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Analysis of Design Approaches for Sustainable Buildings and Communities

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This study intends to analyze the concept of sustainability focusing on design approaches for buildings and communities in relation to architectural design methods. Since the extent of sustainability in buildings and communities still poses challenges on how to measure, evaluate, and interpret it into the architectural design, the study develops an architectural design method to understand and evaluate the sustainable buildings against economical, environmental, social and other aspects. The study analyzes and evaluates various cases of selected sustainable buildings and the sustainable communities. Conclusively, the study demonstrates clearly how the buildings' elements can be used to achieve the concept of sustainability in designs. Not only that but also, the study clarifies the differences between the sustainable buildings' and sustainable communities' approaches. Finaly, the study presents a broad spectrum of possibilities of approaches that can be used by architects and students to achieve sustainability in the studies of architectural design.

Keywords: *Sustainability, Building technology, Ecological building, Energy conscious design, Environmental symbiosis*
持続可能性，建設技術，エコ建築，省エネルギー設計，環境共生

1. INTRODUCTION

1.1 Background

Communities and individual architects as well as environmentalists and other professional across the world have been striving to attain sustainability in their designs, communities, and researches.

Researchers such as "Lester Brown" (BROWN, 1991) of the World Watch Institute in the US were the first to use sustainable community as a basic organization of human kind to curb food problems. The concept of sustainability is also based on the ideas expressed in earlier studies such as "Silent Spring" (CARSON,1962) warned about environmental pollution as earlier as the beginning of 1960's. Other related ideas such as "Spaceship Earth" by Buckminster Fuller who outlined his philosophy of viewing the habit of humanity and the need to protect it from both global and cosmic perspective.

The "Limit to Growth"by Club of Rome in 1972 alarmed about resource consumption, environmental pollution, population increase and the rate of food production (REES, 1986). The term sustainability was internationally recognized by the United Nations World Commission on Environment and Development (WCED), known as Brundtland Commission in 1987 during the UN earth summit in Rio De Jeneiro in 1992.

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The works of the above researchers have enormously contributed to bring awareness of the importance of the concept of sustainability globally.

However, the contributions from the researchers do not show a direct link to the architectural design for practical application. In light of the above, the concept of sustainability in architecture exists in many phases which need to be precisely focused.

1.2 Previous Studies

Among the previous studies related to this paper include the study on sustainability in terms of city compactness by using representative indicators to measure compactness of the cities. The author defined sustainability in terms of densification, public transport intensification, and independence (MUHAMMAD, 2005). Other studies show that, sustainability assessment can only be realistically applied for the purpose of land use planning (ELSERVER, 2004). The two studies focus on means to define and assess sustainability in cities. Contrarily, this study will analyze both sustainable buildings and communities with different design approaches in architectural design.

1.3 Statement of Problem

Previous studies from the aforementioned researchers are highly appreciated for contribution to the theories of sustainability, however there is still a gap between sustainability and the architectural design. Due to the complex nature of the concept of sustainability, the means to analyze, evaluate, and assess sustainability in architectural design are not fully developed. Although the social, environmental, and economical were established as the key aspects of sustainability, it is still difficult to integrate them in pragmatic architectural designs. Most of the discussions refer sustainability in terms of only one or two aspects.

2. OBJECTIVES

In order to respond to the research problems above, this paper aims to:

•Establish a general spectrum in the various design approaches for sustainability as far as the architectural design is concerned.

•Enlighten the relation between the buildings's elements and the concept s of sustainability to address the economica, social and the environmental aspects.

•Clarify and highlight the differences between sustainable building and the sustainable communities' approaches.

3. RESEARCH METHODOLOGIES

Due to the broad perspective nature of the concept of sustainability, the study involves three kinds of methods to collect and analyze information. This is due to the fact that, sustainable concept exists and is implemented as as a multi-faced discipline. It is necessary for this study to understand the concepts from theoretical, buildings, and community design approaches.

3.1 Methodology I- Theoretical Approaches

This involves a collection and analysis of the paper from the previous sustainable proceedings, which included views from various professionals, criticisms, and challenges. The information was a result of the reaction of scholars including environmentalists, architects, engineers, and the international organizations towards the declaration of the concept of sustainability "Our Common Future, 1987" which led to the establishment of the concept of Sustainable Development.

3.2 Methodology II-Sustainable Buildings Approaches

In this method, data (buildings) which are designed to demonstrate the concept of sustainability are collected. The buildings are analyzed with graphical descriptions with an identification of the "Notion of Sustainability". In this study, the notion is defined as a conceptual statement showing an intension to achieve sustainable design on a designated project. Due to the multifaceted nature of sustainability, the cases are classified into four major groups sharing similar approaches. The groups consist of; renewable energy, materials and construction techniques, vertical landscape, and the re-uses of buildings. From the four groups, various sustainable concepts related to the architectural design are identified. The concepts are then analyzed to obtain the notions of sustainability.

3.3 Methodology III-Sustainable Communities Approaches

Sustainable communities are selected among the best examples of the cases designed to achieve the concept such as Village Homes Davis California, USA; Bo01,Malmo community, Sweden; and the Viiki in Helsinki Finland. These communities were established in different eras during the movements of sustainable development as explained below:

The Village Home was established before the UN has officially initiated the idea of sustainability. The community was designed to demonstrate pedestrian walkways, clean transportation, low energy oriented, food production, cycling and garbage recycling.

The Bo01,Malmo Community was established after the Rio Declaration with an intention to achieve 100%renewable energy and the protection of habitat. It was considered as an example for EU to implement the resolution of the Rio Declaration. Also, the community was redeveloped as a model for future cities. Viiki, community was established after the Kyoto protocol It addresses 100% renewable energy, rain water re capture and re uses, car free above the ground, green courtyards and corridors, smart houses,and generated energy from wastes. From the above uniqueness, the study analyzed the approaches in design.

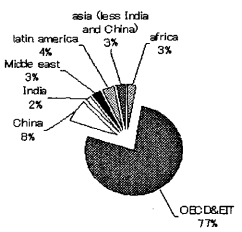
4. TARGETS OF CASE STUDIES

The study involves three kinds of case studies to achieve the intended objectives.

4.1 Theoretical Cases

The first case study involves theoretical understanding of the concept of sustainability which supports the design approaches. In this case, various works related to the subject matter from different authors, researchers, politicians, scientists, and environmentalists are gathered and analyzed. Table 1 shows some of the collected criticisms and challenges on sustainability.

Table1 Challenges and Criticisms of Sustainability

No.	Authors, Publisher, Year of Publication	Quotations from a Document Indicating Challenges for Sustainability	Discussions
I	CONNEL, James and GRAHAM, Smith: Politics and Environment: From Theory to Practice 2nd edition, Routledge, 2003	"Sustainable development is an umbrella concept: on analysis we find it that, it unites a number of related concepts which are central to green political thought, but which themselves are equally contested. The manner in which these different concepts are understood and then balanced one another leads to different conceptions or interpretations of sustainable development".	The concept of sustainability is received with suspicious due to its ambiguos nature. It is means that, the main concept has other various concepts which are of equal importance hence creating mis conceptions of the Sustainable Development (SD).
II	STEELE, James : Sustainable architecture: Principles, Paradigms, and Case Studies, McGraw-Hill, 1997	"Needs "are met. The question remains, development, how, of what, and for whom? The word "*needs*" is also vague. Used in conjunction with development , it implies materials enrichment rather than social satisfaction".	To this extent, the goals of sustainability are not clear to define how to meet the "Needs" SD seems to emphasize more on resource and materials achievements than to social aspects
III		"The proposals put forward by the commission happened at a time when the global economic pendulum had taken a turn in favor of the industrialized countries following an attempt at autonomy by OPEC, a decade earlier and revolved primarily around the issue of trade and self sufficiency".	Brandt Commission in 1977 focuses on solving energy crisis between the North and South Countries for economical interdependence. The report favors industrial countries upon energy, free trade, and self sufficiency. The report does not focuses much on actual sustainable matters.
IV		"Sustainability, which is being put forward by its enthusiasts as the theoretical apologia for this new brand of utopian ecological politics, appears through its lineage and implementation to be nothing more than capitalism striving for political correctness. Many issues reiterated in the *Agenda 21*, such as land reform, decentralization, reparations, and changes in value systems are fraught with political overtones involving nothing less than revolutionary change in many existing government systems".	Sustainability is being handled more political than architectural and environmental. It is perceived as an utopian theory that can not be practically implemented. The agenda 21 comprised of political ideologies.
V	WILIAMSON, Terry, ANTONY, Radford, BENNET, Helen; Understanding Sustainable Architecture. Spon Press, 2003	"I am confident that, the environmental path that I announce will benefit the entire world. This new approach is based on this common-sense idea: that economic growth is key to environmental progress because it is growth that provides the resources for investment in clean technologies. This new approach will harness the power of market, the creativity of enterprenuers and draw upon the best scientific research". (Bush,2002)	The decision taken by the US to resist on reduction of CO_2 emission level shows dis agreement among industrial nations on a global common goal to achieve sustainability. This shows that, economical interests are given prior preference than the concept of sustainability.
VI	HANAKI, Keisuke; BACCINI .Peter: Future Cities: Dynamics and Sustainability,Kluwer Academic Publishers, 2002	 Figure A, Urgements on energy consumption levels Source: Marland, et al. 1998	According to the study, the cumulative data for Carbon emissions for the years 1950 -1995 created a global division between Organization for Economical Cooperation and Development (OECD): Economies In Transition (EIT); and Non-OECD countries. The study showed that, 77% of the global Carbon emissions come from the OECD countries while the Non-OECD countries' rate of production of CO2 was gradually increasing. The figure below shows a Share of cumulative Carbon emission 1995 (Figure I)

Information from the table 1 is analyzed where we obtain the following observations:

The concept has a multi interpretations which result into various disciplines of applications. Most of these interpretations and definitions do not show a direct link to the architectural design.

There is a global division upon the discussion of sustainability between Industrial countries and non-industrial countries upon meeting a common goal to reduce the rate of energy consumption as well as the production of CO_2.

There is a conflict of interest among nations in trying to protect their economic welfares than to reach a global common goal to achieve sustainability. This can also be seen in the direction taken by the US and Australia during ratification of the Kyoto Protocol (Table 1 No.III &V).

The concept of sustainability is perceived mostly as a political propaganda and utopian ideas which need more critical analysis for the implementations. These observations are found to be some of the challenges which face the concept of sustainability. Further more, Table 2 below is analyzed to find the preference of definitions and understandings of the concept by the international organizations. This table focuses in the international organizations who are the global pioneers of sustainability.

Table 2 Multi-faceted Definitions of Sustainability

No.	Organization/Author/Year of Publication	Understanding, Views, and Definitions from the International Organizations	Related Aspects		
			Econ.	Env.	Soc.
I	UN Source: Agenda 21: "The United Nations Programme of Actions from Rio and Rio Declaration", UNDP Information, NY, 1992	Development that meets the needs of the present without compromising the ability of the future generations to meet their own needs	o	o	o
II	OECD Source: "ISSUES PAPER: On Integrating Environment and Economics" Paris:OECD, 1990	Buildings with minimum adverse impact on the built and natural environment in terms of buildings themselves, their immediate surroundings and the broader regional and global settings		o	
III	IUCN, WWF, UNEP Source: "Caring for the Earth", Gland, Switzerland: ucn,1991	The preservation of genetic diversity and sustainable utilization of species and ecosystems		o	
IV	OECD Source: Haveman, Robert; "The Economics of Environmental Issues", Paper No. 5. Sept. 1989	Sustainable is a process of change in which the exploitation of resources, direction of investments, the orientation of technological development and institutional changes are made consistent with future as well future as well as present needs.	o	o	
V	WCED Source: World Commission on Environment and Development, "Our Common Future", Oxford, OUP,1987	The sustainable development concept constitutes further elaboration of the close links between economic activity and the conservation of environmental resources. It implies partnership between environmental and economy.	o	o	
VI	IUCN, UNEP, WWF Source: http://www.sustainableliving.org/appen-a.htm "Caring for the Earth", Gland, Switzerland, 1991	Sustainable development- Improving the quality of human life while living with the carrying capacity of supporting ecosystems		o	
VII	IIED, 1982 Source: McCormick, John; "Reclaiming Paradise", Bloomington; Indiana University Press, 1991	The process of improving the living conditions of the poorer majority of human kind while avoiding the destruction of natural and living resources so that the increase of production and improvements in living conditions can be sustained together.		o	o
VIII	World Bank, Source: Norgaard, Richard, "Sustainability of the Economics of Assuring Assets for Future Generation, World Bank, Asian Regional Office", Working Paper Series No. 832, 1992	Sustainable development means basing developmental and environmental policies on a comparisons of cost and benefits and on careful economic analysis that will strengthen environmental protection and lead to rising and sustainable levels of welfare		o	o
IX	IUCN, 1993 Source: "Guide to Preparing and Implementing National Sustainable Development Strategies", Pre publication draft, 1993	Sustainable development means achieving a quality of life that can be maintained for a long time. Socially desirable, fulfilling peoples' cultural, materials, and spiritual needs Economically viable, paying for itself, with cost not exceeding income Ecological sustainable, maintaining the long term viability of supporting ecosystems	o	o	o

The above definitions can be found in; http://www.sustainableliving.org/appen-a.htm

4.2 Sustainable Buildings

The second case study consists of existing sustainable buildings which bear different backgrounds, architects, and contexts (Fig. 1). These buildings have unique characters that, they were built to demonstrate the concept of sustainability. In order to understand the application of the concept in the design approaches, the buildings' elements are analyzed in relation to sustainability.

The analysis is done to observe the relation between the buildings' elements and the concept of sustainability. The cases involve 60 buildings with different design approaches to achieve sustainability. Fig.1 represents the cases in four main groups.

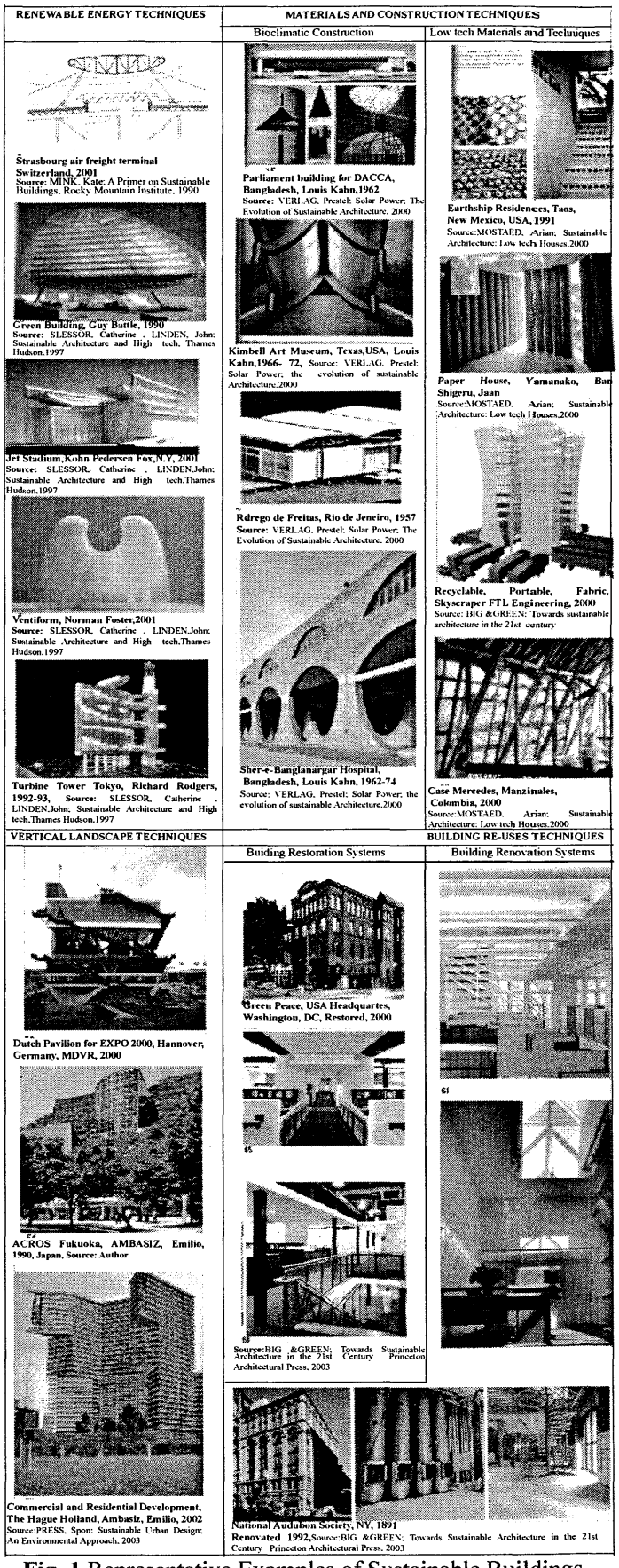


Fig. 1 Representative Examples of Sustainable Buildings

4.3 Cases for Sustainable Communities

The third case study is about the approaches of sustainable communities from different backgrounds and contexts. Examples from unique sustainable communities are collected to identify design features (Fig. 2).

Sustainable communities are selected among the best examples of the cases designed to achieve the concept such as Village Homes Davis California, USA; Bo01,Malmo community Swede, and the Viiki in Helsinki Finland. These communities were established in different eras during the movements of sustainable development as explained below:

Village Home was established before the UN has officially initiated the idea of sustainability. The community was designed to demonstrate pedestrian walkways, clean transportation, low energy oriented, food production, cycling and garbage recycling.

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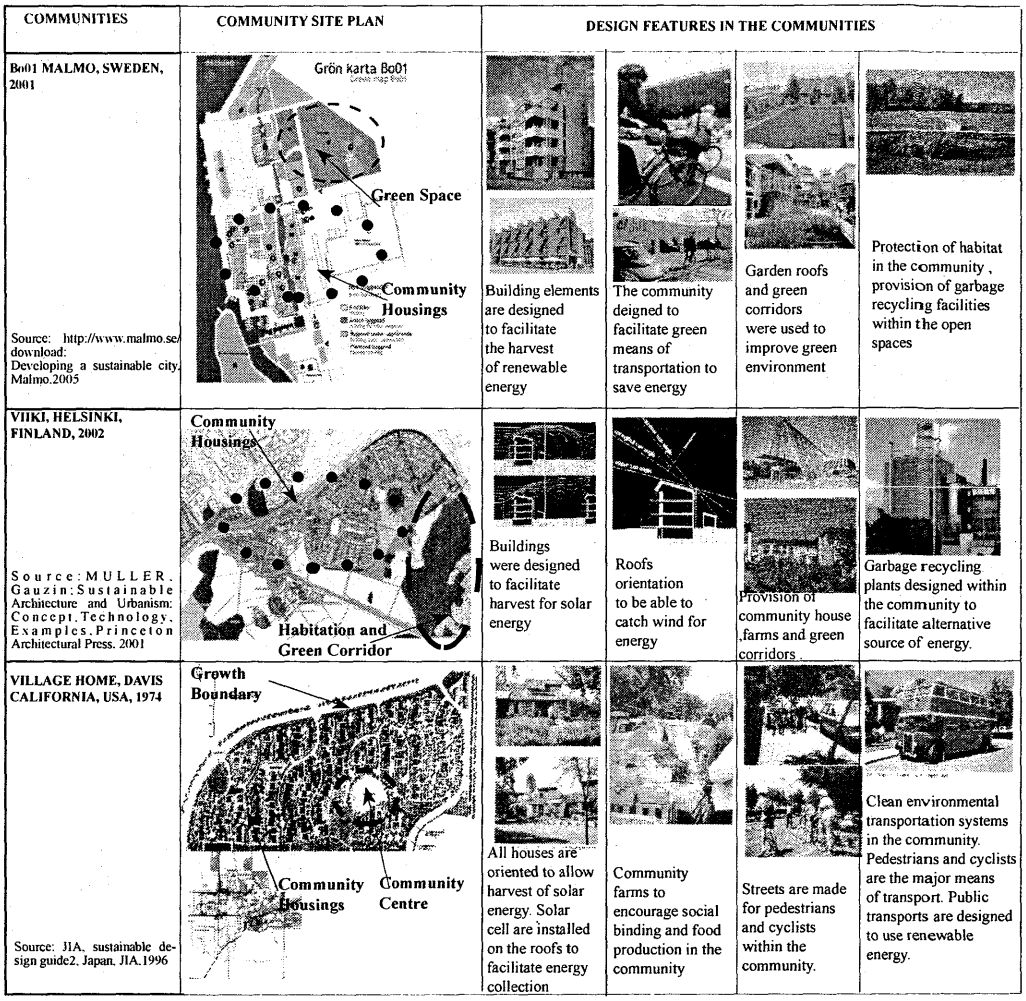


Fig.2 Case Studies of Sustainable Communities

4.4 Selection Criteria for the Case studies

Generally, the selection of the case studies is influenced by two main factors:

The broadness of the concept of sustainability which covers a broad spectrum of approaches, definitions, and examples.

The analysis does not base on the numerical methods, but rather on the high degree of diversity and range.

Diversity in terms of design approaches, context, designers, and the background is considered for selection.

5. GENERAL ANALYSIS

Analysis is conducted in two main categories depending on the nature of the case study, it involves the analyis for the sustainable buildings and the sustainable communities.

5.1 Analysis of Sustainable Buildings

According to the collected cases, we firstly analyze the cases in terms of their design concepts. Among the concepts, we develop classification comprising the common or close related thinking. We therefore obtained four main groups for further analysis. This comprised of renewable energy techniques, materials and construction techniques, vertical landscape techniques and the re-uses of buildings techniques (Fig.3).

5.2 Classification of Sustainable Buildings

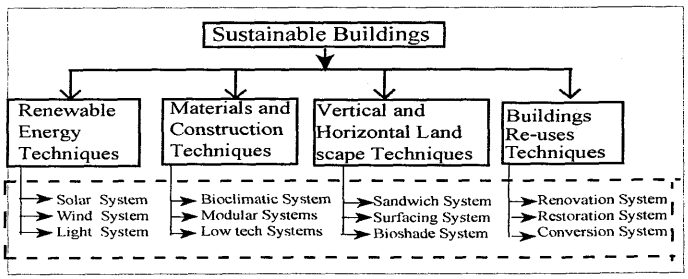


Fig.3 Classification of the Case Studies of Sustainable Buildings

From the classification of the four groups, we obtain architectural related design systems such as solar design system, bioclimatic design system, sandwich system, and renovation system all related to buildings and sustainable approaches.

Later, the systems from each group are analyzed separately in relation to the building elements. The factors in which sustainable ideas are integrated in designs such as building forms, materials, and high tech were also revealed.

i) Renewable Energy

It is found that, the harvest of wind energy relates to the building forms which incorporate the wind turbines. The designs of the turbines are made not only as mechanisms but also as architectural elements in size ,proportion and aesthetics.

Glass technology is another way of energy saving in public buildings. According to the study, it is observed that, glass is used in various ways to conserve the use of fossil energy. These includes contemporary insulators in a form of glass.

The building forms are designed to fulfil their basic functions such as sports centre, office, research centre or any other desired while performing as energy collectors and suppliers to their respective neighborhoods. These projects show a relation between the intended function of a building to collect natural energy and the organic forms.

Mechanisms to harvest energy are part of the architectural elements in terms of aesthetics and proportion. Most of these buildings behave multi factional to satisfy their basic functions and to collect and generate the renewable energy (Fig. 4).

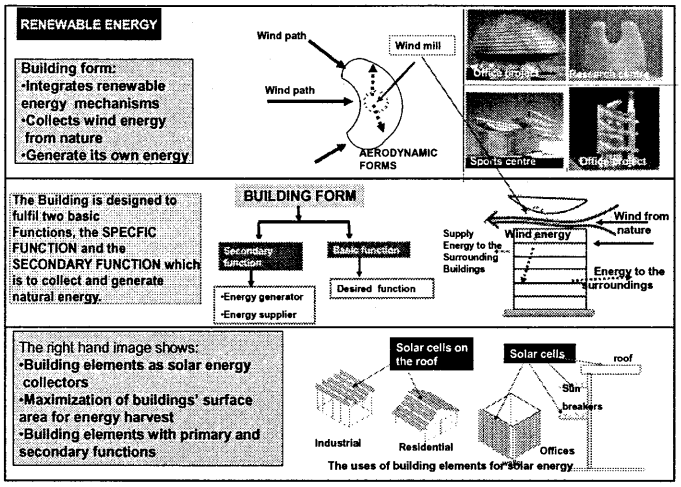


Fig. 4 Design Approaches by Building Elements for Re-newable Energy

ii) Materials and Construction

The concept of sustainability is demonstrated through the use of exterior shading devices, maximum use of natural light, and the use of regional materials. These features a re related to minimizing the cooling cost, binding the building into the context, and respecting the culture of the building context.

The use of light weight materials which are innovated to improve strength as a means to control the amount of fossil fuel in building construction process. Materials like sinuous strands of resin impregnated carbon are found to be lighter and stronger than steel hence less energy consuming in building process. Structures such as domes which are extremely strong and light with the ability to cover huge volumes with the minimum surface area. For these factors, are considered economically sustainable.

Traditional materials and construction systems are found to be the key and fundamental elements to achieve sustainability in the aspects of economical, social, and environmental. Appropriate techniques to improve the construction methods give new possibility to isolate heat, energy storage, durability and cultural binding (Fig.5).

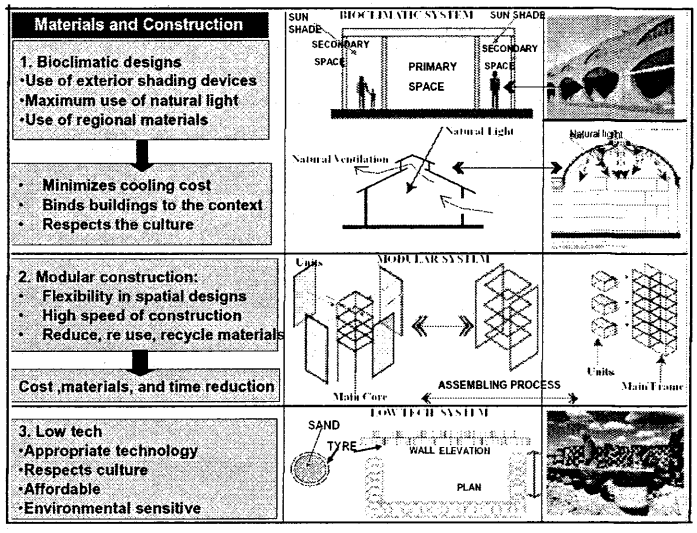


Fig. 5 Design Approaches by Materials and Construction Techniques

iii) Vertical and Horizontal Landscape

The study finds that, some designs demonstrate vertical and horizontal landscape in high rise buildings as a means to bring back nature to cities. According to the study, the greenery and trees around the buildings are found to cool the built environment, filter the surrounding air, and attract ecological process. The study revealed that, wrapping the skyscrapers with green landscape does not only create fresh air but also it can reduce the amount of heat that goes into the building to minimize cooling costs (Fig. 6).

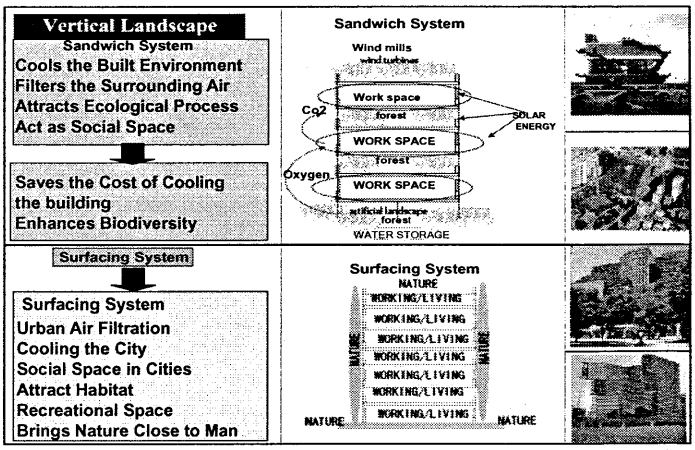


Fig. 6 Design Approaches by Vertical and Horizontal Landscape

iv) Building Re-uses

The study analyze building re uses systems which are designed to express the idea of sustainability. The analysis of the re-use systems is sub-grouped into three categories; renovations, restorations, and conversions. From these, three sub groups, sustainable design approach is analyzed.

All these categories relate with sustainability in terms of spatial re use, materials savings, improvement of energy systems, improvement of human comfort, and working efficiency in office buildings. During the re use process, spatial circulations are improved, historical architectural features are maintained, new environmentally friendly materials are used, new spaces are created with economical planning, while

natural light and ventilation systems are introduced. Due to these approaches, the recycling process is considered to be sustainable (Fig. 7).

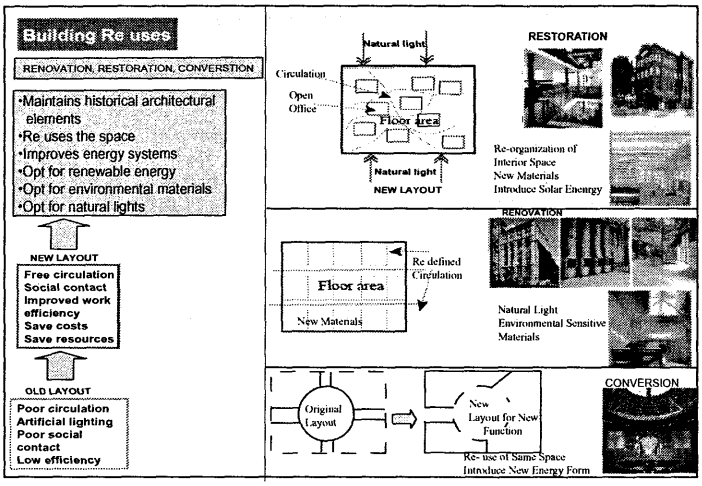


Fig. 7 Design Approaches by Re uses of Buildings

6. ROLE OF BUILDINGS' ELEMENTS FOR SUSTAINABLE DESIGN

From the above four major techniques to achieve sustainability, different design systems which relate to both architectural design and sustainability are obtained. We further analyze the case study buildings' elements such as roofs, windows, walls, floors, and the decorational elements, to find out how they support the sustainable design. Then, the design systems are broken in to various possibilities which are matched with the buildings' elements to show the way they relate to the concept of sustainability (Table 3).

Table 3 shows the analysis of design possibilities obtained from the four main design techniques. Through the coding system, we have obtained four different relations among the design possibilities.

The first group shows the design possibilities which originate from different design techniques but they have alternative approaches in other design techniques. In this group, one building element can be used to achieve other functions of sustainability.

The second group shows the related design possibilities all from one technique to another possibility in different group.

The third group shows one to one relation of design possibilities from different design techniques.

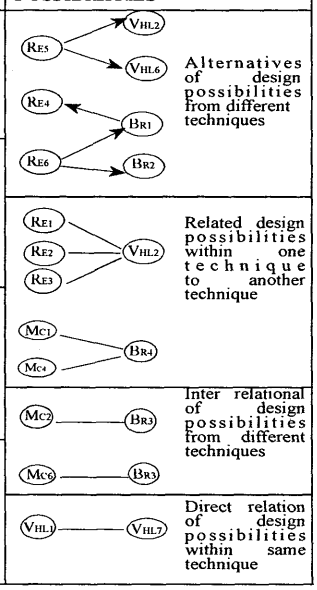
The last group shows a direct relation of the design possibilities which belong to the same design techniques. This kind of table can be used prepare an architectural program for sustainable design.

6.2 Notions of Sustainability

As it was stated previously, during the analysis we obtained the notions of sustainability for the sustainable buildings. We use this as a method to evaluate how the statements supporting sustainable building design are related to the three aspects of sustainable development (Economical, Social and Environmental). The outcome of this process gives lists of notions which are considered by the designers of the selected case studies. The respective relation between the notions and the three aspects are developed (Table 4). As a result, we have finally determined in percentage the dominant aspects which dominate the concept of sustainability in architectural designs.

Table 3 Design Possibilities using Buildings' Elements

TECHNIQUES	DESIGN SYSTEMS	DESIGN POSSIBILITIES	BUILDING ELEMENTS					CODES	RELATIONS AMONG DESIGN POSSIBILITIES
			WINDOW	WALL	ROOF	FLOOR	DECORATION		
RENEWABLE ENERGY (RE)	Solar Systems	Use solar cells for energy	o	o			o	RE1	
		Use environmental friendly energy	o	o	o		o	RE2	
	Wind Systems	Use wind energy		o	o		o	RE3	
		Use high quality light	o		o		o	RE4	
	Light Systems	Use energy saving mechanisms	o	o	o	o	o	RE5	
		Use light shear roof			o		o	RE6	
MATERIALS AND CONSTRUCTION (MC)	Bioclimatic Systems	Use durable materials	o	o	o	o		MC1	
		Use environmental friendly materials	o	o	o	o	o	MC2	
	Modular Systems	Use regional materials			o	o	o	MC3	
		Use of re-useable materials	o	o	o	o	o	MC4	
	Low tech Systems	Use affordable materials			o	o	o	MC5	
		Materials production control	o	o	o	o	o	MC6	
		Flexible materials			o	o	o	MC7	
VERTICAL AND HORIZONTAL LANDSCAPE (VHL)	Sandwich Systems	Encourage biodiversity		o	o		o	VHL1	
		Use nature to conserve energy	o	o	o		o	VHL2	
	Surfacing Systems	Use rain water to plantations			o			VHL3	
		Apply natural lighting control	o				o	VHL4	
	Bioshade Systems	Use plantations to control climate	o	o	o		o	VHL5	
		Use plants to conserve energy			o		o	VHL6	
		Provide green factor system			o		o	VHL7	
BUILDINGS RE-USES (BR)	Renovation Systems	Opt for natural light	o		o			BR1	
		Introduce natural ventilation	o	o	o		o	BR2	
	Restoration Systems	Consider renewable of buildings	o	o	o	o	o	BR3	
		Consider buildings life spans	o	o	o	o	o	BR4	
	Conversion Systems	Practice building management	o	o	o	o	o	BR5	
		Improve energy systems	o	o	o	o	o	BR6	
		Conserve architectural elements	o	o	o		o	BR7	



6.1 Relation Among Design Possibilities

From table 3, we observed that, within any design technique, design possibilities tend relate among each other in a group and also to others in different design techniques. Using the system of numbering we called "coding system", the design possibilities are represented in code bearing the name of the design technique in which it belongs (Table 3).

The notions (Table4) are evaluated in percentage to observe the perspective of designers towards the concept of sustainability. The observation shows that, most of the designers consider sustainability in terms of environmental aspect. It also showed that, most of the designs do not consider social aspect in sustainable buildings (Figure 8). However, the

observation does not represent a global perspective for sustainability, the selected cases indicates possibilities that social aspect is not well considered (Fig.8).

Table 4 Co-ordinating Notions with Aspects

Notions of Sustainability	Sustainable Aspects			
	Environmental	Economical	Social	Others
Use of renewable energy	o	o	x	x
Environmental protection	o	x	x	x
Use energy saving systems	o	o	x	x
Harvest energy from nature	o	o	x	x
Apply material to save energy	o	o	x	x
Use form of building to catch wind	x	o	x	o
Apply energy conservation system	o	o	x	x
Use building Form to generate energy	o	o	x	o
Energy harvest systems	o	o	x	x
Export energy from the building	o	o	x	x
Energy conservation system	o	o	x	x
Daylight illumination systems	o	x	x	x
Natural ventilation	o	o	x	x
Harvest renewable energy	o	o	x	x
Improve building performance	o	o	x	o
Bioclimatic design	o	o	x	x
Heat isolation systems	o	x	x	x
Appropriate technology	x	o	o	x
Use of regional materials	x	o	o	x
Save energy	o	o	x	x
Use energy from nature	o	x	x	x
Natural lighting	o	o	x	x
Natural ventilation	o	o	x	x
Modular construction	o	o	x	x
Use water as a cooling and heating system	o	x	x	x
Use prefabrication system	o	o	x	x
Use of renewable materials	o	o	x	x
Local and regional materials	o	o	x	x
Use low VOC materials	x	o	x	x
Use modular construction	o	o	x	x
Consider building re use	o	o	x	x
Re use, reduce and recycle	o	o	x	x
Minimum damage on site	o	x	x	x
Less fossil energy	o	x	x	x
Flexible design	x	x	x	o
Save time	x	o	x	x
Save space	o	o	x	x
Conserve energy	o	o	x	x

o Notions Related to Aspect
Notion NOT Related to Aspect

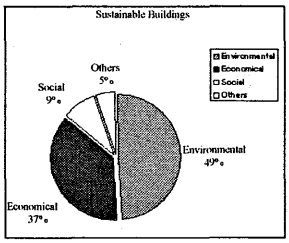


Fig. 8 Relation of Notions to Aspects

7. ANALYSIS OF SUSTAINABLE COMMUNITIES

Due to the observations from the analysis of sustainable buildings, we will analyze sustainable communities. The analysis involves three sustainable communities to find various design approaches featuring concepts of sustainability. All the design concepts are listed, then the common ones are identified from each community. Table 5 shows the three communities indicating the locations, their basic information, and the main concepts.

7.1 Coding of Common Features

In the analysis of the three selected communities, all concepts of sustainability approaches are listed. In further observation, it shows that, although communities are selected from different backgrounds, regions, and are designed in different years, they have two kinds of approaches. These include specific requirements and the common requirements which are shared in all three communities. Since the concept of sustainability has some common aspects which are implemented in different ways depending on the local conditions, our interest in this analysis is to find the common concepts from the three communities.

Table 5 shows the process to select the similarity among the communities. The concepts which are similar from each community are coded and marked red. We use number andalphabet to code the common sustainable features. The three letters were used to indicate a set of common elements from each community. The set representats certain shared sustainable concepts.

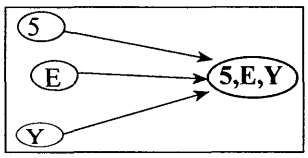


Fig. 9 Shared Concept

Figure 9 shows a group of shared concepts from different sustainable communities. The analysis shows that, citizen participation in decision making, design and management of the communities are common approaches in community designs.

Table 5 Coding Process for Shared Concepts

COMMUNITIES	BASIC DATA	MAIN CONCEPTS	CODES	GROUPING	SHARED CONCEPTS
Bo01, Malmo, Sweden sustainable community	Area: 30ha 600 units 10,000 people to be housed and work	Use of renewable energy Use plants oil for clean energy Clean transportation system Information technology integrated in transportation system Protect natural habitat Garbage recycling Citizen participation Community integrated with agriculture	1 2 3 4 5 6	1,A,U 2,B,V 3,C,W 4,D,X 5,E,Y 6,F,Z	USE RENEWABLE ENERGY CLEAN TRANSPORTATION PROTECT NATURAL HABITAT GARBAGE RECYCLING CITIZEN PARTICIPATION INTEGRATED WITH AGRICULTURE
Viikki, Helsinki Sustainable community	Area: 1132 ha housing and commercial area 292 ha recreation, nature reserve, and water areas 840 ha 600jobs to be created House 13,000 people	Use sustainable design guidelines Community land use pattern Use renewable energy Adopt clean transportation Integrate community activities Provide community market Recycle garbage Citizen participation Provide open spaces	A B C D E F		
Village Homes Sustainable community	Area:70 acres 220 single family, 20 apartments	Use building configuration to save energy Use renewable energy Provide green corridors Use compact design Recycle garbage Provide community garden Ecological transportation system Citizen participation Use building materials	U V W X Y Z		

The communities are analyzed to obtain the notions of sustainability. Finally, an evaluation is done to find out how the notions of sustainability relate to the social, environmental, economical, and other facets. Table 6

7.2 Comparison Between Sustainable Buildings and Communities' Approaches

Since the analysis has resulted into obtaining the lists of notions of sustainability from both the sustainable buildings and the sustainable communities, we will match the notions with the aspects of sustainability as the case was done on table 4 of the previous case.

Table 6 Co-odinating Notions to Aspects

Notions of Sustainability	Sustainable Aspects			
	Environmental	Economical	Social	Others
Consider building orientation	o	x	x	x
Use passive system	o	x	x	x
Allow solar access	o	x	x	x
Design with microclimate	o	x	x	x
Apply solar harvest system	o	o	x	x
Use solar envelope for shading	o	o	x	x
Introduce natural parks in neighborhood	o	x	o	x
Use natural plantations	o	x	o	x
Create courtyards, foliage, streets, and squares	o	x	x	x
Use water for habitation	o	x	x	x
Buildings stand closely together	o	x	o	x
Courtyard with green points for biodiversity	o	x	x	x
Achieve outdoor green environment	o	x	x	x
Achieve outdoor green environment	o	x	x	x
Provide green spaces in buildings	o	x	x	x
Use wall creepers, climbing plants,	o	x	x	x
Green roofs, water surfaces in ponds	o	x	x	x
Preserve large trees and bushes	o	x	x	x
Courtyard with traditional cottage gardens	o	x	o	x
Use land efficiently	o	o	x	x
Energy from renewable source	o	o	x	x
Energy available near the place	o	o	x	x
Energy from refuse and fuel	o	o	x	x
Biogas from refuse and sewage	o	o	x	x
Provide packaging materials	x	x	x	o
Collection point near homes	o	x	x	x
Kitchens sink waste mill installation in area	x	x	x	o
Increase separation of organic waste	o	x	x	x
Use garbage for biogas extraction	o	o	x	x
Separate drains for kitchen sink	o	x	x	x
Organic waste converted to fertilizer	o	o	x	x
Biogas used for heating and vehicle fuel	o	o	x	x
Generate manure from organic waste	o	o	x	x
Minimum emission from traffic	o	x	x	x
Environmentally responsible transport	o	x	x	o
Dense development	o	o	x	x
Network for walkways	o	o	o	x
Recreational options to reduce traveling	o	o	x	x
Environmental friendly vehicles	o	x	x	x
Bicycles for circulation	o	o	o	x
Vehicles powered by environmental sensitive fuel	o	o	x	x
Neighborhood with filling and charging stations	o	o	o	x
Priorities given for green vehicles	o	x	x	x
Car time share ownerships	o	o	o	x
Well planned car trips	o	o	o	x
Tool to improve environmental performance	o	o	x	x
Facilitate lower energy	o	o	x	x
Environmental friendly life to residents	o	o	x	x
Measure, control and regulate energy use	o	o	x	x
Use road information technology systems	o	x	x	x
Information on traffic control	o	x	o	x
Reduce the need to travel out the community	o	o	o	x

o Notions Related to Aspect
x Notion NOT Related to Aspect

The comparison of sustainable buildings and sustainable communities shows some differences between the design approaches (Table 4 and 6).

The table represents part of the overall observations regarding the preferences showing the relations between the aspects and the notions of sustainability for the three communities.

The observation shows that, most of the notions relate sustainability to the environmental aspects. However, social aspect is also given considerations for the case of communities.

This process was followed by a numerical evaluation for further clarifications.

7.3 Numerical expression

A quantitative evaluation of the notions is done to find a numerical value. The value is expressed in terms of percentage showing how the aspects were related to sustainability in their respective cases. The study found that, most of the sustainable buildings did not give much consideration to the social aspect in the design expressions. Also it was found that, most of the cases, related sustainability with environmental aspect. For the case of sustainable communities, it was found that, the three aspects were more expressed in designs. A scale is used to express the numerical values into graphics. In this case, the relation between the aspects and sustainability are expressed in terms of their gradation and strengths such as very strong, strong, weak, very weak, and negligible with respect to their percentages.

7.4 Findings and Observations

Quantitative observation showed that, there is an even distribution among the considerations of the three aspects. However, the environmental aspect is found to be more considered followed by economical and social (Fig.10).

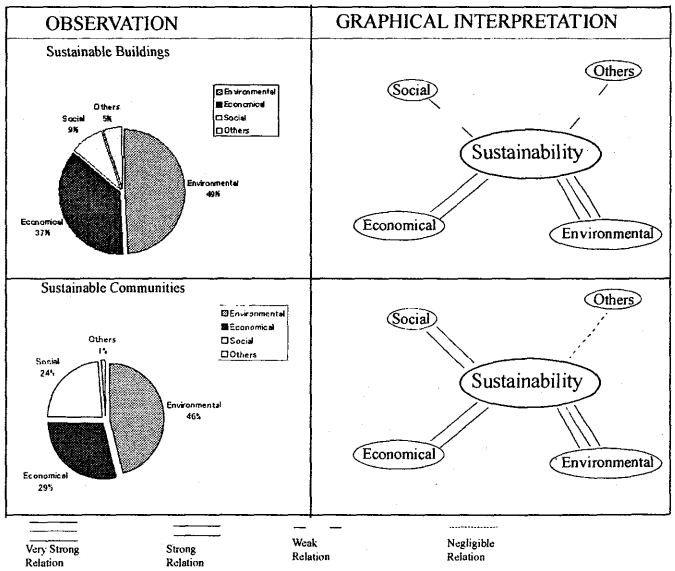


Fig. 10 Graphic Interpretations of Numerical Comparion

i) Findings from the Sustainable Buildings' Approaches

According to the study, the results on Fig.10 might have been influenced by the fact that, sustainable building is still often understood as being a technical question of space efficiency, energy, water, wastes, etc which are only the eco-technical or material aspects of sustainability. This also might have been contributed by the starting point of sustainability which was environmental problems. Another factor is that much of the research has been done by technical people, who only work with measurable, quantifiable things. This historical background of sustainability marginalizes the social aspect of the concept.

ii) Findings from the Sustainable Communities' Approaches

The study has shown that, the whole concept of community approach is more sober and wholistic where various social aspects are involved.

The idea of citizens participation in community designs automatically tends to give many communities the essence of social achievements. In architectural designs, the process can be materialized by creating design programs that involve citizens and which seek the interests of the society.
Even though the aspect of environment is given more priority in evaluation, but the total assessment of the community indicates a balanced consideration of economical, environment and social aspects together. However much is still needed to achieve social aspects in designs.

8. CONCLUSION

In this study, the followings were achieved;
The study clarified a general spectrum through various possibilities that can be used to develop architectural programs for sustainable designs. However, apart from the possibilities, the study finds that, there is a need to establish sustainable programs at schools and local communities where simple and practical techniques in materials, appropriate technology, and designs can be used to enlighten the society about the importance of sustainable living. In the case of building designs, sustainable program can be integrated in the design program, where architects will include sustainability idea from the conception stage to planning, construction, operation, repair, re-use, and disposal of a project.

Implementation of sustainable development in architecture can be conducted through sustainable building and community designs in which the techniques for using buildings' elements , building form, and multi functions can be integrated into designs to meet economical, social and environmental aspects in the sustainable buildings and the communities.

The differences between the sustainable buildings' approaches and the sustainable communities approaches has been clarified. In this point, the study highlights that, sustainability is a wholistic approach which integrates various notions that can be better practiced at community level than at sustainable building level. In this case, the study shows that, there is a gap between the definition of sustainability according to Brundtland Commission, 1987 and the practical implementation in architectural design.

Thefore, this study finds that in order to consider the economical, environmental, and social,aspects of sustainability, then community design is a future of sustainability.

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