 is a sample of survey questionnaire for companies to collect actual data for their performance in GP. Respondents were asked to rate the relative importance of criteria by comparing each criterion with each other as per survey tier 1.

Relative importance of evaluation criteria obtained by survey1 is calculated with the values obtain by survey 2. Simple Additive Weighting (SAW) method is used in the analysis. The SAW method is a commonly known and very widely used method for providing a
comparative evaluation procedure in MCDM. SAW uses all criterion values of an alternative and employs the regular arithmetical operations of multiplication and addition (Chen, 2012, pp.1848-1861).

### Table 6: Survey II questions for companies

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Environmental Sustainability</strong></td>
<td></td>
</tr>
<tr>
<td>(1) De-materialization</td>
<td></td>
</tr>
<tr>
<td>Raw material</td>
<td>Total raw material consumption (ton/year)</td>
</tr>
<tr>
<td></td>
<td>Total amount of recycled material (ton/year)</td>
</tr>
<tr>
<td></td>
<td>Total production (Overall production)</td>
</tr>
<tr>
<td>Renewable energy (Energy saving)</td>
<td>Percentage of renewable energy to total energy consumption</td>
</tr>
<tr>
<td></td>
<td>Metric ton or equivalent of energy save per ton of product</td>
</tr>
<tr>
<td>Reclaimed water</td>
<td>Total water consumption (unit: Unit: m³/year)</td>
</tr>
<tr>
<td></td>
<td>Total amount of recycled water Unit: m³/year</td>
</tr>
<tr>
<td>(2) De-toxification</td>
<td></td>
</tr>
<tr>
<td>Air quality</td>
<td>Sox, NOx, VOC (Y/N) above regulation/ law</td>
</tr>
<tr>
<td></td>
<td>Total amount of emission to air</td>
</tr>
<tr>
<td>Water quality</td>
<td>BOD, COD, other toxics (Y/N) above regulation/ law</td>
</tr>
<tr>
<td></td>
<td>Total amount of waste water</td>
</tr>
<tr>
<td>Solid waste</td>
<td>Total amount of solid waste Unit: Ton/year</td>
</tr>
<tr>
<td></td>
<td>Amount of hazardous waste Unit: kg/year</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2. Productivity</strong></td>
<td></td>
</tr>
<tr>
<td>Labor productivity</td>
<td>Production(value added/total employees (y))</td>
</tr>
<tr>
<td>Energy productivity</td>
<td>Production(value added/energy consumption (y))</td>
</tr>
<tr>
<td>Water productivity</td>
<td>Production(value added/water consumption (y))</td>
</tr>
<tr>
<td>Material productivity</td>
<td>Production(value added/ material consumption (y))</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>3. Social Contribution</strong></td>
<td></td>
</tr>
<tr>
<td>Social investment</td>
<td>Amount of investment towards for social contribution (money/year)</td>
</tr>
<tr>
<td></td>
<td>Number of employees and time spent for social service</td>
</tr>
<tr>
<td>Safety (Health)</td>
<td>Number of industrial incidence inside and outside (no/year)</td>
</tr>
<tr>
<td></td>
<td>List of safety and health measure implemented/ practiced</td>
</tr>
<tr>
<td>Green label and certification</td>
<td>Current number of label/ certification</td>
</tr>
<tr>
<td>Customer and consumer</td>
<td>Any channel for Customer/ consumer (Y/N)</td>
</tr>
<tr>
<td></td>
<td>Number of complaints</td>
</tr>
</tbody>
</table>

Note: value added in current US dollars; energy in ton of oil equivalent (TOE)
2. Checking Credibility of Survey

Consistency ratio (CR) was obtained by above equations. CR in the 1st tier was 0.028. CR of 1st tier in each country was 0.275 (India), 0.005 (Indonesia), 0.002 (Philippine), 0.01 0 (ROC), 0.012 (ROK), and 0.083 (Thailand) each other. The case of India, the value of CR, 0.275 shows is a little lower level of reliability. If there would be an award program for India companies only within the country, the answer sheet of survey 1 (India case) need to be checked and answer sheets that significantly lack consistency be removed. Within the scope of this research, the Indian sample size was not big enough to make the CR of whole participating countries to the level of unreliable level, i.e. 0.2. Thus, the credibility of CR in this research is secured. CR in the 2nd tier was 0.016 (dematerialization), 0.01 (detoxification), 0.046 (productivity) and 0.10 (social contribution) each other. The research used Microsoft Office Excel 2010 in the simulation of the analysis. derived the weighting value among criterion, and finally obtained the priorities among companies by composing the weights in the hierarchy with the values of each company through each criteria.

V. Analysis and Result of Survey

1. Analysis of Relative Importance

The table 7 shows the weighing value and order of the criteria of 1st tier and 2nd tier driven by the 367 respondents from 6 Asian countries. On the whole, the respondents gave high priority in order: environmental sustainability, productivity, and social contribution. As
shown in the table, the highest value of relative importance in the 1st tier criteria in 6 Asian countries was environmental sustainability (0.550) and productivity (0.246). Social contribution was the lowest value of 0.204. On the whole, respondents consider environmental sustainability as the most important element in the evaluation, while social contribution was regarded as the important issue, implying that people in the region did not give high point to social contribution in green productivity. For the environmental sustainability aspects, respondents gave priority to detoxification (0.554) over dematerialization (0.446).

The number of sample size in survey 1 was big enough in securing the validity of the research, but the case of ROC was relatively very big, comparing with the size of other countries. ROC could be highly influential in driving the weighting values among criteria. So, the study additionally conducted an analysis the weighting pattern by each country (see in the figure 2) and its result showed very similar outcomes as seen in the general. The order of relative importance by each country is exactly same to the order of 6 countries’ aggregative relative importance. The study decided to adopt the results of survey 1 because the influential of one country is not enough significant in changing the evaluation framework while not adjusting the number of respondents from ROC.
Comparative Analysis of Green Productivity in Selected Asian Countries by AHP Method

(Table 7) Weight values from survey I

<table>
<thead>
<tr>
<th>1st tier Criteria</th>
<th>Weight (order)</th>
<th>2nd tier Criteria</th>
<th>Weight (order)</th>
<th>Final weight (order)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental Sustainability</td>
<td>0.550 (1)</td>
<td>Raw material</td>
<td>0.330(2)</td>
<td>0.081(4)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Renewable energy</td>
<td>0.386(1)</td>
<td>0.095(3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reclaimed water</td>
<td>0.284(3)</td>
<td>0.070(7)</td>
</tr>
<tr>
<td>De-materialization</td>
<td>0.464 (2)</td>
<td>Air quality</td>
<td>0.437(1)</td>
<td>0.133(1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Water quality</td>
<td>0.363(2)</td>
<td>0.111(2)</td>
</tr>
<tr>
<td>De-toxification</td>
<td>0.554 (1)</td>
<td>Solid waste</td>
<td>0.201(3)</td>
<td>0.061(9)</td>
</tr>
<tr>
<td>Productivity</td>
<td>0.246 (2)</td>
<td>Labor productivity</td>
<td>0.267(2)</td>
<td>0.066(8)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Energy productivity</td>
<td>0.314(1)</td>
<td>0.077(6)</td>
</tr>
<tr>
<td>Social Contribution</td>
<td>0.204 (3)</td>
<td>Water productivity</td>
<td>0.222(3)</td>
<td>0.055(10)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Material productivity</td>
<td>0.197(4)</td>
<td>0.048(11)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Social investment</td>
<td>0.220(2)</td>
<td>0.045(12)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Safety(health)</td>
<td>0.396(1)</td>
<td>0.081(6)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Green label/Certification</td>
<td>0.182(4)</td>
<td>0.037(14)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Customer/Consumer</td>
<td>0.202(3)</td>
<td>0.041(13)</td>
</tr>
</tbody>
</table>

Still, ROC’s weighting value in environmental sustainability is high (0.607), while India’s and Philippine’s weighting values in the same criteria are relatively low (0.441) and (0.440) respectively. the significance of the difference vary by country and by criteria.

The order of the outcome of the evaluation of 2nd tier criteria for GP is as follows. The first, in the criteria of dematerialization, relative importance was shown with priority order of renewable energy (0.386) → raw material (0.330) → reclaimed water (0.284) respectively. In detoxification, relative importance was shown with priority order of air quality (0.437) → water quality (0.363) → solid waste (0.201) respectively. Respondents think maintenance of air quality is the most important in attaining environmental sustainability.
Relative importance in the criteria of productivity was shown with priority order of energy productivity (0.314) → labor productivity (0.267) → water productivity (0.222) → material productivity (0.197) respectively. This means the efficiencies of energy and labor input in production are more important than other elements in the consideration of green productivity.

Relative importance in productivity was shown with priority order of energy productivity (0.314) → labor productivity (0.267) → water productivity (0.222) → material productivity (0.197) respectively. This means the efficiencies of energy and labor input in production are more important than other elements in the consideration of green productivity. Relative importance in social contribution was shown with priority order of safety (health) (0.396) → social investment (0.220) → customer/consumer (0.202) → green label/certification (0.182) respectively. Respondents consider industrial incidence and investment for society are important than labeling and certification policy and customer’s or consumer’s complaints in pursuing green productivity.
The final weighting value and order by criteria is shown in the last column of the table 7. The values are obtained by multiplying weights in the 1st tier with weights in the 2nd tier in the hierarchy. The most highly regarded elements in all criteria are air quality (0.133), water quality (0.111) and the use of renewable energy (0.095). The consumption of recycled material (0.081) and safety (health) (0.081) are considered as the next important elements in GP. Green label (0.037) and customer/consumer (0.041) are considered as least important.

2. Analysis of Companies

In the second survey, survey companies are confined to be survey candidate only in the case of energy and resource intensive manufactures in 6 countries. National experts from each country anies which were asked to give specific and objective value by each criterion from 2015 to 2016. All values surveyed by criteria and by company are transformed into values of SAW. All values for 89 companies of 6 Asian countries in each criterion are calculated by SAW method and added into four groups such as dematerialization, detoxification, productivity and social contribution.

All participating companies are coded by country: 8 companies of Indonesia from EC1...to EC8, 30 companies of India from IC1...to IC30, 13 companies of Philippines from PC1...to PC13, 7 companies of Korea from KC1...to KC7, 16 companies of Thailand from TC1...TC16, and 15 companies of ROC from CC1...to CC15. All survey 2 data were transformed by 2nd tier criteria by SAW and added into 4 criteria groups respectively.

The table 8 shows ranks of 20 companies among 89 companies
from 6 countries. All values of each criterion by each company come from the combination of final weights from the table 7 with corresponding values transformed by SAW. For each country, values by criteria are summed by which all companies are ranked by each sum from the best company to the worst company in GP. In result, CC5 of Republic of China is awarded as the best company in the study. In this way, EC3 of Indonesia and CC15 of Republic of China win the award as 2nd and 3rd companies. Only highly scored 20 companies among 89 companies are listed in the following table.

(Table 8) Evaluation of 89 companies and best 20 companies

<table>
<thead>
<tr>
<th>Companies</th>
<th>De-materialization</th>
<th>De-toxification</th>
<th>Productivity</th>
<th>Social contribution</th>
<th>Sum</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>EC1</td>
<td>0.005</td>
<td>0.244</td>
<td>0.005</td>
<td>0.124</td>
<td>0.378</td>
<td>12</td>
</tr>
<tr>
<td>EC3</td>
<td>0.09</td>
<td>0.244</td>
<td>0.001</td>
<td>0.124</td>
<td>0.459</td>
<td>2</td>
</tr>
<tr>
<td>EC7</td>
<td>0.023</td>
<td>0.244</td>
<td>0</td>
<td>0.128</td>
<td>0.395</td>
<td>10</td>
</tr>
<tr>
<td>IC10</td>
<td>0.013</td>
<td>0.244</td>
<td>0.001</td>
<td>0.128</td>
<td>0.386</td>
<td>11</td>
</tr>
<tr>
<td>IC12</td>
<td>0.028</td>
<td>0.244</td>
<td>0.001</td>
<td>0.081</td>
<td>0.354</td>
<td>19</td>
</tr>
<tr>
<td>IC16</td>
<td>0.056</td>
<td>0.244</td>
<td>0.001</td>
<td>0.133</td>
<td>0.434</td>
<td>5</td>
</tr>
<tr>
<td>IC20</td>
<td>0.096</td>
<td>0.134</td>
<td>0.001</td>
<td>0.126</td>
<td>0.357</td>
<td>17</td>
</tr>
<tr>
<td>IC22</td>
<td>0.001</td>
<td>0.244</td>
<td>0.001</td>
<td>0.126</td>
<td>0.372</td>
<td>15</td>
</tr>
<tr>
<td>IC23</td>
<td>0.004</td>
<td>0.244</td>
<td>0</td>
<td>0.126</td>
<td>0.374</td>
<td>13</td>
</tr>
<tr>
<td>IC26</td>
<td>0.038</td>
<td>0.244</td>
<td>0.001</td>
<td>0.124</td>
<td>0.407</td>
<td>8</td>
</tr>
<tr>
<td>IC29</td>
<td>0.038</td>
<td>0.244</td>
<td>0.001</td>
<td>0.124</td>
<td>0.407</td>
<td>8</td>
</tr>
<tr>
<td>PC1</td>
<td>0.038</td>
<td>0.244</td>
<td>0.001</td>
<td>0.133</td>
<td>0.416</td>
<td>6</td>
</tr>
<tr>
<td>PC7</td>
<td>0.082</td>
<td>0.244</td>
<td>0</td>
<td>0.083</td>
<td>0.409</td>
<td>7</td>
</tr>
<tr>
<td>KC1</td>
<td>0.011</td>
<td>0.244</td>
<td>0.09</td>
<td>0.001</td>
<td>0.346</td>
<td>20</td>
</tr>
<tr>
<td>TC1</td>
<td>0.004</td>
<td>0.244</td>
<td>0.002</td>
<td>0.124</td>
<td>0.374</td>
<td>13</td>
</tr>
<tr>
<td>CC5</td>
<td>0.141</td>
<td>0.244</td>
<td>0.036</td>
<td>0.124</td>
<td>0.545</td>
<td>1</td>
</tr>
<tr>
<td>CC8</td>
<td>0.005</td>
<td>0.244</td>
<td>0.072</td>
<td>0.123</td>
<td>0.444</td>
<td>4</td>
</tr>
<tr>
<td>CC12</td>
<td>0</td>
<td>0.244</td>
<td>0.001</td>
<td>0.124</td>
<td>0.369</td>
<td>16</td>
</tr>
<tr>
<td>CC13</td>
<td>0.007</td>
<td>0.305</td>
<td>0.001</td>
<td>0.042</td>
<td>0.355</td>
<td>18</td>
</tr>
<tr>
<td>CC15</td>
<td>0.081</td>
<td>0.244</td>
<td>0.001</td>
<td>0.123</td>
<td>0.449</td>
<td>3</td>
</tr>
</tbody>
</table>
The research divided 89 participating companies into two groups by its output size. The companies were lined in which 44 companies belonged in the large-scale companies and 45 in the small-scale companies. Following the same way of simulation with the previous case, the best 10 companies in each group were shown in the following two tables.

As shown in the table 9, CC5 of Republic of China is the best company in Large-scale Group. In this way, EC3 of Indonesia, CC8 of Republic of China can win the award as 2nd and 3rd companies in Large-scale company group

(Table 9) Best companies within large-scale group

<table>
<thead>
<tr>
<th>Companies</th>
<th>De-materialization</th>
<th>De-toxification</th>
<th>Productivity</th>
<th>Social contribution</th>
<th>Sum</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>IC10</td>
<td>0.013</td>
<td>0.244</td>
<td>0.001</td>
<td>0.128</td>
<td>0.386</td>
<td>7</td>
</tr>
<tr>
<td>IC12</td>
<td>0.028</td>
<td>0.244</td>
<td>0.001</td>
<td>0.081</td>
<td>0.354</td>
<td>9</td>
</tr>
<tr>
<td>IC16</td>
<td>0.056</td>
<td>0.244</td>
<td>0.001</td>
<td>0.133</td>
<td>0.434</td>
<td>2</td>
</tr>
<tr>
<td>IC23</td>
<td>0.004</td>
<td>0.244</td>
<td>0</td>
<td>0.126</td>
<td>0.374</td>
<td>8</td>
</tr>
<tr>
<td>IC26</td>
<td>0.038</td>
<td>0.244</td>
<td>0.001</td>
<td>0.124</td>
<td>0.407</td>
<td>4</td>
</tr>
<tr>
<td>IC29</td>
<td>0.038</td>
<td>0.244</td>
<td>0.001</td>
<td>0.124</td>
<td>0.407</td>
<td>4</td>
</tr>
<tr>
<td>PC7</td>
<td>0.082</td>
<td>0.244</td>
<td>0</td>
<td>0.083</td>
<td>0.409</td>
<td>3</td>
</tr>
<tr>
<td>EC7</td>
<td>0.023</td>
<td>0.244</td>
<td>0</td>
<td>0.128</td>
<td>0.395</td>
<td>6</td>
</tr>
<tr>
<td>PC3</td>
<td>0.001</td>
<td>0.244</td>
<td>0.001</td>
<td>0.083</td>
<td>0.392</td>
<td>10</td>
</tr>
<tr>
<td>CC15</td>
<td>0.081</td>
<td>0.244</td>
<td>0.001</td>
<td>0.123</td>
<td>0.449</td>
<td>1</td>
</tr>
</tbody>
</table>

In ranking among small-scale companies, CC15 of Republic of China is shown in the table 10 as the best company. In this way, 1C15 of India, PC7 of Philippines can win the award as 2nd and 3rd companies.
Table 10: Best companies within small-scale group

<table>
<thead>
<tr>
<th>Companies</th>
<th>De-materialization</th>
<th>De-toxification</th>
<th>Productivity</th>
<th>Social contribution</th>
<th>Sum</th>
<th>RANK</th>
</tr>
</thead>
<tbody>
<tr>
<td>IC10</td>
<td>0.013</td>
<td>0.244</td>
<td>0.001</td>
<td>0.128</td>
<td>0.386</td>
<td>7</td>
</tr>
<tr>
<td>IC12</td>
<td>0.028</td>
<td>0.244</td>
<td>0.001</td>
<td>0.081</td>
<td>0.354</td>
<td>9</td>
</tr>
<tr>
<td>IC16</td>
<td>0.056</td>
<td>0.244</td>
<td>0.001</td>
<td>0.133</td>
<td>0.434</td>
<td>2</td>
</tr>
<tr>
<td>IC23</td>
<td>0.004</td>
<td>0.244</td>
<td>0</td>
<td>0.126</td>
<td>0.374</td>
<td>8</td>
</tr>
<tr>
<td>IC26</td>
<td>0.038</td>
<td>0.244</td>
<td>0.001</td>
<td>0.124</td>
<td>0.407</td>
<td>4</td>
</tr>
<tr>
<td>IC29</td>
<td>0.038</td>
<td>0.244</td>
<td>0.001</td>
<td>0.124</td>
<td>0.407</td>
<td>4</td>
</tr>
<tr>
<td>PC7</td>
<td>0.082</td>
<td>0.244</td>
<td>0</td>
<td>0.083</td>
<td>0.409</td>
<td>3</td>
</tr>
<tr>
<td>EC7</td>
<td>0.023</td>
<td>0.244</td>
<td>0</td>
<td>0.128</td>
<td>0.395</td>
<td>6</td>
</tr>
<tr>
<td>PC3</td>
<td>0.001</td>
<td>0.244</td>
<td>0.001</td>
<td>0.083</td>
<td>0.392</td>
<td>10</td>
</tr>
<tr>
<td>CC15</td>
<td>0.081</td>
<td>0.244</td>
<td>0.001</td>
<td>0.123</td>
<td>0.449</td>
<td>1</td>
</tr>
</tbody>
</table>

VI. Conclusion

The research aimed to evaluate the effectiveness and performance of green productivity in six Asian countries. The study established a comprehensive framework with a set of indicators to rate green companies in the region. The multi-criteria decision making method was adopted and the analytic hierarchy process was used in evaluating these criteria and in performing pairwise comparison.

The main framework has basically two tiers of each criterion. Environmental sustainability, productivity and social contribution were criteria in the 1st tier under which 14 specific criteria in the 2nd tier were used. In the case of environmental sustainability, two specific criteria of dematerialization and detoxification are additionally used to cover diverse elements of environmental issues.

The survey was conducted through two stages: survey 1 is to collect pairwise comparison data in each criterion from 367 respondents by
country; and survey 2 is to collect direct and objective data from candidate companies in energy and resource intensive sectors by country from 2015 to 2016. Based on survey 1, the study derived relative importances (weights) in all evaluation criteria. Then, the study collected actual data from 89 companies through survey 2 and combined weight values and actual data together. The study finally evaluated comparatively 89 companies for their performance in GP.

As a result of survey 1, the people in 6 Asian countries gave the highest value in environmental sustainability (0.550) among three 1st tier criteria. Productivity and social contribution gained much lower weights such as 0.245 and 0.204, respectively. For the environmental sustainability aspects, detoxification (0.554) has a priority over dematerialization (0.446).

In the 2nd stage of analysis, participating companies were ranked by total values in each criterion from the best company to the worst company in GP. SAW method was used in the transformation of all original values into the comparable values. The company name of CC5 from the Republic of China had a highest point (0.545). The rank of other companies was EC3 (0.459), CC15 (0.449), CC8 (0.444), IC16 (0.434) and PC1 (0.416) et cetera. In order to see biases from the county and the size, the study divided 89 companies into diverse companies by the production size and by country, and simulated all companies in each category. The Republic of China and Indonesian companies highly ranked in large-scale group, while in small-scale group, Indian and Philippine companies also ranked highly with Republic of China companies.

The evaluation model has a system both a relative evaluation system and an absolute evaluation system, taking into account the
university of indicators and the variety of evaluation objects so it can reflect each company’s characteristics as well as overall performance. All indicators are quantitative ones to ensure that the evaluation results can be compared over time and among different companies. Its theoretical contribution comes from improving the previous literatures in terms of specification of resource uses including renewable energy sources, and of corporate social responsibility in GP. The model can be used in evaluating not just the environmental impact of productivity but also the adoption of clean energy technology and social considerations generated by companies.

The study can practically contribute in improving the applicability of GP in the region, because the identification of the specific criteria of GP will allow companies to understand which activities reduce energy and material consumption, environmental impacts and social risk and consequently, increase their efficiency, productivity social reputation.

Finally, considering the relevance of the study, it is necessary to mention some limitations regarding its application: the lack of systemic data about the company, mainly from different products and/or production process. The limit also comes from the initially loose definition of the survey company in which the rewarding target companies set bounds to not specific but general type of energy and resource intensive manufacturing sectors. If the study had focused on a specialized area, more accurate and deep comparison of companies could be possible. On the other hand, the resistance on the part of the companies in supplying such informations also presents a limit, especially in the case of an international study. The situation is changing due to the increasing pressures from the global community and green marketing requirement.
Comparative Analysis of Green Productivity in Selected Asian Countries by AHP Method

References


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**Kim, Jong-dall**: a professor, School of Economics and Trade and director, Research Institute for Energy, Environment and Economy, Kyungpook National University. He received Ph. D in University of Delaware and was the President of International Solar Cites Initiative (jdkim@knu.ac.kr).

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Accepted: 20 December 2019
제1조 (논문제출 및 심사)

1. 투고논문
『환경정책』에 투고하는 모든 원고는 투고규정과 윤리 규정에 위배되지 않아야 하며, 이 규정을 준수하여야 한다.

2. 투고자격
(1) 환경정책 및 이와 관련된 학문분야의 회원은 누구나 본 학회지에 투고할 수 있다.
(2) 투고자격은 주저자를 포함하여 모든 저자가 학회 회원이어야 하며 당해연도 연 회비를 납부한 사람에 한한다. 단, 공동발행기관인 한국환경정책·평가연구원 소속 연구진은 학회 회원 여부와 관계없이 투고 자격을 부여한다.

3. 논문접수
(1) 원고는 수시로 접수하며, 그 접수는 학회 홈페이지(http://www.kepas.or.kr/) 상의 온라인논문투고시스템을 이용한다.
(2) 저자는 저자점검표의 점검사항 확인하고 논문을 제출한다.
(3) 원고 접수일은 논문의 온라인 논문투고일로 하며, 게재확정일은 심사가 완료된 일자로 한다.
(4) 논문의 내용에 대한 책임은 집필자가 진다.

4. 심사료 및 게재료
(1) 투고자는 논문 게재확정시 심사료 및 게재료 100,000원을 납부하여야 한다. 단,
연구비 지원을 받아 사사를 표기하는 논문은 게재료 200,000원을 납부하여야 한다.
긴급심사 경우, 심사료 및 게재료는 일반논문의 2배로 한다.
(2) 투고면수가 10면을 초과하거나 투고자가 다색인쇄를 희망하는 경우에는 추가 인쇄비를 부담하여야 한다.
- 초과 면당 10,000원
(3) 게재논문의 별쇄본은 20부를 원칙으로 하며, 추가 인쇄를 희망하는 경우에는 투고자가 인쇄비를 부담하여야 한다.

5. 학회지 발간
(1) 투고된 논문은 편집위원회의 심사를 거쳐 게재 여부를 결정한다.
(2) 학회지는 연 4회 (매년 3월 31일, 6월 30일, 9월 30일, 12월 31일) 발간하며 필요 시 특별호를 발간할 수 있다.

제2조 (논문 작성지침)

1. 작성언어 및 분량
(1) 원고는 국문 또는 영문으로 작성하는 것을 원칙으로 하고, 필요한 경우에는 한자
의 사용도 가능하다.
(2) 원고는 워드프로세스 또는 아래한글 프로그램을 사용하여 작성한다.
(3) 투고원고는 특별히 매수를 규정하지 않으나 A4용지 15매 내외로 작성한다. 논문
의 최종 인쇄시 도표를 포함하여 10쪽 이내로 하며, 이를 초과하는 경우 제1조 4
항에 의거하여 투고자는 1면당 초과게재료를 납부하여야 한다.
(4) 약어를 사용하는 경우 처음에 원래의 용어를 표기하고 ()안에 약어를 표기한다.
그 다음부터는 약어를 사용할 수 있다.
[예] Green Climate Fund(GCF)

2. 논문의 구성
원고는 표지, 본문, 참고문헌, 저자 소개 순으로 구성되며, 필요한 경우 부록을 포함
할 수 있다.
2-1 표지
원고의 표지에는 논문제목(국·영문), 저자의 이름(국·영문) 및 소속, 초록 및 주제어 (국·영문)를 수록한다.

2-2 논문제목
(1) 논문 제목은 국문, 영문 순으로 한다. 단, 영문 논문의 경우에는 영문, 국문 순으로 한다.
(2) 가운데 정렬을 하며, 국문과 영문제목은 행을 분리한다.
(3) 부제목은 “:”으로 시작하고 주제목과 행을 분리하지 않는다.
(4) 영문제목은 전치사와 접속사를 제외한 모든 단어를 대문자로 표기한다. 단 전치사가 제목의 첫 단어일 경우에는 대문자로 표기한다.
(5) 연구비 지원, 감사의 글, 사전에 발표된 내용 등 논문에 관련된 사항이 있을 시에는 제목의 우측 끝 상단에 위치자 “*”로 표기하여 첫 페이지 하단 각주에 그 내용을 기술한다.

예* 본 논문은 0000년도 00연구비 지원에 의하여 연구되었음.
   * 본 논문은 00에서 수행한 00연구보고서의 일부를 발췌, 수정·보완한 것임.
   * 본 논문은 0000년도 00학회 00학술대회에서 발표한 내용을 수정·보완한 것임.

2-3 저자
(1) 저자명 및 소속기관은 국문, 영문 순으로 한다. 단, 영문 논문의 경우에는 영문, 국문 순으로 한다.
(2) 저자가 2인 이상일 경우에는 저자명 사이에 “*”를 삽입하여 구분한다.
(3) 가운데 정렬을 하며, 국문과 영문이름은 행을 분리한다.
(4) 영문 이름 경우, 영문 성명은 이름을 먼저 쓰고 성은 뒤로 쓴다.
(5) 저자의 소속기관은 저자명 우측 끝 상단에 각각 저자 순서대로 위치자 *, **, *** 기호로 표기한다. 논문제목에 각주가 있는 경우 위치자 기호는 **에 서 시작한다.

예]
Chul-Soo Kim*·Young-Hee Lee**·Gil-Dong Hong***
(6) 각주에는 주저자(First author)와 교신저자(Corresponding author)를 포함한 모든 저자의 소속 및 직위를 기재한다.

| [예] * 주저자, OO대학교 OO학과 교수 |
| ** 교신저자, OO대학교 OO학과 교수 |
| *** 공동저자, OO연구원 OO과 OO연구원 |

2-4 초록 및 주제어

(1) 국·영문 초록은 논문의 목적과 주요성과를 구체적으로 기술하여야 하며, 그 분량은 가능한 300 단어 이내로 한다.
(2) 초록은 국문, 영문 순으로 한다. 단 영문 논문의 경우에는 영문, 국문 순으로 한다.
(3) 국문초록(요약)과 영문초록(Abstract)을 모두 작성해야 하며, 다섯 단어 이내의 핵심주제어(Key Words)를 초록 하단에 각각 명기하여 한다. 국문 초록 뒤에 국문 주제어, 외국어 초록 뒤에 외국어 주제어를 명기한다.
(4) 영문 주제어는 전치사를 제외한 모든 단어를 대문자로 시작한다.

2-5 본문

(1) 본문은 서론, 본론, 결론의 형식으로 구성하며, 본론은 내용에 따라 장을 세분해야 한다.
(2) 서론과 결론에 해당하는 장의 제목은 각각 “서론”과 “결론”(영문 논문의 경우 “Introduction”과 “Conclusion”)으로 명시하거나, 또는 적어도 그 내용이 서론과 결론에 해당함을 알 수 있는 제목으로 표현해야 한다.
(3) 본문 속의 제목들에 사용하는 기호 I., 1., 1), (1)...와 같다.

2-6 숫자, 수식, 단위, 기회의 서식

(1) 숫자
   ① 수량을 표시할 때에는 아라비아 숫자를 쓴다.
   ② 1 미만의 소수는 소숫점 앞에 반드시 0을 쓴다.
   ③ 분수는 가급적이면 ⅓으로 표시하지 아니하고 ¹/₃, 으로 쓴다.
(2) 수식
   ① 수식은 줄(행)을 바꾸어 1행으로 쓰기를 원칙으로 하고, 수식이 2행 이상에 절개 때에는 “+”, “−”, “×”, “÷” 등 연산기호부터 줄을 바꾸되 그 위치를 통일한다.
2) 수식의 첨자는 논문집으로 나왔을 때 보일 정도의 크기로 한다.
3) 수식은 수식 오른쪽에 (1), (2), (3) 등의 일련번호를 넣는다.

(3) 단위 및 기호
① 단위는 미터법을 사용함을 원칙으로 하고 필요한 경우 다른 단위를 병기한다.
② 단위기호 및 양(량)기호에 대하여는 한국공업규격의 단위기호, 양기호에 따라
   램을 원칙으로 한다.
③ 단위는 이탤릭체가 아닌 정자로 쓴다.

2-7 표, 그림, 사진
(1) 표와 그림, 사진은 본문의 삽입위치에 기재한다.
(2) 표와 그림, 사진의 제목과 설명은 모두 한글로 표기하고, 차례대로 아라비아เลข
   자로 번호로 표기한다. 단 영문 논문의 경우에는 영문으로 표기한다(예2).
① 표와 그림, 사진의 제목과 설명은 모두 한글로 표기하고, 차례대로 아라비아เลข
   자로 번호로 표기한다. 단 영문 논문의 경우에는 영문으로 표기한다(예2).

| 예1 | 표1, 그림1, 사진1........... |
| 예2 | Table 1, Figure 1, Photo 1........ |

(3) 모든 제목은 해당 표, 그림, 사진 상단에 ‘가운데 링추기’로 표기하며, 제목 끝에
   마침표를 붙이지 아니한다.
(4) 표와 그림에 대한 주(출처 및 추가사항)는 표, 그림, 사진 하단 좌측에 기재하며,
   일반주(주: 영문논문 경우, Note 1), 개별주(a, b, c), 확률주(*p<.01, **p<.001)
   출처 순으로 배열한다.
(5) 동일한 번호 하에 두 개 이상의 그림 및 표를 두고자 할 경우 (a), (b)로 구분하여
   소제목을 부여한다.
(6) 관련된 표와 그림을 본문에서 언급할 때 < >를 붙인다.

| 예 | <표 1>에서 볼 수 있듯이... |
|    | ...단계로 구분하였다<그림 1>. |
表 11 탄소포인트제 및 그린카드 동시 가입자 에너지 감축량

<table>
<thead>
<tr>
<th>구분</th>
<th>전기 (원/kwh)</th>
<th>수자원 (원/㎥)</th>
<th>가스(LNG) (원/㎥)</th>
</tr>
</thead>
<tbody>
<tr>
<td>탄소포인트 그린카드 동시가입자 감축량</td>
<td>120.2</td>
<td>550.0</td>
<td>840.0</td>
</tr>
<tr>
<td>그린카드 1개월 평균</td>
<td>10.044</td>
<td>0.364</td>
<td>0.309</td>
</tr>
</tbody>
</table>

1) 전기요금 한국전력 요금정보 (도시가구 평균 전력사용량이 301.8kwh(지식경제부)이며 감축했을 때 적용이 될 수 있는 구간인 200kwh-300kwh의 전기료 2012.09월 요금 기준). 서울시 상수원사업본부 요금정보 (1인당 평균 346L/일 사용(수자원공사)기준
2) 2011년 12월까지의 그린카드 누적발급수의 합 = 1,763,543좌 기준

表 1  국가 온실가스 배출량 통계 및 전망


2-8 본문에서의 참고 및 인용

(1) 각주는 설명을 필요로 하는 문장, 어구, 또는 단어의 오른쪽에 위첨자로 “1)” “2)” 등의 일련번호를 부여하고, 해당페이지 하단에 “1).” “2).” 등으로 표기하여 설명을 붙인다.
(2) 인용문에 저자명이 포함된 경우
① 1인 저서 : 자료 전체 인용은 저자의 성명과 출판연도를 기재하며 부분 인용은 면수까지 기재한다. 서양 저자는 영어로 성만 표기한다.

이남순(2006)은 아동들의 관심이 수업에 반영되었을 때...
Muller(2000)는 문학을 이해하는 …
McAlister (2002, pp.439-455)는 …
...라고 주장하였다(이남순, 2006).
② 2-6인 공저서 : 저자가 2인 공동저자인 경우 두 저자명을 ‘와(과)’로 연결하나(예1) 문장 끝에 괄호로 묶어 처리했을 때는 저자명을 절달로 구분하고 영문 문헌의 경우에는 ‘and’를 사용한다. 그리고 복수 연구물은 세미콜론(;)으로 서로 다른 연구임을 표기한다(예2).

셋 이상 여섯 명 미만의 저자가 함께 수행한 공동연구를 본문에 인용할 때는 처음 인용할 때마다 모든 연구자의 성명을 표시한다. 같은 연구일 경우, 두 번째 인용될 때부터는 첫 저자명만 기재하고 두 번째 이하는 ‘등’, ‘et al.’로 표기한다(예3).

| 예1 | 강영숙・고윤주(1992)는...
|     | Dobson and White(2006)는...
| 예2 | ...라고 주장하였다(강영숙・고윤주, 1992: Dobson and White, 2006)
| 예3 | 류창하・김인용・조태진(1994)에 따르면....
|     | 류창하 등(1994, p.18)의 주장은....
|     | Wasserstein, Zappulla, Rosen, Gerstman and Rock(1994, pp.56-58)은...


| 예 | 김병철・이정윤・이건수・김문석・이영석・정혜윤 등(1995)은....
|     | 김병철 등(1995, p.37)은.....

④ 단체의 저서 : 단체명을 약어와 함께 기재하며, 두 번째 이하는 약어만 기재한다.

| 예 | 정신문화연구원[정문연](1999, p.72)은.....
|     | 정문연(1999, p.14)은...........
|     | National Institute of Mental Health [NIMH] (1991, p.66).....
|     | NIMH(1991, pp.37-38).....

⑵(3) 인용문에 저자명이 포함되지 않은 경우

① 1인 저서 : 직접 인용은 인용부호 “”로 그대로 기재하며, 서양인명은 ‘성, 발행 연도, 면수’로 기재한다.

| 예 | “아름다움을 만들어 가는 활도[i.e.: 활동] 속에서 인간의 정서는 결정처럼 아름다운 틀을 이룩하는 것”(Read, 1999, p.141)이라 한다면….
② 2-6인 공저시: 두 저자명을 ‘와(과)’로 연결하거나(예1) 영문 문헌의 경우에는 ‘and’를 사용한다.

[예] ......한 점에서 일치하고 있다(West and Sandler, 2000, pp.30-41).

③ 동일인의 2개 이상의 저자 인용: 한 저자의 동일 년도 저작은 발행년도에 ‘a, b’로 등을 붙여 구분한다.

[예] 특정지역을 나타내기 위한 보조표이다(오동근, 1994a, p.34).

… 보조표의 행정조직이 참조되어야 한다(오동근, 1994b, p.33).

④ 저자미상의 저서: 무저자명의 자료는 ‘서명, 발행년도, 면수’ 기재한다.


“racial injustice, war, and the university itself” (Report, 2000, p.3)

⑤ 인용문에 저자명과 자료명이 포함된 경우

[예] 김정현은 목록조직의 실제(pp.25-70)에서 그 예를 제시하고 있다.

브리태니커 백과사전(11판)에서...

McRae’s The Literature of Science includes many examples of this trend.

(4) 블록 인용: 블록인용은 직접 인용되는 내용이 3행 이상(40 단어 이상)인 경우이며, 블록인용 내용의 일부를 생략할 경우 3점 줄임 ‘…’ 사용한다. 인용부호를 쓰지 않고, 인용문의 앞과 뒷부분을 2-3스페이스 들여쓰며, 본문보다 행간을 좁게, 활자를 1-2포인트 낮추어 쉽게 구별할 수 있게 한다.

[예] 현규섭은 국립중앙도서관의 MARC개발에 대하여:

국립중앙도서관은 한 나라의 법정납본기관이며 국비에 의해 공익적 선 투자
의 가능성을 가진 기관이란 점에서 마땅히 MARC의 개발의 임무가 부여되었
다...1909[i.e. 1980]년대에 한국문헌 자동화목록법을 출범시켰던 것이다. 이
는 도서관의 자원을 통신계와 연결시키려는 노력이었다(1986, p.iii).

(5) 2개 이상의 자료 동시 인용: 한국어, 한국어와 가까운 언어순, 저자명은 문자순, 동일 저자는 연도순으로 기재한다. 저작과 저작 사이는 세미콜론으로 구분하며, 동일 저자의 다른 저작은 콤마로 구분한다.
2-9 참고문헌

(1) 참고문헌의 순서

원어로 표기함을 원칙으로 하며, 문헌의 기재 순서는 동양문헌(한국, 중국, 일본), 서양문헌(영문, 기타언어)로 한다. 국문 문헌은 신문기사, 법령, 보도자료 등을 포함하여 저자명의 가나다 순서로, 영어 및 기타 문헌(홈페이지 주소 등)은 저자명의 알파벳 순서로 기재한다.

참고문헌에 포함되어야 할 사항들을 순서대로 나열하며, 저자, 출판년도, 제목, 출판사명, vol., no., 그리고 페이지 등이다.

동일한 저자의 문헌은 발표 년도의 순서로 기재하며, 발표 년도가 동일한 경우에는 “a”, “b”, “c………”를 연도 뒤에 붙여 구분해주며, 맨 처음 자료에만 저자명을 쓰고 다음부터는 저자명 자리에 밑줄로 (____) 대체하여 표시한다.

[예] 김철수, 2013a,

[예] 김철수, 2013b,

(2) 저자명 작성

서양저자명은 저자의 성 다음에 콤마(,)를 적고 이름순으로 기입하며, 성은 완전명, 이름은 약자로 표기한다. (last name, first name middle name)

저자가 2인 이상일 때, 국내문헌의 저자명 사이에 가운뎃점(·)으로 구분하며, 외국문헌은 맨 마지막 저자명 앞에서만 ‘and’를 붙인다. 그리고 이때 외국문헌은 맨 처음의 저자명은 성, 이름 순으로 기재하고 두 번째 이후에는 이름, 성의 순으로 표기한다.


(3) 문헌명 작성

외국문헌의 책명, 정기 간행물명, 학회지명은 이탤릭체로, 국내문헌은 괄호(‘ ’)로 표기한다.
(2) 외국문헌의 저서 및 단행본, 논문의 제목은 첫 단어만 대문자로 표기하고 나머지는 모두 소문자로 표기한다. 단, 정기간행물의 제목은 각 단어의 첫 글자를 대문자로 표기한다.
(3) 논문제목을 표기하는 방법에서 논문제목 뒤에는 콤마(,)후에 큰 따옴표로 표기한다.

(4) 기타
① 인용문헌은 본문이나 미주에서 인용한 모든 문헌을 빠짐없이 포함하여야하며, 본문이나 미주에서 인용되지 않은 문헌을 포함해서는 안 된다.
② 년도는 아라비아 숫자로 표기한다.
③ 쪽(페이지)이 2쪽 이상인 경우에는 “-”로 표기하고, 쪽의 모든 숫자를 표기한다.
④ 이상의 원칙과 함께 참고문헌은 다음과 같이 표기한다.

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2-10 저자소개

(1) 논문의 마지막 부분 참고문헌 다음에 저자소개를 첨부한다.
(2) 저자소개는 성명, 이메일, 최종학력, 현직, 관심분야, 주요논문 혹은 저서 2-3개
   등을 3-4줄 정도의 완성된 문장으로 소개한다.

2-11 부록

필요한 경우에 한하여 기재할 수 있다.

부칙

기타 본 규정에 명시되지 아니한 사항에 대한 결정은 편집위원회에 위임한다.
『환경정책』편집 및 심사규정

제1조 (목적)

본 규정은 한국환경정책학회와 한국환경정책평가연구원의 학술논문집《환경정책》(이하 ‘학회지’라 한다)에 게재할 논문의 심사 및 게재에 관한 사항을 규정함을 목적으로 한다.

제2조 (편집위원회)

1. 편집위원회 구성
(1) 편집위원회는 1인의 편집위원장과 부편집위원장 외 25인 내외의 편집위원으로 구성한다.
(2) 편집위원장은 학회장이 임명한다.
(3) 부편집위원장은 학회와 학회로 추천을 거쳐 임명한다.
2. 편집위원장 등
(1) 편집위원장은 편집위원회를 주관하고 상임이사회 위원이 된다.
(2) 부편집위원장은 편집위원장의 위임을 받아 편집위원회의 재판 업무를 관장할 수 있다.
(3) 편집위원장과 부편집위원장의 임기는 2년으로 하고 연임할 수 있다. 임기의 시작은 해당년도 3월 1일로 한다.

3. 편집위원
(1) 편집위원의 선정기준은 다음과 같다.
   ① 편집위원은 박사학위 소지자, 대학교수 또는 그와 동등한 능력이 있다고 인정된 자, 각 연구 분야에 대해 최신 지견을 갖춘 자를 원칙으로 한다.
   ② 편집위원은 최근 활발하게 학술활동을 하는 사람으로써 연구실적이 우수한 사람으로 한다.
   ③ 편집위원은 지역분포 및 직급을 고려하여 선정한다.
   ④ 학문적 기여도 등을 기준으로 하여 선정한다.
(2) 편집위원의 임기는 2년으로 하고 연임할 수 있다. 편집위원회의 연속성 유지를 위하여 교체되는 편집위원 수는 전체 편집위원 수의 2분의 1을 초과하지 않도록 한다.

4. 편집위원회 회의
(1) 편집위원회는 매년 2회 이상 전체회의를 개최하고 필요시 임시회의를 수시로 개최한다.
(2) 편집위원회 회의의 의사결정은 전체 편집위원회의 과반수 출석으로 개최하며 출석위원 과반수의 찬성으로 가결된다.

제3조 (논문 심사)

1. 심사대상 논문
(1) 본 학회지 원고제출 요령에 맞게 제출된 원고만 심사의 대상이 된다.
(2) 투고된 논문에 대하여 편집위원회에서는 분야, 형식, 분량 등의 적합성 여부를 검토하는 예비심사를 행한다.
(3) 투고된 논문은 반환하지 않는다. 단, 편집위원회는 투고된 논문에 대하여 1차적
으로 본 학회의 목적과 취지의 적합성 여부를 판정하여 적합하지 않은 논문의 경우, 본 심사 이전에 반려(탈락)할 수 있다.
(4) 예비심사를 통과한 논문에 대하여 내용의 학문적 수준을 종합적으로 평가하는 1차심사를 행한다.

2. 논문의 심사절차
(1) 학회지 게재를 원하는 논문은 연중 수시로 접수하고 수시로 게재여부를 심사한다. 단, 논문투고는 온라인상의 논문투고시스템을 이용한다.
(2) 예비심사에서 탈락한 경우는 심사과정 없이 기고자에게 반려할 수 있다.
(3) 예비심사를 통과한 논문에 대하여 1차심사를 위하여 편집위원장은 3인의 심사위원을 선정하여 심사를 의뢰한다.
(4) 투고된 논문은 심사위원에 의해 비밀심사를 받는다. 즉 심사위원에게는 논문저자의 이름을 비밀로 하고 논문저자에게는 심사위원의 이름을 비밀로 한다.
(5) 편집위원장으로부터 논문심사를 의뢰 받은 심사위원은 의뢰 받은 날로부터 4주일 이내에 심사를 끝내고 그 결과를 온라인논문시스템에 탑재하여야 한다. 선정된 심사위원이 불가피한 사정으로 논문심사를 할 수 없을 때에는 즉시 편집위원장에게 통보하여야 한다. 심사자가 의뢰 받은 날로부터 4주일이내에 심사를 끝내지 못할 경우 편집위원장은 새로운 심사자를 선정하여 심사를 위촉할 수 있다.
(6) 편집위원장은 심사가 완료된 후 집필자에게 그 결과를 즉시 통지하며 심사의 결과에 따라 논문의 수정을 요구할 수 있다.
(7) 편집위원장으로부터 논문의 수정을 요청 받은 집필자는 수정을 요청 받은 날로부터 3개월 이내에 수정논문을 제출하여야 한다. 집필자가 사유를 통보하지 않고 기한내에 수정된 논문을 제출하지 않을 경우 게재불가로 처리한다.
(8) 논문집필자가 수정하여 다시 제출한 논문은 당초 심사자가 다시 심사를 원칙으로 한다. 재심의 경우 게재가, 수정후 게재, 게재불가의 판정만을 하며, 불가판정의 경우 심사자는 반드시 불가에 대한 심사평을 제출한다. 심사결과 “게재불가” 판정을 받은 논문은 재투고할 수 없다. 단, 전면수정하여 통보 후 3개월 이후에는 재투고가 가능하다.
(9) 편집위원장의 위의 과정을 통과한 논문을 게재함을 원칙으로 한다. 다만 학회초청 논문 또는 특별기고 논문 등은 편집위원회의 결의에 의해 게재할 수 있다.
(10) 편집위원장이 논문을 투고할 경우에는 회장이 임시 편집위원장의 역할을 수행
하며, 편집위원이 투고한 논문은 편집위원장이 심사위원을 선정한다. 또한 다른 편집위원이 심사자에 선정되지 않도록 한다.

(11) 긴급심사제도
① 긴급심사제도는 접수 후 15일 이내에 1차 심사를 완료하여 논문의 게재여부를 조속히 판정하며, 심사료 및 게재료는 일반논문의 2배로 한다.
② 심사결과가 ‘수정·보완 후 재심’ 등으로 판정되어 게재여부가 불확실할 경우에는 게재여부의 판정이 지연될 수 있다.

3. 논문심사 기준과 심사 결과
(1) 예비심사는 투고된 논문이 본회의 사업 목적에 부합하는 분야를 다룬 것인지의 여부와 별도 투고 지침에서 정한 형식 및 분량을 준수하였는지를 기준으로 한 다.
(2) 1차심사는 아래 사항을 염두에 두고 투고된 논문의 내용을 중심으로 학문적 수준을 평가한다.
   ① 주제의 적절성
   ② 기존 연구의 검토과정
   ③ 국문·영문 초록의 충실성
   ④ 논문 전개의 논리성 및 일관성
   ⑤ 분량·표·그림·지도 형식의 적절성
   ⑥ 정책적 기여도
   ⑦ 학술적 기여도

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</table>
(3) 심사결과에 대한 이의신청

논문제출자가 심사결과에 대한 불복사유를 문서로 제출하고 편집위원장이 그 사유가 합당하다고 판단할 경우, 편집위원회의 의결에 의해서 기존의 심사위원을 제외한 새로운 심사절차를 실시할 수 있다.

4. 기타 사항

(1) 논문의 게재순서는 게재확정 순서에 따르나, 편집위원장이 학회지의 편집구성을 고려하여 이를 조정할 수 있다.
(2) 논문게재예정증명서는 투고논문이 게재확정된 후에 저자의 요청이 있을 경우 편집위원장이 발행할 수 있다.
(3) 본 규정에서 정하지 않은 사항은 편집위원회에서 따로 정한다.

제4조 (학회지 편집방침)

1. 저작권

(1) 본 학회지에 게재되는 모든 논문에 대한 저작권은 한국환경정책학회와 한국환경정책평가연구원이 공동으로 소유한다.
(2) 저작권에는 디지털로의 복제권 및 전송권을 포함한다. 다만 게재된 논문 등의 필자가 본인의 논문 등을 사용할 경우에는 본 학회는 특별한 사정이 없는 한 이를 승인한다.
(3) 게재 확정된 원고의 저자는 저작권이양동의서를 최종논문 투고시 제출하여야 한다.
(4) 저작권이양동의서에 서명하는 것은 저자가 본 동의서에 기재된 모든 내용을 읽고, 그 내용을 이해하였으며, 그 내용에 동의하는 것을 의미한다.

2. 출판 윤리

(1) 투고 논문은 연구윤리규정에 따라 본 학회지외의 타간행물에 발표되지 않은 것이어야 한다.
또한 본 학회지에 게재된 논문은 임의로 다른 학회지에 게재할 수 없다. 즉, 본 학회지는 이중게재를 허락하지 않는다. 단 학술대회 발표논문은 예외로 한다.
(2) 학회지에 게재되는 논문은 학문적인 독창성을 가지고 환경 연구가 가지는 사회
적 책임을 인식하여 다른 논문이나 연구결과를 인용할 때 그 출처를 명백하게 밝혀야 한다.
(3) 편집위원장, 부편집위원장, 편집위원 및 심사위원들은 학술윤리를 고양하고 표절방지를 위해 논문심사과정에서 최선을 다하여야 한다.
(4) 편집위원회는 투고되는 논문에 대해 1차심사천에 한국연구재단의 논문유사도 검사 및 Copykiller를 시스템을 활용하여 논문의 표절여부를 확인하여, 논문유사도검사 결과가 일정비율 초과시 편집위원회 결정에 따라 게재를 불허한다.
# 회원가입신청서

※ 회원가입번호 : ____________________

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본인은 귀 학회의 취지에 동의하여 입회하고자 하오니 승인하여 주시기 바랍니다.

20 년 월 일
신청인

(사) 한국환경정책학회 회장

○ 사무국 : 우03367 서울특별시 은평구 진흥로 215 한국환경산업기술원 B동 102호
  한국환경정책학회
  Tel : 02-354-6884, Fax : 0303-3445-6885  E-mail : kepas@kepas.or.kr

○ 회비 · 개인회원 입회비 : 5,000원 · 연회비 : 30,000원 · 평생회비 : 500,000원
  · 특별회원 A : 1,000,000원 이상 · 특별회원 B : 500,000원
  · 특별회원 C : 200,000원 · 도서관 : 100,000원

○ 계좌번호 : 우리은행 1006-501-550951 (사)한국환경정책학회

○ 회원가입 발송자료 : 학회지 4회, 학술대회자료집, 각종 세미나 자료집, 소식지

○ 회원가입을 독려하여 주시고 주소변경사 실명사항을 보내주시기 바랍니다.
이 학술지는 2013년도 정부(교육부) 재원을 빌리하여 한국연구재단의 지원을 받아 출판되었음.

제27권 특별호 (2019. 12)
서기 2019년 12월 30일 인쇄
서기 2019년 12월 31일 발행

공동발행인 / 정영근, 윤재용
공동발행소 / 한국환경정책학회
한국환경정책평가연구원

인쇄 / 조명문화사
(02-498-3017)