Selection of Frontier Green Construction Product

Hyounseung Jang[1], Seokin Choi[1], Boknam Lee[1], Wooyoung Kim[1], Chulki Chang[1], Younghwan Lee[1]

[1] Research Fellow, Construction Management Division, Construction & Economy Research Institute of Korea

Correspond to sichoi@cerik.re.kr

ABSTRACT: Green growth is summarized as the national growth strategies to enhance the quality of life as a whole by converting not only the lifestyle but the economic and industrial structures into the low carbon and eco-friendly environments with the green growth industries with low carbon as the momentum for new growth, based on green technologies including renewable energy technologies, energy and resource efficient technologies, converging technologies related to technologies to reduce the environmental pollution. Roles of the construction industry along with other industries are very important in securing justifications for the cooperation between our government and industries for challenges to this green growth as well. The national effects of economy are very large from leading the construction industry to the green construction from the national level. Accordingly, this study suggested responsive plans for both government and companies for the activation of green construction by selecting 15 frontier green construction products and analyzing them by the type of strategy in Korea, as well as analyzing recent trends of overseas green construction.

Keywords: Green Construction; Strategic Mapping Analysis;

1. INTRODUCTION

The construction industry has made growth through developments to increase convenience, practicality and economy for people until now. If the growth of nation and construction industry was to expand the production quantity and quality even though spending a lot of energy in the process to realize such industrialization and informatization, a society requires the construction industry to minimize the environmental pollution while less consuming energy.

However, it does not mean that the construction industry has no interest in the development and use, and sustainable development among others in consideration of environments until now. On the other hand, it is time to make more efforts to adapt the climate change as well as to the greenhouse gas including carbon dioxide while preventing the global warming, as the energy crisis and climate change have been major issues recently. The increased use of renewable energies while less using fossil fuels is not a matter of selection but of requirement. In addition, it is necessary to have facilities to substantially reduce exhaust gases along with those to convert by-products into resources, which occur necessarily in the production activities.

The green construction aims at the green growth through green technologies to increase 'green' effects including the reduced greenhouse gases, higher energy efficiency and reduced environmental pollution. In other words, the green construction in the green growth plays a role of a connection among environmental improvements and economic growth along with green technologies such as the clean energy, renewable energy and eco-friendly technologies as the momentums for the new growth, as shown in Figure 1.

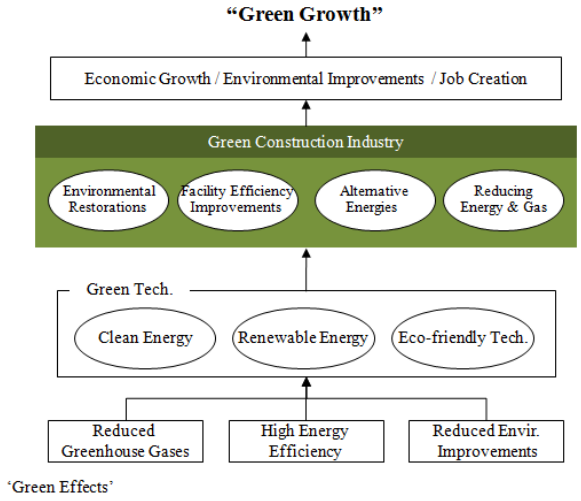

Figure 1. Concepts of Green Growth and Green Construction

Accordingly, the green construction can be defined as "all the activities possible to contribute to enhancing 'green' effects under construction technologies" among those related to the emission of CO_2 and use of fossil energies as major causes of global warming, producing

waste related to the degradation of natural environments, etc. Consequently, the green construction plays a role of a connecter at the center of green technologies, links to other green industries, green economy and green life, and thus the realization of green construction might be presented in the same context with the embodiment of green society.

However, there are restrictions in leading the green construction in the construction fields as of now. This is because it is very difficult to have environments for the distribution and expansion under the principles of market from the demand and supply as the unit price of production for facilities is very high, considering the fact that the demand is small for the low reliability of people on the renewable energy and energy efficiency, and the entities to supply facilities for green technologies rely on a few small and medium companies. Accordingly, this study attempts to seek for responsive plans for both government and companies to vitalize the green construction through the following three approaches. First, it identifies opportunities in the green construction market while reviewing the trends in the green construction market over the world. Second, it selects representative frontier green construction products while identifying the construction greening for the conventional construction products. Finally, it analyzes strategies by the type of representative green construction products.

2. Methodology

This study aims at suggesting strategies to vitalize the green construction market along with the related studies for the market research on the green construction markets over the world, analyses on the greening of construction products, selection of representative green construction products, and process for the strategic analyses by group (Figure 2). The market research on the green construction market over the world was done through analyses of the existing literature using materials from McGraw Hill Construction [1, 3, 5, 6, 7], World Business Council for Sustainable Development [2], and UNEP & New Energy Finance [4]. Limitations lie in the fact that analyses on the trends and markets for the entire construction products could not be carried out as the green construction market has been discussed majorly around energies and green buildings over the world construction market. Analyses on the greening of construction products and strategic analyses by group were carried out through questionnaire surveys on professionals in TFTs of companies or construction technologies research centers related to the green construction. 57 copies of valuable questionnaires were collected from top 10 constructors in total and the analytic hierarchy process was applied to the strategic mapping analysis.

2. Market Research on Green Energy and Green Building over the World

3.1 Green Energy Sectors

Surveys show that the green energy market is growing over 60% on average for the recent three years on the basis of investments. Such investments all include the technology developments, construction investments, etc. The amount stood for 148.4 billion dollars as of 2007, 60% increase comparing to that of 2006. This trend has continued from 2004 and the sector with the largest weight was presented in the investment to facilities (about 57%). It is also find that investments by venture capitals continue to grow by Figure 2.

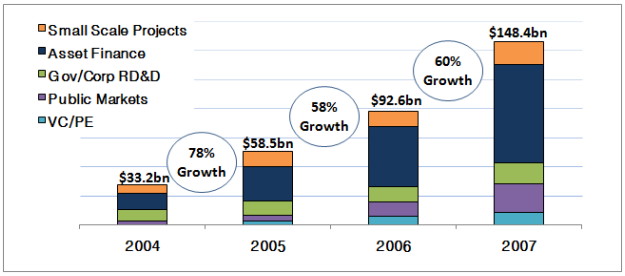

Figure 2. Investment Trend of Green Energy in the World

Source: Global Trends in Sustainable Energy Investment 2008, UNEP & New Energy Finance, 2008, p11 [4]

Considering weights of new investments by the green energy source, they are sequentially accounted for the wind (43%), solar energy and biofuels. The same trend has been shown even in investments to facilities or the related companies. On the other hand, surveys show that venture capitals and private funds have higher investments to the solar energy, energy efficiency, biofuels and other technologies for lower carbon, etc. They also revealed that M&A (25.7 billion dollars as of 2007) between companies had been active to line up their value chain in the green energy production (Figure. 3).

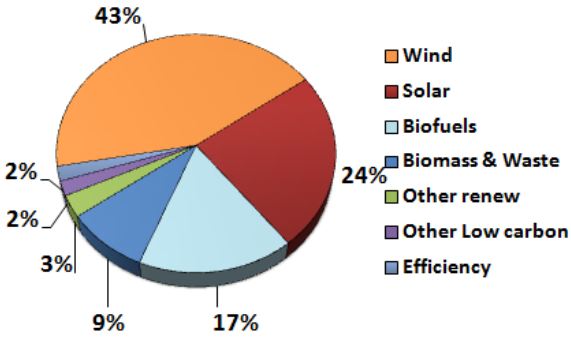

Figure 3. Summary of New Investment Sizes by Green Energy Source (as of 2007)

Source: Global Trends in Sustainable Energy Investment 2008, UNEP & New Energy Finance, 2008, p13 [4]

The investments to the green energy facilities by region revealed that weights taken by both Europe and USA were very large. Other regions include China, India and

Brazil. Surveys showed that a considerable number of registered projects by Clean Development Mechanism (CDM) under Kyoto Protocol had been carried out in India (32%), China (19%) and Brazil (13%).

R&D on the green energy (16.9 billion dollars as of 2007) also continues to grow. Corporate R&D was sequentially accounted for Europe, Middle East, USA and Asia, and R&D by government showed that Asian countries (China, Japan and India) had higher weights. Many of green energy incubator projects were financed with their governmental budgets in USA and Europe. Especially, the solar energy (61 companies) is the most active field, followed by the fuel cell (27 companies), wind and biofuels (26 companies).

3.2 Green Building Sector

The green building market was actually surveyed only around markets in USA and Europe, and the trend related to some new cities (Masdar) in the Middle East or Japan was excluded here. American market is estimated as a market with about 140 billion dollar as of now. It appeared to be concentrating on the remodeling market until now.

However, a rapid growth is expected to become a market with 270~300 billion dollars from 2010. European market is expected to grow up to 40~70 billion dollars in 2010 although it remains a size of 18 billion dollar as of now, as shown in Table 1.

Table 1. Market Outlook on Green Building Market in USA and Europe

Divisions	Current (2006)	2010 Projection
US Market	$12 billion (New) $130 billion (Renovation)	$30 ~ 60 billion (New) $240 billion (Renovation)
Commercial/ Institutional	$4 billion (New)	$10 ~ 20 billion (New)
Residential	$8 billion (New)	$20 ~ 40 billion (New)
European Union	$18 billion	$40 ~ 70 billion (New)

Source: Key Trends in the European and U.S. Construction Marketplace, SmartMarket Report, McGraw Hill Construction, 2008, 1, p26 [6]

Table 2. Market Trend and Outlook for Green Building by Region in the World

Divisions	Overview (Business Weights)	Facilities	Others
Europe	- 2008: 0 ~ 5% weight - 2013: at least 16% or more / 60% or more (65% of respondents)	- Residential>office>governmental office >factories, etc. - Expected growth of 20% or more for the next five years - Growth momentum during recession	- Increased sales and profits - Reason for green business: market demand - Barrier: excessive cost
North America	- 2008: 6 ~ 10% weight - 2013: at least 16% or more / 60% or more (52% of respondents)	- Residential>governmental office>education>office>>hospital, etc. - Growth momentum during recession	- Increased sales and profits - Reason for green business: right direction - Barrier: excessive cost
South America	- 2008: 0 ~ 5% weight - 2013: at least 16% or more	- Residential>office>hospital, etc. - Expected 101 billion dollar market in the future	- Increased sales and profits - Reason for green business: market change - Barrier: lacking political supports and excessive cost
Australia /New Zealand	- 2008: 0 ~ 5% weight - 2013: at least 16% or more / 60% or more (48% of respondents)	- Governmental office>office>residential - Future market is expected to be the focal field	- Increased sales and profits - Reason for green business: market demand - Barrier: excessive cost
Asia	- 2008: 0 ~ 5% weight - 2013: 60% or more (73% of respondents)	- Office>governmental office>factory>residential - Expected growth in a very rapid speed	- Increased sales and profits - Reason for green business: internal corporate decisions - Barrier: excessive cost
Middle East /North Africa	- 2008: 0 ~ 5% weight - 2013: at least 16% or more / 60% or more (59% of respondents)	- Residential>office>governmental office - Possibly highlighted as a rapid growth and attractive market	- Increased sales and profits - Reason for green business: right direction - Barrier: short of related professionals

Source: summarizing and reorganizing contents of Global Green Building Trends, McGraw Hill Construction, 2008, pp. 8 ~ 14

U.S. with the largest related market was expected to have a high possibility of growth in the order of residential l> commercial > office > governmental office > educational facilities. Other regions showed a prospective outlook in the Asian, European, North American, Middle Eastern and Australian market as of 2013 outlook.

These outlooks were obtained through a questionnaire (700 participants from 45 countries) to the related professionals in the world, and those mentioned regions were thought to have initiatives on the green building at least for 16% or more in the total projects in the future markets, and there were considerable opinions of possibilities with 60% or more in reality, as shown in Table 2. The construction industry in USA now acknowledges the green building products as an attractive alternative to break through the recession in the recent recession of the housing and real estate construction business. However, they appear to have great concerns on the excessive cost as a barrier to the vitalization of market. South America pointed out the lack of institutional supports from government as the greatest barrier. The short of related professionals was recognized as a major barrier in the Middle East.

Recently, the green building appears to show the visual performance to both owners and users. Great tangible/intangible performance appears to exist not only in the reductions of energy use, carbon dioxide emissions, water use and waste discharge, but in the operating cost saving, increased value of building, increased ratio of residence and lease, personal health of building users, enhanced achievements, etc.

4. Frontier Green Construction product

The AHP method was applied along with a Delpi survey for the selection of representative green construction products and strategic analysis by group [8]. The Delpi survey consists of three major contents which are (1) Construction Greening Ratio each of the conventional construction products, (2) Frontier Green Construction Products for now and future, and (3) Level of Attraction and competencies of each frontier green construction products.

A survey was done by selecting professionals related to the green construction by field in consideration of professional characteristics in the contents of the questionnaire, and 81% of respondent rate was shown from 70 copies of samples. The matrix of mapping strategy by type contains elements for both the level of attraction and level of competencies. Given each element had the pairwise comparison matrix with the “agreed upon” numbers for deciding of Priory scale.

Table 3. Example of Pairwise Comparison Matrix

Attraction	A	B	C	D
A	-	1	2	4
B	1	-	2	3
C	4	3	-	1
D	2	4	1	-

The “agreed upon” numbers are the following. Given elements A and B in Table 3; if

A and B are equally important, insert 1,

A is weakly more important than B, insert 2,

A is strongly more important than B, insert 3,

A is demonstrably or very strongly more important than B, insert 4.

The Result of AHP is shown in Table 4.

4.1 Construction Greening Ratio

The typical green effects can be represented with the following four ‘construction greening’ in the construction industry.

Table 4. Weight of Each Element’s Factors for Increasing Construction Greening

Elements	Level of Attraction (X)				Level of Competencies (Y)		
	(A)	(B)	(C)	(D)	(A)	(B)	(C)
	Domestic Demand	**Size of World Market**	**Growth Rate**	**Construction Intensive**	**Technological Potential**	**Designing Capability**	**Construction Capability**
Factors	Domestic demand for the next 5 - 10 years?	Size of world market in the future including the present market?	Annual growth rate?	Possibility for construction to be the leading industry?	Possibility of technological development, degree of investment, and commercialization?	Possible degree of designing capability to be realized?	Possible degree of construction capability to be realized?
Weight	**26.7**	**6.7**	**26.6**	**40.0**	**60.0**	**30.0**	**10.0**

First, there are products to reduce CO_2 by reducing the amount of energy use along with the purification of fossil fuels from reducing the energy and gas. Second, there are alternative energies to include the renewable energy products possible to produce energy without using fossil fuels like oil or coal. Third, there are facility efficiency improvements to reduce waste along with the energy efficiency improvements either through remodeling the existing facilities or efficiently utilizing resources. Finally, there are environmental restorations and space improvements. These involve minimizing the existing environmental pollution or producing products to secure the health of ecosystem on earth. Considering the construction products on the basis of the 'Greening', the level of 'Greening' for each product can be identified. Some might be frontier construction products with high greening which are thought to have already had a high degree of 'greening' while others might be products with fair greening which are thought to be necessary for improvements although they have a certain degree of 'greening'. The other products might be those with low greening which are necessary for the technological developments and investments while having lower 'greening' and more CO_2 emissions as of now. Accordingly, Figure 4 shows Frontier Green Construction Products derived from each product to increase 'greening' around know-how and construction intensive majorly preoccupied by the construction industry while identifying the construction greening rate by As-Is construction product.

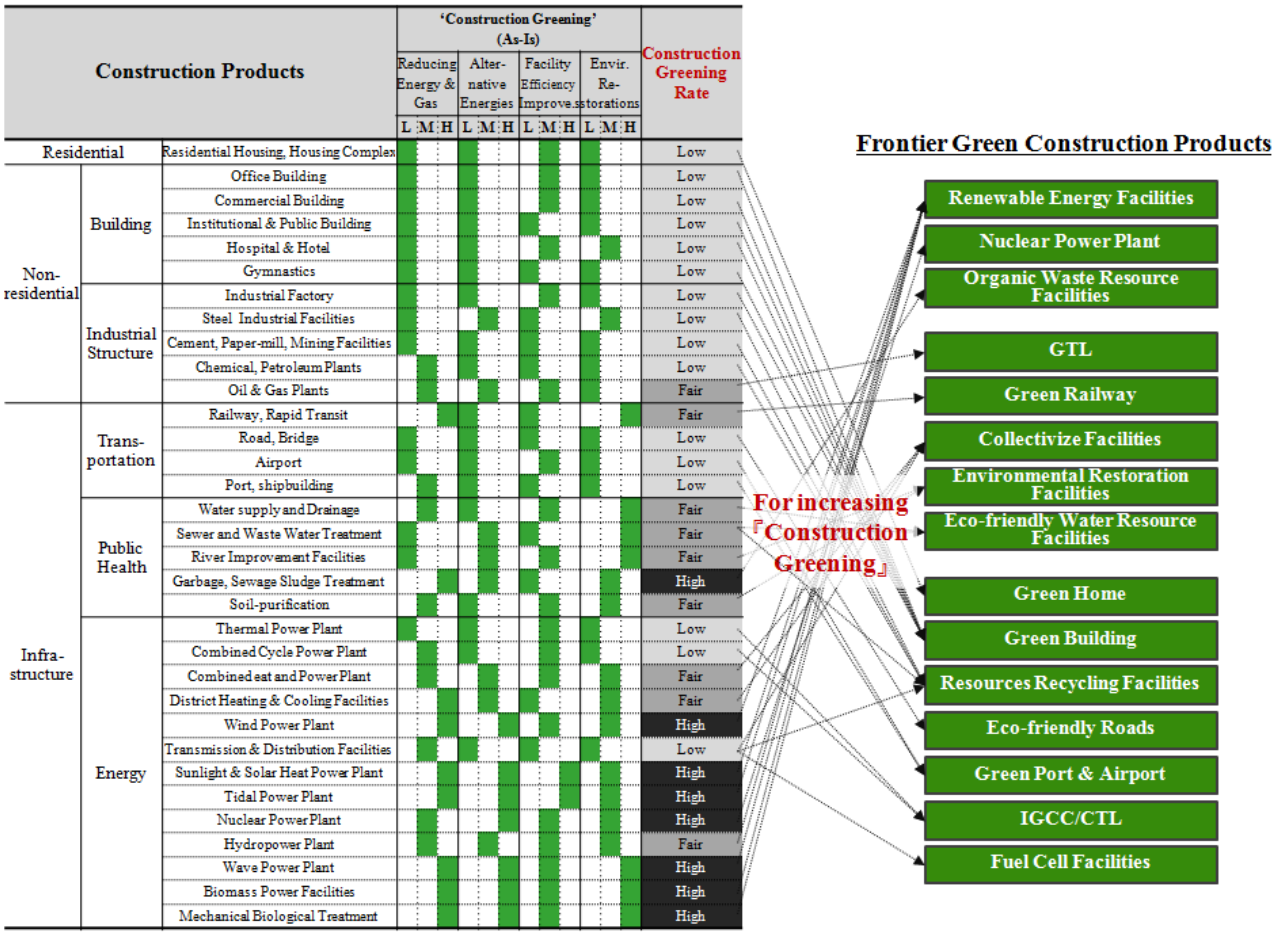

Figure 4. Frontier Green Construction Products to Increase 'Greening'

4.2 Frontier Green Construction Products by Type and their Characteristics

Considering with divisions of types according to the level of attraction and level of competencies for 15 Frontier Green Construction Products derived for the increase of greening, those can be classified into the three groups shown in Figure 5. First is the Strategic Concentration Group that either as businesses necessary for domestic construction industry in any case in the present or as products necessary for the reinforced capabilities according to the characteristics of companies because of lower level of their current capability. Second is Selectively Strengthening Product Group which includes products for investments and improvements with the defined priority according to the strategic directions because of the middle level of business attraction and competencies. The last is the product group to Secure the Necessary Capabilities as those for the necessary investment to R&D because of high possibilities of growth in the new energies in the future although the current level of business attraction and competencies is low.

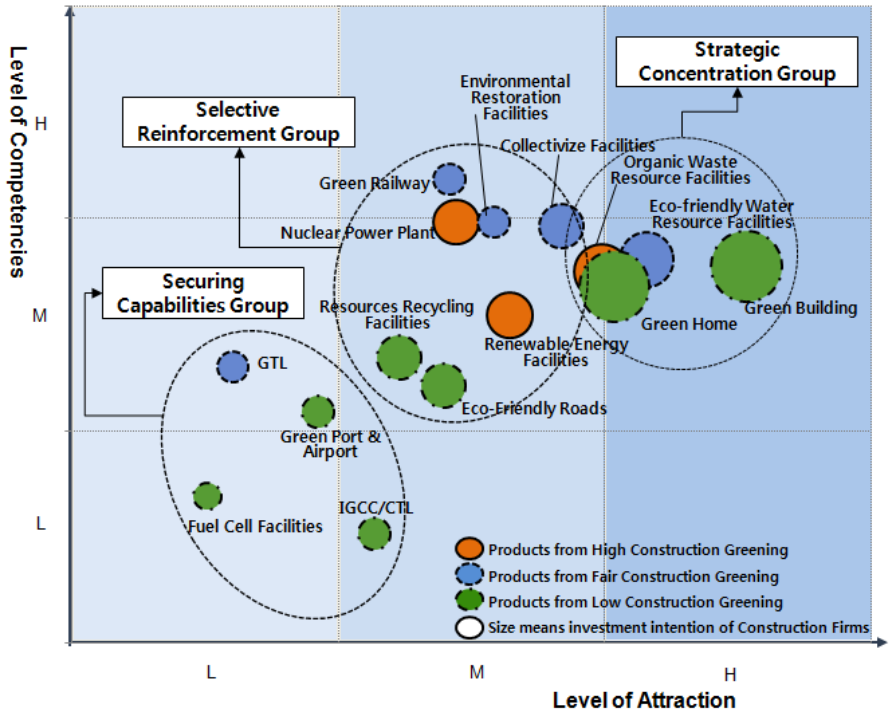

Figure 5. Green Construction Products by Type through Mapping Analysis

Strategic Concentration Group – It includes Green Building, Green Home, Eco-friendly Water Resource Facilities and Organic Waste Resource Facilities, which has a characteristic with a high intent of strategic development by companies as they have easy access to markets for closer relationships with the current governmental policies. Accordingly, the intensive competition between companies is expected in this product group and it is necessary to have the entrance strategies for overseas markets after concentration along with the selection central to our domestic markets. In addition, the strengthening of capabilities for human resources and changes in the perception might be the essential elements for those purposes.

Selective Reinforcement Group – It involves Collectivize Facilities, Environmental Restoration Facilities, Green Railway, Nuclear Power Plants, Renewable Energy Facilities, Eco-friendly Roads and Resources Recycling Facilities, and they are necessary for efforts by government and companies to increase 'greening' because the level of maturity of technologies is low though the possibility of leadership by construction is high as most of them are the existing construction products. In addition, it is also necessary to access by separating products to be led by the strategy-specific technologies from those products good enough to have common technologies.

Securing the Necessary Capabilities Group – It includes Green Port and Airport, Gas-to-Liquid (GTL) Facilities, Integrated Gasification Combined Cycle (IGCC) Facilities, Coal to Liquid (CTL) Facilities and Fuel Cell Facilities for Power Generation. Green Port and Airport are necessary for the technology and method acquisition through the advanced examples as they have lower level of interests from companies rather than the level of attraction, and it is also necessary for other renewable energy businesses to have strategies to seek for the construction leadership through the convergence as they have difficulties to have access because of specified technologies despite the perception of importance. Especially, they are needed fields to have the preoccupation of specified technologies through the revitalization of R&D if the size of green construction grows larger in the future as well.

When companies have any strategic access to the green construction products according to these groups, the most important matter is to select products which reflect the characteristics of those companies, and thus it is necessary to have a sequential access for the increase of 'greening' with the predefined priority by stage in accordance with the target products.

5. Conclusions

Green growth can be summarized as the national growth strategies to enhance the quality of life as a whole by converting not only the lifestyle but the economic and industrial structures into the low carbon and eco-friendly environments with the green growth industries with low carbon as the momentum for our new growth, based on green technologies. Construction should play a very important role of growth engine to increase connections between industries under an umbrella of green growth as described above. It is necessary to perceive the green

construction market as new markets led by the worldwide policy demands and common response strategies rather than by domestic demands. They also have a characteristic of markets with larger possibilities to make new demands by supply rather than the structure of supply after demand in advance. Domestic construction industry and companies are thought to have sufficient opportunities because the green construction products and world markets are still staying at the initial stage of growth.

Hence, it is needed to change the perception to the green construction of all the entities related to construction in order to have the growth of green construction and our government should induce the voluntary developments of green construction products and services from the private companies through the policies and incentives. In addition, it is necessary for companies to have marketing as well as public relations for the new brand value in addition to the vitalization of convergence for the application technologies through strengthening the capabilities of their human resources as well.

REFERENCES

[1] Commercial & Institutional Green Building, McGraw Hill Construction, 2008
[2] Energy Efficiency in Buildings_Summary Report. World Business Council for Sustainable Development, 2007.10.
[3] Global Green Building Trends, McGraw Hill Construction, 2008.
[4] Global Trends in Sustainable Energy Investment 2008, UNEP & New Energy Finance, 2008
[5] Green Outlook 2009: Trends Driving Change, McGraw Hill Construction, 2008.
[6] Key Trends in the European and U.S. Construction Marketplace, SmartMarket Report, McGraw Hill Construction, 2008.
[7] The Green Home Consumer, McGraw Hill Construction, 2008
[8] Thomas L. Saaty, “The Analytic Hierarchy Process: Planning, Priority Setting, Resource Allocation., The Wharton School, University of Pennsylvania, 1980