

**SUSTAINABILITY POLICY AND GREEN GROWTH
OF THE SOUTH KOREAN CONSTRUCTION INDUSTRY**

A Thesis

by

HWAYEON JEONG

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of
MASTER OF SCIENCE

August 2011

Major Subject: Civil Engineering

Sustainability Policy and Green Growth of the South Korean Construction Industry

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Approved by:

Chair of Committee, John Walewski
Committee Members, Stuart Anderson
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ABSTRACT

Sustainability Policy and Green Growth of the South Korean Construction Industry.

(August 2011)

Hwayeon Jeong, B.S., Pusan National University

Chair of Advisory Committee: Dr. John Walewski

South Korea is among a host of countries trying to achieve sustainable development across whole industry sectors by adopting “Green Growth” as the vision of the national development in the Korean government. The government has executed a vast effort regarding the policy, and these efforts have produced several successful results. However, the vision of the Green Growth does not appear to be settled in the construction industry, which is a sector that has a huge impact on sustainability and has made striking economic impacts over the last several decades to Korea’s growth and development.

Although the performances under the Green Growth are difficult to be evaluated because the Green Growth policy is now in the process of revisions and supplement, this is the time to diagnose the current situation and efforts of Green Growth in the Korean construction industry. A primary goal of the thesis is developing a preliminary framework to promote Green Growth in the Korean construction industry in order to reduce possible trials and errors in the early phase of the implementation of Green Growth.

To accomplish this goal, a detailed analysis of the current Korean sustainability system, Green Growth, was then undertaken given this is the current policy guidance for the Korean construction industry. To garner further input on the direction of sustainability policy and methods in Korea, in-depth interviews with professionals in relevant construction-related businesses were conducted. In addition, the study conducts an analysis how sustainable development has occurred in the U.S. construction industry to determine what the driving forces that could transfer and be of assistance to Korea.

A preliminary sustainability system framework is developed along with associated guidelines. The guidelines suggest that sustainability policy directed towards the Korean construction industry should be apparent so that stakeholder can implement it with consistency and detail. Also suggested is a movement away from the current policy that largely focuses on green building to one that is more holistic and includes infrastructure and other aspects of the built, environmental, and socio-economic systems. In this light, the primary concept of the policy aligns with the sustainability concept of the triple bottom line: environment, economy and society. Through the feedback from a performance measurement system, the policy is evaluated and is adjusted to stimulate the Green Growth over the construction industry in South Korea.

DEDICATION

To my family and my lovely

ACKNOWLEDGMENTS

I would like to thank my committee chair, Dr. Walweski, and my committee members, Dr. Anderson and Dr. Kang, for their guidance and support throughout the course of this research. Thanks also to my friends and colleagues and the department faculty and staff for making my time at Texas A&M University a great experience. I also want to extend my gratitude to the Korean government and Public Procurement Service, which provided the opportunity to study abroad and supported me while I have studied. All of the interviewees who were willing to participate in the study are appreciated. Finally, thanks to my mother and father for their encouragement and to my sister and brother for their patience and love.

NOMENCLATURE

BRE	The Building Research Establishment in the United Kingdom
BREEAM	The BRE Environmental Assessment Method
CASBEE	Comprehensive Assessment System for Built Environment Efficiency
DOE	Department of Energy
EPA	Environmental Protection Agency
EO	Executive Order
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GSA	General Service Administration
IUCN	International Union for the Conservation of Nature
KGBC	Korean Green Building Certification
LEED	Leadership in Energy and Environmental Design
PPS	Public Procurement Service
SAGA	Sustainable Aviation Guidance Alliance
UNCED	United Nation Conference on Environment and Development
UNCHE	United Nations Conference on the Human Environment
UNFCCC	United Nations Framework Convention on Climate Change
USGBC	United States Green Building Council
WCED	World Commission on Environment and Development

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1. INTRODUCTION

1.1. Background

Interest in the impact of development on the environment has grown in recent decades, and the impact of the construction industry, in particular, has attracted attention (Mulder 2006, Roderick *et al.* 2009). Such attention made sustainability a keynote of national growth of various governmental agencies at local, national, and international levels. In addition, the concept of sustainability has become the core concept of the governmental policies (Mebratu 1998). While the current sustainability framework focuses on broad national strategic objectives, it is often feeble in translating strategic objectives into practical actions (Ugwu *et al.* 2006).

In 1992, the United Nations Conference on Environment and Development (UNCED) ratified the UN Framework Convention on Climate Change (UNFCCC) to address issues of climate change by greenhouse gas (GHG) emissions. The Kyoto Protocol, including details on performing sustainable activities, was developed based on the UNFCCC. The protocols brought the necessity of constructing practical systems to reduce GHG emissions including carbon dioxides. Because the construction industry is not only a vast consumer of energy and natural resources but also an enormous contributor to GHG emissions, there is a fundamental need to know and enhance sustainable industry policy and practices in the construction industry (EPA 2009).

This thesis follows the style of *Construction Engineering and Management*.

1.2. Problem Statement

In the U.S., the movement toward sustainability in the construction industry has been increasingly encouraged by government agencies and private sectors, and this trend has shown various achievements regarding sustainability practices. The federal government has developed a series of environment-associated policies and supporting regulations as follows: Environmental Protection Act (EPA) 2005, Executive Order 13423 "Strengthening Federal Environmental, Energy, and Transportation Management 2007", Executive Order 13524 "Federal Leadership in Environmental, Energy, and Economic Performance 2009." Furthermore, the U.S. Green Building Council (USGBC) has launched the Leadership in Energy and Environmental Design (LEED), which has advanced into one of the most popular systems for sustainability measurement. The performance of sustainable development in the U.S. provides a cornerstone for other countries to develop sustainability-related systems.

South Korea is among a host of countries trying to achieve sustainable development across various industry sectors by adopting "Green Growth" as a main strategy model for a new vision of national development (Presidential Committee on Green Growth 2009). The concept of Green Growth, which is the vision that pursues environment-friendly development to reduce greenhouse gas emissions and minimize environmental problems by using green technologies, is similar to sustainable development as it focuses on how national development has impacts on the environment.

The Korean government has executed tremendous efforts about Green Growth, and these efforts have created several successful results in spite of the short period from

the adoption of Green Growth to date. The construction industry in South Korea has made remarkable economic impacts over the last several decades and has an enormous impact on the environment. However, the vision of the Green Growth does not seem to be applied successfully in the construction industry. Although the performances under Green Growth are difficult to evaluate because the policies of Green Growth are now in the process of revisions and supplement, this is the time to diagnose the current situation of Green Growth in the construction industry to reduce potential trials and errors in the future. Diagnosis and prescription are required to enable the construction industry to minimize adverse impacts and accelerate implementation of Green Growth practices in the Korean construction industry.

1.3. Limitations

Two limitations may influence the results of this study.

The first limitation is that the interviews for this study are limited to selected experts from the construction industry of South Korea. As such, the interview results may be biased and not a reflective sample of the overall construction industry population.

The second limitation is that it is early to evaluate the achievement of Green Growth in South Korea. Therefore, the diagnosis of the Green Growth does not encompass the whole intents, but just focuses on the phenomenon of the early phase of the implementation in a view of industry.

1.4. Research Objectives

The goal of this study is to suggest a policy framework for the Korean government to enhance existing policies for the Green Growth. The Korean sustainability systems started originally from 2009; thus, it has little performances for Green Growth to be evaluated by December 2010. Furthermore, it is ongoing to systemize policies in details nowadays. Therefore, the purpose of this study is not just comparing Green Growth by South Korea to the sustainable development by the U.S. government. However, the sustainable development by the U.S. in the construction industry can provide lessons as an early starter in the sustainable development sector. The policy framework intends to reduce potential trials and errors in the primary state of implementation of the Green Growth policies in the construction industry.

The objectives for achieving the goal are as follows:

- Analysis of the current situation of the Korean construction industry and policies of Green Growth
- Analysis of the current situation of the U.S. construction industry and policies of the sustainable development
- Identifying the best practices for Green Growth by literature review, interview, and analysis of the U.S. sustainability systems
- Specifying directions and strategies of progress in Green Growth for the Korean construction industry

1.5. Thesis Structure

The thesis makes a structure with eight sections, which progress in accordance with the identified research objectives.

Section 1 comprises the introduction, which includes research background, the main goal and objectives of this research and the structure of the thesis.

Section 2 is a literature review describing the sustainable development history all over the world. It includes the concepts and theory from the main events through history.

Section 3 contains the methodology of this thesis. It contains method of literature review and surveying questionnaires. It also introduces the methods of achieving the objectives, difficulties the author met in writing the thesis and limitation of this research.

Section 4 is describing the current situation for Green Growth in the Korean construction industry.

Section 5 includes an in-depth interview, which is conducted for more accurate diagnosis in a view of industry level than the analysis in Section 4.

Section 6 contains the analysis of US sustainability system by a literature review to help suggest alternatives based on the previous analysis of Green Growth in Korea.

Section 7 describes a suggestion of the preliminary framework for achievement of Green Growth in the construction industry.

Section 8 finally concludes the study by recapitulating briefly the main issues from previous sections. In addition, it recommends the further research related to the Korean sustainable system in the construction industry.

2. SUSTAINABLE DEVELOPMENT

2.1. Introduction

Because there has been a nonspecific definition of sustainability for a long time, many countries and organizations had been struggling with how to incorporate sustainability into their investment and operating decisions.

In this section, the researcher reviews the background of sustainability and the history of sustainable development in the construction industry with some momentous events. Furthermore, the section goes over several current sustainability systems, which are widely used in each country.

2.2. Background on the Sustainable Development

Since the Industrial Revolution, the depletion of natural resource and the deterioration of the environment have been accelerating by expedited development all over the industry because of the vast use of energy in fossil fuels (Meadows *et al.* 1992). Meadows describes that the exponential growth of population and economy caused the change in many features of the earth in his book, *Limits to Growth* (Meadows *et al.* 2004).

The world population has grown gradually since the Industrial Revolution and has increased exponentially from the mid-20th century. This behavior pattern appeared similarly in world industrial production trend. According to Meadows's explanation,

industrial production has increased faster than the population regardless of the economic downturn due to the oil price shocks in 1973 and 1979.

A consequence of these two main growths generated a wide range of phenomenon. Above all, a remarkable change was the growth of carbon dioxide emissions. The concentration of carbon dioxide in the air is mainly caused by a result of fossil fuel burning. As many researchers argue, the growth of population and affluence has the strongly positive relationship with the environmental problems including carbon dioxide emissions (Meadows *et al.* 2004; Kibert 1994).

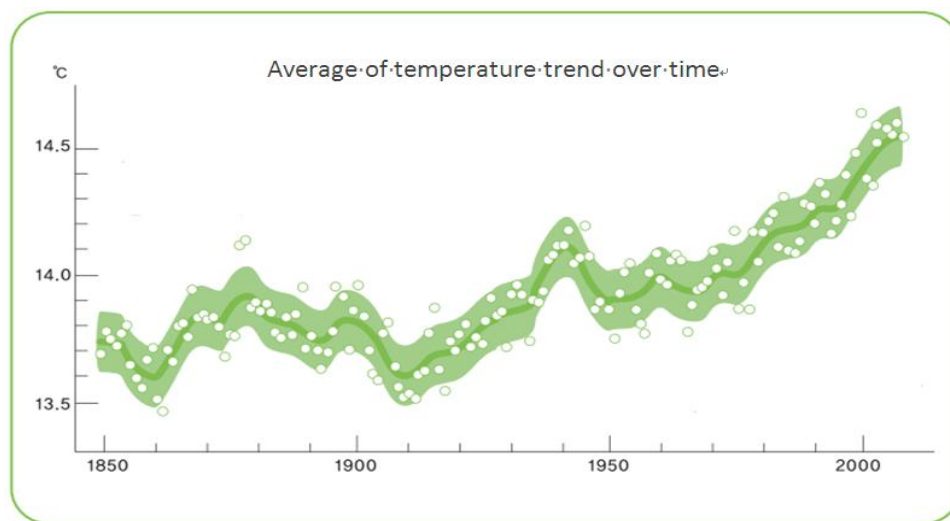


Figure 1. Temperature average trend over time (reprinted from IPCC 2010)

Furthermore, the threat of climate change has come under the spotlight over recent decades as seen in Figure 1. According to the “Stern Review,” which describes the environmental problems and their impacts on the economy, it says that one percent

of world gross domestic product (GDP) should be invested to avoid the worst effects of climate change. In the case of failure to control environmental problems, it can cause risk of global GDP being up to twenty percent lower to recover the worst effects (Stern 2007). This review concludes that the early action on climate change and environmental problems must be conducted to evade the considerably outweighing costs.

Such research and reviews have turned people's attention into the seriousness of the environmental problems, and it became global in scope.

2.3. Main Events of the Sustainable Development through the History

Global interests in environmental problems induced the world to talk about the environmental issues. The United Nations Conference on the Human Environment (UNCHE), which took place in Stockholm in 1972, discussed the issue focused on human activities in regards to the environment. This was the first conference dealing with the environment as well as the leading international meeting for an environmental action at an international level (DuBose *et al.* 1995).

According to Tryzna (1995), however, the first breakthrough into a global approach came from the International Union for the Conservation of Nature (IUCN). IUCN created the World Conservation Strategy in 1980. This was a significant attempt to integrate the economic development into the environmental conservation with an umbrella concept.

The most widely and currently accepted definition of sustainability derives from the United Nations, Bruntland Commission in 1987. The report of World Commission

on Environment and Development (WCED), which is also known as the Brundtland Commission, defined the concept of the sustainability development as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs (WCED 1987).” This definition generated the currently ongoing debate, but it contributed the concept of sustainability to being concrete (Kirkby1995).

Defining the sustainable development gave new impetus to create the practical action plan. In 1992, lots of countries all over the world discussed it in-depth at the UN Conference on Environment and Development (UNCED) held in Brazil. During the conference, UNCED produced historic documents such as the Rio Declaration, Agenda 21, biodiversity, and climate change. From this conference, the most successful aspect was creating a national report, which covers current national environmental and developmental aspects. In addition, it drew up an action plan for promoting sustainable development within the national context. The most significant heritage of UNCED was the preparatory process, which involves participation of key stakeholder down to the bottom level. This process delivered the concept of sustainable development to every corner of the world.

Based on the previous global efforts, the Kyoto Protocol including detailed plans for performing duties came into effect. The protocol brought the necessity of realistic correspondent system to reduce the GHG emission including CO₂. In the construction industry, which occupies more than a quarter of national consumption of energy and resources, it is highly demanded to research and study on the sustainable construction management. In particular, the construction phase of building life cycle is critical

because construction activities maximize CO₂ emissions. Furthermore, the decisions before the construction phase seriously have impacts on every project. Therefore, methods of reducing environmental impacts by CO₂ during the construction phase highlight the importance of minimizing invested resources through information setting before the construction phase. The protocol emphasized the sustainable construction management using information.

The U.S. National Research Council (1999) argues three principal components of sustainable development. They identify three areas to be sustained, namely, nature, life-support systems and community. These three principal concepts are going to be called the triple bottom lines.

In 2002, the United Nations (UN) planned the World Summit on Sustainable Development (WSSD), which took place in Johannesburg, South Africa. The summit established the concept of the sustainable development aiming at seeking balanced development among environment, economy and society as a pivotal concept of human development strategy.

Kasemir *et al.* (2003) studied sustainability through the interactions among environmental, social and economic issues. Savits (2006) describes that sustainability is the art in doing business while people live in an interdependent world, and he recommends that companies should focus on the "triple bottom line" which includes solid profit, environmental quality and improved welfare. The triple bottom line concepts have spread out over the industries in order to dominate new policies for sustainability. Sarte (2010) argued a need of a paradigm shift, which improves the

quality of the construction projects to make engineering produce positive outcomes instead of negative conventional design for the sustainable development.

The United Nations Environment Program (UNEP 2010), which coordinates environmental organization of the United Nations, pursued leadership and encouraged partnerships in caring for the environment. For this purpose, UNEP enabled nations and people to improve their quality of life by launching the Sustainable Buildings and Climate Initiative (SBCI) in accordance with UNEP's key missions such as Sustainable Consumption and Climate Change in 2006. Figure 2 demonstrates the policies of UNEP related to the construction industry as follows:

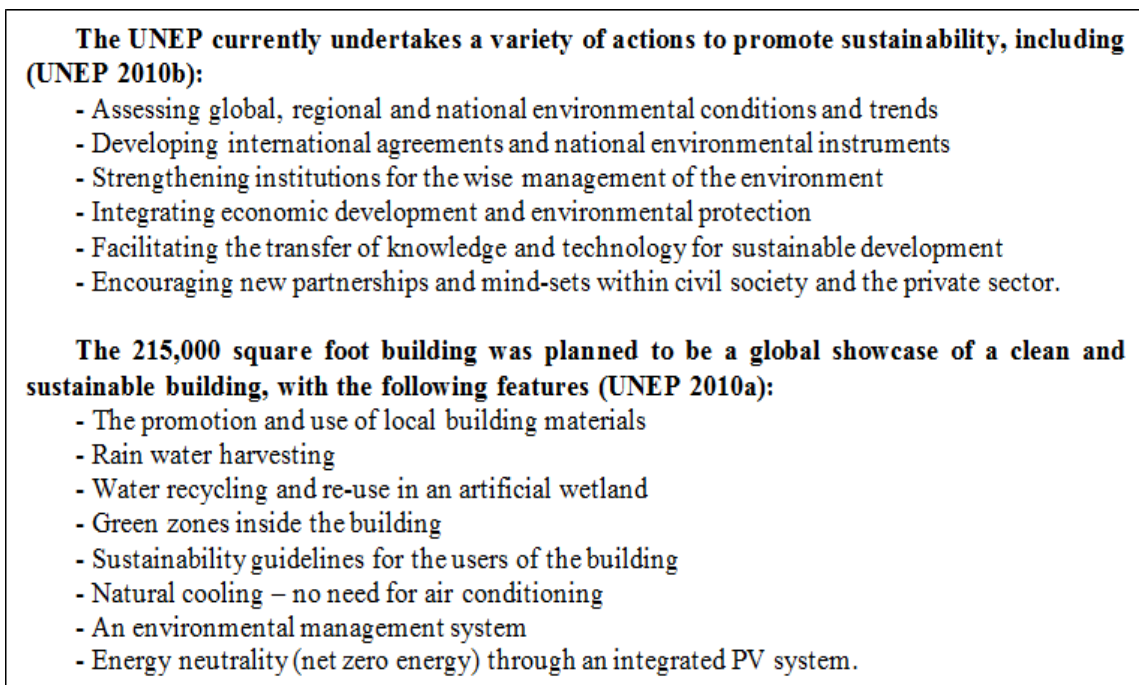


Figure 2. The policies of UNEP for the sustainability (adapted from UNEP 2010)

Based on the literature review, the diagram shows historically remarkable events for sustainability with main contents in Figure 3.

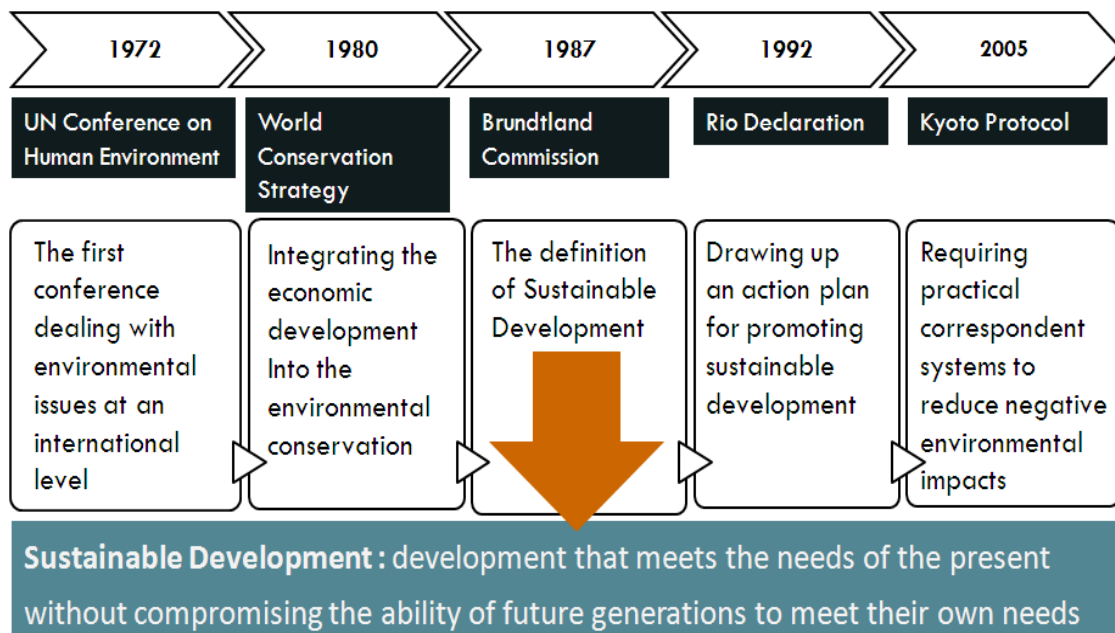


Figure 3. The historically remarkable events with the sustainable development

2.4. Development of Sustainability Efforts

With the emergence of relevant theories to sustainability, there is a terrific deal of effort to map out to apply sustainability to their construction project over the phases. The efforts created rating systems to measure environmental performances at various sectors in the construction industry. Since the building industry started to move toward the support of sustainable building in the latter of the 1980s, the building industry developed various systems to assess the environmental performance of buildings.

The first assessment system widely adopted all over the world is BREEAM (BRE Environmental Assessment Method) in the United Kingdom. The Building Research Establishment (BRE) established this system in 1990 as a tool to measure sustainability performances. BREEAM provides the guideline for best practices in sustainable design for buildings and measures a building's environmental performance with levels as Pass, Good, Very Good, Excellent and Outstanding. The BRE has updated the system regularly in accordance with UK building regulations and currently BREEAM evolved to BRE 2010. It is the one of leading environmental assessment methods for buildings, with over 110,000 buildings certified and over half a million registered. Many countries all around the world such as Asia and Europe have adopted BREEAM to evaluate their sustainability performances.

The introduction of BREEAM stimulated the development of the assessment system for sustainability to other countries. The U.S. Green Building Council (USGBC) in the United States introduced its own assessment system as known as Leadership in Energy and Environmental Design (LEED) as the version of LEED 1.0 in 1998. The council developed the recent version for new construction as LEED V3.0 in 2009 to upgrade the system. LEED is not only the leading environmental assessment tool but also the most widely used method for buildings all around the world. It provides the standard for best practices in sustainable designs for the building sector and assesses with rating level to describe a building's environmental performance. The author will explain LEED in-depth the next section.

In 2001, the Japan Green Build Council (JaGBC)/ Japan Sustainable Building Consortium (JSBC) developed the Comprehensive Assessment System for Built Environment Efficiency (CASBEE) in order to enhance the green building sector in Japan. Through the CASBEE, stakeholders assess the lifecycle of buildings in energy usage, recycles resources, indoor and local environment of the building (Kawazu *et al.* 2005).

Green Star is a building assessment system in Australia. At first, this was for just offices, but it evolved into a rating system for different phases of the building life cycle and different building types. The BREEAM and the LEED affected the system of Green Star. Green Star version 1.0 covers the categories as follows: management, indoor environmental quality, energy, transportation, water, materials, land use and ecology, emissions, and innovation. Based on these categories, the system assesses the performance of the building at the maximum of 132 points. Achieved points determine the level from one star to six stars.

GBTool is a comprehensive system that many countries discussed and developed together as a name of Green Building Challenge. It was a continuous effort to develop a building environmental assessment from the beginning of development in 1996 and to the Tokyo conference in 2005. The difference from other assessment systems is that the participating countries gathered ideas selectively from each country to incorporate or modify their systems.

Canada also made an effort to develop environmental assessment system. The Canadian Standards Association (CSA) released BREEAM Canada for Existing

Buildings in 1996. In 2000, the system was updated as an online assessment system under the title of Green Globes for Existing Buildings. In 2004, the Building Owners and Managers Association of Canada (BOMA Canada) adopted Green Globes for Existing Buildings, and it distributed to the U.S. The Green Building Initiative (GBI) operates Green Globes in the U.S.

2.5. Conclusion

Through this section, the researcher has studied the background of sustainability of the industry and the history of the sustainable development in the construction industry with several remarkable events. These interests in sustainability as a global trend have had impacts on many countries including the U.S. and South Korea. The next sections will examine each sustainability system of the two countries in the construction industry.

3. METHODOLOGY

3.1. Introduction

This section will explain the methodology applied to conducting this thesis. The researcher conducts a literature review to achieve the research objectives. The review helps diagnose the current situation of the Korean construction industry and Green Growth of the Korean government. The following step is in-depth interviews with experts in the relevant sectors. The interviews intend to collect their opinions about Green Growth and make up the gap between the government's policy and views of industry about the policy. Next, the researcher extracts the best practices from the U.S. sustainability system in the construction industry based on the analysis of the South Korean Green Growth. This review aims at suggesting the examples of the US sustainability system in order to make up deficiencies of the Green Growth practice. Finally, the researcher develops a policy framework to suggest a guideline for pursuing Green Growth in the Korean construction industry with findings from the previous sections. Figure 4 shows the diagram of these sequential methods.

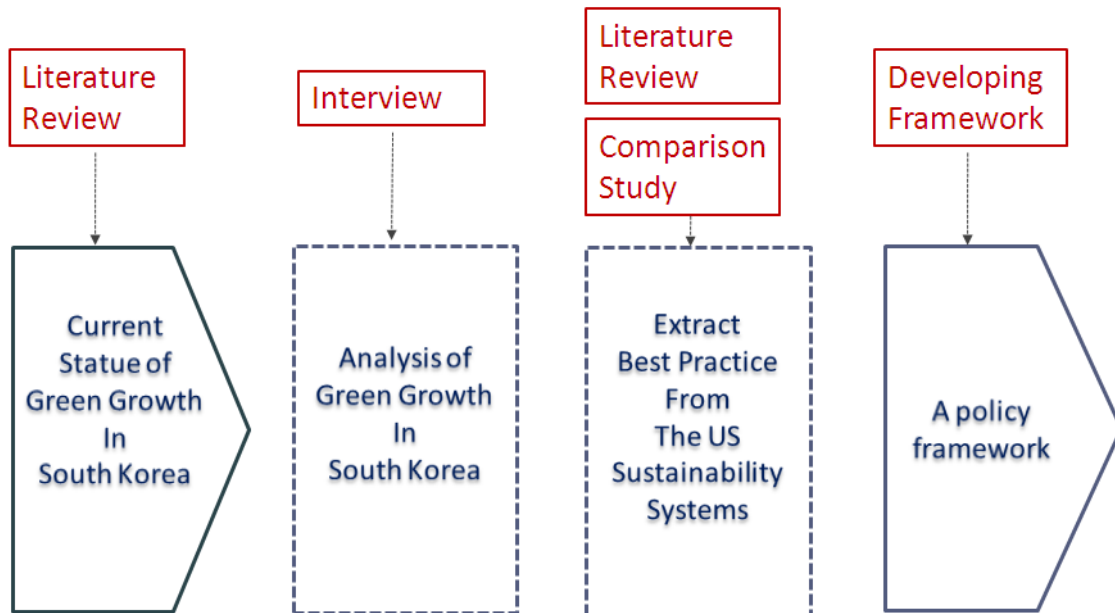


Figure 4. The diagram of the sequential methods to conduct this study

3.2. Literature Review

The main method of research in this thesis is the literature review to understand the background of the research, including identification of potential key factors influencing the promotion of sustainable development. In addition to a literature review of the sustainable development, an essential review is conducted to diagnose the current circumstances of South Korea and the U.S. related to the sustainability practice. In this review, a number of approaches were described such as the current construction industry, sustainability practices until recently, key problems, issues, and deficiencies.

3.3. Comparison Analysis

Based on the literature review, the comparison analysis is conducted. As mentioned in Section 1, it is early to evaluate the achievement of Green Growth by the Korean government because of the late start toward the sustainability development. In addition, it is difficult to compare with the performance of the U.S. However, it could be an acceptable solution to extract differences from the two countries in order to understand potential key factors influencing the promotion of the sustainable development. This method is conducted by investigating the current situation of the Green Growth in South Korea. Next, the researcher analyzes sustainability practices in the U.S. construction industry as an early starter in the sustainability sector. This analysis contributes to minimizing trials and errors from the implementation in this initial phase of Green Growth.

3.4. Interview

After the literature review was conducted, the research requires the analysis of the current situations. The professionals of the related sectors become a targeted pool of the in-depth interview. This effort makes up deficiency from the literature review. Interviews targeted experts in the relevant sectors to learn implications from the current situations of the Green Growth policy in the construction industry. In addition, interviews with contractors/designers who have worked with LEED help the researcher figure out the realistic situation of what contractors/designers are aware.

The interview structure was designed to allow the researcher to obtain relevant information to the research topic concerning:

- How much the stakeholder is interested in and aware of Green Growth.
- How well strategies and policies related to Green Growth are prepared.
- What deficiencies in the current Korean policies for Green Growth are in the perspective of industry.
- How can we make up deficiencies and enhance the current Korean policies for Green Growth.

The previous literature review and comparison analysis are the basis for developing the questions for the interview protocol. The collected information from the in-depth interview will be used to make criteria for the policy framework.

3.5. Development of a Framework for Sustainable Practice

The researcher develops a framework for enhancing existent policies for Green Growth by wrapping up the collected information from the previous works. The potential factors from the interview and critical attributes from the analysis of the U.S. lead to the development of the framework, which shows preliminary strategies mitigating potential sustainability factors in order to boost Green Growth in South Korea.

4. ANALYSIS OF THE GREEN GROWTH IN THE KOREAN CONSTRUCTION INDUSTRY

4.1. Introduction

In this section, the study reviews the current status of the Korean construction industry with some remarkable figures with the economic perspective, and it also describes the environmental problems that the Korean construction industry has encountered in pursuing the economic development over recent years. Then, the researcher describes the current efforts toward Green Growth through literature review and the researcher's experience. As the researcher said in the previous section, this review mainly focuses on the endeavor of the government rather than the overall construction industry toward Green Growth.

4.2. Current Situation of the Korean Construction Industry

4.2.1. Current situation with the economic perspective

The construction industry is a capital industry all over the world when considering a substantial proportion of most countries' gross domestic product (GDP). For instance, the contribution of the construction industry in the U.S. to GDP in 2009 was 497 in billion dollars out of 12,987 in billion dollars as 3.83 % (U.S. Census Bureau). In like a similar manner, GDP of the construction industry in South Korea in the fourth quarter of 2010 was 14,768 in billion won out of 263,011 in billion won, and it marked as 5.6 % in Figure 5 (The Korean Bank).

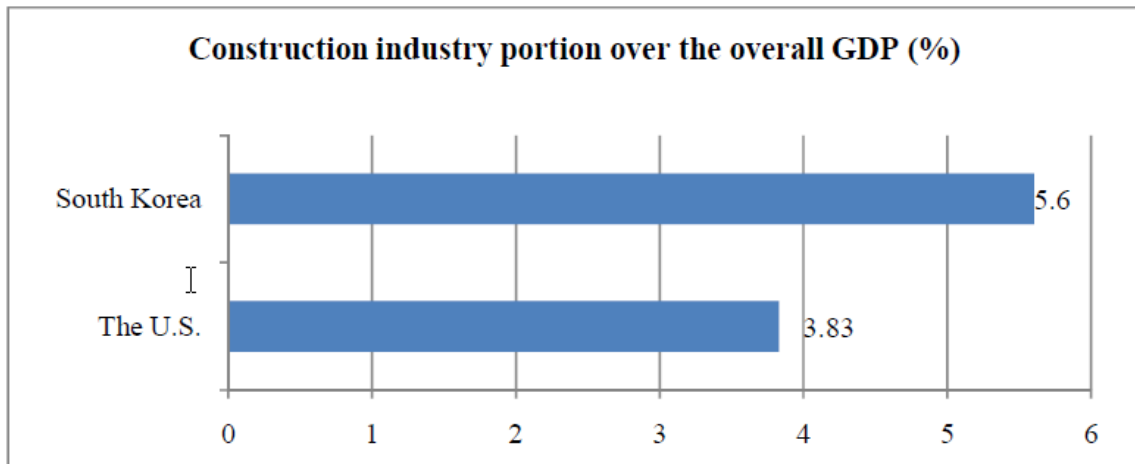


Figure 5. Construction industry portions over the overall GDP of the two countries

According to the recent data, the GDP growth rate of South Korea in 2010 was 6.10%, and it represents relatively higher than the world GDP growth rate of 4.6% and the U.S. GDP growth rate of 2.7% as seen in Figure 6 (CIA World Factbook).

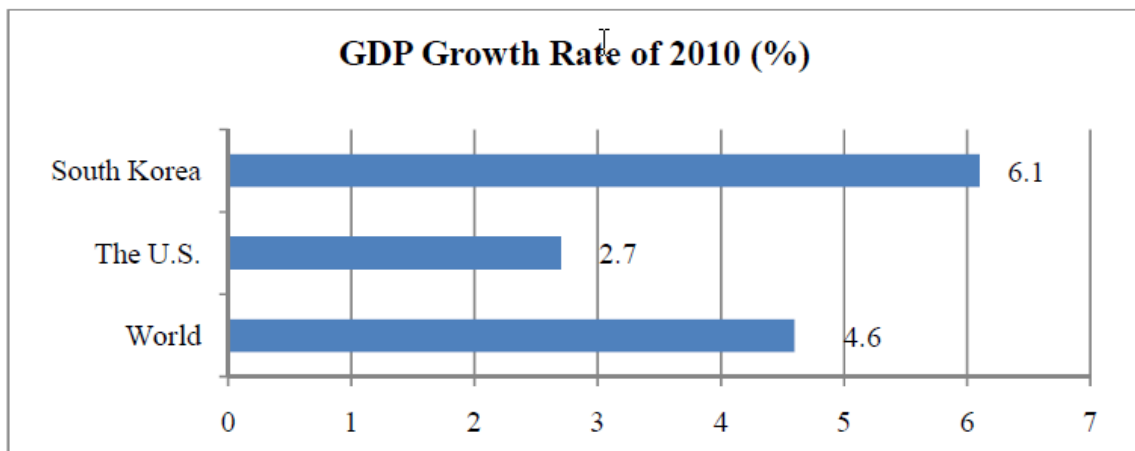


Figure 6. GDP growth rate of two countries and the world

As Figures 5 and 6 show, the Korean economy has been growing rapidly, and the construction industry made a significant contribution to the Korean economic growth. Currently, the Korean construction market ranked the 10th of the world market in 2007 (Davis Langdon & Seah International 2008). Furthermore, according to Global Construction 2020 by Global Construction Perspectives and Oxford Economics, the global construction market will be worth an estimated 12.7 trillion dollars, and South Korea will rank the 5th country as 3.2% of the global construction market as seen in Figure 7 (Global Construction 2020, 2009).

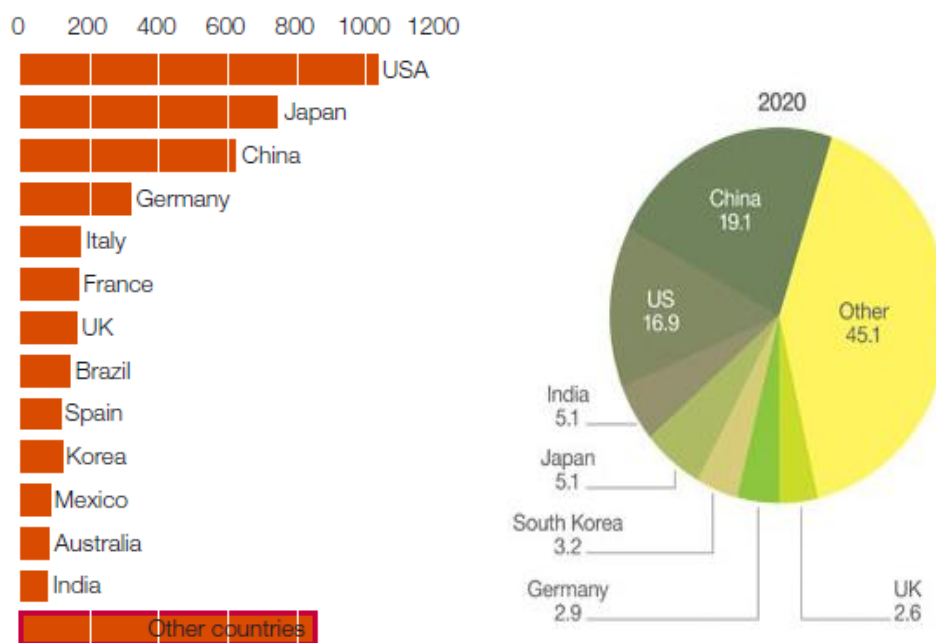


Figure 7. Global construction spending 2007 (US billion dollars) (reprinted from DLSI) and Global construction market (Total value of output(%)) (reprinted from Global Construction Perspectives and Oxford Economics 2009)

4.2.2. The current situation with the environmental perspective

Besides the splendid development of Korean industry, especially the construction industry, South Korea has the other side due to the development. As observed in Section 3, the economic growth causes the environmental problems as a by-product of the industrial development.

Greenhouse gas emission from South Korea was 1.3% of the global emissions in 2005, and this figure made the 15th biggest emission country in the world (Jones & Yoo 2010). What makes even worse is that it recorded double during the period from 1990 to 2005 as the highest growth rate among the countries in Organization for Economic Co-operation and Development (OECD) as seen in Figure 8.

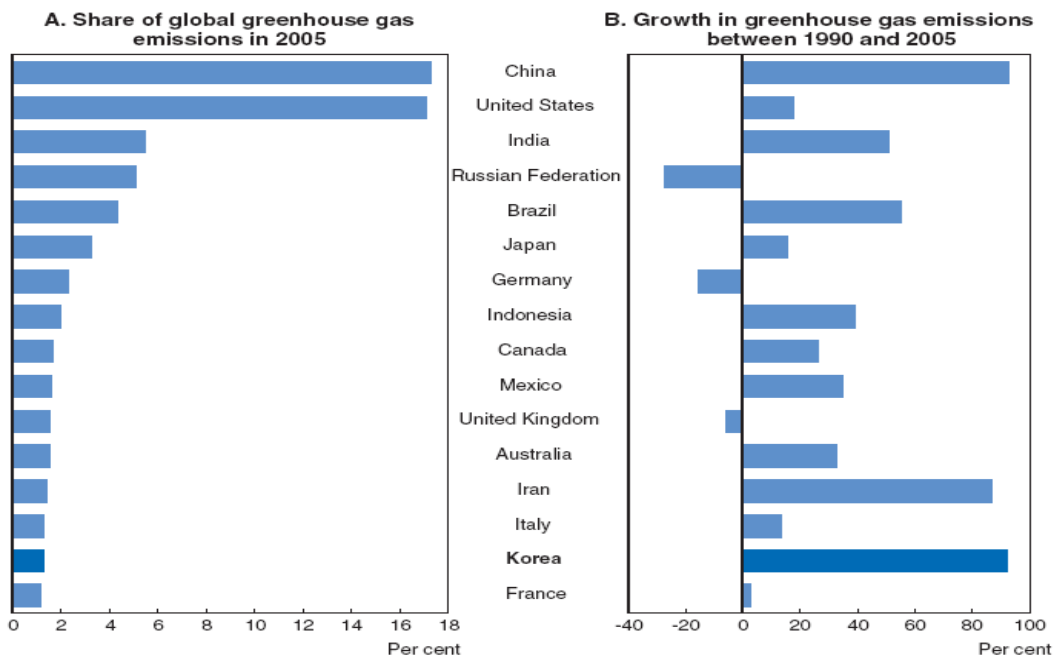


Figure 8. International comparison of GHG emissions (reprinted from OECD 2010)

Greenhouse gas emissions have caused the climate change over a long-term, and it tends to become higher. As greenhouse gas increases, the climate is getting warm as shown in Figure 9.

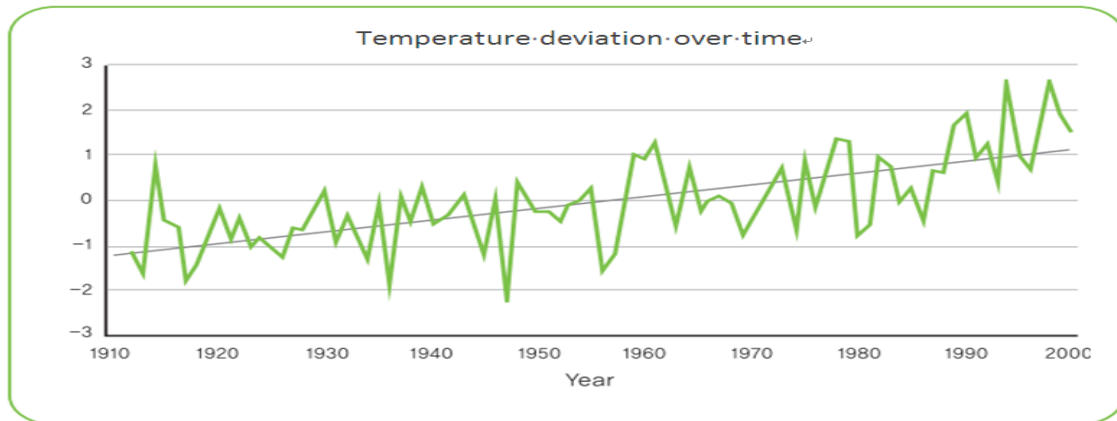


Figure 9. Temperature deviation of South Korea (reprinted from Korea Meteorological Administration 2006)

In addition, energy intensity of South Korea increases higher than the average of OECD countries from 1990's and this figure has kept the fourth highest in OECD countries as seen in Figure 10 (OECD Economics Survey 2010).

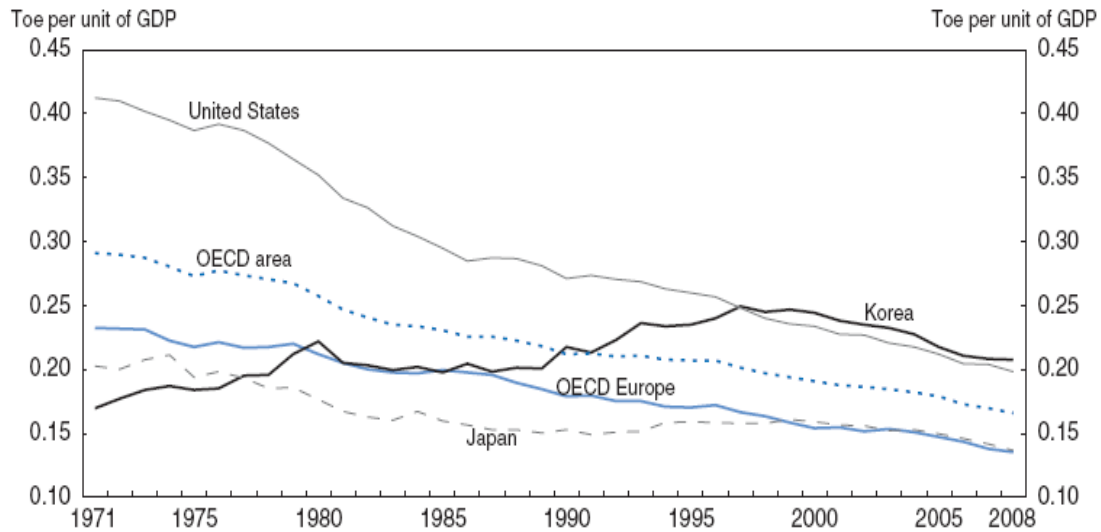


Figure 10. Korea has become one of the most energy-intensive economies in the OECD area (reprinted from OECD 2010)

For the environmental deterioration of the Korean industry, the construction industry has accounted for the significant proportion of GHG emissions as seen in Figure 11. Direct Carbon dioxide emissions from the construction industry occupies 2%, but the whole carbon dioxide emissions by the construction industry accounts for nearly 15% when considering the indirect impacts by the activities related to the construction industry (Jones *et al.* 2010).

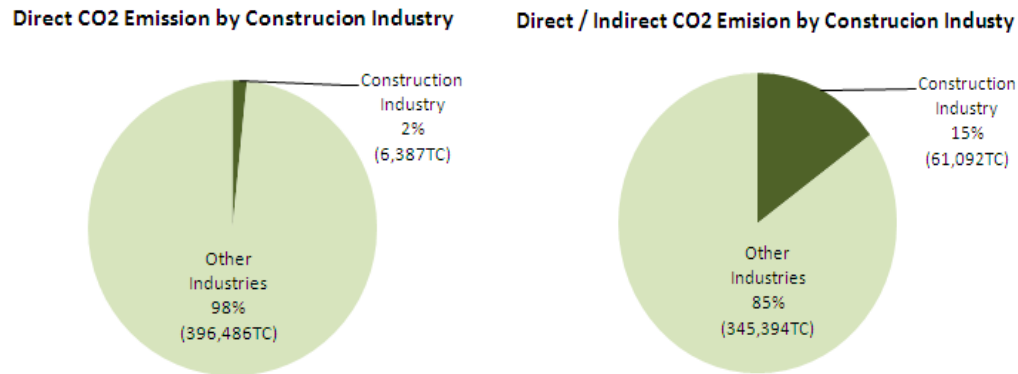


Figure 11. Green House Gas Emission Analysis in the Construction Industry (adapted from Korean Institute of Construction Technology 2006)

4.2.3. Current situation of the Korean construction industry

The reason of observing the figures above is to diagnose the current status of the Korean construction industry. In the sense of economy, the proportion in the world market is significant, and the construction industry is still growing with a high rate. With the enormous size and the rapid development, however, the Korean government encountered the increasing serious global problems with the green gas emission and the high dependency on energy use. This situation made the Korean government turn its attention on the sustainable development in order to balance both the economic development and the environment-friendly development all over the industry.

4.3. Efforts of the Korean Government for Sustainability

The Korean government's endeavor to consider industry's impacts on environment began with the introduction of energy-efficiency programs for electronics and appliances in 1992 as mandatory standards.

An effort considering the environment-friendly concept for the construction industry started by adding related clauses, which encouraged owners to construct buildings with efficient energy use and reuse of material, to Building Construction Ordinance in 1999. However, this added clause mentioning the efficient energy use includes neither any target nor detailed standards. These are the regulations by the federal government at the level of Law in Table 1.

Table 1. Related legislations for Green Growth in the construction industry

Related legislation	Organization
Building Construction Ordinance	Ministry of Land, Transportation and Maritime Affairs
National Contract Ordinance	Ministry of Strategy and Finance
Low Carbon and Green Growth Ordinance	Prime Minister's Office

The global interest in Green Building stimulated the Korean government to promulgate Korean Green Building Certification (KGBC) in 2000, which is a certification system for environmentally approved buildings. The federal government agency has operated the KGBC. This certification system had the purpose to reduce negative impacts on the environment by the building construction during the Life Cycle

of buildings through including the site selection, environment-friendly material use, reduction of energy use. The KGBC evaluation clauses assess the criteria objectively by allotting letter marks, which consider weighting of each clause.

However, the evaluation system of the KGBC had only two levels such as Excellent and Great. In addition, the certification system did not include the entire buildings but schools and apartment housing. Some clauses of the KGBC were vague because they did not state the time of the registration and the position of the experts who can evaluate performance of buildings. In order to improve these shortfalls, Ministry of Land, Transportation and Maritime Affairs (MLTM) revised the existing criteria of Green Building Certification in 2010 (MLTM 2010). It encouraged owners to agree with the government's guideline for their voluntary energy saves and greenhouse gas reduction targets under the government monitoring. The revised certification system stated the clauses for the registration time and experts for the evaluation. It also extended the existent two levels into four levels such as Excellent, Great, Fine, Fair.

In spite of continuous effort for application of environmental concepts into practical uses over the industry, the South Korean government has been struggling with how to integrate sustainability into its strategy. That is because there has been nonspecific paradigm to lead the Korean government to make a progress to overcome difficulties, which South Korea currently faces in climate change, energy and natural resources consumption, and economic downturn.

In 2010, more evident efforts for the Green Growth have emerged as promulgation of the related ordinance. Low carbon and Green Growth Law came into

force as from the day of its promulgation, and the government brought the law to effect for the related industry (MLTM 2010). The related clauses to the construction industry are to manage all lands green and minimize energy use for new buildings and major renovation. This law describes the definition of “Green Growth” as the economic and environmental development, which provides growth engine and creates new jobs through research for clean energy and green technology, and decreases the climate change and environmental degradation through efficient use of energy and reduction of resources. Defining the Green Growth stimulated new impetus to create practical action plans.

Furthermore, Ministry of Strategy and Finance (MOSF) and Public Procurement Service (PPS) announced Public Green Market Promotion Plan in 2010 (MOSF & PPS 2010) and Green Procurement Action Plan (PPS 2010). This plan mainly took a target for public green business market to grow twice in Scale by 2013 in accordance with Low Carbon and Green Growth Law. It includes promotion of design and construction for Green Buildings, and it tends to give shape to the provision of Green Buildings in Low carbon and Green Growth Law. After this plan, the government scored the green performance records such as preliminary examinations and memorandum evaluations as the score of Firm’s Credit ratings. The performance records are considered when government contracts for construction projects and procurement are awarded in open bidding to support the firms, which use energy efficiency. The other effort of the plan is that PPS recommended that contractors should use Building Information Modeling (BIM) during the entire phase of building projects. Furthermore, the PPS starts the use of BIM

from 2012 in order to facilitate Green technology for all the public building construction projects.

This is the diagram showing the remarkable events on the regulation development in Figure 12. As seen in this figure, there are breakthroughs to trigger promulgations and revisions of related regulations successively in 2010.

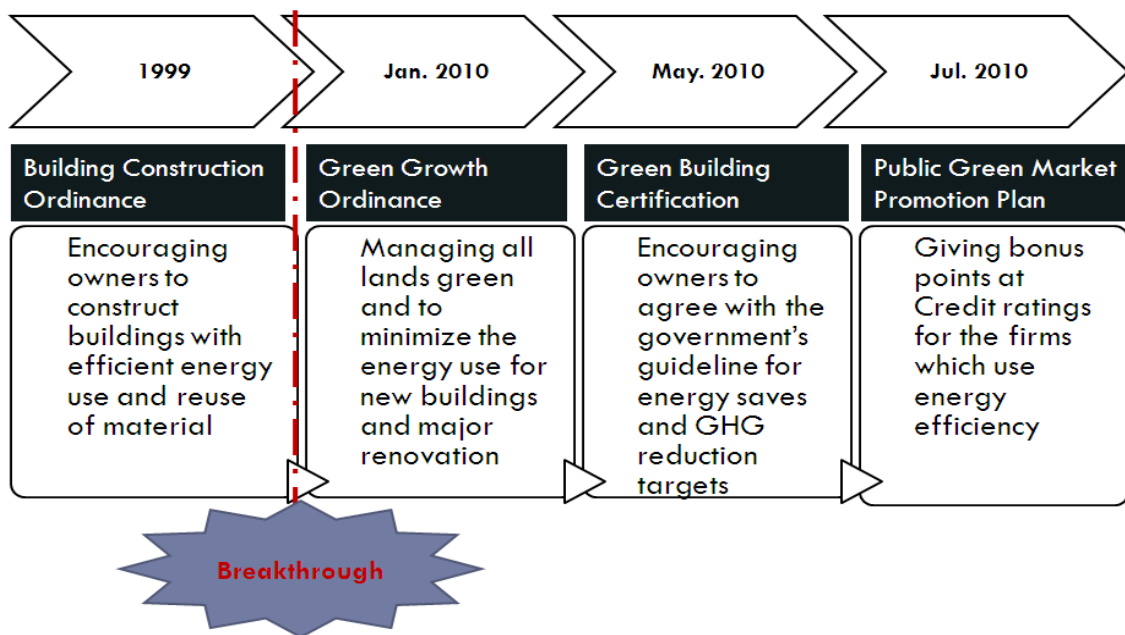


Figure 12. Remarkable regulations for environment-friendly development in the construction industry

4.4. Breakthroughs

4.4.1. Tokyo protocol

The first participation of the Korean government to the international cooperation for the environment was the Kyoto Protocol which was validated in 2005. Although

South Korea was a non-Annex I country, which meant that it had no duty to make a particular GHG reduction target for 2008 to 2012, the government ratified the code to the UN Framework Convention about Climate Change. Consequently, South Korea has created related policies to mitigate climate change as seen in the previous section.

4.4.2. Green Growth

In 2008, the government declared the vision, Low Carbon and Green Growth (Green Growth), as a national development paradigm that creates new growth drives and jobs in the Green industry. This vision includes environment-friendly development to reduce greenhouse gas emissions and minimize environmental problems. In order to map out the vision of Green Growth, the government assigned the task force team in 2008 and officially launched Presidential Committee on Green Growth in the next year. The committee has a purpose to promote South Korea to develop in a sustainable and responsible manner into one of the most advanced industrialized countries all over the world. To spread out the vision of Green Growth over the whole industry, the committee encourages all sectors of society including government agencies and businesses to participate proactively in national development.

The committee is in charge of establishment, operation and supervision of national strategies for Green Growth through a communication network to connect federal government agencies, local agencies, and related businesses. Currently the committee aims at being the world's 7th green power by 2020 and the 5th by 2050, and it established national strategies as follows: mitigation of climate change and energy

independence, creation of new engines for economic growth, improvement in quality of life and enhancement of international standing.

These national strategies include ten policies, which are to be implemented by Five-Year Plan, as seen in Figure 13. The reason for make the period of plan five is to examine the performance of Green Growth policies toward the aims for 2020 and 2050 in 2013 (PCGG 2009).



Figure 13. National strategy of Green Growth (reprinted from Presidential Committee on Green Growth)

Among the ten policy directions, “Greening the land and water, creation of green transportation infrastructure” is highly related to the construction industry. The details of this provision are as seen in Figure 14, and they mainly focus on Green Buildings and vehicle fleets.

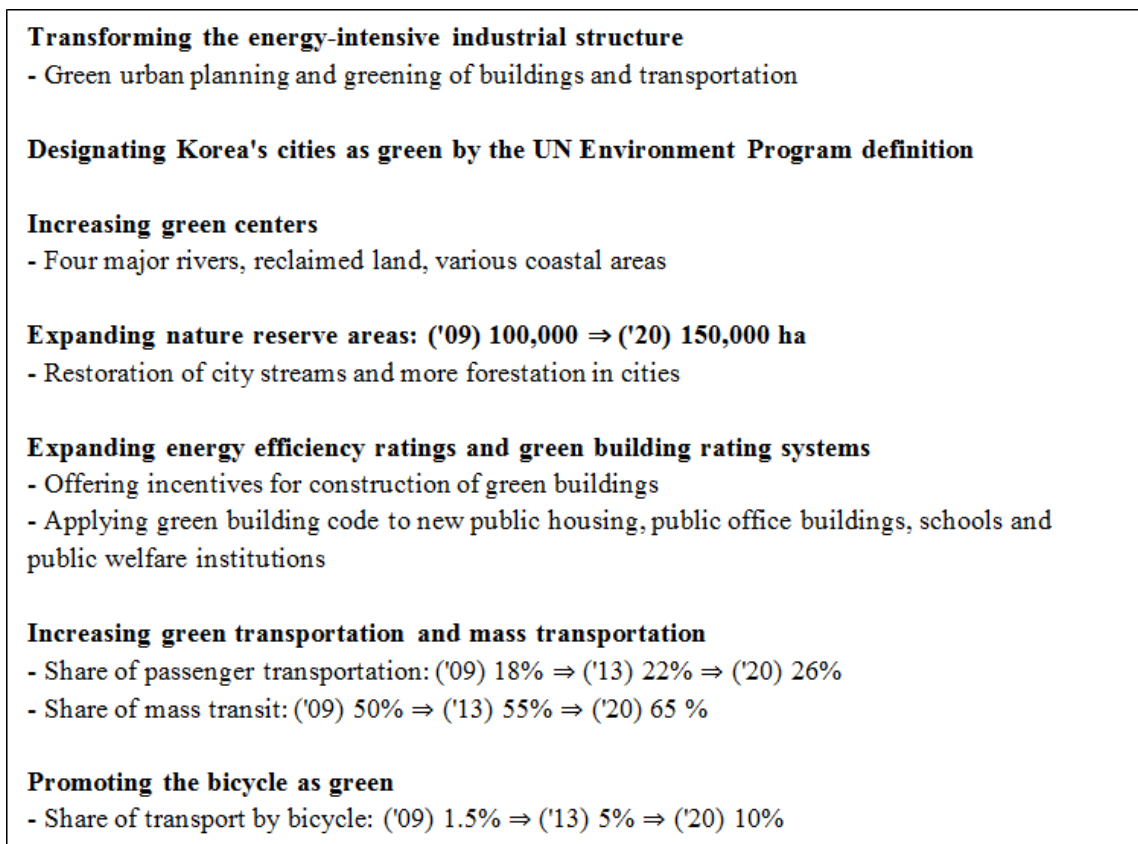


Figure 14. Greening the land and water, creation of green transportation infrastructure

The noticeable difference of Five-Year Plan from the previous this new ordinance offers incentives for construction of Green Buildings. It could be expected that this policy encourages owners to reflect the policy of Green Growth on their buildings.

In addition to the main ten policies, the committee included the Green New Deal, the Green SOC, low-carbon and high-efficiency technologies, and ecology-friendly green life in Green Growth policy.

Through its Five-Year Plan, the government is trying to promote green growth by spending 2% of GDP per year by 2013. For this plan, one of the main challenges is to make sure whether the expenditure is a suitable target to achieve the green growth with make less the risks inherent in industrial policy. In addition, the Committee announced to increase its funding for ecology-friendly public building from 3 trillion won into 6 trillion won by year 2013.

4.5. Conclusion

In this section, the researcher observed the current position of the Korean construction industry and Green Growth in the construction industry in a government position.

The vision of the Green Growth was established just in 2008, and the Presidential Committee for preparing the systematic policy for the Green Growth was launched in 2009. During such a short period from the establishment of the vision of Green Growth to date, the government has created the necessary regulations and standards, and it is still ongoing in the process of development.

5. DATA COLLECTION AND ANALYSIS

5.1. Introduction

It is early to evaluate the achievement of the Green Growth policy because it is now in the process of development. However, it is the time to diagnose the current situation of Green Growth in the construction industry in order to reduce potential trials and errors in the future (Lee *et al.* 2010). Therefore, this section collects and analyzes data of view of the industry for the government's Green Growth efforts.

5.2. Data Collection

After the review of the current situation of Green Growth in South Korea, the researcher conducted interviews with experts related to Green Growth and the relevant industry. The interview intends to collect their professional opinions about the current situation of Green Growth, its pros and cons, implications from the current situation and ways forward to promote Green Growth in the construction industry.

It was difficult to make an interviewee pool because there were not enough candidates to give responses for the interview with a comprehensive understanding of Green Growth and Sustainability. Therefore, professionals of the related sectors became a target of the in-depth interview, and this effort could make up deficiencies from the literature review and provide wider perspectives about the topic.

5.2.1. Design of the interview

This interview mainly focuses on the analysis about the current situation of Green Growth in South Korea and strategies that professionals suggest taking steps for Green Growth. To research this topic with a more realistic approach to this section, targets of the interview were industry professionals to listen to more about Green Growth and Sustainability systems.

5.2.1.1 The purpose

The aims of the interview were as follows:

- To diagnose the current situation of the Korean construction industry related to the Green Growth
- To find ways for setting up the Green Growth in the Korean construction industry and for improving it over time

5.2.1.2 Determining the sampling group

The researcher chose three different groups that respectively represent government, institute, contractor /designer in the construction industry in order to collect reasonable information as seen in Figure 15. Each body chosen in each group was the foremost organization in the Korean construction industry with targets of the following list.

1. Client(Government) group
 - Ministry of Construction and Transportation (1)
 - Public Procurement Service (3)
 - Korean Water Resource Corporation (1)
2. Contractor /Designer group
 - Samsung Construction and Engineering Company (2)
 - Hyundai Engineering & Construction (1)
3. Researcher group
 - Construction Economy Research Institute of Korea (1)
 - The Korean researcher in University of Texas at Austin (1)

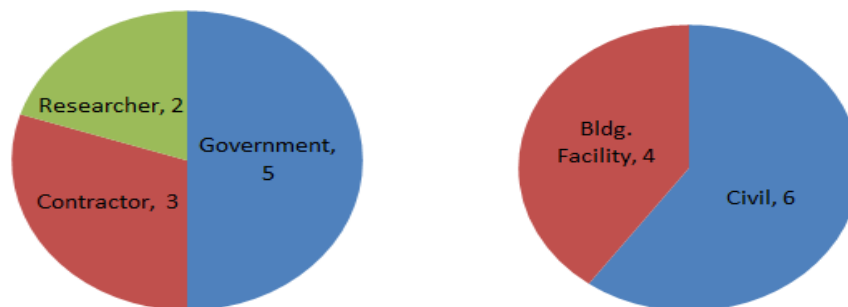


Figure 15. Interviewees' constituent proportion

Each group was composed of experts who have worked in their occupation over than five to ten years. There is no claim that the samples of the study are fully representative of each group. Individuals who are engaged in civil and building/facility sectors were chosen to mirror each respective construction industry.

5.2.1.3 Process of interview

The interview intended to diagnose the current situation by several experts in the relevant sectors of South Korea. The researcher interviewed by phones, email or telecommunication. The interview took about 45 to 60 minutes with each interviewee and several times more after the first interview with some interviewees. In addition, some interviewees sent email with attachments for providing their opinions.

In order to conduct this interview section, the section was based on sequential efforts. Figure 16 shows the diagram of these sequential methods.

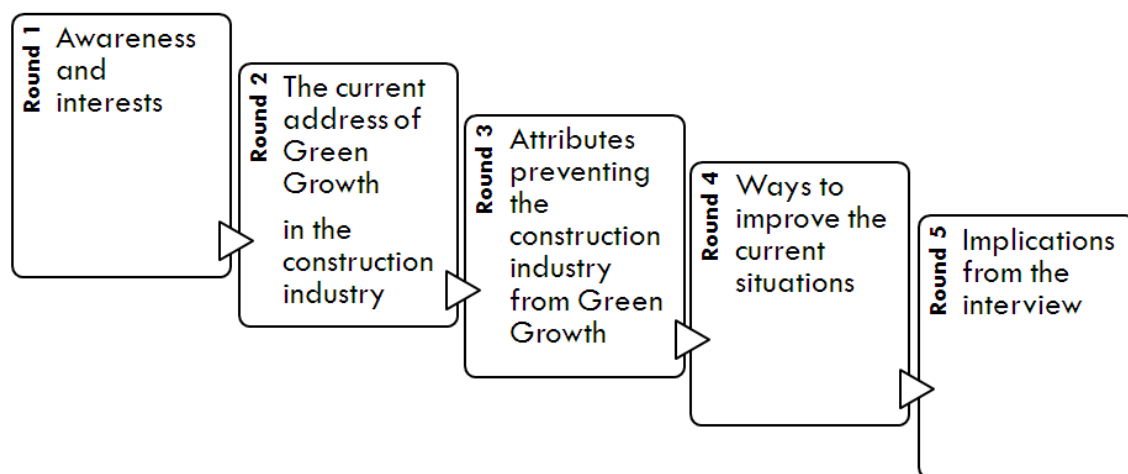


Figure 16. The structure of the survey

Appendix A provides a list of interview questions being discussed. The answers presented in this section are the author's interpretation of the ideas put forth in the interviews from Korean into English.

5.3. The Result and Analysis of the Interviews

5.3.1. Awareness and interests

All of the interviewees agreed with national interests in Green Growth of the construction industry. However, only the groups of the researchers who have studied this topic and the government officers who have been working in a building sector with Green Growth policy were well aware of the concept of the Green Growth.

Contractors/Designers answered that they became aware of the importance of Green Growth, but they applied the related technologies to their projects in a passive manner just following the existing regulations. Especially the government officers in the civil engineering department were not well aware, and they even thought that Green Growth is the vision for Green Buildings, not for the civil infrastructure sector.

However, all of the interviewees showed their opinions of one accord that Green Growth should be pursued in the construction industry in a consistent manner.

5.3.2. The current situation of Green Growth in the construction industry

5.3.2.1 Green Growth in the construction industry

As seen in the response of civil engineers in the previous interview session, the awareness of Green Growth in the infrastructure sector stayed at a low level. The researcher asked the reasons for less interest of civil engineers in sustainability and Green Growth than engineers in the building industry. The biggest reason is nonexistence of the relevant ordinances by the government. As observed in previous sections, the current laws and policies related to Green Growth focus mainly on the

building sector. In addition, they limited transportation and land development related to the infrastructure industry, not for construction activities.

Another reason for low interests in the infrastructure industry would be caused by the focus of strategies and targets. The interviewees said that the main targets of the Green Growth Committee were reductions of energy consumption and GHG emissions as the percentage over the baseline in the construction industry. However, the characteristic of the infrastructure construction is not energy-intensive and GHG-emissive like the building industry, but material-intensive industry. In current strategies and targets, they do not suggest material and resource targets for the infrastructure industry. Thus, these conditions make the interests in the infrastructure industry stay at the low level.

This response of the interview showed that Green Growth has not been promoted over the whole construction sectors evenly.

5.3.2.2 Evaluation of Green Growth in the construction industry

Because of the late promulgation of the Green Growth Ordinance in South Korea in 2010, it is still in an early phase to evaluate the achievement of Green Growth. Thus, the interviewees provided various point of views on the achievement of Green Growth in the construction industry. The interviewees in the building industry gave the positive view that relevant laws and criteria for Green Buildings were prepared well, and Green Growth contributed to raising public awareness of Green Growth. However, the interviewees in the civil industry gave the negative view that the current policies of

Green Growth have not led to the change of the overall construction industry for Green Growth.

5.3.3. Barriers preventing the construction industry from taking steps toward Green Growth

5.3.3.1 Government agencies' willingness and effort

The interviewees pointed out that the biggest barrier preventing the construction industry from taking steps for Green Growth would be inconsistent policy by the government. The short-term policies by the change of the government cause the stakeholder to be doubtful of the consistency of the vision of Green Growth itself.

In addition, the government provides less apparent criteria in a passive manner despite enormous efforts for Green Growth. Achieving Green Growth should be a top-down method from the federal government in order to permeate throughout the construction industry. However, the government just encourages public building sectors to reduce energy and GHG emissions without determined goals and guidelines. The policies providing less systematical criteria and less apparent standards cause the industry itself to wander for the construction industry's way forward to Green Growth.

5.3.3.2 Sustainability performance evaluation

When a policy is established, the policy needs to be evaluated with relevant criteria to meet utmost vision and goal. In a similar manner, the policy of Green Growth in the construction industry needs performance measurement. All of the interviewees

agreed that apparent criteria and performance measurement tools for Green Growth in each construction sector should be prepared. Currently, the Korean Green Building Certification (KGBC) system is existent for the building industry.

5.3.3.3 Budget/Incentive

One of the critical reasons of the low interests by contractors is increasing construction cost for the improvement of Green Growth. Green design and green construction accompany the investment in Green Technology and R&D, and it can be a burden to contractors, who have the goal of creating profits from their projects. In order to encourage the contractors to make efforts for Green Growth, an incentive should be provided to make up invested cost. The current incentive system under the law of Low Carbon and Green Growth states that an incentive is rewarded to green technology developers and construction firms, who apply the green technology to their construction projects. However, it is required to prepare a budget for incentives to encourage contractors to adopt the policy of Green Growth when ordering construction projects. Contractors gave their opinions that the incentive for ordered green projects could encourage contractors to participate in the movement of Green Growth in the construction industry.

5.3.3.4 Deficiencies of the connectivity between the government and the market

The green market, especially in the construction industry, is not as large as the scale of the early starting countries such as the U.S., Japan and European countries.

When considering that the paradigm of Green Growth is in the beginning phase of implementation, the government should push stakeholders to participate in the green market. The connectivity between the government policy and industrial efforts is not enough to make improvements in sustainability efforts towards the green market.

Construction firms prefer using LEED systems to using KGBC. This situation is interpreted into the construction firms' desire to break into markets all over the world because most of countries and companies follow the guideline of LEED system, which is the most prevalent sustainability assessment system all over the world. In this sense, the Korean government needs to take the current situation of KGBC adoption by construction firms into consideration.

5.3.4. Ways to improve the current situations

To promote Green Growth in the construction industry, the interviewees gave a voice for the first requirement. The government needs to institute policies that promote basic systems to support the construction industry pursue sustainability. The policies should reflect the reality of the current situations of the construction market. In addition, all interview subjects agreed that the policy should be long-term perspective and consistent over time.

The goal of the government for Green Growth for the construction industry is to reduce greenhouse gas emissions and create energy-efficient use. For the building industry, the KGBC could establish the detailed target of goals toward the sustainability. In the same manner to the building industry, in order to develop the Green Growth in the

civil infrastructure industry, the superior rank goal should be established, and the evaluation systems of the goals like Green Infrastructure.

In order to develop green market for the construction industry, the consistent policy of the government and the incentive system to encourage contractors to conduct the sustainability performance by offering a variety of incentive resources to contractors who pursue Green Projects as well as contractors who just adopt green technology.

This incentive system can induce the voluntary implementation of the sustainability of the construction industry. Thus, the assignment of budget for the incentives to contractors following the sustainability policy should be prepared.

5.3.5. Implications from the interview

Through the interview with professionals who have worked in the related business, the study could conclude that the government should make the policy and system systematic in a proactive manner. The systematic policy can encourage the overall construction industry to implement the sustainability to prepare the concrete blueprint for the Green Growth above all. In addition, experts who participated in the interview pointed out that the promotion of Green Growth needs to go hand in hand with the balance among the whole construction industry sectors.

5.4. Conclusion

Through this section, the researcher has collected data that represent the opinions of the stakeholder about the Green Growth in the construction industry. The interviewees

provided their idea that there are some pros and cons of the current status of the Green Growth in the Korean construction industry related to budget/incentives, federal government agencies' attitude, the necessity of the whole sector's performance measurement system, and green market.

Based on the findings from the interview, the existent policy of Green Growth is required to supplement deficiencies in the early phase of implementation of Green Growth in order to prevent from deviating from the original intent of the vision of Green Growth.

6. ANALYSIS OF THE SUSTAINABILITY SYSTEM IN THE US CONSTRUCTION INDUSTRY

6.1. Introduction

This section reviews the current situation of the sustainable development in the U.S. construction industry and introduces various policies and systems. The analysis of sustainability systems in the U.S. construction industry can be a benchmark for providing a guideline to improve the current Korean system.

6.2. Current Situation of the U.S. Sustainable Development

According to an economic census of the U.S. Census Bureau, the scalable size of the expenditure of the construction industry was 1.2 trillion dollars in 2002. In addition, the contribution of the construction industry to the U.S. economy shows its significance as one of the leading sectors consuming enormous amount of materials and resources (U.S. Census Bureau).

The Environmental Protection Agency (EPA) shows the contribution of the construction industry on GHG emissions among the major industries as seen in Figure 17.

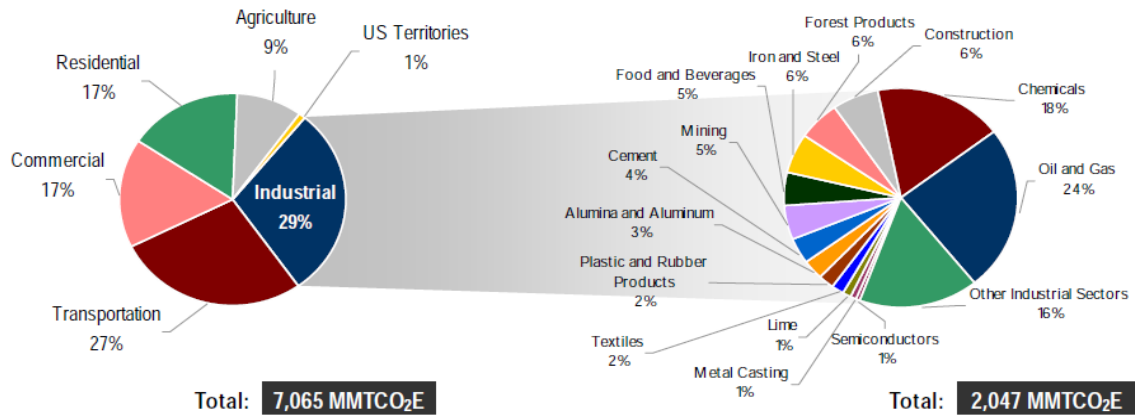


Figure 17. Carbon dioxide Emissions of the construction industry (reprinted from EPA2009)

Because of the huge size of the construction industry and its contribution to negative impacts on environment, the green design and green construction firms that try to reduce the negative impacts on the environment have expanded over time as shown in Figure 18.

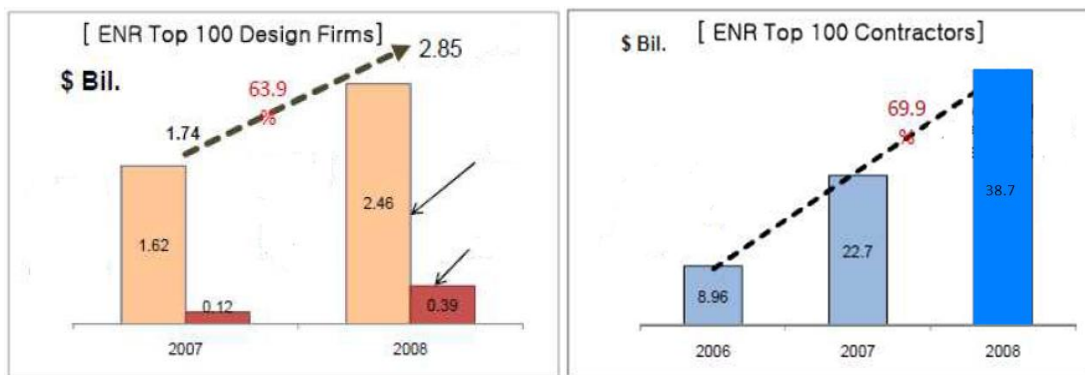


Figure 18. Sales trend of green design and construction firms in the U.S. (adapted from ENR 2006~2008)

However, the sustainable efforts by the construction industry were different among its sub-sectors. Engineering News Record released the statistics how green the markets are as seen in Figure 19, and most of the green markets are mainly led by the building industry sectors.

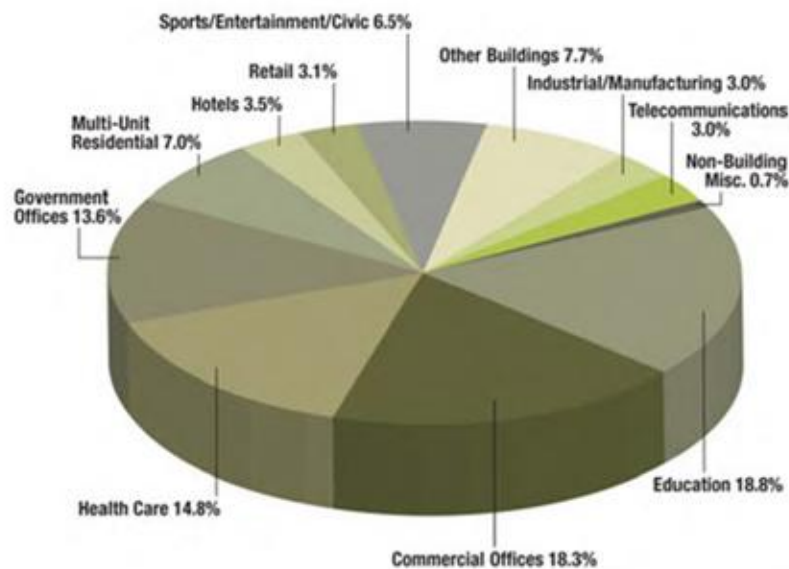


Figure 19. How green are the markets (reprinted from ENR 2010)

Until recently, a number of sustainable systems such as LEED which have already been developed are mostly for the building industry sector. However, interests in sustainability at national level encourage the whole construction industry to promote the sustainability practice into their sectors with relevant policies and regulations. Federal, state and local government agencies provide the unique sustainability systems to be utilized in building, roadway, aviation, plant and other facility industry.

6.3. The U.S. Sustainability Policy by the Government

6.3.1. The history of the U.S. sustainability policy

In order to keep pace with the increasing interests and efforts toward the environmental problems globally, the U.S. government established National Environmental Policy Act (NEPA). This act set a national goal, “to create and maintain conditions which make humans and nature exist in harmony with the social, economic and other requirements for present and future generations” in 1970. The act became the cornerstone of the following policies and systems.

The beginning point of the sustainability policy at national level of the U.S. in the construction industry was to set up the National Construction Goals (National Construction Goals 1995). Under Clinton administration, National Science and Technology Council (NSTC 1996) developed a National Plan for the construction goals in order to improve the quality and productivity related to construction activities as they relate to planning, designing, construction, operation, and maintenance of commercial and institutional facilities. Observing these goals, the noticeable things associated with the sustainable environment are as follows: 50 percent reduction in operations, maintenance and energy costs; 50 percent fewer occupant-related illnesses and injuries; 50 percent less waste and pollution. This was the first layout to make strong criteria to represent the willingness of the government toward the environmental-friendly policy.

In 2005, the bill of the Energy Policy Act was passed by the United States Congress. The act contains legislation to change energy issues in the United States. The act attempts to solve the growing energy problems, and it encouraged to follow US

energy policy by offering tax incentives and loan guarantees with regard to energy production of various types. The principal provisions affecting Federal facilities include the requirements as seen in Figure 20.

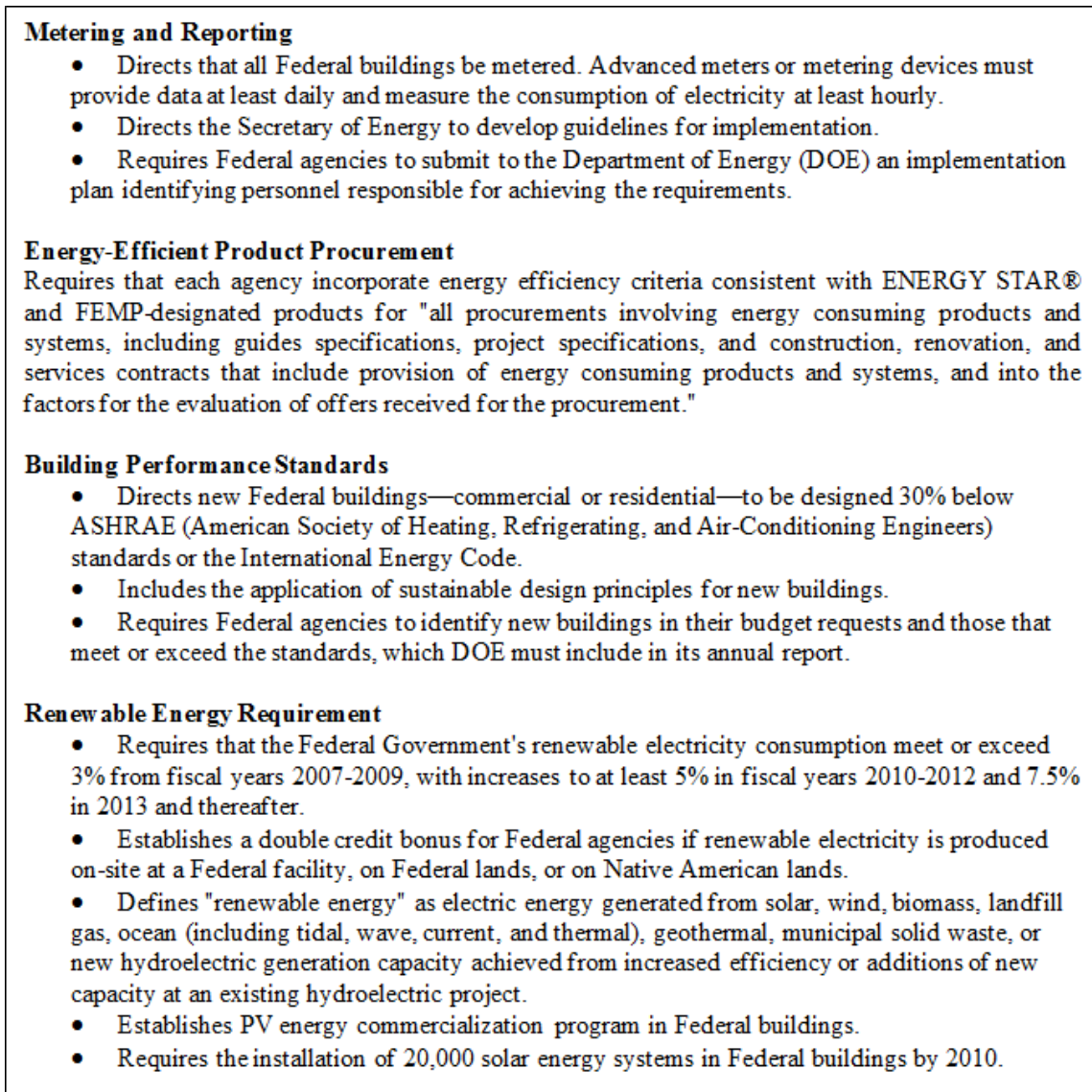


Figure 20. The goals related to the construction industry of excerpt from Act 2005

The Energy Independence and Security Act (EISA) of 2007 is concerning the energy policy of the U.S. The EISA 2007 is the energy legislation to save energy in areas including building design and construction sectors to move the U.S. toward greater energy independence and security as seen in Figure 21. The Act intends to lower energy costs to consumers. The EISA 2007 followed the Energy Policy Act of 2005.

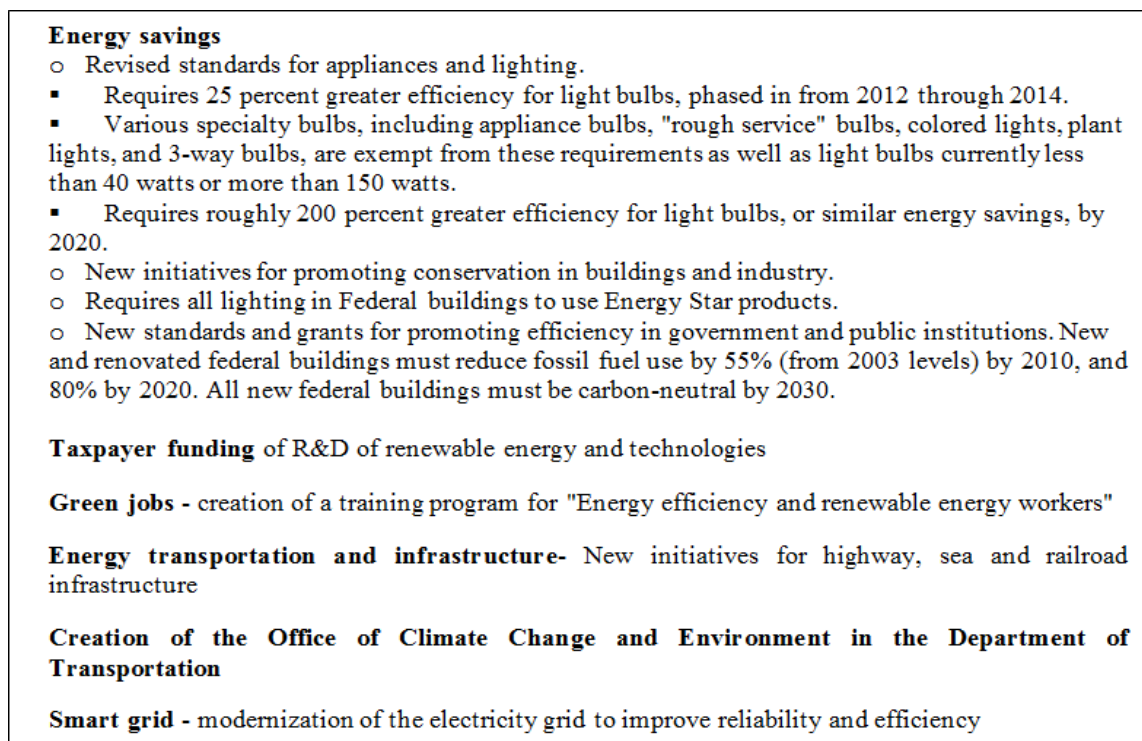


Figure 21. The goals related to the construction industry of excerpt from EISA 2007

The desire to make the construction industry perform their activities to make sustainable was reflected by Executive Order 13423 which is named "Strengthening Federal Environmental, Energy, and Transportation Management" in 2007 (Federal

Register 2007). This order is composed of policy, goals and duties for agencies in implementing the policy. The policy is to urge Federal agencies to implement their environmental and energy-related activities under the law in order to support their missions in an environmentally, economically sound, integrated and continuously improving, efficient and sustainable manner. The main targets in the order are the areas of energy use, sustainable buildings, water conservation, recycling, electronics stewardship, fleets, and so on as seen in Figure 22. Furthermore, it requires more extensive use of Environmental Management Systems as support to manage and continually improve the sustainable practices.

<p>Reducing Energy Intensity Reduce energy intensity by 3% annually and lead to 30% by the end of fiscal year 2015 compared to an FY 2003 baseline</p> <p>Increasing Use of Renewable Energy Ensure that at least half of all renewable energy required by the agency comes from new renewable sources</p> <p>Reducing Water Intensity Reduce water intensity by 2% each year through FY 2015 for a total of 16% based on water consumption in FY 2007</p> <p>Reducing waste and maintain cost-effective manner Reduce the quantity of toxic and hazardous chemicals and materials Increase diversion of solid waste Maintain cost-effective waste prevention and recycling programs in its facilities</p> <p>Designing and Operating Sustainable Buildings To ensure that new construction and major renovation of agency buildings comply with the <i>Guiding Principles for Federal Leadership in High Performance and Sustainable Buildings set forth in the Federal Leadership in High Performance and Sustainable Buildings Memorandum of Understanding</i></p>
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Figure 22. The goals related to the construction industry of excerpt from EO 13423

In 2009, successive effort toward sustainability showed up as Executive Order

13514, “Federal Leadership in Environmental, Energy, and Economic Performance.”

The order extended the energy reduction and environmental requirements of EO 13423.

This order sets sustainability goals for the federal government agencies. The intent of this order is to urge the federal government to implement sustainability practice. The order can create innovative ways toward the sustainable industry by putting reductions of GHG emissions as a priority of the government (Loper *et al.* 2008). In addition, it requires agencies to advance sustainability policies focused on cost-effective projects. It emphasizes making improvements in their environmental, energy and economic performance. The order requires the federal government agencies to set goals in order to promote implementation in environmentally responsible manner as shown in Figure 23.

The new Executive Order requires agencies to measure, manage, and reduce greenhouse gas emissions toward agency-defined targets. It describes a process by which agency goals will be set and reported to the President by the Chair of CEQ. The Executive Order also requires agencies to meet a number of energy, water, and waste reduction targets, including:

- 30% reduction in vehicle fleet petroleum use by 2020;
- 26% improvement in water efficiency by 2020;
- 50% recycling and waste diversion by 2015;
- 95% of all applicable contracts will meet sustainability requirements;
- Implementation of the 2030 net-zero-energy building requirement;
- Implementation of the stormwater provisions of the Energy Independence and Security Act of 2007, section 438; and
- Development of guidance for sustainable Federal building locations in alignment with the Livability Principles put forward by the Department of Housing and Urban Development, the Department of Transportation, and the Environmental Protection Agency.

Figure 23. The goals related to the construction industry of excerpt from EO 13514

These successive orders will aim at incorporating achievement of sustainability goals with the missions of agencies to optimize performance and minimize costs.

Another striking policy of the government agency is shown in the U.S. General Service Administration (GSA)'s sustainability policy. As the satisfactory results of LEED which measures the sustainable performance of the building industry, GSA looked forward to obtaining sustainable impacts on their projects. GSA required the projects to achieve LEED Silver grade or more than Silver grade under the construction from 2002. All GSA projects were encouraged to deploy LEED rating system at strategic project phases in support of project challenges. Furthermore, GSA upgraded requirement of the LEED certification to LEED Gold as a minimum for all new federal building construction and major renovation projects. This upgrade intended to provide the federal buildings with sustainable future in 2010. By using the LEED Rating System, GSA can evaluate and measure achievements in sustainable designs.

6.4. The Sustainability Systems in Construction Industry Sectors

With the increasing attention to sustainability in the construction industry, efforts to make the industry sustainable have created assessment tools to rate performance of each industry in the U.S.

6.4.1. Building

In the building industry, there are quite a number of rating systems all over the world. Among those lots of systems, the representative of rating systems in the U.S.

nowadays is LEED. The study does the in-depth study about LEED for the building industry because many of sustainable practices from other sectors have set their standards by regarding LEED as a benchmark.

LEED stands for Leadership in Energy and Environmental Design. The U.S Green Building Council (USGBC) introduced the version of LEED 1.0 by in 1998. The recent version for new construction was developed as LEED v3.0 in 2009 with efforts to enhance and upgraded the system. LEED is the most widely used rating system for green building in the U.S., and it helps to assess a building's performance all over the building's life cycle.

Main LEED users are local, state or federal government and profit or nonprofit corporation. It is globally adopted as standards for building projects by Canada, China, India and more countries worldwide.

Project must meet all prerequisites to qualify for certification. Prerequisites represent the critical criteria that define green building performance and failure to meet any prerequisite will render a project ineligible for certification. Then, it can choose credits selectively for the following aspects: Sustainable sites, water efficiency, energy and atmosphere, materials and resources, indoor environmental quality, innovation in design and regional priority. Each category has a particular sustainability goal which is referred to as the intent of the credit. Satisfying the intent of a credit leads achieving the points assigned to each credit. During the project review, prerequisites and credits are updated with one of status such as anticipated, clarify, achieved and denied. Credits are not earned during the design phase, but the points are only earned after the construction

phase. Points are given to each credit when the requirements are met by how much performance is achieved until the construction completion. A project can achieve up to 110 points and one of four levels, which are Certified (40+), Silver (50+), Gold (60+) and Platinum (80+) according to the points.

Registered project directory by the USGBC shows that there are 8,334 LEED Certified projects and 38,639 LEED Registered projects under the LEED rating system, and it distributed the system in over 120 countries. This figure shows how popular LEED is in the building industry for measuring sustainability of projects all around the world. For this prosperity of the system, its numerous advantages which have been through the revise and upgrade over time contributed to that. Using LEED provides many benefits such as a lower life cycle cost (Kats Establishing principles and a model for sustainable construction. 2003), productivity and health benefits (Ries *et al.* 2006), flexibility, and reducing the environmental impact.

6.4.2. Roadways

While the building industry has already developed various systems until recently, nonexistent rating systems for the roadway projects led to poor sustainable strategy to the local, states and federal agencies in the roadway industry. However, there are emerging efforts to develop a rating system to help roadways evaluate sustainability by several state leading research. The approach of sustainability to incorporate a broader range of issues into the development has been concrete. Currently used systems are

Greenroads of Washington State DOT, Illinois– Livable and Sustainable Transportation Rating system (I-LAST) of Illinois DOT and GeenLITES of New York DOT.

In January 2010, the Washington State Department of Transportation (WSDOT) introduced a rating system which is Greenroads version 1.0 to be applied to assess the sustainability of the roadway projects. Now WSDOT is doing the pilot programs to verify the system's application and usability. Greenroads is a voluntary sustainability rating system for roadway design and construction and is applicable to all roadway projects including new, reconstructed and rehabilitated roadways (Shuster 2010).

The rating is based on project requirements and voluntary credits for the following aspects: Environmental and Water, Access and Equity, Construction Activities, Materials and Resources, Pavement Technologies and Custom Credit. It awards points for sustainable choices/practices and can be used to assess roadway project sustainability. Points are given to each credit when the requirements are met by how much performance is achieved by the total 118. There are four certification levels as Certified (32+), Silver (43+), Gold (54+) and Evergreen (64+) according to the points.

Greenroads was developed based on LEED after careful analyses of it. For the development of the Greenroads system, the developers researched advantages and disadvantages through a review of experiential evidence and existing standards and goals related to roadway design and construction. These are the advantages from Greenroads.

However, this system excludes so many significant structures including the highway such as tunnel, bridge and railway. In addition, it contributes to only the

roadway design part, thus the other phases like construction, maintenance and operation are excluded.

6.4.3. Aviation

As same as the other infrastructure system, a large number of airports in the U.S. are also trying to develop sustainability programs that are applicable to their policies and systems. City of Chicago made their Sustainable Airport Manual to follow sustainable standards when they design, construct, maintain and expand airports.

When starting-up on a sustainability program, it is crucial for each airport to determine its definition of sustainability, which is a critical step that establishes the basis for future planning and implementation.

Transportation Research Board (TRB) issued the RFP for Airport Sustainability Practices: Tools for Evaluating, Measuring, and Implementing in October 2010. This effort has the purpose to integrate the sustainability practice into the airport construction activities with the best practice, which can encompass a variety of practices in the sector. The target date for the release is 2012, and the airport industry expects the system will help airports choose the best practice for airport sustainability and measure sustainability performance.

The Sustainable Aviation Guidance Alliance (SAGA) is created in 2008 as a coalition of aviation interests to help airport operators in all the phases such as planning, implementing, and maintaining a sustainability program. SAGA made an effort to

consolidate existing guidelines into a comprehensive resource that can be applicable to the requirements of individual airports in the U.S.

The SAGA guides airports on how to start a sustainability program compiles airport sustainability practices in a searchable database in Excel spread sheet and Web-based database. It also suggests methods to adapt practices to airports of all sizes and types in addition, provides references to airports' source documents.

Sources of sustainable practices are from Sustainable Aviation Guidelines, industry experts, leading airports, professional organizations including USGBC. The database, which SAGA consolidated, lists more than 1,000 sustainable practices. They have been implemented or are planned for execution at both domestic and international airports. It includes 68 column categories/searchable criteria. These are organized by a broad range of criteria including Activities, Functional Area, EONS (Economic, Viability, Operational Efficiency, Natural Resources, Social Responsibility). One of stimulating criteria is potential LEED applicability, which is included as searchable criteria so that users can search for sustainable practices that relate to LEED Credits.

6.4.4. Water

Environmental Protection Agency (EPA) issued the Clean Water and Drinking Water Infrastructure Sustainability Policy in 2010 in order to take action to FY 2010 President's budget. In addition to the request, EPA has the vision for sustainable water infrastructure as the long-term policy. The purpose of this policy is that EPA is willing to give a support to make water infrastructure sustainable and efficient in the water

sector which includes drinking water treatment plants, sewer lines, drinking water distribution lines, and storage facilities for water and sanitation. The ultimate goal of the sustainable water infrastructure is to protect public health and water quality. To achieve the goal, EPA considers upgrading of aging water systems in communities.

In order to promote sustainable infrastructure, EPA has been developing a guideline with a Four Pillars approach which includes Better Management of Water and Waste water Utilities, Reflecting the Full Cost Pricing of Services, Efficient Water Use and Watershed Approaches to Protection in Clean Water and Drinking Water Infrastructure Sustainability Policy (<http://water.epa.gov>).

6.4.5. Infrastructure

The American Society of Civil Engineers (ASCE) is in the development of a new infrastructure sustainability rating system, which is arranged for full release in March 2011. This system is a web-based rating system with the goal of the new system and the training program to enhance the sustainability of all types of the civil infrastructure such as transportation, water and environmental projects. They call this Project Rating for Infrastructure Sustainability and Management (PRISM) or Sustainable Infrastructure Project Rating System (SIPRS).

A pilot was rolled out as version of 1.0 in October at the annual conference in 2010. ASCE plans to offer this sustainable certification program, which will encompass an overall context for improved design of infrastructure with educational purpose. The

new system is intended to be performance-based, scalable for size and complexity, adaptable for needs and circumstances, for self-assessment, and voluntary.

6.5. Implications from the U.S. Government's Policy

Through the literature review, the researcher could find some lessons from the U.S. systems as the further developed country toward the systems for the sustainable development. The analysis of the U.S. sustainability systems can be a benchmark to establish or enhance the sustainability policies for other countries, which have been developing their own sustainability policies by providing various cases of the sustainability practices.

From the researcher's point of view through the literature review and interview, the main best practices of the U.S. sustainability systems to give some tips to South Korea are as discussed next.

6.5.1. Direction of policy

6.5.1.1 Attitude of the Federal government through EO 13514

Showing its strong intent of promulgation of orders, the US Federal government has made it clear that it will continue its initiatives to develop the sustainability practice and to set an example of implementation. Through Executive Order (EO) 13514, the federal agencies are urged to follow the provisions and implement the goals of the EO 13514 to reach the target goal by the designated time. It is a top-down approach to encourage the overall construction industry to follow the government's regulations by

showing a role model. It plays a role not only to promulgate related legislation, but to show a leading model. The government provides apparent criteria in a proactive manner, and this manner will help the sustainable development permeate throughout the construction industry.

6.5.1.2 Needs for establishment policies indifferent perspectives

A variety of rating systems to measure sustainability of the construction industry in the U.S. not only assess how sustainable they are, but also provide relevant guidelines and criteria which are concrete and practical.

The government needs to institute policies to promote basic systems to support the construction industry, and pursue the sustainability. The policies should reflect the reality of the current situations of the construction market. However, the policies and the related legislation of the government are limited to efficient use of energy and reduction of greenhouse gas emissions. Even worse, the policies provide less systematical criteria and less apparent standards.

6.5.1.3 Mandatory requirements by General Service Administration (GSA)

PPS, which is in charge of contracts of public construction projects like GSA, considers the Green Performance records such as preliminary examinations and memorandum evaluations are considered as the score of Firm's Credit ratings when government contracts for construction projects and procurement are awarded in open bidding in order to support the firms which use energy efficiency. While GSA makes use

of LEED for the public building projects mandatory, PPS gives a bonus point by the green performance records.

As the satisfactory results of LEED which measures the sustainable performance of the building industry, GSA looks forward to obtaining more sustainable impacts on their projects. GSA requires the projects to achieve Silver grade or more than silver grade under the construction. All GSA projects are encouraged to deploy LEED rating system at strategic project phases in support of project challenges.

6.5.1.3 Triple bottom line

In order to achieve the sustainability in the construction industry, the sustainability policy needs to meet the overall objectives in terms of environment, economy and society to get close to the ultimate goals. In addition, the issue of environmental, social and economic objectives determines the appropriateness of sustainability issue (Kasemir *et al.* 2003).

The concept of sustainability in the U.S. is based on encompassing the triple bottom lines. It is essential that policy makers should understand, quantify and apply these concepts to incorporate sustainability into construction projects decision making. Increasing awareness of the environmental, economic, and social effects of the infrastructure system has already led to new demands on the government agencies to be responsive for providing infrastructure services. Government agencies would face the challenge to lead consensus from balancing cost effectiveness in a short-term and sustainability in a long-term. For this challenge, there are common organizational

attributes to support the environment, the economy, and social equity as seen in Figure 24.

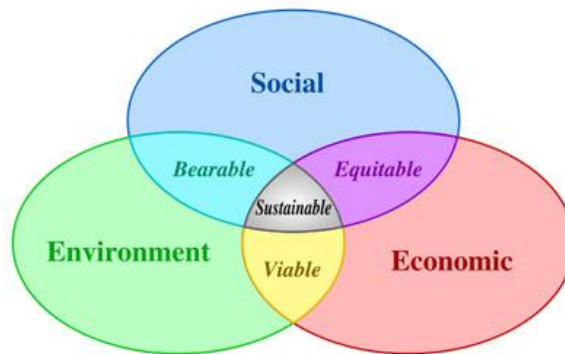


Figure 24. The triple bottom lines

6.5.2. Performance measurement to help set policies and goals

Various performance measurement tools in the U.S. such as LEED, GreenRoads, and Green Infrastructure specify a series of criteria for judging how sustainable a project is in each industry. These measurement tools provide guidance not only for implementation of the sustainable practice, but also for setting up goals and objectives. In addition, the tools assess the achievement of objectives of projects. Because of the late start of Green Growth in South Korea, it is indispensable to establish appropriate goals and objectives to meet the vision of Green Growth.

In addition, the measurement of indicators to represent attributes of Green Growth can help adjust ongoing policies if the result of achievement is not satisfied. The GSA's Carbon Footprint tool can be a principal instance for this session.

6.5.2.1 GSA Carbon Footprint

According to EO 13514, this order requires all federal agencies to inventory their GHG emissions, set targets to reduce their emissions, and develop a relevant plan and policy for meeting a wide range of sustainability goals. GSA has developed the GSA Carbon Footprint Tool to help federal agencies in managing their GHGs under EO 13514 as seen in Figure 25. This tool helps as follows:

- Estimation of GHG baseline in each agency
- Developing GHG reduction targets
- Building GHG emissions inventory
- Assisting preparation for of GHG emissions

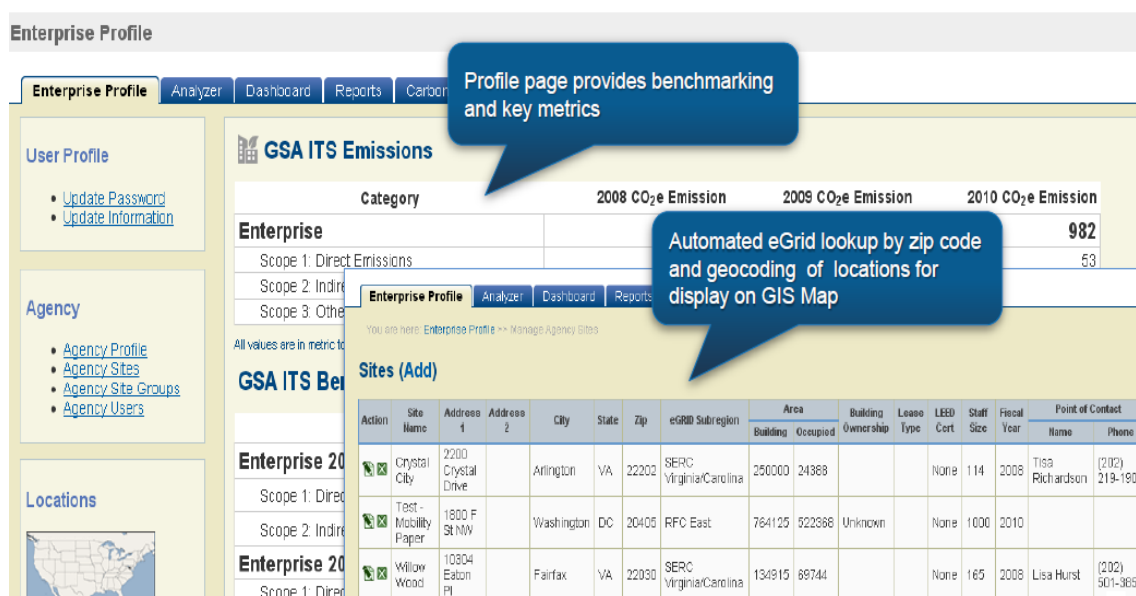


Figure 25. GSA Carbon Footprint Tool (reprinted from GSA)

Participated agencies have to submit an inventory of all GHG emissions generated during the fiscal year with deadlines for achieving the each agency sustainability targets to a determined year. After federal agencies submit GHG reduction targets relative to a baseline year, each agency is required to submit a Strategic Sustainability Performance Plan, which details how the agencies will meet the various sustainability requirements by the requirement of the order.

This tool connects a Geographic Information System (GIS) mapping feature that shows the GHG emissions for the agencies' locations across the country, enabling agencies to target the highest emitters.

6.5.3. Budget/Incentive

When the government agencies determine to invest in making a system and technology related to sustainability, they raise funds for the program at first. In addition, they provide the firms and agencies which follow the sustainability provinces with incentives. In the U. S., numerous sources of funding for sustainability are accessible at the national, state and local levels. The funds have the purpose to reward individuals, industry, government and nonprofit organizations by providing a variety of funding sources such as grants, tax credits, and loans. Furthermore, President Obama announced Better Building Initiative which would promote creating jobs, saving energy and money.

6.5.3.1 Better Building Initiative

This plan sets a goal of a 20 percent improvement in the energy efficiency of buildings by 2020. Therefore, it aims at reducing 40 billion dollars of the energy bills annually. The government provides owners with tax incentives and financing chances for building's retrofit in order to facilitate this plan in a cost-effective manner. In addition, this initiative includes a new concept, named "Race to Green," which offers competitive grants to local agencies that update relevant regulations to encourage upgrades and draw private investment for projects. The initiative suggests a new preliminary program through the United States Department of Energy (DOE) in order to guarantee loans for efficient use of energy to commercial buildings. These incentives will lead to momentous upgrades in commercial building.

6.5.4. Balanced growth over the whole sectors in the construction industry

There are a large number of systems and standards are existent mainly for the building sectors with the name of Green Building in South Korea. In the U.S., however, there are more various efforts for the sustainability system in the overall construction sectors. The overall construction sectors include roadways, aviation, water resource, land development and integral infrastructure at the national, state and local level as observed in Section 6.4.

6.6. Conclusion

The current status of the U.S. sustainability system in the construction industry gives lessons in the sense of that South Korea is among a host of countries trying to achieve sustainable development across the whole industry sectors by adopting “Green Growth” as the vision of the national development the Korean government. The lessons from the case of the U.S. could be a clue to find a way of improving Green Growth in the Korean construction industry.

The study investigated that the connectivity would be required between the government policies and the Green market in the previous section. Vigorous Green Markets in the U.S. construction industry are led by contractors’ efforts for pursuing the sustainability paradigm through the related government agencies’ regulations and standards. However, the Korean green market, especially in the construction industry, is not as massive as the scale of the U.S. Considered that the green growth paradigm is in the beginning phase in South Korea, the government should push the construction industry to develop the green market with aggressive standards leading to the voluntary participation eventually. In the case of the US construction industry, the green market in the construction industry was created through the proactive and aggressive government agencies’ policies, various performance measurement tools, incentives and financing, and balanced interests in the sustainable development over the whole construction sectors.

7. FRAMEWORK OF POLICIES FOR GREEN GROWTH IN THE KOREAN CONSTRUCTION INDUSTRY

7.1. Introduction

This section suggests a framework to enhance policies for Green Growth in the Korean construction industry. This framework suggests steps to create or diagnose the Green Growth policy with low trials and errors for the achievement of Green Growth in the Korean construction industry. The framework, which suggests how to settle Green Growth in a successful way, is created thoroughly by the researcher's understanding. The criteria of the framework are based on the findings from the literature review of the current situation of Green Growth in the Korean construction industry and the diagnosis through the interviews. In addition, solutions for the relevant criteria are suggested from the analysis extracting best practices of the U.S. construction sustainability systems.

7.2. Framework for Policy Making in Sustainability

It is crucial that a necessary component in seeking policy responses to sustainability issues in the construction industry is iterative. That is because the relative characteristics of policies face some problems. For a practical framework, the framework should be based on identification of the key attributes, which affect policy problems related to the sustainability issues (Dovers 1994). Key attributes and issues from the previous analysis are identified to build the framework for successful settlement of Green Growth as below:

- Government's willingness to push and to be consistent for Green Growth
- Apparent and specific goals and objectives setting
- Performance measurement
- Consistent support with fund/incentives
- Balanced promotion over the whole construction industry
- Creating an atmosphere for Green Market

With the attributes above, the preliminary framework for policy making pertained to Green Growth issues is suggested in Figure 26. When the Green Growth issues emerge, goal setting should be ranked as the top priority. Next, the objectives to meet the established goal are described to make the goal clear. With those goal and objectives, the government can propagate the Green Growth policy among the whole construction industries to make Green Market lively. The achievements from the projects which follow the Green Growth policy are evaluated, and the results can provide feedback to optimize the policy. The detail of each step will be discussed from the next sub-section.

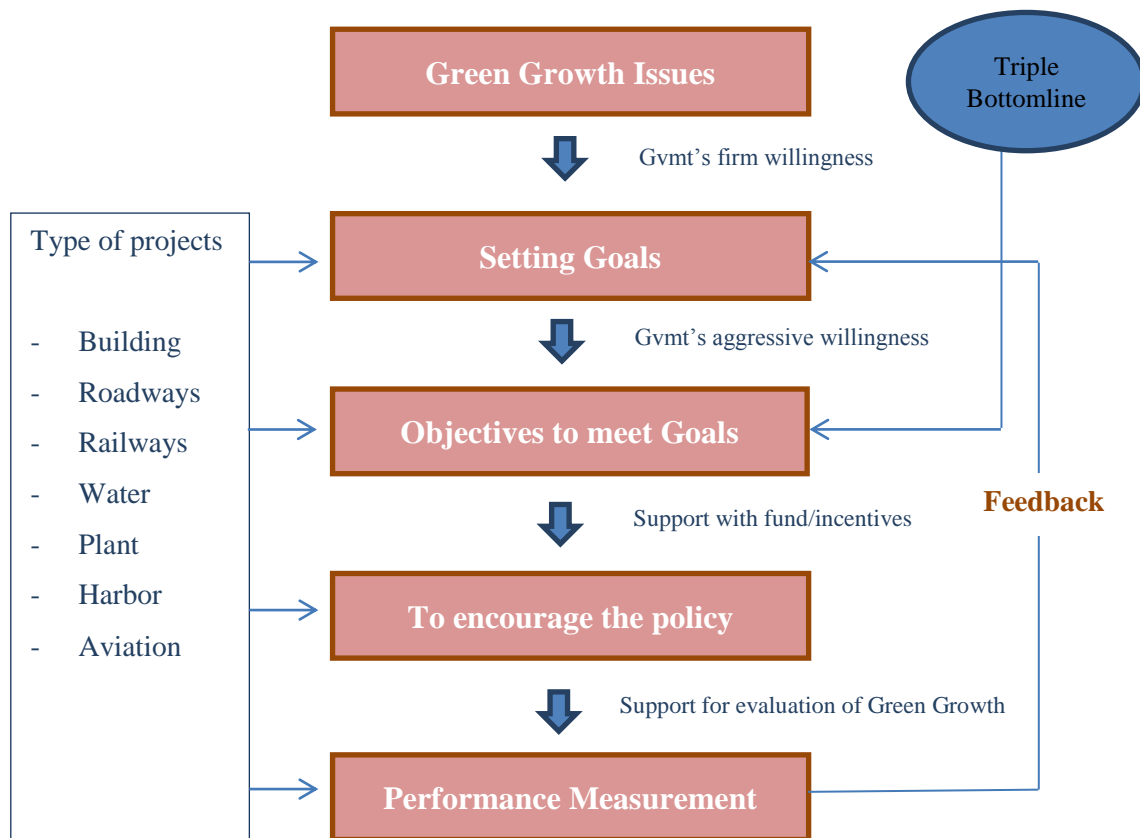


Figure 26. A framework for enhancing the policy for the Green Growth

7.2.1. Goal setting

The goal defines the endpoint that represents a target by policy efforts. Given a goal, the related policy task becomes clearer. Without such a goal, policy is aimless beyond the level of management, and more serious problem is that sustainability has not had such goals agreed by stakeholder (Dovers, 1994).

In spite of the late start toward the sustainability system, the South Korean government has established the related regulation as quick as possible since the vision of Green Growth was set up as a national development strategy. The collaborative efforts

between government agencies to prepare the ordinances and the rules can be highly evaluated. However, the definition and the goal of related terminologies are inadequate to lead stakeholder to understand ambiguously. For instance, there are no definitions for Green Growth in the construction industry such as Green Building and Green Infrastructure in current laws. Such vague goals without clear definitions are common in policy statements. Considering clear definition can generate obvious goals, the researcher suggests defining the significant terminologies in high-level regulation like the law. It is also crucial to set a goal in accordance with the unique characteristic of each construction industry sector. Clearly defined goals will significantly influence the identification of policy problems and the policy response to those problem issues.

7.2.2. Objectives to meet goals

To meet goals established by Green Growth issues, related objectives should be created in accordance with the unique characteristic of each construction industry sector. Every project starts with a set of objectives. These objectives can be defined with the project value, and this project value is capable of being measured. Quantitative goals are advantageous because they allow a project to measure its success in various ways. For quantitative goals, it is crucial to define the metric that will be used to determine achievement. Thus, it is recommended to create objectives to measure quantitatively.

The objectives should reflect unique characteristics of each sector in the construction industry. For instance, as investigated in the analysis of Korean Green Growth policy, the building sector is an energy intensity industry and the roadway sector

is a material intensity industry. The need of the objective setting for each sector will be studied in the next section.

7.2.2.1 Triple bottom lines

Triple bottom lines urged the approach to the sustainable development to accompany environmental, economic and social studies to lead to more integrated development with the interaction among these three issues. It is critical to share common objectives and information generated during the whole process as early as possible among the stakeholder participating in a project. Economic bottom line has a long-term and positive economic impact on a project. Environmental bottom line is about sustainable environmental practice and is to reduce the negative impact on the environment by putting more efforts. Social responsibility is related the well-being of the whole community members and other stakeholder by improving the quality of life and enhancing more convenience in a community. In order to amplify the synergy toward the sustainability, it is indispensable to make the triple bottom line interdependent.

In environmental impacts, one of the main roles of the sustainable construction is to minimize the use of resources and material during the construction life-cycle. Two means of improving sustainable construction are to minimize the amount of energy consumption and material waste. This term should include energy use and GHG emission issues, pollution of air and water, land use, water use and ecology issues.

In order to decide the economic value of a project, Life Cycle Cost Analysis (LCCA) is mostly used with benefit, which considers environmental implication of

construction materials and resources, including life-cycle impacts in terms of economic impacts.

Social impact promotes health and the well-being of community by using the sustainability systems such as the reach within access, the pedestrian-friendly surrounding, green aesthetics and community.

7.2.2.2 Balance among the construction industry sectors

As the researcher observed in the interview about the awareness and interest in Green Infrastructure, systems and interests for the infrastructure industry are too immature to develop the industry market into the sustainability compared to those for the building industry. Of course, there are several differences between the building industry and infrastructure industry. For example, the infrastructure industry is more a public industry than a commercial or private one, and it can cause problems with budgeting. However, the infrastructure industry is also resource-intensive during an operation phase as well as during a construction phase. For example, roadways make a large impact on the environment because of enormous material and resources usage during construction activities.

Strategic combination of different types of construction sectors is required to sustain Green Growth. Therefore, the researcher extended the Green Building to the Green Infrastructure.

Because the relevant data of the infrastructure industry in the Korean construction industry is not enough to be studied, the researcher uses data from the U.S.

The U.S. construction industry uses about 1.2 billion tons of aggregate for construction each year (Ewell, 2004). There are large quantities of steel, water, cement and bituminous products being used during construction activities. Most road construction activities are rehabilitation or repairs of existent roads nowadays. Rehabilitation and maintenance of these roads has to take place regularly, depending on pavement type. Recycling and reuse of construction materials in roadway construction helps promote Green Highway instead of using virgin materials to replace after the end of its life and reduce large quantities of energy to extract, process, and transport (Tuncer, 2006).

Consequently, the researcher could find that the related policy to support Green Infrastructure should be prepared, and the assessment of the Green Infrastructure should be considered long-term by adoption of Life Cycle Cost. That is because the initial cost of the investment increases, but the cost over the life time eventually decreases. In addition, the government should establish related design standards for Green Infrastructure as observed in the sustainable systems over various sectors in the U.S. although the U.S. is currently trying to integrate sustainability into the whole infrastructure industry. The expansion of the policy to the Green Infrastructure can generate benefits such as defining environmental concern, making measurable targets and calling attention to environmental awareness of the infrastructure industry.

7.2.3. To encourage implementation of Green Growth policies

The reasons for the less vigorous Green Market in the construction industry are nonexistence of a role model and an economic burden of increasing construction cost to

contractors.

7.2.3.1 Government's attitude

In order to accomplish goals of Green Growth, the government should show a firm willingness to accomplish Green Growth in the construction industry by taking a role and leading the responsibility to implement it. By showing its strong intent toward Green Growth through the establishment of related regulations to promote the government to take actions, the government has can make it clear that it would continue its initiatives to develop the sustainability practice (Raynsford 2000). The federal government is urged to follow the provisions of regulations and the target goal until the designated timeline. It is a top-down approach to encourage the overall construction industry to follow the government's way by showing a role model (Ballhorn 2005). It should be a top-down method from the federal government in order to permeate throughout the construction industry.

In the case of South Korea, Public Procurement service (PPS) is in charge of contracts of public construction projects like the US General Service Administration (GSA). For selecting contractors, the PPS investigates green performance records for preliminary examinations and memorandum evaluations in order to support the firms, which use energy efficiency. The Green performances are utilized as the score of firm's credit ratings in open bidding.

While GSA makes use of LEED for the public building projects mandatory, PPS provides bonus points to firms with the green performance records. Through the

mandatory requirement of achieving LEED Gold grade or more than Gold grade by the GSA, the target projects are encouraged to deploy the LEED rating system at strategic project phases in support of project challenges.

In the same manner to the GSA's mandatory requirement, the Korean government should be aggressive for goal settings. In addition, the attitude of the government toward the policy of Green Growth should be persistent over the changes of the government administration, but should be flexible to reflect the main change of the industrial situation and market condition.

7.2.3.2 Incentives

The other factor to encourage Green Growth in the construction industry is reducing a burden of increasing construction cost for green design and green construction to contractors.

For these efforts by the contractors, an incentive should be provided enough to make up the invested cost of promoting Green Growth. Sales of green design and construction firms of the U.S. have increased over time. Vigorous green markets of the U.S. are led by contractors' voluntary efforts to pursue the sustainability paradigm, or push by the related government agency's guidelines. However, the Korean green market, especially in the construction industry, is not as large as the scale of the U.S. When considering that the green growth paradigm is in the beginning phase, the government's push is needed to develop the green market. The level of connectivity of the government policy into the industrial efforts is still low in terms of improvements in the

sustainability efforts towards the green market.

It is required to prepare a budget for incentives to encourage ordering green construction projects and to encourage stakeholder in the relevant industry. The incentive can induce the participation in the green market to support them. In assigning budget for such incentives, the government's action should be firm and consistent.

7.2.4. Measurement tool

In order to achieve the sustainability, goals have to be assessed by the particular criteria (Ness *et al.* 2007; Ugwu *et al.* 2005; Muench *et al.* 2008; Dasgupta *et al.* 2005). The Korean government should establish practical and easy-to-use tools to integrate sustainability into the current construction industry for the Green Growth policy.

This measurement tool is helpful in evaluating the achievement of the established objectives, and it is crucial to give some feedback to setting goals and related objectives if there is some deficiency between the goals/objectives and the achieved performance. Thus, the objectives are recommended to be able to be measured. Quantitative goals are advantageous because they allow a project to measure its success in various ways. For quantitative goals, it is crucial to define the metric that will be used to determine achievement (Tugnoli *et al.* 2008).

This performance measurement tool can provide more concrete concepts for a project and the design standards in the relevant industry. It also clarifies requirements of regulation of federal, local agency and specification of engineering by suggesting stakeholder to meet given criteria.

Various performance measurement tools in the U.S. such as LEED, GreenRoads and Sustainable Aviation Guidance Alliance (SAGA) specify a series of criteria for judging how sustainable a project is in each industry. These measurement tools provide guidance not only for implementation of the sustainable practice, but also for setting up goals and objectives, and assessing how well the goals and objectives are achieved (Sahely *et al.* 2005). Because of the late start of Green Growth in South Korea, it is indispensable to establish appropriate goals and objectives to meet the vision of Green Growth.

7.3. Example of Application of the Framework into a Policy

This section provides an example of how the government applies the framework for policy development to an exemplary case for enhancing the existing policy for Green Growth.

7.3.1. Green issues on civil structures

As seen in Figure 27, civil structures such as roadways, bridges, tunnels and water structures are contributors to GHG emissions in South Korea. Although the figure seems as low as 4%, the potential of accumulation of GHG emissions from the civil structures is high enough to affect the environment. However, the current policy is inappropriate to reach consensus on the most suitable measures to reduce GHG emissions from the civil infrastructure industry. The current policy neither prioritizes

strategies based on potential GHG emissions reductions nor recommends specific strategies of Green Growth for the infrastructure industry.

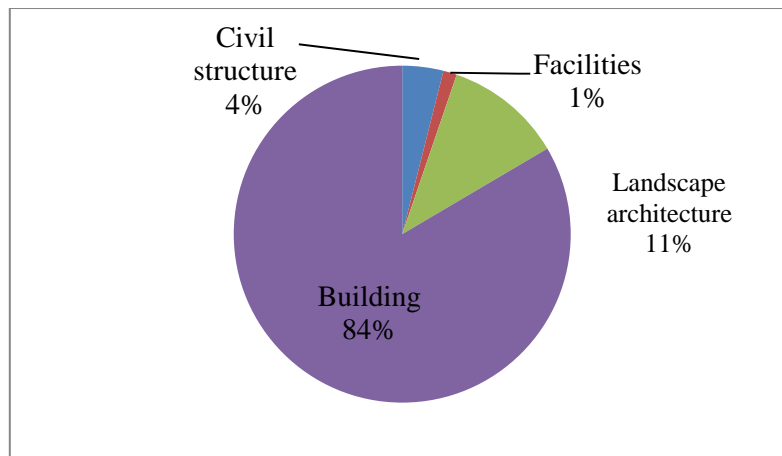


Figure 27.Greenhouse Gas emissions by sectors during the construction phase (adapted from Ministry of Land, Transportation and Marine Affairs 2010)

In order to mitigate environmental side effects including GHG emissions from the civil structures, the Green Infrastructure approach over the whole civil structure is required. Above all, the government should prioritize the goal setting as a primary task for taking actions of Green Growth policy.

7.3.1.1 Goal setting

There is no evident definition elucidating the concept of Green Infrastructure in South Korea. Prior to the goal setting, the government should define Green Infrastructure. The Green Infrastructure can be delineated as the approach leading the

infrastructure to environmentally, economically and socially responsible structures in a way that enables infrastructure's function throughout the life cycle.

Green Growth and Low Carbon Law should describe the goal of Green Infrastructure to have a tread of connection with the definition. The definition helps policy makers integrate strategies into the vision of Green Growth, which makes reduction of environmental side impacts a priority in the infrastructure industry.

For setting goals, the time frame is a significant consideration, and a policy is required to be effective in meeting goals over time. In a similar manner with the Five-year plan of the Presidential Committee, realistic short-term targets for Green Growth in the infrastructure industry may encourage the industry to meet the targets of the goals. The federal government should take aggressive actions to meet a series of target levels for achieving this goal. In addition, the policy should be consistent over the long term.

7.3.1.2 Objectives to meet goals

Implementation of the policy of the Green Infrastructure integrates sustainability goals with strategic planning to optimize sustainable performance. Related agencies must develop Green Growth performance plans and objectives to achieve such goals. These objectives can be determined with project values such as cost, schedule and quality, and these project values are measurable. Quantitative objectives are advantageous because they allow a project to measure its success in various ways. In addition, the objectives should encompass the triple bottom lines to achieve the goals.

The followings are examples of the objectives with a deadline by Fiscal Year (FY) 2020 relative to FY 2005.

Environment

- Improve energy efficiency: 30% reduction
- Reduce Greenhouse gas emissions: 20% reduction
- Increase water efficiency: 30% reduction
- Reduce storm-water runoff: 30% reduction
- Reduce natural resources use: 15% reduction

Economy

- Increase marketability: Green Market 30% increase
- Stay within budget limits: $\pm 10\%$ within budget
- Optimize maintenance and operation: 30% reduction

Society

- Improve site aesthetics
- Increase connectivity in the society

These objectives are just examples, and the target levels should be determined by researches of the current situation and potential possibility to meet those targets. The concept of the society in the Green Infrastructure is relatively difficult to make quantitative targets, but it should be take a portion among the objectives as qualitative targets.

The objectives should specify the characteristics of each sector in the infrastructure industry. The relevant agencies are required to cooperate to establish objectives toward the goals of the Green Infrastructure.

7.3.1.3 How the Korean government encourages implementation of Green Growth policies

In order to propagate the enhanced policies for Green Infrastructure throughout the construction industry, the Korean government should be aggressive to lead the industry to follow the policies. The Public Procurement Service (PPS), which is in charge of contracts of public construction projects like the General Service Administration (GSA), can require projects to achieve targets as a mandatory standard. For example, projects over a certain cost can be encouraged to deploy more than a required level of the Korean Green Infrastructure Certification (KGIC) rating system, which is currently nonexistent system, at strategic project phases. Mandatory requirements by the government can lead the construction industry to a vigorous green market by creating contractors' efforts to pursue the Green Growth paradigm. The connectivity between the government's policy and the industrial efforts can generate improvements in the sustainability efforts towards the green market.

In addition, incentive systems can stimulate contractors to develop their projects in the way for Green Growth. By assigning a budget for incentives to encourage ordering green construction projects, the government can encourage stakeholder in the relevant industry to participate in the green market. For a goal of Green Infrastructure

improvement by 2020, the government should provide owners with tax incentives for ordering green infrastructure projects in order to facilitate this plan in a cost-effective manner because the improvements reduce maintenance and operation bills annually. The incentive for ordering green projects will lead to momentous upgrades in the Green Infrastructure industry.

7.3.1.4 Performance measurement

Government agencies must develop an integrated Green Infrastructure performance measurement tool, which prioritizes the agency's actions toward the goals of the Green Infrastructure policy. In order to create an assessment system for the Green Growth of infrastructure in the Korean construction industry, it should be prerequisite to set categories, which enable contractors to measure the Green Growth. Criteria include the triple bottom lines such as environment, economy and society. For evaluation of the performance of Green Infrastructure, the study proposes the use of quantitative criteria for each category. For instance, Ministry of Land, Transportation and Marine Affairs (MLTM) developed a Greenhouse Gas (GHG) emissions calculator tool in December 2010 (MLTM 2010). The tool estimates GHG emissions from the activities of roadways, railways and buildings construction during material production and construction phases. The amount of GHG emissions can be a criterion of the performance measurement of Green Infrastructure during the fiscal year with deadlines for achieving a target. After a project is completed, the government requires contractors to submit a Green

Infrastructure performance record, which details how the project meets the requirements by the Green Infrastructure goals.

The performance measurement system provides guidance not only for implementation of sustainable practices, but also for adjusting goals and objectives by feedback, which enables government agencies to evaluate their strategies of Green Infrastructure policy. Consequently, the optimized policy will bring about the Green Growth in the Korean construction industry.

7.4. Conclusion

This section deals with the framework of the policy for Green Growth in the Korean construction industry. For Green Growth throughout the construction industry, the policy of the relevant industry should be apparent, and it prioritizes the goal setting. In addition, not only the building industry but the whole infrastructure industry should be sustainable together. In order to the established goals, the objectives that encompass the triple bottom lines and have aggressive targets will stimulate the vigorous Green Market over the whole construction industry. The feedback from the performance measurement enables the government adjust the goals and objectives. Consequently, the Green Growth of the construction industry will be achieved in South Korea.

8. CONCLUSIONS AND FUTURE RECOMMENDATIONS

You cannot manage what you do not measure.

Jack Welch, CEO of General Electric

8.1. Conclusion

The primary goal of the thesis was to suggest a framework for policy development, which can help promote Green Growth in the Korean construction industry. To accomplish this goal, the research presented the current situation of the Korean systems and suggested the best practices of the U.S. systems for enhancing the policy of Green Growth. Through the analysis of Green Growth and sustainability system of two countries, the framework for policy development of Green Growth was suggested.

As mentioned early in this thesis, it is difficult to evaluate the achievements of Green Growth because the Low Carbon and Green Growth Law was promulgated in 2010, and the period from the promulgation to date is short. In addition, the policy is now in the process of revisions and supplementation. However, the researcher suggests a policy framework to reduce trials and errors in the early phase by enhancing existing policies through the analysis of the U.S. sustainability systems.

The framework of the policy for Green Growth suggests the policy should have apparent and aggressive goals. Clearly defined goals will significantly influence the identification of policy problems and the policy response to those problem issues. In

In addition, the goals should promote not only the building industry but the whole infrastructure industry to be sustainable. In order to meet the established goals, government agencies have to develop integrated strategic Green Growth performance objectives. When establishing objectives, quantitative objectives are beneficial because they allow a project to measure its success in an objective way. In addition, the objectives should encompass the triple bottom lines to balance among environment, economy and society.

The established goals and objectives stimulate the vigorous Green Market over the whole construction industry through incentives for ordering green projects. The achievement from the activities of stakeholder during a project life cycle is evaluated to assess if it meets the targets of the goal through performance measurement system. The results from the performance measurement provide the government with feedback, which helps adjust the goals and objectives. Consequently, the enhanced policy can reach the ultimate goal that makes the whole construction industry sustainable in South Korea.

8.2. Recommendation

This study developed a framework to enhance the existing Green Growth policy in the Korean construction industry. The next step requires continuing the work with development as follows:

- The development of assessment system of the sustainability objectives and standards should be researched for the successful establishment of the policy. As

mentioned in Section 7, goals have to be assessed by scrupulous criteria in order to achieve Green Growth. For future research, not only the indicators and the criteria in accordance with the relevant objectives but also weighting of the credits can be studied by forming an expert group.

- As observed in the previous sections, the planning of the policy in a long-term perspective is a prerequisite because the Green Growth is presumed to be sustainable for the next generation. For this research, Life-Cycle Analysis is considered as one of the best ways to reflect economic and environmental performance.
- The current policy, Green Growth, in South Korea calls an attention from minor professionals' not from overall construction industry. In order to be aware of the importance of Green Growth, education and outreach is critical to be prepared to promote it. In addition, this education and outreach can be considered as one of the objectives of the policy.
- For setting objectives, one of the main concerns is the society. While the concept of environment and economy can be quantified in a qualitative manner, there are no specific instructions towards the social impacts of the construction projects. To encompass the whole concept of sustainability, the impact of the social factors and the development of the goals/objectives and measurement indicators for social impacts can be further researched.

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APPENDIX A

In-depth interview questions

Expected time: 45~60min

Introduction

1. To explain the thesis topic and the theoretical framework that I used in the thesis briefly
2. To ask interviewee's brief information (profession, career, etc.)

Questions for the research

1. How much do you know about Green Growth?
2. How do you think about Green Growth in the construction industry and do you think Green Growth should be pursued continuously?
3. What important concepts do you think the vision of Green Growth implies for the whole construction industry sectors?
4. Because of the late start of Green Growth in 2010, it is early to evaluate the achievement of Green Growth. Nevertheless, how do you evaluate the achievement of Green Growth related to the construction industry until now?

5. Related to Q4, there is no visible achievement in the construction industry. What attributes prevent the construction industry from taking steps toward Green Growth?
6. Related to Q5, how the attributes effect on Green Growth in the construction industry?
7. In order lead the construction industry to Green Growth, what kind of alternatives can be suggested?
8. If there are some problems with the Korean government's sustainability policy, do you have any opinion to solve the problems?
9. In the U.S., there are a lot of sustainable practices and related regulations in various sectors as an early starter for the sustainable development. If the Korean construction industry adopts some of the practices of the U.S. and adjusts them to apply into the development of Green Growth, what systems do you think available for the Korean construction industry?
10. How do you see the future of sustainability and construction in South Korea?

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