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Toward Sustainable Neighbourhood Design:
Examining Shinjung Environmentally Friendly Housing Estate Development Project

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Abstract

Since the late 1990s Korean housing authorities and private companies have been pursuing various initiatives towards sustainable neighbourhood design, however, there has been no attempt to examine their progress. This research aims to suggest a sustainability evaluation framework and analyse the progress of sustainability of a cutting edge project: Shinjung Environmentally Friendly Housing Estate Development, using that framework. The results of the analysis suggest that the project failed to make significant progress in the sustainability evaluation criteria compared to normal projects in Korea and there exist significant barriers: economic/financial barriers; institutional/structural barriers; and implementation barriers within current planning and design practices. Most of the project's design strategies were simply adopted and used as a marketing tool without public participation, sustainability targets or benchmarking for sustainability. Furthermore, most of the responsibility for maintenance was left to residents who normally lack the knowledge, experience, interest and money to carry out such tasks. These problems cause significant concerns over the future success of the project toward sustainability. The experience of the Shinjung project also highlights the need for a more proactive central and local government stance towards sustainable neighborhood design.

Keywords: sustainable neighbourhood design, sustainability evaluation criteria, sustainability barriers

1. INTRODUCTION

With a great deal of interest from the public and construction companies, the development of 'Environmentally Friendly Housing Estates' in Korea have significantly increased since the late 1990s due to them appealing to consumers and enabling developers to derive economic benefits from the development. However, most of these projects have focused on cosmetic adaptations of external or internal differentiation strategies and have clear limitations in terms of environmental and social sustainability concerns. Moreover, there has been no significant attempt to analyse or evaluate their progress or achievements towards sustainability. These problems have resulted in settlements becoming less sustainable and less socially cohesive. Strong unsustainable trends require equally strong actions at all levels, i.e. nation/region, city, neighbourhood and housing, to reverse them. A package of strong, complementary planning/design measures for sustainable mixed communities has the potential to begin reversing the current unsustainable trends and improve the quality of life in neighbourhoods.

This research aims to suggest a sustainability evaluation framework and analyse the progress of sustainability of a cutting edge project: Shinjung Environmentally Friendly Housing Estate Development using that framework. Key research questions are as follows:

- How can we monitor or evaluate whether current environmentally friendly housing development projects are going towards or away from sustainability? What are the key indicators? What sustainability design principles were identified? How were these implemented in practice? What are the sustainable/unsustainable factors, Why? What are the lessons to be learnt?

The paper begins by explaining the key research methodology and evaluation framework adopted. After this, using the evaluation framework, it analyses the Shinjung environmentally friendly housing estate development project, by conducting in-depth analysis of the initial development plan, design guidelines, sustainability targets, objectives, development process and the final result of the construction. It continues by analysing key lessons from the planning, design and construction process of the case study project through interviewing key actors such as planners, architects and developers and studying secondary documents. It ends by evaluating the progress of the Shinjung project toward sustainability compared to current normal projects, based on the evaluation criteria.

2. THE RESEARCH METHODOLOGY AND EVALUATION FRAMEWORK

A case study protocol was devised as a major tactic to overcome limitations of the case study such as construct validity, internal and external validity and reliability (see Yin, 1994). The protocol includes an overview of the case study project, field procedures, evaluation framework, case study questions, data collection methodology and a guide for the case study report. The most important factor is the sustainability evaluation framework and Table 1 shows the structures. Nine key issues of sustainable neighbourhood design are presented on the vertical axis. Sustainability indicators, calculation formula, five levels of progress evaluation scales and a place to specify the rational of the evaluation are devised and presented on the horizontal.

The sustainability evaluation framework was established by the following in-depth analysis processes:

Step 1: The analysis of previous models of sustainability and current new movements towards sustainability (i.e. eco-village movement, urban village movement and new urbanism movement) in order to establish a research model of sustainability and the identification of key sustainability factors and various environmental problems. A total of 15 environmental problems with 7 key sustainability factors: air; water; flora & fauna; land/soil; mineral resources; people/community and built form were identified as the results. These are out of the focus of this paper.

Step II: The analysis of the causes, effects and planning & design responses against the 15 environmental problems to identify key planning & design issues towards sustainability on a neighbourhood scale. Consequently, nine sustainable neighbourhood design issues are identified: land use & transportation; energy; air; water; soil; flora & fauna; built form; solid waste/waste recycling and people & community (see Table 2).

Step III: The analysis of design goals, objectives and indicators of sustainable neighbourhood design issues. This research analysed several examples cutting edge research for sustainable neighbourhood design (e.g. Barton et al., 1995; MOCT, 2000; Barton (ed.), 2000, etc.) and for setting sustainability evaluation indicators at a neighbourhood scale. This research adopts the ecological indicators of the City of Vancouver Planning Department (1998) because they are one of the most comprehensive indicators developed through in-depth research and public consultation. Some of the weakest parts (i.e. air sustainability indicators) of the indicators were amended or added by authors based on the documentary analysis. A total of 25 indicators were identified (see Table 2).

Step IV: The formulation of the sustainability evaluation framework.

Table 1: Sustainability Evaluation Framework

Key issues	Indicators	Formula for calculating the level of indicator	Level of sustainability indicator → -2 -1 0 +1 +2	Rationale of the Evaluation
xample	mount o ater nsump- n (litre/ rson/ da	mount of water consumption within the neighbourho partment) / average water nsumption within normal ighbourhood) x100		% reduction water nsumption
Land use & Transportation				
Energy				
Air				
Water				
Soil				
Flora & Fauna				
Built form				
Solid waste/ Waste recycling				
People & Community				

Note: -2: significantly regress, -1: regress, 0:current stage, +1: progress, +2: significantly progress

In order to analyse key lessons that emerged during the processes of designing, planning and construction of the project, this research conducts qualitative empirical research using a semi-structured interview method with key actors of the Shinjung project since it was felt that the obstacles to sustainable design identified by the key actors could provide the most critical lessons for future development as they spring from actual experience. A total of nine Korean professionals including 3 architects, 3 planners and 3 developers were interviewed between August and September 1999. The interviewees remained anonymous to maintain confidentiality. However, broad descriptions of job/position of the interviewees (e.g. senior researcher in Housing Research Institute) are provided.

Documentary analysis (e.g. newspaper and journal articles, project evaluation reports, etc.) was also conducted and observation carried out in order to collect further in-depth understanding of the real context (i.e. barriers/constraints) of the project. The findings of interview analysis, documentary analysis and observation have been faithfully transcribed and analysed into the following four key areas: perceptual barriers; economic barriers; institutional barriers and implementation barriers/constraints.

3. CASE STUDY

3.1 Description of the project

The Shinjung environmentally friendly housing estate development project (1996-2000) has been conducted as a pilot project by Seoul City and Seoul Metropolitan Development Corporation (SMDC) in Shinjung-dong Yangchun-Gu, Seoul. Through the project, Seoul City and SMDC aimed to achieve a model of environmentally friendly housing estate design. They also aimed to convince developers and house builders of the problems of current housing development and to demonstrate a new approach for environmentally friendly housing-land development and housing estate design, which considered the 'environment' as a high priority. The design competition was held in 1997 by SMDC who adopted a 'turn-key bidding and construction method' to facilitate the use of new technologies, reduce construction cost and duration, and provide clear responsibility for the developers. A consortium of Doosan Construction and Engineering Corporation (DCEC) and Wonyang Architects & Engineers Corporation was selected and nominated as the key developer and the key architect. Construction work began in July 1998. The development of Danji[1] 1 and Danji 2 were completed in September 2000. Danji 3 is still under construction. The first residents will be able to move into their apartments in November.

3.2. Analysis of the project

(1) Land use & Transportation

The design goal of SMDC was to build an environmentally friendly, water friendly, urban housing estate which could minimise the damage to existing woodland and geography of the site, provide green-networks and pedestrian networks and build a self-sufficient urban community. In order to minimise the damage to existing woodland and maximise the use of existing topography of the site, SMDC specified a land use plan based on site investigations of the existing site conditions such as flora, fauna, geography, precipitation, soil, land use, etc. Due to these unusual efforts: site investigation; detailed land use plan and guidelines, this project achieves a relatively high level of success in minimising the level of damage to existing woodland and topography compared to that of other current projects.

[1] Danji: a unit of planning and design of apartment estate in Korea

Table 2: Key environmental problems, causes & effects, goals and objectives of sustainable neighbourhood design, and sustainability evaluation criteria

Key themes of sustainable neighbourhood design	Key environmental problems	Causes	Effect on humans	Goals and Objectives of sustainable neighbourhood design	Sustainability evaluation indicators	Source of indicators
Land use and Transportation	Lack of Open space	Population growth, urbanisation And urban sprawl	Land shortage Loss of outdoor leisure and Recreation	Higher densities to reduce urban land take.	FAR, housing unit hectare, habitable rooms hectare, etc	MOCT (2000)
	Air pollution	Segregated land use	Increased long distance trips	Increase mixed use development to promote a balance of jobs, housing and open space	Job working residents ratio within the neighbourhood	Amended by the author based on Barton et al (1995)
	Traffic danger	The growth of private car ownership	High risks of death and injury	Discourage car reliance and increase pedestrian, bicycle and transit amenities	Percentage of street area that is dedicated to non-car use (i.e. walking, cycling)	CoVPD (1998)
					Percentage of dwelling units within 400 m of basic personal services (e.g. food shop, post office, bank, school) and public transit services	CoVPD (1998) and Barton et al (2000)
				Increase accessibility and safety of public transit	Number of public transport routes to local centre within 10 minute journey	Amended by the author based on Barton et al (1995) & CoVPD (1998)
Energy	Depletion of natural energy resources	Increased consumption in building, industry and transport.	Shortage of energy supply and its effects on health (e.g. Hypothermia, cold, etc.)	Reduce energy consumption	Total amount of energy consumption for typical dwelling within the neighbourhood (GJ per m²)	TAFSH (1994) Barton et al (2000) and KICT (1999)
				Increase neighbourhood generation of renewable energy	Amount of renewable energy generated within the neighbourhood	CoVPD (1998), Barton et al. (2000) and TAFSH (1994)
Air	Global warming & Depletion of ozone layer	Green house gases from burning fossil fuels (e.g. building, industry, **Transport**, etc), CFCs emission	Natural disasters (e.g. floods through increasing sea level)	Reduce green house gas emissions	CO_2 emissions from energy used for transportation, heating and cooling	Amended by the author based on KICT (1999), TAFSH (1994), Barton et al. (1995) and CoVPD (1998)
	Poor indoor air quality	Air pollution Loss of plants	Respiratory diseases Acid rain, Smog, natural disasters	Reduce chemical and biological contaminant Emissions indoors	Percentage of buildings designed and built with basic features that minimise indoor pollutant levels	CoVPD (1998)
Water	Poor quality of Surface water	Increasing domestic and industrial **Sewage**	Lack of drinking water Water borne diseases	Minimise water consumption	Amount of water consumption (litres/person/day)	KICT (1999), TAFSH (1994) and Barton et al (1995)
				Maximise local surface water/sewage treatment Increase rainwater recycling/reuse	Percentage of sewage treated within the neighbourhood	CoVPD (1998)
	Poor quality of Ground water	Ground water contamination by Toxic chemicals, radioactivity	Lack of drinking water Cancer and genetic defects Flood, drought, natural disasters	Minimise ground water contamination and the level of imperviousness of the surface	Average imperviousness of the total site area	MOCT (2000), KICT (1999), CoVPD (1998) & TAFSH (1994)
Soil	Poor soil fertility	Soil contamination	Loss of food production	Increase productivity	Amount of produce grown within the neighbourhood	CoVPD (1998)
			Loss of outdoor leisure and recreation, heath problems due to the pollution of air, water and soil	Increase soil decontamination and soil safety	Percentage of land that preserves good quality top soil	Amended by the author based on MOCT (2000)
					Percentage of contaminated land reclaimed	Amended by author based on MOCT (2000) TAFSH (1994)
Flora & Fauna	Loss of variety and diversity of species, habitats and ecosystem	Loss of green space/ open space due to industrisation and urbanisation	Loss of contact with nature	Increase the quality and quantity of habitat provided for a range of appropriate species	Amount of land with significant habitat value	CoVPD (1998)
					Percentage of total neighbourhood roof area designed to carry plant life	CoVPD (1998)
		Air/water/soil pollution **Waste** contamination	Loss of food production Extermination of wildlife Health problems	Increase vegetative cover on the site	Percentage of vegetative land lost by the development	Amended by the author based on MOCT (2000) and TAFSH (1994)
Built forms	Lack of identity and aesthetic quality	Standardisation, mass production Lack of guidance for Planning and design	Lack of identity, sense of place and Uncomfortable and unpleasant built forms.	Increase aesthetic quality, sense of place and flexibility		
	Poor energy efficiency	Bad design and layout	Economic loss due to lack of energy efficiency	Provide an energy-efficient built form and layout	Percentage of dwelling units with good solar orientation	CoVPD (1998)
	Lack of safety	Lack of surveillance due to bad design and layout	Fear of crime Vandalism	Increase safety design and mechanical safety facilities (e.g. CCTV)	Percentage of buildings that adopt anti crime design strategies (e.g. eyes on street, security elevator, CCTV, etc.)	Amended by the author based on MOCT (2000) TAFSH (1994)
Solid waste/ waste recycling	Depletion of mineral Resources	Lack of recycling reuse	Shortage of mineral resources Maximise waste recycling/reuse	Minimise waste production	Amount of waste produced (per capita waste disposal per year)	CoVPD (1998)
					Percentage of construction materials recycled/reused	Amended by the author based on CoVPD (1998), MOCT (2000), TAFSH (1994)
	Lack of waste deposit site	(")	Economic loss, difficult to find deposit site	Maximise the diversion of all waste from disposal	Amount of organic waste processed within the neighbourhood	CoVPD (1998)
People/ Community	Lack of social contacts. Increasing social conflicts	Poverty segregation Lack of communal facilities	Social conflicts/ vandalism, isolation, loneliness, social inequality.	Increase housing type and tenure depending on household's income level	Percentage of affordable housing for low income people	Amended by the author based on CoVPD (1998)
		Lack of participation	Lack of ownership vandalism	Increase level of residents, local environmental agencies and citizen group involvement	Percentage of environmental agencies and citizen groups participating in planning and design process	Amended by the author based on TAFSH (1994)
					Percentage of residents participating in planning and design process	Amended by the author based on TAFSH (1994)

Note: MOCT; Ministry of Construction and Transport in Korea, KICT; Korea Institute of Construction Technology, CoVPD; City of Vancouver Planning Department, TAFSH; The Association for Symbiotic Housing in Japan

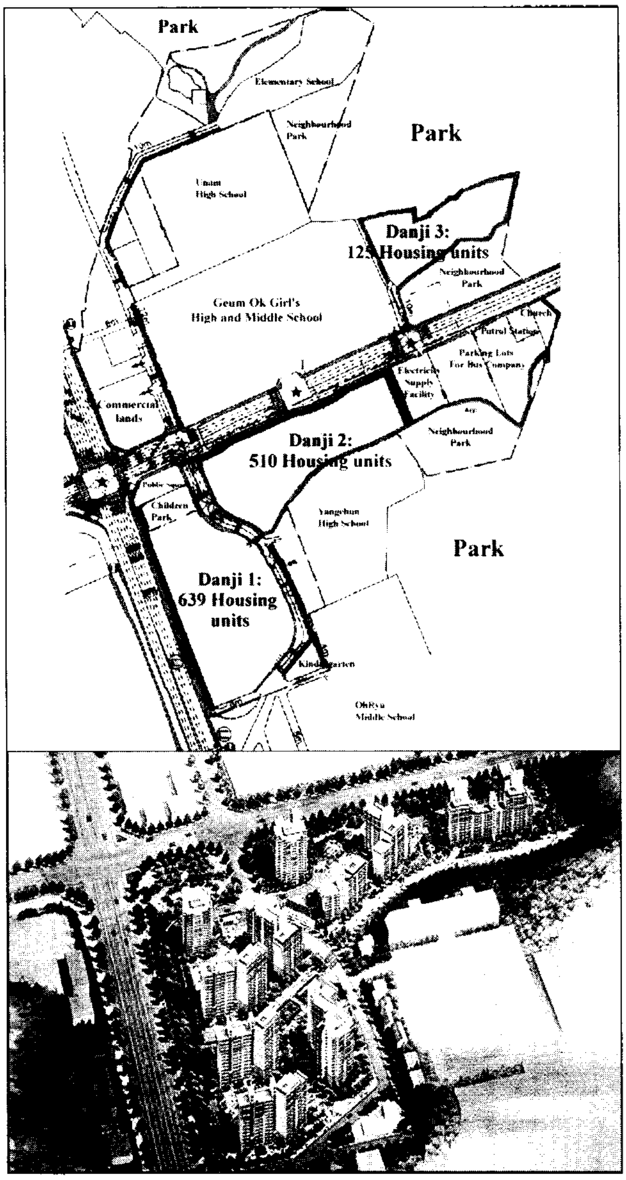

Figure 1: Site plan and 3-D model of Danji 1& 2

A total 32.9% of land was designated for housing development areas. These consist of three small areas called 'Danji'. Each 'Danji' has a specified land use purpose: Danji 1 apartments for selling. Danji 2 apartments for rents, Danji 3 apartments for selling and is developed into a high-rise high-density apartment estate with different scales of housing (less than 60 m^2, 60-85m^2, over 85m^2). Through the segregated land use plan this project attempted to develop the site into several homogeneous communities according to the size and tenure type of apartments. Apartments for higher income groups were separated from apartments for low-income groups. This was to meet the design guidelines of the competition which specified the location of apartments, according to unit sizes, housing types, and householder's income. These guidelines were a result of the planners' intention to avoid potential problems such as difficulty in selling properties as a result of mixed tenure (see also the issues of 'people and community').

In order to design a self-sufficient mixed community, a total 67.1% land of the site was designated for the development of community support facilities: a elementary school; kindergarten; shops; etc. and other uses such as roads, community parks, office and parking space. Each 'Danji' was also designed to contain a small amount of land for basic shops, pharmacy, elderly centre, etc. within the boundary as well as various parks, water features and rest spaces. However, despite these efforts this project failed to achieve the goal of creating a self-sufficient community. This is because the project followed the previous pattern of apartment development which lacks in-depth mixed land use development. Only a slightly higher amount of spaces for community support facilities and employment facilities were provided compared to that of normal projects, consequently, this project depends on its mother city because of the shortage of community support facilities and employment facilities within the site.

With the needs for a sustainable transportation and safety system foremost in designer's minds, the site plan sought to establish a green network and pedestrian circulation network which provide accessibility to surrounding roads and other spaces. In total, 1068m of pedestrian streets have been included within the site's 400m length cycling roads and 10 cycle shelters and 90 units for 3298 residents have been incorporated into the design along the connecting roads between apartment buildings and other community support facilities (e.g. shops, schools, sport facilities, etc.) providing residents with an infrastructure within which it is possible to function without the use of cars

However, as a consequence of lack of flexibility of the design guidelines and current housing regulation for car parking provision, no attempt has been made in the plans to reduce the provision for car parking space. This represents the main reason behind the considerable level of parking lots provided with a total of 841 units, when 754 units was the minimum required for 1150 households by housing regulation. In addition, it was the planners' intention to avoid potential problems such as difficulty in selling properties as a result of the lack of car parking provision.

(2) Energy

In terms of energy use, the Shinjung project sought to reduce consumption in various ways. Most importantly, the project adopted a district heating supply system from the Mockdong combined heat and power (CHP) plant located within 10km distance, as a key strategy for reducing energy consumption. LNG line was also installed as an energy resource for cooking and solar water-heating systems and 26 units of photovoltaic street lamps were also installed. However, there were concerns over maintenance problems and cost-effectiveness as these facilities were seen as having been adopted for cosmetic rather than practical purposes. For example, in relation to saving electricity and energy developers, architects and planners have been criticized for simply focusing on increasing the popularity of the project through the adaptation of various new technologies without considering the future maintenance process. Consequently, it is generally expected that these facilities will cause considerable maintenance problems and further high levels of investment in terms of money and effort (see also "uncertainty about the effectiveness..." on page 8-9).

In addition, in order to reduce energy use several passive design methods were adopted. The majority of buildings were oriented in either a south or east direction in order to maximise solar gains. To minimise heat loss, the form of housing unit was designed in a rectangular shape and the main living space was positioned to face in a southerly direction. Moreover, a cross ventilation system was installed to maximise natural ventilation; high efficiency glazing in the form of double or multi-layer glazing was installed for air-tightness; and the size of the windows was influenced by considerations of solar gain and attractive views. Furthermore, in an effort to reduce energy consumption, various energy efficient appliances such as lamps, pumps, electricity converters, and automatic lighting controllers were installed.

However, although it is generally expected that this project will reduce energy consumption compared to normal projects in Korea, there is no specific estimate about the potential results of the innovative designs either from SMDC or the developers. Again, this may be because they do not have either a long-term plan, responsibility for monitoring the effectiveness of new design strategies or developing further modification ideas.

(3) Air

It is generally expected that this project will reduce CO_2 emission compared to normal projects in Korea due to the use of a CHP system and solar heating panels, and the comparatively large amount of plants. However, there was no further detailed consideration for setting design goals, targets, innovation strategies or indicators for improving air quality. In addition, no detailed concern was adopted for improving indoor air quality within the project despite indoor air quality being a major consideration for many interested in green issues or living in an urban environment.

(4) Water

Although in the planning process SMDC and its consultant; Hyundai Total Engineering Corporation (HTEC) considered the use of a natural water recycling system (using a reed bed pond) and a grey water recycling system within the Shinjung site, these ideas were not included in the final design guidelines for the competition. There were a number of factors behind this decision. One key factor was that the planners and designers believed such ideas were not suitable for the Shinjung site. SMDC stated that:

> "Considering the potential possibility of public discontent at the potential problems of bad smells, harmful effects and the difficulties of finding land, it is not reasonable to adopt natural water recycling methods along the stream within the site. But, it may possible to adopt this concept outside of the project area: the upper stream greenbelt area… It is difficult to import a grey water recycling system within the site since the price of water is relatively low compared to the high initial investment and the residents would have to pay for the maintenance costs"
> (Source: SMDC, 1997d, p 45)

In a response partly then to perceived negative public attitudes to innovative methods of water cleansing and recycling, the project used the current sewage treatment facilities. Thus, the sewage after minimum treatments (i.e. collection and residuum disposal) will be sent to a local sewage treatment centre for main treatments. However, the project did also install a separate drain for rainwater collection and partially water penetrable pavement materials were used to enable the penetration of rainwater within the site, although there were no detailed plans for using rainwater as an alternative water resource. Even for the water of various waterfront spaces (i.e. small pond and stream) in the site, this project used underground water wells installed during the process of the construction. In addition, this project did not attempt to specify detailed targets, indicators and benchmarks in terms of water consumption, water quality and water recycling. This analysis indicates that many design strategies for water recycling/saving could not work effectively because of the lack of detailed systematic/strategic planning for water sustainability.

(5) Soil

In addition to the problems experienced in relation to the recycling of water and the provision of environmentally friendly transport and communication systems, planners met similar difficulties when considering top-soil sustainability. At the planning and design stages of the process, planners, architects and developers agreed to preserve existing topsoil at the site as much as possible and these intentions were specified and established as a plan. However, at the construction stage, the developer ignored the idea of topsoil preservation and instead of reusing the natural topsoil of the site, made heavy use of artificial soils in the landscaping of housing sites. Most of the pre-existing soils in the housing development areas were removed and 1.0m depth of artificial soil installed for the entire housing site area. This situation resulted from a belief on the part of the developer that using natural soil during the construction process would be much more costly and require more time and effort than simply using artificial soil. Although it is probably true that the use of natural soil is more costly and involves a more complicated process, the decision also demonstrates the developer's lack of in-depth understanding of the issue of top-soil preservation. Top-soil preservation does not mean using huge amounts of natural soil for total site landscaping, but preserving only high quality natural 10-20cm top-soil which then provides valuable habitats for flora and fauna. Due to this lack of understanding and difficulty in changing established procedures this project failed to preserve existing natural habitats of soil. Again, there was no practical attempt to monitor or evaluate the future effects of artificial soil on site habitats and no target for soil sustainability was specified within this project.

(6) Flora and Fauna

The project initially aimed to provide various external green spaces where humans, flora and fauna could live together in a symbiotic relationship which preserved the variety of species within the site (SMDC,1997b). In pursuing this goal, a number of design strategies were utilized. First, the project aimed to increase the green space ratio within the site and in this instance it was largely successful. In fact, it provided a much higher level of green space with a total 34.8% of landscaped area in Danji 1 & 2 compared to current regulations requirements of 15%. Furthermore, a larger number of plants were also planted compared to the current level set by housing regulations (e.g. 1,862 trees planted instead of 1,102).

Second, the project sought to plant artificial land. Most parts of the deck floor above the car parks in addition to three rooftop gardens were planted and used as garden space although there are doubts over whether these spaces will work successfully. SMDC and the developers did not set out detailed maintenance plans before giving responsibility to future residents (mostly low-income households) and considering the unique conditions (i.e. artificial soils above deck floor). It is unlikely that the residents will be able to manage it successfully without sufficient knowledge or financial support.

Third, the project sought to provide various habitats for flora and fauna by preserving existing natural forest and building new habitats within the site. In this, it can be argued that the project has failed. Artificial ponds and streams for water life habitats have been constructed, but it is unlikely that these water spaces will work successfully as a habitat due to the practical problems of operating such water features and managing changes such as floods in summer, or drought in winter and controlling & supporting running costs for pumping the underground water.

Finally, the project adopted various ecological planting methods with local species being selected for the parks, gardens and other green spaces. Various species of plants with three different heights (i.e. small, middle and tall) were planted in order to create a natural woodland to provide various habitats for birds and insects. These features then illustrate the aims of the project and also the subsequent varying levels of success.

(7) Built forms

The following design strategies were used in pursuit of the project's aims to provide a sense of community and improve the quality of the built environment for residents.

Firstly, in response to present negative perceptions of high-density urban housing in the form of high-rise, simply shaped, rectangular apartment buildings lacking identity or personality, the designers aimed to use a variety of elevation design to create more individual buildings with character. Various heights of apartment buildings were designed to provide a variety of skyline and two tower-shaped buildings were located at the main entrance area. The elevation of each building was divided into three blocks: foundation, middle and top in an attempt to avoid the negative images associated with tall buildings and produce a human-scale streetscape.

Secondly, external space design was developed with the aims of creating a sense of place, through providing various characteristics of spaces by zoning, sculpture design, landscape design and building colour. Pedestrian streets linked various green spaces such as communal gardens, ponds, streams, parks, etc. with community facilities such as shops and welfare facilities. For convenient circulation networks and visual openness, a few apartment buildings were designed to provide short paths at the ground floor.

Thirdly, in terms of internal apartment design, the project attempted to include flexibility of use through the inclusion of a number of design features. For instance, adaptable plans were partially adopted for the efficient use of space:

- 12 'pyung' (net area: 40 m^2) type apartment: changeable between 1LDK and 2 LDK by using two sliding doors between the master bedroom and living room.
- 15 'pyung' (net area: 50m^2) type: changeable between 1LDK and 2LDK by using a sliding door between the master bedroom and living room
- 18 'pyung' (net area: 60m^2) type: changeable between 2 LD·K and 3 LDK

Finally and importantly for design in an urban context, the project adopted strategies for minimising the problems of external noise (i.e. airplane and car noise). Apartment buildings were laid out vertically along the roads (Nambu circulation road: 40m, Shinjung road: 25m) and a line of green mounds as buffer zones built along the roads. In addition, airtight windows and the structure of the floors were both designed to minimise the transmission of sound.

Due to these design strategies it is expected that this project could create better living quality (e.g. less noise, flexible unit plan, better quality of external space, etc) for residents) compared to the other surrounding apartments. However, because of the high level of housing density and probable high levels of noise from car & air traffic it is unlikely that this project will have made sufficient provision to create a model of sustainable living for the residents.

(8) Solid waste/waste recycling

The project aimed to reduce solid waste and increase recycling of materials and several innovative design strategies were implemented to achieve this aim.

For example, a total of six food waste disposal units were installed within the apartment estates in order to minimise domestic waste which would then be used as natural manure for plants. Another strategy was the provision of rubber ground covering utilizing rubber recycled from car tyres for the childrens' playgrounds and basketball courts. In addition to these innovative ideas consideration was also given to construction efficiency. For example, standardised construction materials were used in order to reduce construction duration and secure economic efficiency, and durable materials were chosen for features such as the water pipes in order to extend the lifetime of the buildings.

However, despite these positive attempts at maximising sustainability, there were flaws in the plans. For example the project failed to provide a detailed maintenance plan for these facilities and no further consideration was given to monitoring the progress or failure of the innovative designs and machines. Instead, most of the responsibility for maintenance of these facilities was left to residents who normally lack the necessary knowledge, experience, interest and money to undertake such maintenance. Considering the lack of a practical maintenance plan, residents' participation and budgets, there is doubt over the likelihood of success with the waste recycling scheme.

(9) People and community

One of the aims of the project was to establish a socially mixed community within which residents could live safely and the design therefore, included a number of features to achieve this. However, as was the case with a number of the other objectives, this was not wholly successful.

One decision that was taken with the focus on establishing a mixed community was in relation to tenure. The design incorporated mixed tenure in that 640 units were provided for sale and 510 for public rent. However, despite these two types of tenure being incorporated into the same project, they were separated geographically with the owner-occupation in Danji 1 & Danji 3 and the public renting in Danji 2. The project also aimed to provide housing for people with different needs and consequently incorporated 43 apartments specially designed for elderly and 40 for disabled residents which is about 7.2% of the total units at the site. Again however, these were all located together in Danji 2 and as a result it can be argued that the project has not been successful in creating a mixed community. In addition, the project did not consider in the design the needs of families with children or issues of child density. Although community support facilities such as a library (71 m^2), elderly centre (219 m^2) and community centre (292m^2) were provided, they represented only a slight improvement on those required normally by law. However, a community garden provided to encourage interaction between residents, and a natural education centre designed for use by children and the elderly were included, and these represented a significant improvement on other urban housing development in Korea.

In relation to issues of safety a number of features were included. As has been mentioned before, pedestrian and road systems were separated by raising the pedestrian walk ways in a deck system and it is predicted that this will greatly improve pedestrian safety from cars, especially for children and the elderly. However, the extensive use of underground parking, the lack of CCTV surveillance and the provision of only one security office for every two or three apartment blocks raised issues of personal safety especially for female, disabled or frail residents.

3.3. Evaluation of the project

As can be seen in Table 3, the project only achieved a very limited level of success in the sustainability evaluation criteria, compared to current normal projects. The most significant achievement is in energy issue. By adapting energy efficient appliances and a CHP system, it could save huge amount of fossil fuel and reduce heating costs. In addition, there is some progress in the aspects of waste recycling, car-free external space design, vegetative land ratio and social housing provision.

However, in many ways the project failed to make significant progress towards sustainability in most of the other issues. It failed to achieve the goals of topsoil preservation, habitat construction and mixed use community design. Furthermore, the lack of concerns for safety from crime, especially in the underground car parking space is another critical failure of the project. In addition and most importantly, it failed to set detailed targets, maintenance plans and monitoring plans. Thus, most of the innovative design strategies were simply adopted and used as a marketing tool and most of the maintenance responsibility was left to residents who normally lack the necessary expertise, experience, interest or money to undertake these tasks successfully. Because of these reasons there exists very significant doubt over the future success of the project's sustainability.

Table 3. Sustainability Evaluation Table

Key issues	Indicators	Level of sustainability indicator Toward sustainability Significantly Regress / Regress / Current Status / Progress / Significantly Progress →	Rationale of the evaluation
Land use & Transportation	•Density	:	High-rise high- density apartment, no significant difference existed
	•Job Housing ratio within the neighbourhood	.	High-density residential development with basic support facilities
	•Percentage of street area that is dedicated to non-car use within neighbourhood	-	Car free pedestrian road and cycle road installed but unconnected in many parts
	•Percentage of dwelling units within 400m of basic personal services (e.g. food shop, post office, bank, school) and public transit services	:	Relatively easy access to public transits, but small amount of stores and food shops
	•Number of public transport routes to local centre within 10 minute journey		A few bus routes
Energy	•Total amount of energy use for typical dwelling within the neighbourhood	=	Energy efficient appliances, 100% connection with CHP plant, etc.
	•Amount of renewable energy generated within the neighbourhood	:	Solar panel & photovoltaic street lamp, but cosmetic

Air	•CO_2 emissions from energy used for heating and cooling	[illegible]	Connection with CHP plant, the use of natural gas
	•Percentage of tree cover	[illegible]	Large number of plants compared to the minimum level by housing regulation
	•Percentage of buildings designed and built with basic features that minimise indoor pollutant levels	[illegible]	No concern for indoor air quality
Water	•Amount of water consumption	[illegible]	Water efficient appliances, but no attempts to examine their effects
	•Percentage of sewage treated within the neighbourhood	[illegible]	Separate rainwater collection, but no sewage treatment facilities within the site
	•Average imperviousness of the total site area	[illegible]	Water permeable pavements, large green space, etc.
Soil	•Amount of produce grown within the neighbourhood	[illegible]	No farmland installed
	•Percentage of land that preserves good quality top-soil	[illegible]	Artificial soil adopted because of lack of experience and willingness.
	•Percentage of contaminated land reclaimed	[illegible]	No soil remediation
Flora & fauna	•Percentage of land with significant habitat value	[illegible]	A cosmetic space adopted without significant habitat value
	•Percentage of total neighbourhood roof area designed to carry plant life	[illegible]	Cosmetic roof top gardens with little habitat value
	•Percentage of vegetative land lost/increased by the development	[illegible]	Increased vegetative land
Built form	•Percentage of dwelling units with good solar orientation	[illegible]	Some units face north-east/ north-west
	•Percentage of buildings that adopt anti-crime design strategies	[illegible]	Lack of CCTV, security office and huge amount of underground space
Solid waste/ waste recycling	•Amount of waste produced	[illegible]	Waste decomposer, separate waste collection system, etc
	•Percentage of construction materials recycled	[illegible]	Standardised construction method and a few decorative attempts to use recycled materials
	•Amount of organic waste processed within the neighbourhood	[illegible]	Six organic waste disposers installed, but significant doubts over maintenance
People and Community	•Percentage of affordable housing for low income people	[illegible]	Housing for rent, public housing for disabled people and the elderly
	•Percentage of residents, local environmental agencies or citizen groups participating	[illegible]	No in-depth participation of residents, citizen groups and the public

4. Key barriers/constraints that emerged in the project

(1) Perceptual barriers/constraints

• Lack of understanding about the concept of sustainable development

A senior researcher who works in a housing research organisation argued, "the greatest obstacle of sustainable neighbourhood design in Korea is the lack of understanding of the concepts of sustainable development". The same researcher insisted that:

> Not only lay people but also a high percentage of housing researchers have this problem…Most of them have no clear idea what the concepts of sustainable development mean… they have a limited knowledge about sustainable development.

As an example, he mentioned his own research data on the miscomprehension of the term "sustainable development" by both lay people and housing researchers. This research also supported his views on the problem of misunderstanding or lack of in-depth knowledge of the concepts of sustainable development. A high percentage of professionals interviewed understood the concept of sustainability mainly in terms of environmentally friendly external landscape design. In addition, most of the design strategies for environmentally friendly housing development were focused on the use of new mechanical technologies (i.e. solar panels, solar lamps, etc.) and landscape design ideas (i.e. private gardens, waterfronts, parks, green networks, etc.) aiming to create the image of suburban housing. Features of sustainable development such as social equality and public participation were not put forward during interviews. This is probably because there has been no practical attempt to identify the concepts of sustainable development, conduct experimental projects and analyse their achievements, since the idea of sustainability in Korea was introduced only a few years ago (i.e. late 1990s). In addition, attempts such as using mechanical facilities and landscape design concepts could be achieved immediately without significant financial investment. Consequently, most of the design strategies were collectively adopted and used as decorative devices to create a new image of high quality apartments rather than as a critical tool for environmental sustainability. Thus, it is very difficult to identify some practical/ strategic approaches with long-term views to global/local sustainability

• Uncertainty about the effectiveness of new technobgies/strategies

Although a number of new strategies/technologies were implemented, there was uncertainty amongst the key actors over the effectiveness. For example, many professionals who were involved in the project raised questions over issues such as economic efficiency and maintenance effectiveness. One senior planner involved in the project argued:

> Regarding the condition of climate, soil and vegetation, there is a great number of doubts about the innovative designs applied within the project. I think, many of the innovative designs will not work effectively and the spaces will be left useless in the future… The construction of the small stream looks fine, but it works only in limited seasons in Korea. In the winter season all the water should be drained out in order to prevent potential damage from extremely cold weather… The so-

> lar energy system sounds good, but there are many problems in terms of maintenance and economic efficiency of the system.

A senior architect interviewed criticised the ineffectiveness and economic inefficiency of photovoltaic street lamps as follows:

> The photovoltaic street lamps show the limitations of this project. A total of 23- 26 photovoltaic street lamps were installed in the site as a result of extremely large amount of financial investment... The problem is that the maximum capacity of the lamps is very low, about 25W. It is not a sufficient level of brightness for a street lamp. Thus, it is necessary to install additional street lamps at the same time in order to achieve a sufficient level of lighting... We continually explained this problem and provided alternative solutions for a higher level of energy efficiency and brightness within a similar or lower amount of budget. But, the photovoltaic lamp was selected for decorative effects! I am very dissatisfied about it.

These critics indicated that among the key actors there was a high level of uncertainty over the effectiveness of new design strategies and technologies. It seems that such a high level of uncertainty was caused partly as a result of the lack of an in-depth economic feasibility study and partly due to inadequate future maintenance plans within the Shinjung project. In addition, it is because there was a lack of collaboration, design/planning process and information sharing among the key actors. Thus, the key professionals had no opportunity to participate within the project, to share their ideas and to find the best solution for the various challenges. Furthermore, these issues are linked closely to financial barriers such as lack of financial investment, and institutional barriers such as difference in perception. Consequently, even the professionals failed to have a clear agenda or confidence about the effectiveness of the strategies/technologies adopted. This perceptional barrier itself raises grave doubts over the success of the project.

(2) Economic barriers/constraints

• Lack of resources (e.g. financial investment, incentive, manpower, etc.) vs. making profits and increasing the quality of housing design

Although this project sought to increase the quality of the individual housing unit and housing estate this represented a challenging task. The developers, architects and planners still had to make profits from the development without financial subsidy and this economic condition constituted a fundamental barrier to increasing the quality of the design. For example, in order to secure a better quality living environment, the project needed to reduce the current level of housing density (i.e. about FSR 2.0- 3.0). But, the housing density (i.e. about FSR 2.5) in the Shinjung project was kept at a similar level to other current estates because the developers had to make a profit even at a minimum level. A senior researcher in one of the key housing research organisation in Korea argued that:

> It was impossible to achieve a high quality sustainable living environment in the Shinjung project from the beginning, because of the excessively high requirement...I think, any attempt for achieving sustainable housing estate development in Korea should have less than FSR 2.0.

There is a general belief that such a high level of housing density acted as one of the main negative factors for increasing the quantity and quality of the external open space.

Another interviewee highlighted the wider economic context as a key factor in the quality of the design process. He argued that:

> Regarding the worsening economic condition in Korea, architects and developers in Korea cannot afford enough time and money for conducting in-depth research about new technologies... Without governmental support, there is no way to achieve sustainable development by the developers and architects... Today, architects spend only about 2 months on a design. It is impossible to seek in-depth design and analysis, and so many ideas were adopted without detailed analysis.

These critics indicate that there needs to be a sufficient supply of resources in order to pursue sustainable development in Korea. This experience also indicated that the Korean Government should be involved much more actively and invest to a greater extent through subsidy, manpower, etc. especially in establishing an effective planning and design tool (i.e. providing design guidelines, goals, targets, indicators and benchmarks), testing new technologies and providing information.

(3) Institutional barriers/constraints

• Lack of integrated project management and information sharing

This barrier was commonly cited by the key players including architects, planners and developers who expressed frustration with the separated responsibility for project management and lack of information sharing throughout the development process. Building a housing estate is a highly complex process and requires an effective project management system. However, the responsibility of the project management in Shinjung project was highly separated. Although SMDC took total responsibility for the development process, there was a lack of integrated project management and information sharing between the various departments of the authorities.

In addition, there was no project coordinator who could control conflicts between departments and maintain the original idea of the project. Each stage of the development process (i.e. planning, designing and construction) was conducted by a different group of people without in-depth information sharing. Thus, original ideals set as design guidelines were ignored or changed in the process of implementation.

Perhaps, the failure of top-soil preservation is an example of this, where the original ideas for top-soil preservation were ignored by the developers.

In addition, there was a lack of cooperation and information sharing among the different organisations and agencies included such as SMDC, the developers and other government research centres. There was no coordinated attempt to examine or monitor the implementation process and achievements of the project.

• Current housing law/regulation

One senior academic interviewed argued that:

> There is a great limitation in current Korean housing regulation for pursuing sustainable neighbourhood design...Current housing regulations are so loose that they can not secure a high quality environment.

One of the factors mentioned in relation to this issue was the problem of poor regulation of distance between buildings. According to current housing regulation, the minimum distance between each building is 1.0H (H: building height). This minimum distance has been shortened over time by the changes in Apartment Construction Promotion Law and is now too narrow to provide adequate spacing to minimise overshadowing on the southern aspect. In fact, some housing units in the Shinjung project were located in an overshaded area, because of the project aiming to keep the minimum distance and place the majority of building in a south-easterly direction. These weak housing regulations need to be strengthened in order to secure a high quality built environment, maximise solar energy collection and improve penetration of natural light.

In addition, it seems necessary to establish a regulation to secure the efficiency of new technologies (e.g. water efficiency, energy efficiency, etc). Since there was no specific regulation for maintenance or a consistent monitoring process within the Shinjung project, the architects and developers could adopt many technologies without a detailed feasibility study or feed back plan, and consequently this caused great uncertainty for the future success of the project.

Furthermore, establishing a regulation for preventing the misuse of the name of environmentally friendly housing is necessary in order to promote sustainable neighbourhood design. Every new apartment project in Korea uses the term "environmentally friendly housing estate" as a marketing strategy, without in-depth practices for sustainable development. As things stand, there is no regulation to prevent or reward genuine developers by acknowledging their achievements through some merit or incentive system such as providing qualifications, tax reductions, etc.

In addition, guidelines for sustainable design need to be provided. In many aspects, changing old regulations and establishing new regulations should be achieved in advance in order to promote sustainable neighbourhood design. It seems that setting evaluation criteria and providing merits for good practice according to the results would be a good starting point to promote genuine attempts toward sustainable development.

(4) Implementation barriers/constraints

• Lack of design targets, indicators, benchmarks and monitoring processes

Seoul Metropolitan Development Corporation (SMDC) provided some very general goals for environmentally friendly housing estate development and a set of general design guidelines for the Shinjung project. These design guidelines were accepted as a form of compulsory regulation by the developers and architects in the Shinjung project. In this sense, the initiative represents a move toward sustainable development in the Korean housing industry, since most housing competitions in Korea have no detailed design guidelines for sustainable development. However, the goals and design guidelines were broad and there were no detailed targets, indicators or benchmarking for monitoring progress towards sustainability. Most of the innovative design strategies were simply adopted and left as decorative marketing tools without a detailed monitoring process or long-term feed back plan to promote future sustainable development.

It is suggested that Korea needs to pursue a long-term strategic approach by setting clear targets using indicators and benchmarking and monitoring progress in order to make real progress toward sustainable development. At the same time, it is necessary to identify the current statutes of environmental sustainability within normal projects in Korea. Individual private company cannot afford to do this type of long-term work in the context of typical 90s housing development in an environment of NIMBYism, social inequality, lack of natural resources, etc. Thus, it seems necessary for the government or regulatory agencies to adopt further strengthened regulation and strategic approaches in order to achieve the goals of sustainable neighbourhood development. Without government and developers pursuing a long-term strategic approach 'sustainable development' will be an unachievable goal and significant progress will never be made.

5. LESSONS AND CONCLUSION

This research then, aimed to suggest a sustainability evaluation framework and analyse the progress of sustainability of the Shinjung environmentally friendly housing estate development project using that framework.

As a result, the research suggests a sustainability evaluation framework with a total of 9 key issues, 23 goals and objectives of sustainable neighbourhood design and 25 sustainability indicators (see Table 2) and analyse their effectiveness by conducting a case study. The results of the case study suggest that the sustainability evaluation framework could be used as an effective planning and design tool for key actors including planners, architects and developers for monitoring or evaluating the sustainability progress of current projects. However, further in-depth quantitative and qualitative research is required to establish a set of sustainability indicators including quantitative and qualitative indicators which are much more easily measurable and understandable, require less time and financial investment.

Moreover, the results of the analysis suggest that the Shinjung project failed to make significant progress in the sustainability evaluation criteria compared to normal projects (see section 3.2 and 3.3: Analysis & Evaluation of the Project) and there exist significant barriers within current planning and design practices. A total of six barriers were identified and the lack of design targets, indicators, benchmarks and monitoring processes are the most significant barriers preventing progress towards sustainability. The other key barriers are lack of understanding, uncertainty about the effectiveness, lack of resources, lack of integrated project management & information sharing and current pro-business housing law/ regulation (see Section 4: Key barriers/constraints that emerged in the project). Because of these barriers, most of the innovative design strategies were simply adopted as cosmetic features for marketing without making significant progress towards sustainability.

In addition, the experience of the Shinjung project with its successes and failures provides several lessons for future sustainable neighbourhood design in Korea. Firstly, the experience indicates that it is necessary to establish clear concepts of sustainable development and educate lay people and professionals in what the term actually mean, and secondly, it showed that using design guidelines for environmentally friendly housing estate design is an effective tool for planners, developers and architects for securing environmental sustainability. It also demonstrated that design guidelines should include detailed design targets, indicators and benchmarks for monitoring progress of achievement in new innovative design ideas and technologies. Thirdly, the experiences illustrated that in-depth research into economic feasibility and long-term maintenance efficiency of innovative design ideas and new technologies should be undertaken in order to secure the long-term success of the project. Finally, the experience highlighted the need for the Korean central government to participate in these attempts through setting new housing law/regulation, design guidelines and financial support mechanism.

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