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Sustainable Environmental Housing

Case Studies in Lund and Hanoi

Author: Nguyen Viet Huong, Master of Architecture
Hanoi Architectural University, Vietnam
Email: toankts@hn.vnn.vn

Supervisors: Lars Reuterswärd, Professor of Architecture
& Maria Nyström, PhD of Architecture
School of Architecture, Lund University, Sweden
Tel: 46.46.2227277. Email: Lars.Reuterswärd@ark3.lth.se
sustainable environmental housing
# Table of contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abbreviations</td>
<td>4</td>
</tr>
<tr>
<td>Summary</td>
<td>5</td>
</tr>
<tr>
<td>Preamble</td>
<td>6</td>
</tr>
<tr>
<td>1. Introduction</td>
<td>7</td>
</tr>
<tr>
<td>1.1 Problem Definition</td>
<td>7</td>
</tr>
<tr>
<td>1.2 Socio-Economical Description of the Two Cities</td>
<td>7</td>
</tr>
<tr>
<td>2. Planning, Architecture and Environmental Problems</td>
<td>10</td>
</tr>
<tr>
<td>2.1 Urban Planning, Architecture and Environment</td>
<td>10</td>
</tr>
<tr>
<td>2.2 Analysing Environmental Problems in the Two Housing Areas -</td>
<td>13</td>
</tr>
<tr>
<td>Should future housing in hanoi have the same standard as that of</td>
<td>13</td>
</tr>
<tr>
<td>Bonifacius?</td>
<td>13</td>
</tr>
<tr>
<td>2.2.1 Low Density Increases Transportation and Reduces Agricultural</td>
<td>13</td>
</tr>
<tr>
<td>Land</td>
<td>14</td>
</tr>
<tr>
<td>2.2.2 Large Green Areas Make Housing More Attractive but Create Low</td>
<td>14</td>
</tr>
<tr>
<td>Density</td>
<td>15</td>
</tr>
<tr>
<td>2.2.3 Lack of Service Centres Reduces Attraction of Housing and Creates</td>
<td>15</td>
</tr>
<tr>
<td>Transport</td>
<td>17</td>
</tr>
<tr>
<td>2.2.4 Housing Architecture - Artistic Feeling in Human Life</td>
<td>17</td>
</tr>
<tr>
<td>2.2.5 Energy End-use</td>
<td>18</td>
</tr>
<tr>
<td>2.3 Environmental Impacts</td>
<td>20</td>
</tr>
<tr>
<td>2.3.1 Environmental Impacts from Transportation and Infrastructure</td>
<td>20</td>
</tr>
<tr>
<td>2.3.2 Lack of Green Areas Causes Environmental Pollution</td>
<td>21</td>
</tr>
<tr>
<td>2.3.3 Attraction of Housing Area and Social Environment</td>
<td>21</td>
</tr>
<tr>
<td>2.3.4 High Risk of Environmental Damage due to Energy End-use</td>
<td>22</td>
</tr>
<tr>
<td>Inefficiency</td>
<td>22</td>
</tr>
<tr>
<td>2.4 Current “Fixed-and-Failed” Solutions</td>
<td>24</td>
</tr>
<tr>
<td>2.4.1 High-rise Housing Project in Magretadal in Lund</td>
<td>24</td>
</tr>
<tr>
<td>2.4.2 Boring Housing for Rent and Sale in Hanoi</td>
<td>24</td>
</tr>
<tr>
<td>3. Solutions</td>
<td>24</td>
</tr>
<tr>
<td>3.1 Solutions for a Sustainable Housing Area in Sweden</td>
<td>24</td>
</tr>
<tr>
<td>3.1.1 More Dense</td>
<td>25</td>
</tr>
<tr>
<td>3.1.2 Creating Social, Human Contact</td>
<td>25</td>
</tr>
<tr>
<td>3.1.3 Reducing Transportation by Good Service System</td>
<td>26</td>
</tr>
<tr>
<td>3.1.4 More Attractive Architecture</td>
<td>26</td>
</tr>
<tr>
<td>3.1.5 Energy End-use Efficiency</td>
<td>26</td>
</tr>
<tr>
<td>3.2 Solutions for a Sustainable Housing Area in Hanoi</td>
<td>27</td>
</tr>
<tr>
<td>3.2.1 Density and more Green</td>
<td>27</td>
</tr>
<tr>
<td>3.2.2 Improving Quality of Housing</td>
<td>27</td>
</tr>
<tr>
<td>3.2.3 Reducing the Waste of Energy End-use</td>
<td>28</td>
</tr>
<tr>
<td>3.2.4 Bus Instead of Motorbike</td>
<td>28</td>
</tr>
<tr>
<td>4. Making Things Happen</td>
<td>29</td>
</tr>
<tr>
<td>4.1 In Lund</td>
<td>29</td>
</tr>
<tr>
<td>4.1.1 Actors Involved in Housing Construction</td>
<td>29</td>
</tr>
<tr>
<td>4.1.2 Long-term Environmental Consideration</td>
<td>29</td>
</tr>
<tr>
<td>4.1.3 Co-operation with Other Actors</td>
<td>30</td>
</tr>
<tr>
<td>4.1.4 Enhance Media, Education and Changing Human Behaviour</td>
<td>30</td>
</tr>
<tr>
<td>4.2 Making Things Happen in Hanoi</td>
<td>31</td>
</tr>
<tr>
<td>4.2.1 Actors Involved in Housing Construction</td>
<td>31</td>
</tr>
<tr>
<td>4.2.2 Long-term Environmental Consideration in Policy</td>
<td>31</td>
</tr>
<tr>
<td>4.2.3 Co-operation with Other Sector</td>
<td>32</td>
</tr>
<tr>
<td>4.2.4 Water and Electricity Management - Price Policy</td>
<td>32</td>
</tr>
<tr>
<td>4.2.5 Media, Education and Changing Human Behaviour</td>
<td>33</td>
</tr>
<tr>
<td>5. Opportunities and Barrier Analysis</td>
<td>33</td>
</tr>
<tr>
<td>5.1 Opportunity of the Country for a Good Housing Area</td>
<td>33</td>
</tr>
<tr>
<td>5.1.1 In Sweden</td>
<td>33</td>
</tr>
</tbody>
</table>
List of Tables, Figures and Photos

Table 1: Urban Population in Vietnam......................................................... 10
Table 2: Environmental Effects from Urban Planning and Architecture in Two Areas... 10
Figure 1: History of Human Settlement......................................................... 6
Figure 2: Causal Loops of Environmental Effects........................................... 13
Figure 3: Housing Construction Management Model in Lund............................. 29
Figure 4: Housing Construction Management Model in Hanoi........................... 31
Map 1: Map of Bonifacius:.............................................................................. 8
Map 2: Map of Thanh Cong............................................................................ 9
Photo 1: Bonifacius Housing Area.................................................................... 8
Photo 2: Thanh Cong Housing Area................................................................. 9
Photo 3: Children Play Ground in Bonifacius.................................................. 14
Photo 4: Shared Garden in Thanh Cong.......................................................... 14
Photo 5: Selling Things by Semi-mobile in the Streets..................................... 15
Photo 6: Small Local Shops in Thanh Cong.................................................... 15
Photo 7: Disorder in Architecture in Thanh Cong.......................................... 17
Photo 8: Main Entrance of the House in Bonifacius........................................ 17
Photo 9: Boring Architecture in Bonifacius..................................................... 18
Photo 10: Old Housing in Adelgatan in Lund. Photo: P.Andersson..................... 18
Summary

Housing is one basic need in human life. It is a place where people live and spend most of their life time. A good living environment includes good indoor environment, comfortable local service system and rich social life in a housing area. Architecture and planning of the housing area therefore would decide the quality of human living conditions. The physical or social problems in living conditions are environmental problems in housing areas. This study analyses two housing areas, Thanh Cong in Hanoi and Bonifacius in Lund. They are two examples of housing areas that have poor living conditions in physical and social aspects. Poor physical conditions in Hanoi housing area, such as bad indoor climate, lack of green area, etc. cause environmental pollution, and effect directly the local human health. The low density in Lund causes urban spread, which is addressed as the waste of land use, more transportation and more infrastructure. The poor social condition of boring architecture, and poor service system in housing area in Lund causes the cold feeling, by lacking social contact. The wasteful use of energy in the two housing areas by human behaviour causes environmental impacts.

Focused issues will be the density, green area, service system, public places, transportation, architecture and energy end-use including water use. Bonifacius is lower density compared to Thanh Cong. However the service system is better in Thanh Cong. Architecture is monotone and boring in Bonifacius but rather colourful and messy in Thanh Cong. Energy end-use and water use are wasteful in both areas in different ways. Car and motorbike use is popular in the both areas. The solution will repair the mistakes, orient in to environmental friendly. Implementation will mention the important key sectors and the method to achieve SD.

The report includes six parts. The introduction mentions the major environmental problems in the two housing areas causing unsustainable development. The second part analyses environmental problems in the two areas by comparing figures in terms of the density, green area, service centres, housing architecture and energy end-use. The environmental effects from current housing areas, and reference solutions are also addressed here. The solutions are proposed in the third part as to avoid the current mistakes and to exchange experiences. The fourth part will discuss the method to reach the solutions. Opportunities and barriers in implementation are introduced in the fifth part and the sixth part is reserved for the conclusion.

The report is a collaboration between architectural and environmental knowledge, between Orient and Western culture in analysing the quality of housing areas. Each country has its own culture characters that may not be suitable to another. However it is good to learn more experiences from the other culture.
Abbreviations

app.: Appendix
env.: environmental
fls: floors
ha: 10,000 $m^2$
GDP: Gross Domestic Product
HH: household
ITV: Interview
Lumes: Lund University Master Program of Environmental Science.
MARD: The Ministry of Agriculture and Rural Development.
$m^2/c$: square metres per capita
OECD: Organisation for Economic Co-operation and Development
SD: Sustainable Development
SEK: Swedish Crown
SIDA: Swedish International Co-operation Development Agency
TC: Thanh Cong
UN: United Nations
USA: United States of America
USD: USA Currency
Preamble

Originally, humans were living without clothes or houses. They had to face with hard climate conditions. With the time, humans have created a more comfortable life by developing clothing, and living in shelter. They took from the nature things that they could to build a shelter, like wood, stone, etc. Starting from a simple, to a much more complicated level today, people have reached comfortable living conditions. In order to fulfil their increasing demands, humans have come to destroy the nature, not only by extracting natural resources but also by releasing pollutants into the atmosphere. Housing construction consumes natural materials, agricultural land and energy. A house was used for many people to live in, a long time ago, but now is only for a couple of persons. This means that the number of dwellings is increasing. The fast development of the population also creates more housing need. More housing constructed means that more natural resources are consumed and more pollutants are emitted.

The type of human settlements also causes different environmental effects. Housing settled in urban USA has sometimes a very low density, so that the only way to reach another house is by car (Reuterswärd, 1998). In urban Asia, for example, people live so close to each other that they need only to walk for daily activities. Therefore the settlement style effects a lot the transportation needs. Transportation consumes natural resources, such as metal, oil, petroleum, etc. It requires a lot of infrastructure as roads, bridges and garages that also consume a lot of natural materials, agricultural land and cause barriers for the wild life. Transportation is addressed as the main cause of environmental pollution today.

The earliest humans lived together as a social group. Nowadays, humans are living separately in smaller groups as they feel safe and do not need help from others. At last, humans are becoming all alone. Do they really feel happier as to live alone?

Therefore, a sustainable housing area has to negotiate the limit of using natural resources, including materials, energy, and land, the increasing the density, the reduction of transportation demand and the provision of a warm atmosphere for the inhabitants.

Figure 1: History of Human Settlement
1. Introduction

1.1 Problem Definition

Housing has been addressed as a Human Right in the UN Habitat II Conference (June 1996). People in the world are facing different problems of housing. The problems in housing areas could be natural or social environmental types. In the material sense, the poor living condition of housing is popular, in developing countries like Vietnam. The shortage of green area, bad indoor climate, inefficient energy end-use, and a disordered architecture, have caused negative human health effects, and many environmental problems. In a developed country like Sweden, the shortage of housing is not a problem. The lack of social activities and boring architecture, as well as the poor spiritual environment in most housing areas in Sweden are problems of the social environment. A “cold feeling” in many housing areas and people feeling lonely, are common problems in Sweden. Many people are living alone in Sweden, for example, 40% of apartments have single owner (SOU 1996: 48). The big transportation need and the waste of energy and natural resources have caused natural environmental degradation. Although Sweden is considered as a country of good environmental quality, it is still not sustainable and needs to be improved. In the future, Vietnam should reach the high living standard as that of Sweden. However, the housing, life style and the energy consumption should be controlled right now to ensure a sustainable environmental development, in a country which has ten-time-higher population, but only \( \frac{3}{4} \) of the land area \((310,000 \text{ km}^2 \text{and } 450,000 \text{ km}^2)\).

Among many reasons that cause the present situation, the urban planning and housing architecture have a prominent influence on human life and environment. Having different socio-economic conditions, urban housing in Vietnam and Sweden will develop in different directions. However, there are lots to learn from each other. We could learn the positive, avoid the negative experiences, to achieve a sustainable development of urban housing.

SD of the environment including a SD of the society, nature and economy. The SD of natural resources will support the SD of the economy. The report therefore will orient housing areas toward a better society, reduce natural resource consumption and environmental pollution.

Aims: The report will try to indicate some solutions for housing development, in terms of sustainable environment and society in each city.

Methodology: By figuring out the environmental effects of each urban housing area in the two countries at present, the future can be predicted, if the present tendencies are continued. The system analysis by causal-loop diagram shows the relationships between current situation and environmental effects. Therefore the SD of the environment will be achieved by changing the current situation. The experiences from each country could be used to mitigate unsustainable developments.

Scope: The report focuses on two new housing areas, Bonifacius in Lund, Sweden and Thanh Cong in Hanoi, Vietnam. Planning and the architecture of the housing areas are analysed in terms of density and green areas, service centres, aesthetics of architecture and energy end-use issues. These effect factors on the environment will be shown in human, physical and spiritual (social) conditions of the residents. There are more issues in housing area such as waste, sewage system, etc. They are not discussed here due to the limitation of the report.

Limitation: The report will express an architectural viewpoint from Vietnam, in collaboration with the environmental knowledge obtained from the Lumes courses. The way of thinking that is influenced by Vietnamese culture and society may not fit to Swedish
culture and society. The human happiness may be different, due to different cultures. The proposed solutions, therefore, will only be references for each country in seeking its own real solutions.

**Key words:** housing area, density, green area, social contact, architecture and energy end-use.

1.2 Socio-economic Description of the Two Cities

Lund and Hanoi are quite different in size, culture and population, but they share the same function as a city of humans.

**Lund:**

Lund is a university city in the South of Sweden and has been named as the green city. The population is 95,000, many of which are students. The main economic activities are higher education, training and services. Some major high-tech industries as Tetra Park, Ericsson and Astra are also located there. The GDP per capita of Sweden has been one of the highest in the world for decades and is about 16,867 USD (Rapport 1993 2e). The social subsidies are very high. Children, elderly and unemployed people are supported by the government.

The demand for housing in Lund is increasing, following the increasing population. There have been problems of housing shortage in Lund in recent years. The Bonifacius housing area was built in 1995-1996 (ITV) in the response to the need for housing, and has a very good reputation among the local people.

*Map 1: Map of Bonifacius Housing Area (Folkeson, et.al., 1992)*

*Photo 1: Bonifacius Housing Area*
Hanoi:
Hanoi is the capital of Vietnam with a population of 3 million. The average housing floor area per person is 6-8 m². The economic activities include industry, agriculture, service, tourism and education, etc. The immigration into Hanoi is increasing very fast due to the economic development of the city, which leads to a high demand for housing. The GDP has been increasing since 1990 following the economic reform, and has reached the level of 1,430 USD/c in 1998 (National Statistic report, 1998). Most of the government subsidies have been cut since 1990.

Thanh Cong housing area was constructed in the 1990s. It has been considered as one of the best residential areas in Hanoi. The Thanh Cong lake was filled and divided into many plots. Each family is provided with one piece of land, having an area of 50-100 m², with infrastructure. The HHs design and build the houses by themselves.
2. Planning, Architecture and Environmental Problems

2.1 Urban Planning, Architecture and Environment

Environmental problems are experienced in the two housing areas in different ways.

Shortage of housing is a big problem in developing countries like Vietnam, when the urban population is increasing very fast. The city housing capacity is not developed sufficiently to match this need.

<table>
<thead>
<tr>
<th>Year</th>
<th>1965</th>
<th>1980</th>
<th>1995</th>
<th>2010</th>
<th>2025</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban population</td>
<td>5,107,000</td>
<td>10,327,000</td>
<td>15,327,000</td>
<td>26,580,000</td>
<td>45,669,000</td>
</tr>
</tbody>
</table>

*Table 1: Urban Population in Vietnam (Tannerfeldt, 1995)*

Not only the quantity is a problem, the quality of housing has a low standard. The bad insulation system causes a not-good condition of the indoor and outdoor environment.

Although the population of Lund is also increasing, and the housing demand is high, the average number of persons per apartment is still not high, only 2,1 persons per HH (Statistic..., 1997). The problem of housing is more about social type and the wasteful habit in human life. Boring housing areas, inefficient energy end-use and the habit of excessive use of private cars have been addressed as the main causes of environmental problems. Almost 40% of the annual cost of the environmental damage repair is related to impacts, mainly in climate, from the traffic and energy sectors (SOU 1996: 48). The residential areas have got only one function of living, but not any of social and cultural activities.

The following table will give some statistical figures of the two new housing areas in Hanoi and Lund. The aim is, firstly, to analyse the differences in environmental problems in each area. The second aim is to foresee the future result of the present westernised tendency in Vietnam.

<table>
<thead>
<tr>
<th>Factors</th>
<th>Bonificius Thanh Cong</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Construction year</td>
<td>Condominium (Bostadsrätt)</td>
</tr>
<tr>
<td>- Ownership type</td>
<td>Ready infrastructure (roads, sewage system, water and electricity supply net work)</td>
</tr>
<tr>
<td>- Infrastructure</td>
<td>Ready houses with basic appliances (electricity stove, refrigerator, ventilation, heater).</td>
</tr>
<tr>
<td>- Housing construction</td>
<td>Down payment and monthly rent</td>
</tr>
<tr>
<td>Rent</td>
<td>47.2 m²/c (app.)</td>
</tr>
<tr>
<td>The density</td>
<td>90 m²/c (app.)</td>
</tr>
<tr>
<td>- m²/c of housing</td>
<td>158.8 m²/c (app.)</td>
</tr>
<tr>
<td>Factors</td>
<td>Bonifacius</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Green area</strong></td>
<td>About 67.2 m²/c (app.). Surroundings have plenty of grass fields and trees.</td>
</tr>
<tr>
<td>- Trees along street</td>
<td>Trees are small, but growing</td>
</tr>
<tr>
<td>- Children play ground</td>
<td>About 2.8 m²/c (app.)</td>
</tr>
<tr>
<td>- Roads in the area</td>
<td>The roads are for walking and bicycling.</td>
</tr>
<tr>
<td>- Garage area Car port + Parking</td>
<td>0.6 car parking place /c &lt;br&gt;= 9 m²/c (app.)</td>
</tr>
<tr>
<td><strong>Conclusions</strong></td>
<td>Long distance transports, lack of social contact large infrastructure system, city spread</td>
</tr>
<tr>
<td>Environmental problems</td>
<td>Environmental pollution and consumption of natural resource</td>
</tr>
<tr>
<td><strong>Attractive housing</strong></td>
<td>People meet in private houses, talk with neighbours in the garden while gardening. A common house is opened in the evenings and at weekends.</td>
</tr>
<tr>
<td>- Public places (meeting places)</td>
<td>Food store is 1.5 km away (Matex or ICA Tuna), Local shop is ICA Tornet (400m).</td>
</tr>
<tr>
<td>- Daily service centres</td>
<td>Hair dressers, pubs, restaurants are in the centre (3.5 km away).</td>
</tr>
<tr>
<td>Conclusions</td>
<td>Poor local service system, poor neighbourhood relationship, good quality assurance of goods</td>
</tr>
<tr>
<td>Environmental problems</td>
<td>Boring society in residential areas, lonely and cold feeling.</td>
</tr>
<tr>
<td>- Housing architecture</td>
<td>The decoration is poor; non-welcome architecture, cold feeling; houses have the same colour and style.</td>
</tr>
<tr>
<td>Factors</td>
<td>Bonifacius</td>
</tr>
<tr>
<td>-------------------------</td>
<td>------------</td>
</tr>
<tr>
<td>Conclusions</td>
<td>Boring architecture, poor social life in the housing area, lack of service centres.</td>
</tr>
<tr>
<td>Environmental impacts</td>
<td>Boring social life for the residents</td>
</tr>
<tr>
<td><strong>Energy efficiency</strong></td>
<td></td>
</tr>
<tr>
<td>- Insulation system</td>
<td>2-3 glass-layered windows</td>
</tr>
<tr>
<td>- Energy conservation system</td>
<td>Walls and roofs have good insulation.</td>
</tr>
<tr>
<td>- Electrical appliances in HH</td>
<td>Central space heating system using natural gas, no cooling system</td>
</tr>
<tr>
<td>- The consumption of electricity</td>
<td>About 162 kWh/c/month (app.)</td>
</tr>
<tr>
<td>of water:</td>
<td>214 L/c/day(Lunds ..., 1997), hot and cold water; cold water is drinkable</td>
</tr>
<tr>
<td>of gas or petroleum</td>
<td>Natural gas for heating: 480 kWh/c/month (app.)</td>
</tr>
<tr>
<td>- Indoor climate condition</td>
<td>Warm in the winter 20 °C, cool in the summer 22 °C, weak natural light in some parts of the house (ground floor toilet)</td>
</tr>
<tr>
<td>- The cost of construction</td>
<td>1375 USD/m² (11,000 SEK, Rapport 1993: 2e)</td>
</tr>
<tr>
<td>Conclusions</td>
<td>Highly efficient insulation, good indoor climate, high energy consumption</td>
</tr>
<tr>
<td>Environmental problems</td>
<td>Wasteful use of energy, waste of natural resources</td>
</tr>
</tbody>
</table>

*Table 2: Environmental Effects from Urban Planning and Architecture in Two Housing Areas*
Following causal-loops show the relationship between the above factors. The causal-loop diagram is constructed following the Stella system analysis program. The arrows show the effect direction between factors. "+" means reinforcing effect when "-" shows the negative feedback. **SD of Environment** is the centre factor that is effected from other star factors, such as the density, green area, attractive architecture, energy end-use efficiency and other substitute factors.

![Causal-loop diagram](image)

**Figure 2: Causal-loops of Environmental Effects**

The analysis of environmental problems in the two housing areas (part 2.2) will focus on the relationships between: the density, green area and transportation, the attractive housing area and the architecture art, service system and meeting place (social life), good indoor climate, energy insulation, energy management, efficient appliances, energy end-use efficiency and between them.

The relationship between **SD of Environment** and transportation, attractive housing area and energy end-use efficiency will be introduced in the environmental impact (part 2.3).

**2.2 Analysing Environmental Problems in the Two Housing Areas**

Should future housing in Hanoi have the same standard as that of Bonifacius?

**2.2.1 Low Density Increases Transportation and Reduces Agricultural Land**

Bonifacius has a very much lower density compared to that of Thanh Cong. Although the average housing floor area per person in the two areas are almost the same, about 47 m²/c & 41 m²/c, the average land areas for housing and garden per person are quite different: 90 m²/c & 14 m²/c (table 2). In average, Bonifacius has about six times bigger size of land per person, not including the parking place. When parking place and carports are added, the land area per capita could be nine times larger: 159 m²/c & 17 m²/c (table 2) respectively. It creates big transportation and infrastructure demand due to long distant travel.

Each plot of land for one family in Thanh Cong has a limit of 50 m², because of the high density of the population and the limitation of available land. In order to provide enough
place for a family of 4-5 people, the house often has 3-4 floors. Living in such a house, people have to go up and down the 3-4 floors, which is not convenient, specially for the elderly and handicapped. However, if a house in Hanoi has only 1-2 floors as in Bonifacius, it will need at least 2 times bigger land area compared to the present. This would cause problems of agricultural land degradation.

2.2.2 Large Green Areas Make Housing Area More Attractive, but Create Low Density

Green area is necessary in human’s physical and spiritual life. It does not only supply oxygen, absorb CO2, provide a purification function for the living creation, but also give people's spirit a relaxation, peaceful, artistic and romantic feeling. The green colour from trees, flowers in grass, blue colour of water and sky, are nature gifts presented to human being. Green areas in Bonifacius are abundant and 100 times bigger than in Thanh Cong (67 m²/lec compared to 0.6 m²/lec, table 2). Bonifacius houses are surrounded by big gardens. The main green areas in Thanh Cong are small and shared, located between groups of houses in Thanh Cong. However, families here are always trying to plant trees everywhere, to make the area more green. They plant trees in balconies, along the fences and even on the facades and roofs. This somehow could give people a feeling of nature, and provide shadows for the houses and the inhabitants.

Children do not have a place to play in Thanh Cong, so they have to play in the streets, which is unsafe, while it is 2.8 m²/lec in Bonifacius (table 2).

The green areas in Bonifacius are large and good for living conditions. However, it creates the low density, which enhances the transport volumes. If new housing areas in Hanoi have the same green area as in Bonifacius, the land area must be extended five times more. Adding the parking place, it would be eight times more, which is unacceptable in Hanoi, because of the high population and shortage of land.

In the Bonifacius housing area, garages for families have only one floor, and take a large land surface in the housing area. It occupies about 5.8 % of total land area, and about 28 % of the total construction area (app.). Bus stop is nearby the housing area and it is rather convenient for the residents to use buses. However, the available parking place in Bonifacius has encouraged people to use private cars instead of public transport, which is better for the
environment. At present, only a small part of the families in Thanh Cong has private cars (2-3 %). At present, a lot of people are using motor-bikes for daily travel, causing busy traffic and pollution. In the future, if each Hanoi citizen has the same number of cars as Swedish, problems of city expansion and transportation will be huge, due to the big number of the population.

2.2.3 Lack of Service Centres Reduce Attraction of Housing Area and Create Transport Shopping Centre

Service centres of the two areas, are located at a distance, that seems very convenient for the residents. It is so close (about 1-3 km away) that people could reach on foot, or by bike. However, the local shops in Sweden are very expensive compared to far-away big stores. This leads to the preference of shopping by car. On the other side, Swedish families have a habit of buying food once per week, for which a car is needed for carrying the big amount of food and things. In a sense, it does not matter if the shop is close or not. In Vietnam, the food is bought fresh every day, on the way home, so that carrying by hand is not a problem. This shows that the way of shopping by car in Sweden is not sustainable, since it leads to the use of a lot of private cars, which causes main environmental problems. Supermarket creates demand for transportation by car while small local shops are convenient for walking, bicycling and carrying things home.

Street shopping is popular in Hanoi. On the way home, you can just stop on the street, buying some things, even through the shop windows or out side of the shops, without a need to come into the shops. Semi-mobile services will bring things to your door and ask you to buy some things. In this way, you even do not need to carry. Small local shops and market places are more sustainable in terms of reducing transportation needs.

From the social point of view, the way of shopping in big stores or supermarkets means a lack of human contact, compared to shopping in small shops and markets. The people going
to big stores come from different areas, which causes a difficulty of communication between them. People are only there to pick and pay, without a need to talk to anyone else. Talking and bargaining is the main activities in smaller shops and traditional markets, which create human contacts. In Thanh Cong area, the semi-mobile style of selling is very popular. These create job opportunities, better sale, and are more convenient for the buyer, since they reduce transportation and create interesting social activities in the housing area.

Local Service System
The demand for transport to the city will increase, when local service centres are not available in the area. These two housing areas have the same distance to the city centre. However, in Thanh Cong, you can find small pubs, restaurants, coffee shops, and get hair cut, or bike repaired, etc. There is no need to go to the city centre by car, bus or bike as you do in Lund. This does not only reduce transportation demand, but also provides for a convenient life for local people. It can also provide employment by doing small service jobs, and create a lively urban society in the housing area. Increasing local job opportunities have been addressed as one important aspect of sustainable development in Sweden (SOU 1996:48). The introduction of international culture will be optimal, when the foreigners living in the area could sell their food and products. Small shops or service places in housing areas always make people know each other better. When you take a walk to a local shop, you could meet and talk to a neighbour and even the seller, whom you know among a limited number of local people. During waiting in a barber-shop, you will not feel bored, when talking to someone that is your neighbour, instead of sitting between strangers.

Local service centres are therefore very important in social human life, which has been almost forgotten in the Bonifacius housing area.

Public place - Human Meeting Place
Although there is a public house in the Bonifacius that might sound very interesting, with big party room, kitchen and even sauna, only specific groups of people, such as children and the youth, like to come there, to drink or have parties. The elders think that it is too noisy. It is wrong to think that human spiritual life just needs eating, drinking, dancing and taking a sauna. What about other cultural demands that also are needed as reading, art creation, talking, exchanging culture? On the other hand, the house has no service staff. So if you want to have a party, you have to prepare all by yourself, which will take a lot of time. Further, these common activities will only take place at specific times, in-between you can not find anything there. Human meeting is most common in gardens in Bonifacius, when people are gardening. It is somehow nice, because you will have a lot of time working in the garden as not being alone. However, the number of people you meet is very few, and gardening is not a daily work, specially in the cold season.

Many activities are running in Hanoi streets that people can be involved in and communicate with. There are always semi-mobile vendors roaming, bike repair men sitting under tree shadows, etc. make streets more interesting. Everywhere in squares, in front of fountains and in streets, people are sitting, walking and talking days and nights in Rome. The attractive thing is not only the fountain itself, but also the atmosphere that welcomes people with a gathering feeling.

Weather is not the main reason preventing people going out and meeting others, but rather the lack of attractive outdoor public places. Swedish people often blame the cold weather for not going out very often. It is somehow true, because more people go out in the summer. However, not very far away, in Copenhagen, the city is always exciting and crowded of many people in the streets. When people join activities in exciting places, the weather does not really matter.
2.2.4 Housing Architecture - Artistic Feeling in Human Life

Disordered Architecture or Functional Architecture Render No Nice Feeling

The architecture of Thanh Cong, and of Bonifacius housing areas are different. In Thanh Cong, the decorations and the details are too many, and not harmonious, but they are too plain and monotone in Bonifacius. The beauty of a housing area is very important in creating an artistic sense for children growing up in the area. More decoration and multi-colour make housing area more interesting. However, houses in Thanh Cong have too much decoration and they are not balanced. Sometimes, the colours, styles of houses do not fit to each other in a street. This gives a messy and disordered feeling in Thanh Cong housing area. Bonifacius housing area, as well as most of housing area in Sweden, has a rather poor decoration. It shows only the function.

![Photo 7: Disordered Architecture in TC](image)

![Photo 8: Main Entrance of the House in Bonifacius](image)

The entrance of the house looks so closed and poor in decoration, that sometimes makes us wonder, whether it is the front or the back of the house! The doors and windows are small and plain, and give a non-welcoming feeling. Cold and boring feeling is dominant in the areas.

Lack of Land-marks, No Personal Identity in Bonifacius

All the houses have the same colour and style. This makes people have to look at the number to find a house instead of looking for any special signal or land-mark. It is not interesting to visit another house when you already visited one. “Equality” has been the standard for the Housing Regulation in Sweden. All the houses have to be the same and have the same standard. However, there are many ways to make an area look better. For example, old street in Lund looks harmonious even each house has a different colour, style and height.
2.2.5 Energy End-use in Housing

Energy end-use includes electricity use, heating system and water use due to its energy consumption in water pump stations and sewage water treatment plants. The large consumption of energy and water has been caused by management and price policy, human behaviour and housing design. Water resource in Sweden is not a problem, since it is abundant and clean in lakes. “The source of water supply however, are vulnerable and most of municipalities have no alternative plans for water supply, should ordinary sources fail” (SOU 1996:48).

Energy and Water Management and Price Policy

Weak management causes energy waste in Bonifacius. The families can only see the electricity and heating bill every third month, so that they can not monitor their daily use.

One of the main reasons of energy waste is, that the price of heating, water supply and even electricity is so low that people do not care enough about saving. The fee for electricity consumption is too low compared to the family income: 1-2 % (ITV). Interviewed people did not remember the fee and had to look at the bills. It is the same for heating gas. The water fee is fixed and included in the rent, for whatever quantity of water used, and the price is known as very cheap. This will not encourage people to save water and why Swedish people often use seven times as much water as Vietnamese people do.

High cost of energy in Vietnam forces most of HH to save energy. The electricity charge is very high compared to the family income (10-20 %). The progressive electricity fee encourages people to reduce the waste in daily life. The price is 0.3 SEK/ kWh for the first 100 kWh per month. The price is higher for additional use, for example 0.5 and 0.7 SEK/ kWh for more than 100 kWh and 150 kWh per month respectively. Even though, the price of electricity is partly subsidised (for the losses), and still low compared to the environmental degradation cost. This price needs to be higher when GDP is increased.

Price of electricity and water do not reflect environmental damage cost. The price of water does not include the environmental damages cost, but only the cost of filtering, sewage water treatment, and the net work. The cost of electricity does also only include generation cost and transferring cost. As we know, 50 % of the electricity production in Sweden is from nuclear power, which is of high risk. If this amount of energy will be generated from other renewable resources, such as wind power or hydropower, it still could cause other
environmental problems. In Vietnam the water resource is limited and the energy supply depends on coal power which cause environmental pollution. The cost of environmental damage will be paid heavily by future generations, if this generation does not pay.

Behaviour of wasteful use
Although the living condition of families in Bonifacius is of a very high standard, the insulation system is so efficient that the energy consumption is not that high. However, energy consumption is still high compared to Thanh Cong household’s. Bonifacius residents consume almost three times the amount of electricity (in almost the same average housing floor area), approximately. Heating is by natural gas in Bonifacius. Air conditioners and fans are used by electricity in Thanh Cong. In other housing areas in Lund, when electricity is used for heating, this amount is much higher. The losses are very low due to a good insulation system and high-efficient appliances. Therefore the main problem of energy waste is due to the user’s behaviour. Energy in Bonifacius is used for too many appliances such as heating, cooking, washing, dish-washing, oven and food storage in refrigerators, etc. Water consumption for daily life per capita in Bonifacius is seven times higher compared to Thanh Cong.

The way of buying food once per week requires big refrigerators, that also demands big energy consumption. Even though the climate is very cold in Sweden and very hot in Vietnam, the Swedish refrigerator’s capacity is always more than the double, compared to Vietnam.

Inefficient Energy Use in Housing Design
The heating system in Bonifacius is using natural gas, and every house has a meter. Therefore it is potentially efficient for saving energy. However, there is a mistake in the heating system in the house. Heating system in this housing area is put in the floor and in the ceiling between the floors, which do not have any insulation. This makes the heat not only warm the second floor but also the first floor, and it becomes too hot in the house. People have to open the window to release some heat (Jönsson, 1998).

It is waste of energy when water use in kitchen, toilet and bath is drinkable in Sweden. The water for all purposes is supplied in the same network. The quantity of clean (drinkable) water is be higher than its really needed. Because some types of water, such as toilet water, can be taken directly from the lakes without filtering. Demand of energy consumption in water supply station therefore is higher, meaning a waste.

Energy end-use efficiency and indoor environment of housing have a two-way relationship (LCHS, 1993). In Thanh Cong housing, the main problem of energy waste is bad insulation, natural lighting and ventilation. Bad insulation causes the waste of energy from electricity appliances. The use of air conditioners and electrical heaters need a good insulation system in walls, roofs, doors and windows. In order to improve indoor climate in the house, a lot of electrical appliances are needed. Good natural lighting in the house could reduce energy for lighting in the day time, but many houses in Thanh Cong have bad natural lighting. Window on one side of the house can not provide enough natural ventilation, that could creates natural cool wind coming into the house and reduces the use of air conditioners and fans. The use of unsuitable materials, such as large-size and one-layer glass windows causes heat in the house and thus induces more use of fans and air conditioning. The highly efficient technologies and materials are not being applied because of their high cost.
2.3 Environmental Impacts

The main global environmental problems as global warming, acid rain, ozone depletion and natural degradation are also caused by human way of living and using energy.

2.3.1 Environmental Impacts from Transportation and Infrastructure

Air Pollution Emission From Transportation Affects Human Health and Climate Change. The primary pollutant as NO and unburned hydrocarbons (HC) are emitted from motor vehicles and have a large percentage in total emission in OECD: NOx: 60%; HC: 50% (Hansson, 1998). In the present of sunlight, the Tropospheric ozone, PANs and NO2 are formed. When Tropospheric ozone and PAN reach high levels, they can cause harmful effects on the human health, such as lung destruction, respiratory track, eyes irritation, and on plants by cutting the rate of photosynthesis (leaf damage) (Jackson & Jackson). The level of Tropospheric ozone in Skåne was measured in May 1996 had almost reached the dangerous limit for human and vegetation (Warfvinge, 1997). “Air monitoring along main traffic lines in Hanoi has shown that the permissible concentration of CO, NO, Pb, and particles was exceeded” (Sweco, 1993).

There is a close link between photochemical smog and acid rain (Jackson & Jackson). Acid rain causes impacts on terrestrial water bodies, fishes, vegetation and building. SO2 emission from transport causes 4% among total SO2 emission in OECD. It also causes acid rain problems in Sweden.

VOC (Volatile Organic Compounds) emission from transport also contribute to the formation of oxidants in the atmosphere, which is the source of Tropospheric ozone (Hansson, 1997). The Tropospheric ozone is increasing and eventually immigrating into the stratosphere, where some of it is converted to nitric oxide (NO). This enhances the destruction of the Stratospheric ozone, that causes serious environmental problems. Stratospheric ozone absorbs UV-B that can damage a number of biological systems including DNA. Decrease in productivity of plants will adversely effect organisms further up the food chain. Human health effects, such as eyes and skin cancer, malaria, etc., are connected to the UV-B level (Jackson & Jackson). The loss of Stratospheric ozone is implicated for the global warming, that causes a lot of environmental impacts, such as the increasing of sea water level, desertification, reducing number of species, etc.

CO emission from transport contributes some 80% of total ground-based sources. It combines readily with free hydroxyl (OH) radical in the atmosphere. OH radical is important actor in reducing methane level in atmosphere, by combining with it. When OH in the atmosphere is sunk due to high level of CO emission, methane is increasing. Methane is Greenhouse gases that cause global warming.

Emission of CO2 in Skåne is 40% from transport (Holden, 1998). CO2 is main contributor for greenhouse effect, causing 50% of global warming potential (Robertson, 1990).

Noise Pollution, High Risk of Accident and Nature Barriers by Infrastructure

Transportation also causes noise pollution for housing area, which located close to the highways. Human life is scared by the risk from traffic accidents. One death every day by traffic accident is high rate in Sweden. Many accidents in Hanoi are caused by busy traffic. Infrastructure, such as highway, creates barriers for animal (natural wild life) and people, who walk or bicycle. It is obvious that the present modern infrastructure is built for cars, not humans nor animals. It is not safe for children to go alone in busy traffic streets.
Natural Resources Degradation Caused by Transportation, Car Producing and Infrastructure Construction Process

Transportation consumes a huge amount of natural resources. Energy, such as fossil fuel and natural gas can be extracted directly from the nature, but also electric energy that is produced from coal, biomass, hydro, wind, etc. Transportation accounts for about 21% of all energy demand among OECD countries (Jackson & Jackson).

Transportation means and infrastructure industry cause air pollution and natural degradation from manufacturing process. A huge amount of metal is used in producing cars. Rocks, concrete, steel, etc., are used in producing roads and bridges. Mining industry that provides these materials create environmental impacts, as land erosion, deforestation. Polluted gases, such as SO$_2$ and CO$_2$, dust, are released into the environment from the manufacturing process. Painting and plating process also discharges polluted water streams through public sewage system from the factories.

Agricultural Land Degradation Due to Urban Expansion

The more urban expansion, the less agricultural land is left. Housing and infrastructure quantity are increasing very fast, to supply for high demand of housing in Hanoi, due to its big population. In Vietnam, agricultural land is degraded about 2000 ha every year for other purposes including housing construction (MARD, 1998). This threatens the food security in the country and in some other countries, when Vietnam is ranked the second in the rice export in the world.

2.3.2 Lack of Green Areas in Housing Area Causes Environmental Pollution

Bad Effects in Climate and Human Health

When the green area is too little in a housing area, its function for air cleaning is very poor and the pollution level will be increased. Trees absorb CO$_2$ and provide O$_2$. The O$_2$ level in the air needed for life of all creations decreases due to the decreasing number of trees in the area. The CO$_2$ level released from humans, animals and burning processes is also increased when the absorbing function from trees is limited. CO$_2$ is the main greenhouse gas that causes global climate change. This has been causing respiratory difficulties and health problems for urban citizens. Noise and dust from traffic, that could be absorbed by trees, will be increased in poor-green housing areas. When the green area is limited, the reflection of noise between concrete walls of houses is increased. The tree shadows, which are wonderful places for people to hide from the sun light in hot seasons, are reduced in Hanoi, due to urban development. The function of climate and humidity balancing for the area, is therefore limited. Trees in housing areas could prevent the strong and cold wind in the winter for housing in Sweden.

The Effects from Lack of Nature on Human Spiritual Life

A green area is a place where people enjoy the nature. All the beauties of nature as beautiful flowers, green trees and grasses, water surfaces, bird’s songs, etc., are lost during the urban development. Humans are now isolated from the nature. All the human sensitive and romantic feelings will not exist any more when the life is lacking the nature. No poem nor song could give a nice feeling without the presence of the nature in it. Humans will feel sorry, unhappy, and may have a cold and hard spiritual life then.

2.3.3 Attraction of Housing Area and Social Environment

Human happiness presents the quality of society or social environment.

Boring Architecture Puts Stresses on Human Life
Housing architecture is boring in Bonifacius as well as in most housing areas in Sweden. The influence on the development of an artistic sense in the residents, specially in the children's soul, will be very limited, when this kind of functionalism is enforced. It may make the children develop a cold, hard and rude character. Although families make a lot of efforts to decorate inside their houses, the outside environment has it own effects. Every person in the area must feel very equal, quiet and peaceful, but sometimes lonely people will not feel good. The suicide rate that is high in Sweden may have the root from the too quiet atmosphere in the housing areas.

*Impact from Disordered Architecture in Thanh Cong*

Housing architecture in Thanh Cong is messy, because the decoration and architectural styles are not unified in the streets. This does not give a peaceful but rather disturbing feeling. It gives stress for residents, who come back from a busy working day, and passer-by. It is too much information on a small spot in Hanoi. This also could make people confused and lose the identity of an address. The beauty of city is reduced. Bad architectural art could effect the art level of people’s cultural knowledge and children's education.

*Lack of Social Contact Makes Residents Feel Lonely*

Humans have been born to live together from the beginning. Is not a nature to be alone, and life will be very much harder in material and spiritual needs. That is why people had lived close together to help each other, shared happiness and solved problems together. It is very common life style in a poor society. Nowadays, human's demand of meeting other seems to be reduced when they have all material things around them. They forgot, that it accounts only half of the human life demand. Another half of the mental need, such as social and human contacts, is lacking. Most people have a very closed life. They dare not share and show their feelings. Everybody has a private world that other people are not allowed to disturb or even to know anything. People have everything, but they are very lonely at the same time. When 40 % of HH are single owners in Sweden, the number of lonely people is not small. These people do not want to disturb the neighbour's life. Where should they go to meet people? The only way to meet people is go to a pub to drink, and the drunk people may not be the people you want to talk to.

*Lack of Activities in Housing Area Causes a Boring Outdoor Atmosphere*

Most of the housing areas in Sweden look so empty all the time. There are no meeting places, such as a local pub, small local restaurant, sport centre, small library or a small market, where all kinds of people could enjoy. The local common house in Bonifacius is often for people who like a party, not for all. Going to the theatre or cinema is expensive if you do very often. Many people come back home from work, just stay home and watch TV.

**2.3.4 High Risk of Environmental Damage Due to Energy End-use Inefficiency**

Energy inefficiency and wasteful use of water will require higher supply. More energy and water supply mean, that more natural resources will be consumed in the production process, thus causing more risk of pollution and natural resource degradation.

*Risk in Nuclear Power and Alternative Energy Resources in Sweden*

Although the energy efficiency in Sweden is high, the present energy resources are not sustainable. Swedish electricity production emanates from hydropower (50%) and nuclear power (50%). The risk from nuclear power plant accident will cause a disaster for human and environment. The radiation waste that is stored may leaks into the environment and will also effect human health and environment. The radiation material will one day be exhausted and leave nothing for the next generations. If the nuclear energy in Sweden in the future is switched into hydropower and wind power, the environmental degradation is not eliminated. Hydropower, which is known as a renewable resource, also causes environmental...
degradation around the hydropower station and down stream. Hydropower station construction consumes a lot of energy and natural materials. A huge amount of soil and forests is taken away which causes land erosion and deforestation. It is the same with wind power, because the number of windmills will be considerable, and that will change the landscape, and it also consumes energy and natural resources due to its manufacturing, etc.

Sweden has very rich hydro, wind and biomass resources in the northern areas, forests and along the coast. They would be the solution for sustainable energy system. However it may be better to save energy by higher efficiency, than to face other risks by developing alternative energy sources.

Waste of Water Means Waste of Natural Resources and Energy
Water in Sweden is abundant and very clean. However, the waste of water will put a high cost and wasteful energy in sewage treatment stations. Sewage treatment plants therefore have to work with higher capacity, means consume more oil, electricity and labour. This means more energy and natural resources are consumed.

Clean water resource is in scarce in Vietnam, by over-extraction. Underground water is the main resource and is limited. The ground water level is sinking, which is unsustainable. Although there is a lack of water in the city, people still waste a lot, because of bad management and low cost. The old and damaged network causes the wasteful consumption and bad hygienic conditions, that effect the human health. The waste of water puts more impacts on the water supply industry, on energy and natural resources.

Environmental Pollution from Coal Generators in Vietnam
The poor economic condition does not allow energy suppliers to afford an expensive and highly efficient energy technology. The customers also can not afford expensive energy bills. In order to reduce the cost, the producers have to find a cheap system, that often is not environmentally friendly. Hydropower is considered as a cheap energy source, but the initial cost is very high. The Vietnamese government can only afford to build some hydropower stations by international loans. Beside hydropower, coal power generators are popular for electricity supply, due to their low cost and because coal is abundant in the country.

Coal generators create air pollution, that causes health effect for local people and the global climate. Coal generators release CO, NOx, SO2 pollutants when burning coal (Morovic & Tuschy, 1996). These pollutants could cause air pollution, global warming and acid rain, that is harmful for human and environment. For example a residential area in Vietnam has been polluted from the Ninh Binh Coal Power Generator. Coal power stations cause natural resource degradation from coal consumption, transportation, etc.

The coal mining industry itself creates environmental degradation and consumes natural resources as petroleum for transportation, infrastructure construction, deforestation and land erosion, etc. During the mining process, methane (greenhouse gas) is emitted into atmosphere and contributes to global climate change (Morovic & Tuschy, et.al.,1996). The mining could also pollute ground water by releasing the heavy metal and pollutant compounds in to the ground water. The hazardous gases in the mines and accident from coal mining cause health risk to miners.

Air-conditioners and the Environment
The use of air conditioners in housing could effect the local climate. The number of air-conditioner used is increasing in Hanoi. Air-conditioners cool indoor climate, but also release heat into the outdoor atmosphere. This causes the very fast increasing local
temperature. The phenomenon of the “heat islands” that is popular in Bangkok at present could be an experience for Hanoi in the future.

2.4 Current “Fixed-and-Failed” Solution for Urban Housing

In order to reduce the urban expansion, which means to reduce the transportation and infrastructure, both cities are trying to achieve a higher density for housing areas. However environmental problems are not eliminated.

2.4.1 High-rise Housing Project in Margretadal in Lund

An example is the case of Margretadal housing project, where 5-10 floor buildings are supposed to be built in 3-5 years (Reuterswärd, 1998).

Apartments in multi-storeyed housing, which were built in the “One Million Apartments Project” in 1960s in Sweden, are not welcome any more. The reason can be the low standard, as the rooms are small. High-rise buildings are not attractive places to live today. The social impact on people living in high-rise buildings has been the barrier between people and people, people and nature. Children find it difficult to reach the ground, where they can get into contact with the nature and friends. Their parents have difficulties in taking care of them, from their apartment at the tenth floor, of course. The apartments in Margretadal may have a high standard. However they are still in a high-rise compound. It is not a good solution to repeat the mistake again.

Further more, people who living in high-rise buildings, where they can not reach the nature easily, tend to seek recreation in the nature far from cities. They might very often go out to the natural landscapes by car at the weekends. This means, that problems of transportation reduction are not really solved this way.

2.4.2 Boring Housing Area for Rent and Sale in Hanoi

In the case of large population and limitation of urban land, multi-floor housing is thought of as the only solution in Hanoi. A high-rise housing (16 floors) project has been set up in Tran Song Hong in Hanoi. High-rise housing will give almost the same effects in Hanoi as in Margretadal. It will give even more stress for the resident in Hanoi, because the living standard is low, and people do not have car to go out to the nature.

New Linh Dam lake housing area in Hanoi, is built for sale. It has a boring architecture, when all apartments look more or less the same. They are 3-storeyed row houses having two walls shared and the front and back opened with doors and windows. The ventilation and natural light are therefore good. The houses are built with brick walls and concrete roof. The rest is supposed to be completed by the households, according to their choice of colour and decoration, when they move in. It seems nice. However, the design of facade and plan of the houses is plain and very similar. It just shows the function, no detail decoration, which causes the boring architecture. The price of the house is rather high. The people, who can afford that much money, will not choose a home that does not look good. The result is that the houses are difficult to sell. Some apartments have been empty for years. It causes a waste of natural resource, money and energy.

3. Solution

3.1 Solution for a Sustainable Housing Area in Sweden

A sustainable urban housing area in Lund can be outlined to fix the failure of the current situation. Some of the solutions could be learned from the experiences of Thanh Cong housing area.
Sustainable housing definition: More dense but not high-rise housing, rich social life and human contact, more local service centres, less car and more public transport, highly efficient energy end-use.

3.1.1 More Dense
Housing in Sweden should be dense, at least as in Bonifacius, and even more. The area of garages should be reduced by multi-story garages instead of one storey as at present. The number of car parking places also needs to be reduced to encourage people sharing a car or using public transport. Green areas could be smaller because the surrounding is plenty of grass fields. The housing could be more dense with three floors instead of two, but should not be higher than that to maintain a convenient and a close social life.

3.1.2 Creating Social Human Contact
Service Centres in Housing Area
In Hanoi, the small service centres in housing area do not only provide a convenient life but a lively atmosphere in the housing area. It creates more social activities, more human contacts in the housing area. Service centres such as small shops, cafés, restaurants, bars, etc. should be available in the Swedish housing areas. These services could be carried out by unemployed people in the area. For example some people could bake some bread and sell in the local market, another can act as a local tailor in his home or in the common house. This will provide a more convenient life for the citizens, reduce transport to the centre or to big shopping stores. It also creates social contacts between people in the housing area. Local shops could make “streets as public space, not only as stretches of transport” (SOU 1996: 48). Local small shops should receive rental subsidy, in order to provide goods with competitive prices. Unemployment could therefore be reduced significantly.

Meeting-place is Available in the Housing Area
The common building in Bonifacius is a good example of creating meeting place for the local people. However, a meeting place is not only a place where people come to enjoy a party. It can also provide for shared daily house work, as in a washing room. The shared washing room is one of the places that already exist in many housing areas in Sweden such as Djingis Khan, but not in the new housing area of Bonifacius. If a shared washing room had been built in Bonifacius, 10 or 20 laundry machines has replaced for 115 individually owned ones. It could help to save a lot of space in the house, avoiding the noise and saving money for HH. It would also be good for the environment by reducing natural resource consumption in washing machine manufacturing process.

A library for local people could be opened for people to come, read, and also meet others at the weekends, or whenever they do not want to go to city libraries in bad weathers. Small self service cafés and restaurants in the housing area could be opened. People could come and enjoy different kinds of food, specially the food of foreigners living in the area. This could help local people to become closer neighbours and develop a richer cultural life. The foreigners living in the area will feel warmer in the Swedish society.

Attractive Outdoor Public Places
In a housing area, a small and beautiful fountain with seats, a small pond with swimming ducks would very much attract people to come for a while in their free time in the day. Some beautiful lights are turned on when the sun is set. Coloured water fountain in the pond is started to work. This would be a wonderful sight and meeting place for the residents. Local children can come and skate in the winter when the water is frozen.
A sport place such as a small hill could attract people to come and climb up and down, take a seat in a little house at the top and see around. Children can come and ski in the winter, etc. There are many ways to create a public outdoor place that is suitable with Swedish society. Small courtyard is a social space for housing areas. The small courtyard in Bonifacius is a very nice place. It is a public area. It creates a safe place for small children to play and the parents could see them from their homes. It also is a place for people to come and meet. This should continue to be applied in other new housing areas in Sweden.

3.1.3 Reducing Transportation by Good Service System
Although private cars in Sweden have a good standard, the amount of km travel by car and the number of cars in the country is so high, that the total pollution is still high. New housing areas should consider the ways to reduce the use of private cars and encourage people to use public transport.

As we known, one of the main reasons of using cars is weekly food shopping. Consider if Swedish people are willing to buy food every second day, and the shop is very close. It would not take much time, because they do not have to travel by car, nor do have to wait long time in cue when everyone buys less food. If Swedish people want to keep a habit of shopping weekly, there is a solution for shopping by bike or bus with a carrier. The carrier is similar to one that you often use to carry things inside a supermarket or food store. It could have some improvement such as rain coast cover, made by light material. It could be able to folded into very small shape to be carried easily by bike or hand. This carrier could be pulled by hand when walking, or able to be connected to the back of a bicycle.

Car Pooling and Limitting Parking Place
Bonificius HH has in average 1.3 car parking lots, and most people have a car. If people are willing to share a car, or accept one more neighbour in their car, when they go the same way, the number of cars would be reduced. Car pooling will save land by reducing parking place. Reducing the number of cars in the city will reduce traffic congestion, fuel consumption and pollution. Limit parking place for cars in the housing area, and a higher price for parking, would encourage people to share car or use public transport instead of having a car.

3.1.4 More Attractive Architecture
More Decoration and Colour
Housing in Thanh Cong may have too many colours and details. However, it creates the exciting housing area. Housing in Sweden should have more decoration on the facades, on the doors and windows. All the houses should not look the same, but each one has individual identity, and at the same time has the same main character. They may have some differences in detail and colour, but fit together in a total view.

Multi-style of Housing Plan
The houses should have different plans. Each person has different personal habit, so that their idea of how a housing plan looks like should be different. For example, some interviewed people are satisfied with the house, while some others think that the kitchen is rather small. In order to let people decide how the plan of the house should be, a house should not be completed when it is sold. After buying the house, the HHs could ask the construction company to arrange the walls between rooms in the apartment, in a suitable way, according to their idea.

3.1.5 End-use Energy Efficiency
Saving Energy in Daily Activities at Household Level
As analysed above, the main reason for big energy consumption is the human behaviour in the daily life. People should change their behaviour to save energy. A lot of things could help
to reduce energy waste in daily life. Turn off the light, the radio and TV when not in use, turn the heat at low levels, try to do some work by hand instead of machines. The habit of buying a lot of food that need to be stored in big refrigerators should be changed. HH should also be encouraged to choose highly efficient electrical appliances.

*High Efficiency in Housing Construction*
Most of the houses in Sweden are designed for highly efficient energy conservation, because of good insulation. The electrical appliances should be highly energy efficient. In order to encourage people to save energy, refrigerator should be smaller, at least in smaller apartments.

3.2 Solution for Sustainable Housing Area in Hanoi

There are a lot to learn from Swedish experiences of housing to void the failure and apply the success. Vietnamese should avoid the high energy consumption, high use of car as of Swedish. Motorbike is very popular in Hanoi, nevertheless it should be switched into bus transport. Housing areas should not be of low density, but have more green areas. Housing architecture should not be plain and also have good indoor climate as Swedish houses. The public service as washing room, common room is a good example of energy efficiency for Hanoi housing areas.

Sustainable housing in Hanoi should mean: *Density but more green areas, high quality indoor climate (indoor environment), high energy end-use efficiency*

3.2.1 Density and More Green
Housing in Hanoi should keep the height of 3-4 floors, and have more green areas. Some apartments should be located in the second and third floor. Because if everybody wants to stay on ground floor, the land will never be enough for everyone, as Hanoi territory is very small compared to its population. However housing should not be higher than three floors to guarantee a convenient life for children, elderly, and the handicapped. The houses are not allowed to cover all the land area, but to leave a small home garden, inside (courtyard) or outside such as 20% land area, for example. The gardens in Thanh Cong at present have just the function of a nice place with some trees on it. They should be converted into parks where children can play and people could come to sit under the shadow of the trees.

3.2.2 Improving Quality of the House
*Improving the Indoor Climate by Using Natural Ventilation and Lighting*
Architects and HHs should realise that natural light and ventilation are not only saving energy, but also give citizens a more healthy indoor climate. Housing in Hanoi should be improved in quality of the indoor climate. It is very hot in the summer and very cold in the winter inside the houses. Natural ventilation is very important to create wind, providing a cooler feeling in the summer for people living in the house. Windows should be located in the front and back to facilitate the natural ventilation. There is a need to create shadow for the house by using wooden ventilation windows, growing trees next to the house, on balconies and even on the roof.

*Improving Insulation System*
At present, very few HH in Hanoi use heaters in the winter even when the temperature can drop down to 5 - 10 °C in combination with a high humidity. In the near future, a lot of people will use heaters and more people will have air conditioners. In order to use air conditioner and heater in an efficient way, the house must be very tight to avoid the leakage of cool air and heat. This means good insulation materials should be applied in the roof,
windows, walls and doors to reduce the losses of heat and cool from the indoor climate to outside. It could reduce environmental effects from using too much electricity.

Building Material
The building materials must be selected carefully and used in the right way, to reach a good indoor climate and reduce the dependency on electrical appliances. Traditional material such as bamboo, leaves, clay, etc. should be used in an efficient way.

Improving Architecture
Architecture of a housing area should reflect the culture and suit the climate character. The modern box with a large-size glass facade, which is not suitable to Vietnamese housing in terms of both the culture and climate, should not be applied. When local climate is highly humid and there is lots of rain, the sloping roof is more suitable as it releases water quickly and avoids the mould on the walls and the roofs.

The houses that are designed separately should be controlled to be aesthetically fit together, including style, painting, colour and height. One individual house should not have too much decorative style, otherwise all streets will look very messy and disorderly, as in the case of Thanh Cong housing area.

3.2.3 Reduce the Waste of Energy End-use
Energy End-use Efficiency by Better Indoor Environment.
The improvement of indoor climate is one way of reaching energy efficiency. When housing is providing a better climate by insulation and natural ventilation, the energy consumption for appliances will be reduced.

Efficient Appliances and the Energy Price
Efficient energy appliances could provide a better indoor climate with at least the same energy amount. Electrical appliances in Vietnam often have low efficiency, because the highly efficient ones are expensive and most of people could not afford to buy them. However the electricity price is high, so people are considering the efficiency. If the price is higher and including environmental cost, people will be willing to pay for high energy efficient appliances.

Common washing room is a good example from the Swedish housing area. It helps to reduce energy consumption, saves money and material resources. This should be applied in housing areas in Hanoi. The way of using may be different when not all people have good operation and maintenance knowledge. Some unemployment people should be in charge of doing washing for a group of HHs and earn some money from this service they offer. The fee for washing should be very cheap to encourage people using it. The machines are bought by HHs who use them.

Reduce the wasteful use of water
Although water is cheap, HH should be aware that it is an unsustainable resource in Hanoi. The more they waste, the higher price for the environmental damage repair and the water treatment will be. A suitable price and meters of water supply must be set up in Hanoi.

3.2.4 Bus Instead of Motorbike
Bus stops in housing area could encourage people to use buses for daily travel instead of motorbikes. When people use buses instead of motorbikes, the space for motorbike parking in the house could be saved for living function. The traffic congestion and air pollution, noise, accidents will be reduced in the city.
4. Making Things Happen

4.1 In Lund

4.1.1 Actors Involved in Housing Construction

In order to implement a sustainable environmental housing development, we have to find the actors involved and the relationship. Housing management model shows the important level of actors involved in a housing project. Look at the figure, the key actors here are the City Municipality and the Construction Company, then Architect also does the detail work. The capacity and standard are decided mainly by the City Municipality and the Construction Company to make sure that the housing project is profitable, after considering the state financial subsidy resource. An architect will be in charge of architectural style under the specified standards. HHs are almost not involved in the style and standard of housing where they will spend all their life. There is one small choice for the HH in interior decoration, such as wall and floor colour in Bonifaci housing area (ITV). There are some complaints about the kitchen size and the living room door. If the HHs could have been involved in the housing design, these problems would not have occurred.

4.1.2 Long-term Environmental Consideration in Decision Making

Housing standard in Bonifaci is quite good in terms of the area, number of floors and green. The problem here is the lack of service centres and boring social life in the housing area. Municipalities should consider public activities as apart of the housing area. A housing area should give a complex social life for the residents. The service centres and service systems must be applied and organised to give the citizen a richer social and cultural life in Swedish housing areas.

Other recommendations for the decision makers, in setting standard for environmentally friendly housing area can be addressed as to reduce car parking places and higher rents, smaller green areas to increase the density.

Architects also have to change the way of thinking that all the houses must look the same in the housing area and give HH a chance to involve themselves in the housing design. Architects should design a housing area with more colours and styles but still keep the main idea and characters. This could help to improve the liveliness of the housing area and the richness of artistic feeling. HHs should be one of the main actors in deciding how their house should be, because they are people who will spend their life there. The house should be very
flexible in changing the size of the rooms, the door and window style. The house should be sold with only the completed main part. The electricity equipment should be chosen by HHs among highly efficient appliances. The partition's position and small details should be decided by the HHs with the help of the construction company and the architect's advice. Although housing construction is in a disorder, Vietnamese people are free in designing the house for themselves. The houses always have personal identities in design and construction. The co-operation with HHs in design the house is one very important issue to ensure a freedom and happiness for the residents.

4.1.3 Co-operation with Other Sectors

Transportation Sector
Transportation policy will guide people in a more environmental friendly way of transport. For example, if the public transportation should be convenient and cheap compared to private car transportation, most of people will not use private car any more.

Energy Sector
Energy policy is the main actors in energy end-use efficiency at the HH level of energy management. The meters of water use, electricity and heating are needed to show the monthly consumption and the charge should be increased when the quantity use passes a normal level. This level could be defined by experiments of basic need in daily life. Nuclear power station should be closed and replaced by other sustainable alternative resources.

Economic Sector, Tax and Fee
Economic sector is a very important actor in changing human behaviour in energy consumption. The customers will reduce their waste when the bills are higher and the bills having environmental cost items will warn or remind people about the environmental effects from their activities. Energy prices including electricity, gas and water should present the full cost including environmental degradation cost and even the tax of using natural resources. This could help to pay for future generation the cost of environmental damage. At present, the public transport in Lund is convenient, but most of buses are going almost empty. If car users are charged higher, more people will use bus. The charge could be higher petrol price for cars, tax on km travel, tax on pollution, etc.

International co-operation
The environmental pollution is transboundary. The low technology in developing countries cause major global pollution. Developed countries such as Sweden should help developing countries by transferring technology, exchanging experiences and assisting finance. By this way, they do not only help the developing countries but also to help themselves by reducing global pollution impacts.

4.1.4 Enhancing Media, Education and Changing Human Behaviour
"To achieve sustainability, changing attitudes and behaviour will be required on all level of society" (The Royal Swedish Academy of Sciences, 1996). HHs are the main actors for SD when they are willing to switch their life style into more environmentally friendly type. Most of Swedish are aware of the environmental issues, but they are not really willing to change their behaviour. It is a big difference between saying and action. Media and education are middle actors between HHs and Sustainable Environmental Development. Media and education could change human behaviour, by small steps every day. Introducing a good life style and reminding of the environmental problems that are caused by human behaviour, could guide people in the right direction in their daily life activities. The guidance could be advertisement for using public transport and reminding people to save energy in the peak hours (this has been applied in Hanoi). The introduction about the environmental effects on
4.2 Making Things Happen in Hanoi

4.2.1 Actors Involved in Housing Construction

To define the actors involved in housing construction in Hanoi, we look at the housing management model in Hanoi.

![Housing Management Model in Hanoi](image)

In this model we found that there are some more important actors in housing construction.

HHs accept the infrastructure system and the land areas that are distributed and planned by the Infrastructure Company under the City Urban Planning Department and City People’s Committee according to the housing demand and available land resources. This means that the Infrastructure Company and the Urban Planning Department have a significant role in planning the housing area. They decide how big green area should be, how big land plot for each HH should be and the inner transportation system as well. The lack of green area is a mistake from the City Urban Planning Department and the Infrastructure Company.

After buying a land lot, the HH decides how the house should be built with the help of an architect, and the design should be approved by the Chief Architect’s Office. When HHs have the construction permits, they are free to choose one Construction Team to build the house. They often change the design by themselves according to their ideas, not of the architects. So HHs keep a very important role in the housing architecture. The houses are designed by HHs individually so that they can not fit together in all the street. The HHs themselves are not very good in architectural education, so the indoor climate organisation and art decoration in the facade and inside may not be very good.

4.2.2 Long-term Environmental Consideration in Housing Policy.

In order to obtain a better housing area, the actors involved should act in an environmentally friendly way. The City Urban Planning Department together with the Infrastructure Company should plan for green areas in each group of housing, so that they become place for people to enjoy the nature and children to play. HHs and architects should highlight the indoor climate by organising good natural lighting and ventilation as well as insulation.
system. The Chief Architect’s Office should set a construction area standard for HHs in their land plots, to limit the construction area and to leave some green area in each house. The standard must be controlled during the construction stage, otherwise it will be too late. When the houses are built completely, the reconstruction is wasteful. The individual designs of houses in the same street must be controlled to fit together in an overview by colours, styles and the height.

4.2.3 Co-operation with Other Sectors
Housing management can not act alone for seeking a sustainable development. The co-operation with related sectors is very important in making things happen.

Population Control
The large population and shortage of land for housing are significant problems in Hanoi at present. The population and family planning program that has reached the district and street level and made some success in Hanoi, should be further promoted. The birth rate is reduced by free introduction and provision of birth control equipment. Economic development and industrialisation process also cause a reduction of the birth rate.

Rural Promotion
It is a significant relationship between rural and urban areas. In order to reduce the migration from rural areas to cities, the rural villages and rural centres must be more attractive. Investment in the service system such as schools, hospitals, infrastructure and job opportunities is the solution. Agriculture which is still the main economic activity in the country, should be enhanced. It is very important as food security for all. Agriculture products should be valued at higher rates, to encourage farmer to stay home, doing farming, instead of coming to cities seeking jobs. This could reduces immigrant rate into cities that caused present over-density situation. The agricultural land will therefore not be used for other purposes such as housing construction, hotels, etc. Rural promotion could also reduce the transportation masses into cities. The reason is when more local products are used locally, fewer people will be going to city for earning and less goods will be transported into cities.

Promoting Bus within City
At present, travel by bus between cities and provinces is popular in Vietnam, but inner-city travel by bus is not convenient, when it only runs in some main roads and the time table does not work properly. In order to encourage people using buses, more bus stops should be set up in the streets of Hanoi, especially in residential areas. The time table should work to reduce the waiting time of the customers at the bus stops. The price of petrol should be increased to reduce the use of private motorbikes.

International Co-operation
International co-operation could help the country in learning experiences and avoiding the mistakes. The help from developed countries as transferring environmental friendly technology is very necessary in SD in Vietnam.

4.2.4 Energy and Water Management - Price Policy
Price and Meter
Policy makers should include environmental cost in the energy prices, and set a fair energy policy for the customers. The subsidised price for electricity and water should be cut, and replaced by market price, plus environmental cost. Even if the environmental cost is not clear, an added cost could make the customer become aware of the environmental effect from their use of energy and encourage them to save. This amount of extra money should be
invested in water supply in poor rural settlements. Water management should be better to reduce the losses. For example, water meters must be applied in every HH, and also in every 3 or 4 HHs, to avoid the stealing of water, which exits in Hanoi at present.

*Changing Institution in Supply Side*

The privatisation of energy sector and water supply is necessary, in terms of encouraging the competition. The result will be better technical system and efficient management.

Coal generators in near future should be closed, and replaced by hydropower or solar power to protect environment from pollution.

*Highly Efficient Technology Application*

High efficient technology and renewable energy should be applied for housing in Hanoi. Although the initial cost is rather expensive at present, the cost will be reduced due to the high efficiency, and the lower cost of environmental damaged in the future. Renewable resource in Vietnam as Solar energy, is abundant. It could be applied at the house’s roof, to convert solar energy into energy for daily use. The recycling that has been very popular for 200 years in Hanoi should be enhanced. New environmental friendly products, such as hot water tank using solar energy is sold now in Hanoi, should be expanded in use.

*4.2.5 Media, Education and Changing Behaviour*

*Media*

Media will open mind for people to have a better idea of how a good house should be and aware of the environmental problems around them. The best environmental housing in the world should be introduced in TV and magazines. An exhibition of housing projects could be one way to give local people an idea of good houses. It is also a place for construction companies to meet their customers and exchange the ideas. In Hanoi, media system works rather actively and needs to be continued. The advertisement for good environmental products as building materials, furniture, etc., will lead the consumption to better environmental products. Thus, it encourages environmentally friendly producing processes and technologies, for instance, re-use, recycling and environmentally harmless products.

*Education*

Education is very important factor to make people be aware of the environmental problems. Environmental issue should be taught in school at different levels, from primary school, high school to universities. The children will influence in their parent at home about environmental problems, which they have learnt at schools. The students will be aware about environmental problems and take care of the environment in the future work. The human knowledge together with better management policy could help people to change their behaviour.

5. **Opportunity and Barrier Analysis**

5.1 **Opportunities of the Countries for a Good Housing Area**

5.1.1 **In Sweden**

*Abundant Financial Resources and the Priority for Environmental Issue*

Sweden is one among the rich countries in the world. Despite of the present going down of the economy, the country still has ability and priority to support a lot of high technology research and the application in housing projects. Big investment for environmental education has been set up in Lund. During the spring and fall 1996, 2.5 million SEK and 7,000 employees learned about the environment. “Lund puts a lot of effort into local Agenda 21
work; approximately five millions Swedish crown during 1995 and 4.7 million in 1996."
"Lund's municipality has the option to request up to 15 millions Swedish crowns yearly in
environmental appropriations" (Nilsson, 1996). Local agenda 21 therefore has great financial
opportunity to act at the local level, which is significantly important to change the human
behaviour.

**High Technology**

Sweden has been leading in applying new technology in housing as district heating, solar
heating panel housing in Malmö. Sweden also oriented energy resources into sustainable
resources as Hydropower (50% energy supply, SOU 1996:48) and starts to build wind power
stations in the Southern coast. The eco-village in Malmö is an experiment housing area of
recycling to save energy, which has been built some years ago. As the result of this effort,
between 1970 and 1994, the number of m2 of heated floor-space of housing in Sweden is
increased from 430 to 630 million, when the total energy consumption is maintained (SOU

**Efficient Housing Management**

Housing in Sweden is preserved in good conditions by gradually repair, that created very
good living conditions and also ensures the energy conservation.

**Highly Educated People Living in Lund**

Lund is a university city. Therefore most of people living in Lund are working for the
university and are highly educated. Most of the people are aware of the environmental
problems at a high level and try to act environmentally friendly. Bicycles are very commonly
used in Lund in daily travel to go to work.

**5.1.2 In Hanoi Vietnam**

**Environmental Issues Start to Have a Place in the Policy.**

Although environmental subject is a very new issue introduced in Vietnam, the government
has taken a serious consideration in the policy at present. The Law of Environment has been
enforced since 1990 and starts to be effective. Faculty of the Environment has been set up in
the National University for five years to improve and spread out knowledge about the
environment. The result is a lot of construction sites that cause bad environmental effects,
are asked to revise their plan or to stop.

**Media System Works Actively.**

Environmental issue is popular in TV, radio and newspapers in Hanoi. The issue is expressed
in different ways. For example, showing the affected regions in localities, survey report of
research groups, advertisement for environmentally friendly actions or life style, movies
about environmental problems in human life. They are very helpful in improving people's
knowledge about the environment. The saving-electricity reminding in peak hours is
announced every day in TV, at the peak times, to remind people to reduce the unnecessary
use.

**Learning from Overseas Experiences and International Co-operation**

Vietnam has a priority to switch into a better solution by learning advanced technology and
experiences from developed countries. Most industry plants, infrastructure and houses are
just started to be built. It will be easy to choose the right solution and not to repeat the
mistakes that waste a lot or even destroy the environmental. It is cheap to reconstruct when
the existing structure is not large and has a low value. Many developed countries are facing
existing, old, polluting systems in housing, industry and construction. It costs a fortune to
replace them by a modern and highly efficient one, due to high cost of just to clear down the
existing and to transport the waste. In Sweden, the sewage water from toilet, bath, washing
and kitchen are mixed and led to the water treatment station. This causes the sewage water volume to be hundred times bigger, meaning waste of energy. It is "mix first and separate later" process in water treatment in Sweden (Niemczynowicz, 1998). The replacement of a separated system will not be simple when the existing systems are put in the houses and under the ground.

Many young students have been sent abroad to learn the latest technology and information. They will be the most valuable properties for the country in reaching sustainable environmental development in the future.

International co-operation in Vietnam has been practised for long time. Sweden is one among developed countries helping Vietnam. The help from developed countries such as education, new technology, finance and information are very helpful for the development of the country.

5.2 And the Barriers

5.2.1 In Sweden
The Barrier of Economic Profitability
Although Agenda 21 has reached the local level, the near-future projects seemingly still repeat the mistake of the past because of the economic profitability barrier. For example, high-rise housing intended to be built in Margretadal is not different compared to the existing housing in the environmental point of view. The construction companies always put the economic benefit in the first priority. The rent price is negotiated between HHs and Housing Union of the area. In order to be profitable and reach competitive price, construction companies have to reduce cost of housing construction by not applying expensive and latest techniques. The decoration is simplified in housing at the maximum because of the expensive labour cost.

Installed Appliances in Housing Construction Limit the Choices
Households have no choice for their basic electrical appliances because all of them have been installed in the house before they move in. The barrier of economical profit does not allow the construction company to invest the expensive and highest energy-efficient appliances.

Difficulty in Changing Human Behaviour
Environmental issue is ignored when people do not want to leave the convenience. It is not the problem of the ignorance of environmental knowledge in a country like Sweden, when most people have a high education, and the information system is very good. People do not want to use public transportation when car is more convenient and saves time. Most people in Sweden have a car. Travelling by car around Europe in the summer is popular in Swedish society. Human's consumption has been addressed as a half of the environmental problem causes. People still keep their consumption habit. Most people still want a big house with big garden and located in the suburb that causes more transportation, urban sprawl - low density. When “Smoke and talk about environment is better than just smoke” is the password in the Stockholm Student Conference in 1997, the talking and action are quite apart.

5.2.2 The Barrier for Reaching a SD of Housing in Vietnam
Financial Shortage
The poverty is a reason why housing and environment are not a priority issue in the national policy and economy. Vietnam is one of the poorest countries in the world. The national property is very small. The economic development just started some five years ago, and the
risk of economic crisis is very high due to the regional economic crisis since the last year. Most people still have not enough housing so that the environment is not the urgent issue in people's life. The government has been trying to built new housing areas to satisfy this demand. However, they are not in good condition because the financial resources are very limited. The government and foreign companies do not want to invest in housing construction, when it does not have high economic return as other economic activities. Foreign investment projects are for profit purposes. The art of architecture, traditional culture and environment are ignored in those projects. Wrong building materials as large-size glass facades in hot climate, high-rise housing and modern western architecture are applied in Hanoi. This is destroying the traditional building culture. The dependence on foreign financial resources limits sustainable environmental development.

Too Much Theory and Policy on Paper, Nothing Happening
There are a number of national and international projects running in Hanoi for improving the housing quality, but nothing happened in reality so far. The local people are in urgent need of good house to live in, but the projects, that consume a lot of money still stay on papers. The practical projects need to be implemented in small scale, in order to evaluate the quality of such theoretical projects. The evaluation will help to revise the project and also direct the research into a right orientation (Reutersträd, 1984). It also gives people a chance to have better living condition, better knowledge about housing.

The Limit of Environmental Knowledge
The lack of environmental knowledge could lead to bad environmental projects and environmentally unfriendly living style. Environment is quite a new issue in Vietnam that most people are not aware of or know very little about it.

6. Conclusion
SD environment includes SD of society and natural environment. Urban planning, housing architecture and life style play important rolls in environmental condition. Beside it, SD of social environment in housing area should provide human not only a good living condition but also a warm social life and the beauty art feeling. Each housing area has some good and bad living qualities. The experiences could be very useful for both cities to learn the successes and avoid the mistakes.

Housing in Lund should be denser, but not higher rise. The green area should be smaller; housing could be 3 floors instead of 2; garage could be 3 floors and reduce parking place. Service centres and public places such as small shops, cafe's, small restaurant, a beautiful pond or fountain, etc. should be located in housing area to create an exciting and lively life. Bus should be more convenient and cheap to reduce the use of private car. Architecture of housing should be more attractive by more colourful and decoration. Energy end-use should be more saved in daily life. Long term environmental consideration should has priority in decision making. The co-operation with all society including individual is very important in making things happen. The media, education, price policy and management would make people change their behaviour.

Housing in Hanoi should be dense but having more green areas. Housing quality should be improved, to provide a better indoor climate, and at the same time reduce energy losses. Insulation and natural ventilation are important in saving energy and providing a healthy environment. Architecture of houses in a street should be harmonious. Energy efficiency appliances should be promoted in daily use. Water management needs to be better to reduce the waste. Solar energy should be applied in housing area for daily use. Bus stops in housing area could help to reduce the use of motorbike in daily transport. Housing management and long-term environmental consideration with the co-operation with related sectors are key
issues to achieve SD of environment in housing. Population control and rural promotion could reduce density in city and at the same time reduce transportation volume. Media and education will lead people toward environmental friendly life style. International co-operation is important in learning experiences and reaching the latest technology.

In order to achieve the sustainable development, each city has to move away the barriers and utilise the opportunities. The individual, housing management and all society have to have the responsibilities for the sustainability of the global environment.

Thanks to the co-operation between Sweden and Vietnam, I could be here to learn from Sweden’s experiences and think about my home country in a different way. I am glad to write this report because it expresses my thinking after one year studying in Sweden. The report may have some mistakes, but I had a chance to say my “impression” in the “farewell party”.
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8. Appendix

8.1 The Calculation of Area.

In Bonifacius

The area of land for housing and garden is measured and calculated from map of Bonifacius housing area (Folkeson, etc. 1992), given by Elsa Grip, Planingenjör (incl. data).

The total area is about 42,000 m².
The total land for housing area is about 6,248 m².
The green area in total is about 17,780 m².
The rest for roads and garage is 17,972 m².
The garage area includes 163 carports and parking places.
All the houses are 2 floors.

The average area is the result of above figure divided to the number of HHs (115) and divided to the average number of people in each HH (2,3 according to Statistic of Ötorn/Linero Community) in 1997.

There fore, the average housing area per capita is:
\[ \frac{6,248 \times 2 \text{ floors}}{115 / 2.3} = 47.2 \text{ (m}^2/\text{c}) \]

The average of the housing land areas including garden per capita is:
\[ \frac{(17,780 + 6,248)}{115 / 2.3} = 90.8 \text{ (m}^2/\text{c}) \]

The average of the housing areas including garden, parking place and roads is:
\[ \frac{42,000}{115 / 2.3} = 158.8 \text{ (m}^2/\text{c}) \]

The green area per capita is:
\[ \frac{17,780}{115 / 2.3} = 67.2 \text{ (m}^2/\text{c}) \]

Children play ground is about 740 m² (measured), the average per capita is:
\[ \frac{740}{115 / 2.3} = 2.8 \text{ (m}^2/\text{c}) \]

The average car parking place per capita is:
\[ \frac{163}{115 / 2.3} = 0.6 \text{ (parking place/c)} \]

One car parking place is estimated of 15 m² of land including the roads for cars coming to parking places. Therefore the area of parking place per capita is:
\[ 0.6 \times 15 \text{ m}^2 = 9 \text{ (m}^2/\text{c}) \]

The total car parking place area compared to total land area:
\[ \frac{163 \times 15}{42,000 / 100} = 5.8 \% \]

The total car parking place area compared to total construction area:
\[ \frac{163 \times 15}{(6,248 + 165 \times 15) / 100} = 28.1 \% \]

In Thanh Cong

The land plot for HHs in Thanh Cong is limited: 50 m² (majority: 90 %) or 100 m² (10%).
The average number of people per HH is about 4. The average number of floors of houses is 3. Therefore the average housing area per capita is:
\[ \frac{(50 \text{ m}^2 \times 3 \text{ floors} \times 90 \%)}{4} + \frac{(100 \text{ m}^2 \times 3 \text{ floors} \times 10 \%)}{4} = 41.2 \text{ (m}^2/\text{c}) \]

The average land for housing including shared garden is:
\[ \frac{(50 \text{ m}^2 / 4 + 0.6 \times 90 \%)}{4} + \frac{(100 \text{ m}^2 / 4 + 0.6 \times 10 \%)}{4} = 14.4 \text{ (m}^2/\text{c}) \]

Parking places is in their houses means included in the area of housing; the width of the roads is 6 m including pavement. Each HH has an area of road which can be calculated as a half of the roads width 3 m and the length of the facade along the streets 4m or 8m.

Therefore the average of land area including housing, shared garden, garage and roads is:
\[ 14.4 + \frac{(4 \times 3 \times 90 \% + 8 \times 3 \times 10 \%)}{4} = 17 \text{ (m}^2/\text{c}) \]

(j can be the area where the road is larger and the road cross, etc.)

0.6 is the average shared garden per capital which is calculated in one group of Thanh Cong housing area: each garden of 200 m² is shared by 80 HHs.
There are about 10% of HHs having car garages in their houses (even they do not have a car at the moment). Therefore garage area actually is included in the housing area and land for housing. It is about 15 m² per car garage and the area per capita will be:

\[15 \times 10\% / 4 = 0.37 \text{ (m}^2/\text{c)}\]

100% of HHs has motorbikes and bicycles and it needs an area of 1 m² each. So the average motor parking area per capita is:

\[2 \times 90\% / 4 = 0.45 \text{ (m}^2/\text{c)}\]

So that in total, the garage area in houses in Thanh Cong per capita is:

\[0.45 + 0.37 = 0.82 \text{ (m}^2/\text{c)}\]

### 8.2 Energy Consumption

**In Bonifacius**

Electricity consumption is 514,219 kWh per year in Bonifacius. The data is given by Stig Brozen, Lunds Energy, Oct. 1998.

The average electricity consumption per capita is:

\[514,291 \text{ kWh} / 12 \text{ months} / 115 / 2.3 = 162 \text{ (kWh/c)}\]

The average natural gas consumption per capita is:

\[1520 \text{ Mwh} / 12 \text{ months} / 115 / 2.3 = 0.48 \text{ (Mwh/c)} = 480 \text{ (kwh/c)}\]

**In Thanh Cong**

The data is mainly based on interviews. The average electricity consumption per HHs is about 250 kWh (ITV), therefore the average per capita is:

\[250 / 4 = 62.5 \text{ (kWh/c)}\]

Cooking gas (propane) is 10 kg per HH per 2 months, therefore, the average per capita is:

\[10 / 2 / 4 = 1.25 \text{ (kg/c)}\]

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*Lund, NOV. 1998*