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THE UNIVERSITY OF HONG KONG

SUSTAINABLE CONSTRUCTION IN HONG KONG

A DISSERTATION SUBMITTED TO
FACULTY OF ARCHITECTURE
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BY

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ABSTRACT

The environmental impact of the construction industry is extensive and readily identifiable. One-tenth of the global economy is dedicated to construction, operating and equipping homes and offices. This activity accounts for roughly 40% of the materials flow entering the world economy. (Rodman and Lenssen, 1994)

Therefore, the construction industry must be responsible to the environment as well as our future generations. The industry will have to adapt the concept of sustainable construction in their practices.

Sustainable construction has different approaches and different priorities in various countries. Some of them identify economic, social and cultural aspects as part of their sustainable construction framework, but it is raised as a major issue only in a few countries.

This dissertation endeavours to interpret the concept of sustainable construction with respect to Hong Kong, to review the current status of sustainable construction in Hong Kong and to criticize current sustainable construction practices adopted by developers, architects, contractors and government bodies which represent the building sector because they are very important characters in construction.

To fulfill the objectives, research is carried out in four stages: literature review, questionnaire survey, face-to-face interview and a case study. Questionnaires are sent out to contractors and architects to collect information about the current situation of

sustainable construction in Hong Kong. Follow-up interviews with representatives from a real estate developer, a contractor, the Buildings department, the Architectural Services Department, the Environmental Protection Department and the Business Environment Council are conducted, which provide a valuable source of information to enable an in-depth study of the subject. A case study of The Science Park is conducted to demonstrate the ability of local building construction industry in the context of sustainable construction.

The results review that Hong Kong professionals generally lack knowledge in sustainable construction. Little incentives were offered by the Government to promote sustainable construction. Sustainable construction practices are exceptions rather than normal practices in building projects. However, The INTEGER pavilion project, the HK-BEAM scheme and together with the current legislations have demonstrated major steps towards sustainable construction by construction professionals and the Government in Hong Kong.

Finally, recommendations are drawn based on the results in order to achieve a sustainable built environment in Hong Kong.

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Mr. Patrick Mak	Gammon Skanska Ltd.
Mr. Calvin Leung	Business Environment Council
Mr. Lee Kin-hong	Buildings department
Mr. Wang Yuen	Environmental Protection Department
Ms. Cheng Ka-lai	Architectural Services Department
Mr. Tom Chapman	Swire Properties Limited

Last but not least, I would like to thank my parents, classmates, friends for their care and support. Without their encouragement, this dissertation could hardly be completed.

Special thanks to John Chan for his unconditional support.

Declaration

I declare that this dissertation represents my own work, except where due acknowledgment is made, and that it has not been previously included in a thesis, dissertation or report submitted to this University or to any other institution for a degree, diploma or other qualification.

Signed: _____

Name: _____

Date: _____

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Chapter 1 - Introduction

1.1 Background

In recent years, the unusual high average temperatures and rise in mean sea levels have generated much concern about the environment of our living place – The Earth. Moreover, the depletion of natural resources caused by human activity has made the environment even worse.

At the same time, industrial development has created unprecedented levels of welfare for people and society. Today most people enjoy a standard of living unthinkable 100 years ago. While people have experienced many improvements in their living conditions, health and material welfare, the world has seen many serious environmental side-effects of this development. (Berggren, 1999)

The term “Sustainable Development” was first used in a public context in the World Commission for Environment and Development (WCED) report *Our Common Future* in 1987 and was defined as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs”. (WCED, 1987, p.43) The sustainability concept has gained widespread acceptance as a model and philosophy for guiding community decision-making related to economic growth, environment preservation and quality of life.

The built environment is one clear example of the impact of human activity on resources. Buildings have a significant impact on the environment, accounting for one-sixth of the world's freshwater withdrawals, one-quarter of its wood harvest, and two-fifths of its material and energy flows. Structures also impact areas beyond their immediate location, affecting the watersheds, air quality, and transportation patterns of communities. (Rodman & Lenssen, 1994)

The environmental impact of the construction industry is extensive and readily identifiable. One-tenth of the global economy is dedicated to construction, operating and equipping homes and offices. This activity accounts for roughly 40% of the materials flow entering the world economy. (Rodman and Lenssen, 1994)

Therefore, the construction industry and the built environment are the main consumers of earth resources (energy, materials). The processes of construction and facilities operations are the key producers of solid waste (inert waste, non-inert waste, chemical waste and hazardous waste etc.) and at the same time emit gaseous pollutants such as carbon dioxide, sulphur dioxide etc. into the atmosphere. If resources are used effectively, wastes and gaseous emissions are controlled. Such actions would be the most important contribution to sustainable development.

Over past decades, Hong Kong has achieved tremendous economic and financial growth, yet there have been warnings that Hong Kong's less-than-perfect environment might make it increasingly difficult to attract overseas corporations to come to Hong Kong to establish a base in the territory. Decades of neglect have left Hong Kong with a first class economy but a third class environment. (Shen and Tam, 2002)

Construction is an indispensable part of growth and development, yet one with implications for the environment. In the early 1990s, the construction sector grew rapidly without any consideration of environmental factors, only focusing on the economic aspects of development. The selection of materials used for construction did not consider environmental effects, only speed and quality. Waste disposal was not well managed and contractors did not take recycling into consideration.

It is sometimes quite astonishing to international observers that in a modern city like Hong Kong, the way we build is still quite primitive when compared to western standards. Environmentally-unfriendly timber panels are used as formwork in a very large scale and extent, and labour-intensive operations such as the erection of formwork, fixing of reinforcing steel bars, placing of concrete, or other wet work like bricklaying or plastering still dominate most working locations within Hong Kong construction sites. (Chan, 2000)

Most people are not serious about environmental protection in construction sites. They assume that a construction site is only a temporary setup lasting for two to three years. In fact, the industry is a major source of urban air pollutants. (Chan, 2000) Buildings built without due consideration to energy, environmental impact and natural resources conservation result in detrimental wastage affecting our ecological integrity. Over thousands tonnes of inert construction waste is now being produced every day in the industry. (Shen and Tam, 2002)

The Hong Kong SAR Government first began its formal recognition of sustainable development in the early 1990s but its commitment as a matter of policy has been spearheaded by the infusion of environmental issues into the most recent review of

the Territorial Development Strategy. This commitment was taken a step further with the commissioning of the Study on Sustainable Development For the 21st Century (SUSDEV21) on 1 September 1997. The objectives of the Study are to raise public awareness about the concept, educate the people of Hong Kong about its importance and assist the Government in incorporating sustainable development into its policy, planning and development decisions. The study shows the intention of Government to promote Sustainable Development in Hong Kong and represents a first step in an ongoing process.

The Hong Kong SAR government has introduced series of environment laws in 1980s to control the activities of construction. The Environmental Impact Assessment Ordinance came into operation in 1998 to control the development of construction projects. However, those regulations do not necessarily imply that this form of intervention is optimal, or even desirable. Many people criticize that the penalties of breaking such ordinances are very low. Thus, most contractors are not afraid of being fined and continue unsustainable practice on site. In addition, contractors are seldom prosecuted because lack of enforcement and supervision by the Government.

The recent discovered case of “Tung Chung River” has demonstrated the weakness of ordinances and control over contractors. An environmental group revealed at early December 2003 that a contractor excavated 400 tonnes of boulders from the river between Shek Mun Kap and Shek Lau Po without a permit. Thousands of tonnes of soil were dredged from the river bed to make a road, reducing the width of the river from around 300 metres to just two metres. According to WWF Hong Kong, the

stream section between Shek Mun Kap and Shek Lau Po of the Tung Chung Stream supports at least seven species of native fishes.¹

According to the Land (Miscellaneous Provisions) Ordinance, the penalty for unlawful excavation activities on unleased land is a maximum fine of HK\$5,000 and six months in prison. "If offenders were only fined HK\$5,000, they could still make a huge profit by destroying the river for commercial purposes," Mr. Leung said.²

Tonnes of boulders were illegally excavated from the riverbed of the Tung Chung River, of which the Government owns the land title, and the boulders were then sold to a government contractor for construction of an artificial lake, resulting in serious ecological damage to the river. (SCMP, 2003)³ The removal of boulders from the river for the construction project nearby has damaged the local environment and endangers the existing ecology of Tung Chung River.

In order to protect our living environment and to become a World-Class City, Hong Kong's construction industry, as well as Government, should strive to keep pace with global trends in meeting the challenges of sustainable development.

¹ Extracted from News Archive, Dec 2003, *Urge for prompt action on habitat restoration of Tung Chung Stream*, WWF Hong Kong
http://www.wwf.org.hk/eng/conservation/intro/tcr_archive_151203.html Assessed on 31-3-2004

² Extracted from Interview with Mr. Calvin Leung, Business Environment Council

³ Extracted from South China Morning Post dated 2/12/2003

1.2 Research Aims

This study considers the views of different participants in the building industry and review what has been achieved so far and the strategies adopted by government and other bodies regarding sustainable development in construction. The overall objective is to promote sustainable construction in Hong Kong.

1.3 Research Objectives

Sustainable construction is a relatively new concept in the Hong Kong construction industry. The main objective of this research is to investigate the meaning of sustainable construction with respect to Hong Kong and to consider the practical implementation of sustainable construction in the construction industry.

Detailed objectives are:

1. To review the current status of sustainable construction activities in Hong Kong
2. To critique current sustainable construction practices adopted by developers, architects, contractors and government bodies
3. To identify major barriers towards sustainable construction
4. To demonstrate the ability of the Hong Kong building industry in the area of sustainable construction
5. To recommend further measures to achieve a sustainable built environment in Hong Kong

1.4 Research Methodology

In this dissertation, the research is carried out by four means: literature review, questionnaire survey, interviews and a case study.

This dissertation starts with a review of the evolving concept of sustainable development and sustainable construction. Global as well as local issues related to sustainable construction are reviewed in Chapter II and III.

To fulfill the first objective, questionnaires are sent out to randomly selected contractors, architectural firms to collect quantitative data regarding their impression of sustainable construction; their views regarding to government policy and the policy adopted by their companies towards sustainability.

Interviews are then conducted with different parties to clarify and reinforce the data collected in the questionnaire survey. The interviews enable a more in-depth study on the current situation of sustainable construction in Hong Kong; the collection of opinions regarding government policy in sustainable construction; and individual practitioners views on their roles on sustainable construction.

A case study is conducted on The Hong Kong Science Park (Phase I). This case study serves the purpose of demonstrate the ability of construction industry in Hong Kong.

1.5 Significance of the Study

Recognition of the importance of building and the construction sector for sustainable development is a topical issue among construction industries world-wide.

Not only can Hong Kong afford the damage caused by pollution to its citizens' living environment, it cannot attain a tarnished image as a global financial and commercial centre. A comprehensive strategy is necessary to prevent the situation from further deteriorating. Sustainable construction is therefore a challenge from which we have no escape. For the purpose of this dissertation, the construction industry is deemed to exclude the civil engineering but only building construction industry.

Chapter 2 - Literature Review

2.1 Definition of Terms

One of the big problems with sustainable construction is how different terms are understood. The terms ‘sustainability’ and ‘sustainable development’ are the biggest sources of confusion, but within the construction sector we find the terms ‘sustainable construction’ and ‘sustainable building’ rapidly expanding around the world.

a) Sustainability

Sustainability is the condition or state, which would allow the continued existence of human beings, and it is the goal we would like to achieve. However, survival alone is not enough, we also want a certain quality of life that meets our full hierarchy of needs. (Hills and Barron, 2002)

Ideally, the state of sustainability will allow all human beings to live a safe, healthy and productive life in harmony with nature and local cultural and spiritual values. In order to achieve this state, our relationship with the biophysical environment, as well as our socio-economic relationships will have to meet certain requirements. (Plessis, 2002)

Firstly we need to balance the needs of humans with the carrying capacity of the planet, and with the need to protect that capacity so that the needs of future generations can continue to be met. Then, we also need to achieve a measure of social and economic equity between individuals, as well as between communities, nations and generations. We therefore have to find a way to ensure that basic human rights are respected, and to equitably distribute wealth (in the form of access to resources and opportunities) and to increase prosperity for all. (Plessis, 2002)

b) Sustainable Development

Sustainable development may now be in the spotlight, but business people will know that the term has been around for over 20 years. It first broke into the consciousness of many international policy-makers and multinational corporations in 1987, with the publication of ‘Our Common Future’, which is commonly referred to as the ‘Brundtland Report’. The Commission’s definition, since widely adopted, was: “Development which meets the needs of the present without compromising the ability of future generations to meet their own needs.” (WCED, 1987)

The definition commonly adopted by most countries is the WCED’s definition. But there are other definitions: by the mid-1990s, there were over 100 definitions. Definitions, which are commonly adopted by researchers include:

“Development efforts which seek to address social needs while taking care to minimize potential negative environmental impacts have been called sustainable development.” (Hill & Bowen, 1997)

“The concept of sustainable development recognizes that human civilization is an integral part of the natural world and that nature must be preserved and perpetuated if the human community itself is to survive.” (National Park Service)⁴

“Sustainable development involves the simultaneous pursuit of economic prosperity, environmental quality and social equity. Companies aiming for sustainability need to perform not against a single, financial bottom line, but against triple bottom line.” (World Business Council for Sustainable Development)⁵

Sustainable Housing Forum in the United Kingdom suggests that many definitions have been attempted, but usually only in terms of future objectives rather than indicating what can be done to achieve these objectives. The Forum believes that sustainable development is development that is designed and built so as to:⁶

- 1) protect the environment, globally and locally, so that the critical life-support systems are maintained for present and future generations;
- 2) enable all people, now and in the future, to improve their quality of life through the pursuit of economic and social objectives, including social equity and environmental justice, in ways that simultaneously protect and enhance biodiversity, eco-systems, and the Earth’s life-support systems, in particular:
 - a) by reducing global warming emissions;
 - b) by improving energy efficiency;

⁴ National Park Service website, <http://www.Nps.gov/gpsd/ch1.html> [Assessed by 1-10-2003]

⁵ World Business Council for Sustainable Development website, Definitions, <http://194.209.71.99/aboutfn.htm#ps> [Assessed on 1-10-2003]

⁶ A Sustainable Housing Forum report (2003), Building sustainably: how to plan and construct new housing for 21st century, WWF-UK <http://www.wwf.org.uk/sustainablehomes/reports.asp> [Assessed on 20-1-2004]

- c) by reducing the consumption of natural resources and utilizing renewable alternatives, and minimizing waste.

The Study on Sustainable Development for the 21st Century in Hong Kong (SUSDEV21) was commissioned by the Government of the Hong Kong SAR in the autumn of 1997. The objectives of the Study are to raise public awareness about the concept, to educate the people of Hong Kong about its importance and to assist the Government in incorporating sustainable development into its policy, planning and development decisions. They define sustainable development as follow:

“Sustainable development in Hong Kong balances social, economic and environmental needs, both for present and future generations, simultaneously achieving a vibrant economy, social progress and better environmental quality, locally, nationally and internationally, through the efforts of the community and the Government.” (Planning Department, 1999) ⁷

The specific purpose of SUSDEV21 is the unique social, economic and geographical characteristics of Hong Kong must always guide the development of the tools. It proposes the scope and working definition of sustainable development in Hong Kong.

The above definitions implicate two important implications of the concept. Firstly, Sustainable Development is so broad an idea that a single definition cannot adequately capture all the nuances of the concept, but it is applicable to the whole world and anyone and anything on it, now and in the future. Secondly, there is no clear aim, but emphasis on the continuation of development.

⁷ Planning Department (1999), Sustainable Development in Hong Kong for the 21st Century, *Planning Department*, HKSAR[http://www.info.gov.hk/planning/p_study/comp_s/susdev/index_e.htm assessed on 2-10-2003]

The definition of sustainable development varies in detail from sector to sector and from author to author. There is no consensus on the definition of sustainable development nowadays. This dissertation adopts the most common definition of sustainable development, the Brundtland Report's definition - "Development which meets the needs of the present without compromising the ability of future generations to meet their own needs." More specifically, sustainable development in this dissertation means the optimal use of resources, protection of environment in the course of economic development, and advancement in different areas without sacrificing the development opportunity of the next generations.

c) Sustainable Construction

Having discussed, albeit briefly, the definition of the term "sustainable development", the focus of this dissertation is the concept of sustainable development in the building construction industry.

The term "sustainable construction" was originally proposed to describe the responsibility of the construction industry in attaining "sustainability". In November 1994, the First International Conference on Sustainable Construction was held in Tampa, Florida, USA. The major objective of the conference was "to access progress in the new discipline that might be called "sustainable construction" or "green construction" (Kibert, 1994a). The conference convener, Kibert (1994b) proposed that sustainable construction means, "creating a healthy built environment using resource-efficient, ecologically-based principles".

According to *MaSC: Profiting from Sustainability Guide*, published by BRE (Building Research Establishment), CAR (Cambridge Architectural Research) and Eclipse,⁸ sustainable construction sometimes termed the “triple bottom line”, being sustainable involves a commitment to:

- i) Economic sustainability – increasing profitability by making more efficient use of resources, including labour, materials, water and energy.
- ii) Environmental sustainability – preventing harmful and potential irreversible effects on the environment by careful use of natural resources, minimizing waste, protecting and where possible enhancing the environment.
- iii) Social sustainability – responding to the needs of people at whatever stage of involvement in the construction process (from commissioning to demolition), providing high customer satisfaction and working closely with clients, suppliers, employees and local communities.

A sustainable construction industry makes good business sense. It will provide better value, pollute less, help sustain resources and respond more effectively to stakeholders. It will improve quality of life now without compromising it for the future.

In 1995, at the Amsterdam meeting of The International Council for Research and Innovation in Building and Construction (CIB), the W82 commission team began

⁸ MaSC: Profiting from Sustainability Guide, BRE, downloaded from http://projects.bre.co.uk/masc/Guide_published_version.pdf

working on a project to investigate the issues of sustainable development as they related to the construction industry globally. The project involved experts from a number of countries and was conducted in a number of stages. The first task was to ask what each country or region understands by the term sustainable construction.

Sustainable construction adopts different approaches and is accorded with different priorities in different countries. It is hardly surprising that there are widely divergent views and interpretation as between countries, with marked differences between developed countries and developing countries. The developed countries are in the position of being able to devote greater attention to creating a more sustainable building stock by upgrading, by new developments or the invention and use of new technologies while developing countries focus more on social equality and economic sustainability.

As identified by Agenda 21 on Sustainable Construction, which is published by CIB, different countries have different definitions to sustainable construction. It is because the practices and culture of construction industry is different. For example,

- In some regions (e.g. China) the main issue is national and regional air pollution which gives rise to health risks. In other regions or countries the main priority is water pollution or diminished availability of potable water; in still others, primary issues are a loss of natural habitat, diminution of scarce materials or a lack of capacity to handle solid wastes. The variety of problems, and their pressing local importance, should not be allowed to cause global issues to be neglected, primarily greenhouse gas emissions and ozone depletion.

- Strategies for implementation of environmental initiatives must take due account of the economic and industrial context if success is to be achieved. For example, countries with mature market economies may find that measures to alter market demand are the most effective, whereas non-market countries, or those with partially developed market economies, may find regulation a more effective mechanism.
- Another factor to be considered in the sustainable construction is the nature and state of the new and existing building stock. In countries with mature development and low population growth, the main focus may be on developing strategies for enhancing the performance of the existing building stock. In high-growth countries, the improvement of new construction may be the priority.

Sustainable construction therefore is approached in various ways and with different priorities in different countries.

Many variables and their intrinsic importance differ from country to country. Features such as density and demography and natural hazards, availability of land and water, energy production and supply, the structure of the building sector or the quality of the existing building stock, etc., all exercise a degree of influence and interpretation in national approaches.

In the CIB Report Publication 225 “Future Studies in Construction”, it said, “Sustainable construction should be an important component of achieving sustainable development. However, no clear consensus on the exact meaning of such a concept seems to be agreed today.” (Bourdeau, L., *et al.*, 1998)

Again, there is no consensus on the definitions of sustainable construction. Furthermore, the element of poverty and underdevelopment are sometimes included in the definition of sustainable construction in some developing countries. This is clearly not the case of Hong Kong.

This dissertation adopted the Kibert’s definition of sustainable - “creating a healthy built environment using resource-efficient, ecologically-based principles”.

2.2 The significance of sustainable construction

a) Limited world resources

Based on the assumption of slowed population growth, steady economic development, and more resource-efficient technologies, the world’s ecological footprint will continue to grow between 2000 and 2050 from a level 20 per cent above the Earth’s biological capacity to a level between 80 and 120 per cent above it. In these scenarios, 9 billion people in 2050 would require between 1.8 and 2.2 Earth-sized planets in order to sustain their consumption of crops, meat, fish and wood, and to hold CO₂ levels constant in the atmosphere. (WWF Living Planet Report 2002)⁹

⁹ http://www.panda.org/downloads/general/LPR_2002.pdf Assessed on 1-12-2003

Taking water as an example, the world is facing a freshwater crisis. Only 2.5 per cent of the world's 1.4 billion cubic kilometers of water is freshwater, and 70 per cent of it is locked up in polar icecaps. The Earth's hydrological cycle constantly replenishes the freshwater supply, but less than 1 per cent of world's freshwater is available as a renewable resource. People already use over half the world's assessable freshwater, and may use nearly three-quarters by 2025. (WWF Factsheet)¹⁰

It is not only people who are threatened by water shortages and pollution. Freshwater ecosystems, which harbour the world's greatest concentration of species, are amongst the most vulnerable on Earth. Half the world's wetlands have been destroyed in the last 100 years.

The lack of basic environmental resources may exacerbate racial and ethnic tensions, resulting in the possibility of water wars.

b) The importance of the construction industry

Excessive resource and energy use and a growing demand for raw materials are largely responsible for the depletion of natural resources worldwide and the acceleration of global warming. 40% of the world's resource and energy use is linked to the construction and maintenance of buildings. Over 30% of conventional buildings have poor indoor air quality and we spend about 90% of our time indoors. (Global Green, USA)¹¹

¹⁰ <http://www.panda.org/downloads/freshwater/worldwaterforumwaterproblems.pdf> Assessed on 10-1-2004

¹¹ <http://www.globalgreen.org/programs/climate.html> Assessed on 10-10-2003

More than half of all resources consumed globally are used in construction, and 45 per cent of energy generated across the world is used to heat, light and ventilate our buildings, with a further 5 per cent arising from constructing them. (B. Edwards, 2001)

In 1950, one-third of the world's people lived in cities. Just fifty years later, this proportion has risen to one-half and will continue to grow to two-thirds, or 6 billion people, by 2050.(Habitat II)¹² In terms of population densities, spatial distribution, economic activity and social attitude, the world has become urbanized. After a half-century of intense global urban growth, the United Nations and its individual member states now recognize the powerful developmental role that cities play, as well as the challenges they face.

The construction industry and the built environment must be counted as two of the key areas if we are to attain a sustainable development in our societies. As an example, in the European Union, buildings are responsible for more than 40% of the total energy consumption and the construction sector is estimated to generate approximately 40% of all man-made wastes. In addition, the construction sector is the Union's largest industrial sector, contributing with approximately 11% to the GNP and having more than 25 million people directly and indirectly engaged. (CIB Publication 237)¹³

The construction industry plays a vital role in the global economy in terms of employment generation, fixed capital formation and its associated industry. The impacts of real estate development extend beyond its economic role. The physical and

¹² <http://www.unchs.org/unchs/english/hagenda/index.htm> Assessed on 11-10-2003

¹³ Agenda 21 on sustainable construction, CIB Report Publication 237, 1999

aesthetic impacts of buildings have a direct effect on the cultural basis of our cities and ultimately our society.

c) International drive for change

There are over thousands of organizations researching sustainable construction, excluding universities doing academic research on different aspects of sustainable construction like energy saving, waste treatment, developing tools, resources saving, etc.

CIB, (International Council for Research and Innovation in Building and Construction) recognized early on the importance of environmental concerns and commitment in all its activities. Working groups whose scopes and terms of reference bore a direct environmental significance and orientation were already being set up in the beginning of the 1980s. The recognition of the importance of the building and construction sector for a sustainable development to be attained, prompted CIB to select Sustainable Construction as the Theme for the period leading up to the CIB World Building Congress 1998 in Gävle, Sweden. (CIB, 1999)

Examples of sustainable construction practices come from the CIB Report Publication 225; extracts of case studies, which are presented in the national reports, are grouped together in the section “Better practice case studies”. The full case studies provide an insight into the many approaches people have taken to putting the theory of sustainable construction into practice. Altogether there are 59 examples coming from different countries present in the report and the case studies give example of what other countries doing and reflect the leading sustainable construction practices all

over the world. It is hoped that these examples will help shape and define the future direction of sustainable construction and encourage the wider application of sustainable construction practices.

The United States Green Building Council (USGBC) also organises Greenbuild, an International Green Building Conference and Expo annually. Professionals from around the world gather to advance the market and state-of-the-art green building. The conference provides an annual meeting place for the rapidly expanding green building industry. Greenbuild showcases the leading edge green technologies worldwide and delivers educational programs that highlight benchmarks of sustainability across a broad array of issues including site location and development, water use, energy, materials, indoor environmental quality, health and productivity and financing.

The drive for change in construction also comes from International meetings. There are several important milestones, namely The Rio Declaration, The Habitat Agenda 1996, and The 1998 World Building Congress.

In June of 1992, the United Nations Conference on Environment and Development held in Rio de Janeiro adopted five important documents, including the Rio Declaration and Agenda 21. These documents express new thinking about the sustainable development of human society, and reflect both political commitments at the highest level and a global consensus on the need for extensive cooperation with respect to the environment and development. Agenda 21 calls for all nations to develop and put into effect their own national strategies, plans and policies for sustainable development, and to be prepared to deal with the common challenges

facing humankind. Consequently, the implementation of Agenda 21 will not only help individual countries to embark on the path of sustainable development, but it will also be a new beginning for greater international cooperation, faster economic development and a better global environment.

The Habitat Agenda was adopted by 171 governments at Habitat II, Istanbul 1996. The Agenda provided a practical roadmap to an urbanizing world, setting out approaches and strategies towards the achievement of sustainable development of the world's urban areas. The habitat Agenda stresses the fact that the construction industry is a major contributor to socio-economic development in every country.

The 1998 World Building Congress was held in Gavle, Sweden. The Congress theme was defined as Construction and Environment. The ambition was to make the Congress the important vehicle in the work process as the means to be the stepping stone for the next goal – a global collaboration to attain a sustainable future in the construction sector.

It is also likely that sustainable construction will remain politically orientated at local, regional, national and global levels. In global terms we will all be aware of the commitments made at Rio in 1992, HABITAT II in 1996 and Gavle in 1998. The decisions and commitments made at these summits are already having an impact on national policy in terms of energy efficiency, habitat protection, pollution control and social provision. Initiatives more closely aligned with regional and local construction businesses include Local Agenda 21, another example of a key driving force for change.

2.3 Benefits of sustainable construction

a) Environmental Benefits

Clearly, construction plays an important role in reserving the earth's resources. More than half of all resources consumed globally are used in construction. (B. Edwards, 2001) The emission of CO₂ by buildings contributed to the global warming and extreme weather change all over the world. The harvest of timber leads to the loss of natural forests. Other impacts of constructing a new building include quarrying to provide aggregates, the wasteful use of water and the widespread use of toxic chemicals in materials.

b) Economic Benefits

It is often a misconception that sustainable construction leads to high construction cost. In fact, sustainable construction often needs a higher initial cost than traditional construction. It can be offset by the saving in energy and running costs of the building. However, due to many developers are not the end-users, they cannot enjoy the benefits derived from sustainable construction. Hence, economic constraints place a major obstacle to sustainable construction.

c) Social Benefits

In social terms, poor living conditions have major adverse impacts on the physical and mental health of residents. Traditionally, we failed to build housing in a way that put the needs of communities first.

Sustainable construction offers significant health benefits such as warm, well-ventilated and healthier indoor environments, with fewer toxic substances and less air pollution from buildings, therefore, increasing the productivity and quality of life.

d) Business Benefits

Sustainable construction makes good business sense. It will provide better value, less pollution, help save resources and respond more effectively to stakeholders. In addition, it also increases the wealth of a business by the following means:¹⁴

- 1) Cutting out waste in time, material and resources can be simple to implement and rewarding, resulting in:
 - Cost savings;
 - Reduced landfill disposal costs;
 - Reduced transport costs

- 2) Improving management of risk across your business can:
 - Avoid adverse publicity;
 - Avoid legal penalties and reduce injuries compensation;

- 3) As sustainability grows in importance, a business embracing these issues will be better positioned for the future, and can:
 - Deliver a competitive advantage;
 - Minimize the financial impact of future legislation;
 - Improve relationships;
 - Improve ratings with investors;

¹⁴ MaSC: Profiting from Sustainability Guide, BRE, downloaded from http://projects.bre.co.uk/masc/Guide_published_version.pdf Assessed on 1-11-2003

2.4 Barriers to sustainable construction

Typical concerns about sustainable construction are common to many industries or sectors that are well established. Why should I change? How can I profit and what will it cost me? Who are the key stakeholders in sustainable decision making process? Which construction activities contribute or conflict with sustainable development? What are the market potentials and competitive threats? Because of the nature of construction industry, such as inflexibility, reluctance to change, traditionalism, culture, long life of building, large number of actors involved, all mentioned factors reflect the barriers of sustainable construction in practice.

According to an OCED report¹⁵, barriers to improve the sustainability of buildings are as follows:

It is very difficult to compare the efficiency of buildings because of the heterogeneity of their design. Even there exists environmental concerned buyers, they often do not have sufficient information to make a rational choice.

The lower level of construction industry are characterized by the dominance of small-scale firms, which often do not have the technical expertise necessary to improve the energy efficiency of buildings.

It is often estimated that the additional cost for upgrading energy efficiency will be recovered through the reduced cost of energy in the long run. However, from the

¹⁵ Environment Policy Committee(2002) , Design of Sustainable Building Policies: scope for improvement and barriers, Organization for Economic Co-operation Development [http://www.oalis.oecd.org/oalis/2001doc.nsf/LinkTo/env-epoc-wpnep\(2001\)5-final](http://www.oalis.oecd.org/oalis/2001doc.nsf/LinkTo/env-epoc-wpnep(2001)5-final) Assessed on 15/1/2004

viewpoint of clients, there are several uncertainties – such as possible changes in energy prices and climate as well as changes of ownership – which lead clients to place a disproportional emphasis on the reduction of capital costs instead.

Because of the long life nature of buildings, existing buildings which are built with the ancient technology usually waste a lot of energy and are thus environmental unfriendly. Moreover, if the building is rented, owners of building have little incentive to improve the energy efficiency of their building.

Potential investors of buildings, most likely developers, have little incentive to consider the recyclability and reusability of building materials and components because demolition will take place in the distant future, often by other individuals or firms.

Lack of information provided for designers, owners and users of buildings on possible polluting emissions from building materials.

In a WWF report¹⁶, the barriers to sustainable construction include:

- i) a lack of fiscal incentives
- ii) current planning and building regulations not facilitating sustainable buildings
- iii) a perceived lack of investor support
- iv) a perception of extra cost
- v) a perceived lack of consumer demand

¹⁶ One million sustainable homes: Moving best practice from the fringes to the mainstream of UK housing, Jan 2004, WWF Report <http://www.wwf.org.uk/sustainablehomes/reports.asp> [Assessed on 20-1-2004]

In CIB report Publication 237, it also identifies main barriers to management and organization to progress in sustainable construction are essentially linked to

- i) professional and institutional inertia defending the status quo
- ii) a lack of understanding of the problem among construction professionals
- iii) inadequate or defective vehicles for participation by the stakeholders
- iv) market delay
- v) insufficient data
- vi) a lack of communication between data sets that do not exist
- vii) a lack of client “Buy in”
- viii) political insecurity (government electoral periods limit the horizon)

2.5 Importance of Government in sustainable construction

Local government constructs, operates and maintains economic, social and environmental infrastructure, oversee planning processes, establish local environmental policies and regulations, and assist in implementing environmental policies. As the level of governance closest to the people, they play a vital role in educating mobilizing and responding to the public to promote sustainable construction.

According to Barrett *et al*, 1999, Governments play an important role in the initiation and development of sustainable construction practices, and they develop environmental policy plans to define sustainability goals for future years. (Barrett *et al.*, 1999) The environmental policy plans have consequences for the future direction of both public and private organizations. In the plans a government will state what the

central, provincial and municipal authorities have to achieve in the field of sustainability and sustainable construction, and also what is expected of private parties in the construction industry.

Laws and regulations are a second element of a governmental sustainability policy: these are prescriptive and performance-based. Governments establish codes and levels of performance, and authorities and private organizations have to work within the boundaries of the rules. (Ngowi, A. B., 1998) In general, building regulation is the instrument that makes building reach predetermined levels of performance in the most certain way if they are effectively enforced. (OECD, 2003)

However, it is noteworthy that both Liso (2003) and Sanders and Philipson (2003) point to evidence that non-compliance with regulation is a significant problem.

Governments also use financial incentives and obstacles to reward environmental friendly initiatives and to hinder activities in other directions. (Raynsford, 1999) An example of an incentive is the municipal subsidy of energy efficient heating boilers, and an example of a financial obstacle is the increase in costs for dumping construction and demolition waste.

Another government sustainable construction policy commonly adopted by other countries is demonstration projects that are organized and subsidized by the authorities and authority-related organizations. In these demonstration projects the innovative sustainable construction options are tested, developed and prepared for use in sustainable construction projects all over the country. (Sha, K., Deng, X. and Cui, C., 2000)

Bossink (2002) mentioned that governments also use public-private arrangements to secure a certain level of sustainability in construction practices. In these agreements governments guarantee a part of the turnover of an entrant in the industry that is producing sustainable materials or is designing and building in a sustainable way. Another example is a government acting a major client in the development of sustainable construction projects, and facilitating, subsidizing and protecting sustainable initiative

Government may also acts as an information provider to help market participants to make rational choices. It is very important in sustainable construction since it always involves new technologies and the effect of construction materials on environment is often neglected.

2.6 Examples of sustainable construction practices in China and United Kingdom

a) China

China's sustainable construction is at an early stage of development. Most construction projects continue to use traditional building materials and processes, which make energy efficiency much less than that of development countries. Furthermore, the wasteful usage of resources and environmental degradation also are direct results. (Chen and Chambers, 1999)

However, the Chinese government has started to realize the environmental impact brought about by construction activities in recent years. In "The 1997 National Report

on Sustainable Development”, sustainable development has been taken as a major strategy of China’s development, and sustainable construction has been added to the agenda of Chinese government administrations and research and design institutes (State Council, 1997).

From the paper of Chen and Chambers (1999), the progress of implementation of sustainable policies and regulations has been very slow. The main reasons include the deep-rooted traditional ideas, unreasonable price system and the lack of economic motives. In addition, the lack of education in China results that many people are not aware of the severe environmental degradation and the concept of sustainable development.

In China, although efforts have been made to contribute towards sustainable development, showing that the construction industry is aware of its environmental impacts, the lack of an effective legal system and public awareness and government bureaucracy contribute to the difficulty of putting the vision of sustainable development into practice.

China has introduced its Local Agenda 21 in 1994 as a contribution to the international debate on sustainable development. It has indicated a vision of a strategy of synchronized developmental and environmental planning; a strategy, which would bring harmony of economic, social and environmental, returns. (State Council, 1994)

From the review of policy reports in China, it can be seen that Chinese government has realized the importance of sustainable construction. However, it is hard to find evidences to prove that China's construction industry has implemented their objectives or policies into practice.

b) United Kingdom

According to Raynsford (1999), wide arrays of measures have been or will be implemented in UK on its approach to sustainable development in construction. They included an integrated national transport policy, a national programme of CO₂ reductions from new (and possibly existing) buildings, a Social Exclusion Unit, a Welfare to Work programme, demonstration projects of sustainable construction, a new sustainable development strategy, dialogue with the construction industry, waste reduction schemes, landfill and aggregate taxes, improved management of water resources, an emphasis on whole life costs rather than initial capital costs of buildings and the development of sustainability indicator.

In 1997, the UK government already set up a Task Force of major construction clients to look at the scope for achieving improvements in value from construction. The Task Force led to a large number of demonstration projects to show the industry how to perform better. These projects are chosen using a range of criteria, and their contribution to sustainable development is taken into account. Already 47 projects, worth £1.4 billion, have been accepted from a range of clients, including the UK government.

In 2002, an energy tax for 2002 as well as an increase in the existing Landfill Tax has been launched in UK. Future budgets are likely to see provisions for other green taxes if industry fails to convince Parliament that it is not only trying to improve its environment performance but that it is succeeding.

The Office of the Deputy Prime Minister (ODPM) has launched the Sustainable Communities Plan, to enable the regeneration of key areas in a sustainable manner.¹⁷

The UK government has gone some ways towards recognizing the environmental and social impacts of buildings. In February 2003 it released the Sustainable Communities Plan: Building for the Future¹⁸, which sets out a number of policy directions intended to create “thriving sustainable communities”. Similarly, in its Energy White Paper¹⁹, the government sets out its aspiration to reduce carbon emissions from homes by 4-6 million tonnes a year by 2020.

There are examples of best practice in the UK that show that it is now possible to build houses which have zero carbon emissions. Water use is being radically reduced through innovative reuse and efficiency technologies. Renewable energy technologies are at a stage where they can play a major part in supplying domestic energy needs. New housing is being designed within communities that people like living in and which will be quality places to live for future generations. However, the problems are

¹⁷ BRE Website http://projects.bre.co.uk/envdiv/planning_sustainability Assessed on 30-10-2003

¹⁸ Sustainable Communities: Building for the Future, ODPM, February 2003 www.odpm.gov.uk
Assessed on 11-11-2003

¹⁹ Our Energy Future – creating a low carbon economy, February 2003
<http://www.dti.gov.uk/energy/whitepaper/ourenergyfuture.pdf> Assessed on 21-1-2004

that these examples are the exception rather than the rule when it comes to building new homes. (A sustainable Housing Forum Report, 2003)²⁰

Carillion is a large international construction service company in United Kingdom. The company has a sustainability programme with specific social and environmental targets that is monitored through yearly reports.

The company's head office purchases hydroelectric power and 100% of its electricity is renewable energy. It also makes a point to incorporate sustainable construction principles in its projects. These include re-use of construction waste and proper solid waste management systems on site. (Carillion, 2000)²¹

At the heart of the Peninsula, on 13 hectares (32.3 acres) south east of the Dome, The Millennium Village is one real example of sustainable construction to show people what can be achieved. It is being built as a part of the wider Millennium project for the regeneration of the Greenwich Peninsula – a former industrial area of derelict and contaminated land. It is a showpiece of environmental sustainability, embodying the highest quality of urban design as well as the most advanced ideas for energy and water efficiency and a radical approach to building new homes. New technologies such as combined heat and power facility, grey water recycling system are used. Greenwich Millennium Village is fitting houses and apartments with the latest water-efficient appliances to cut that wastage by a fifth compared to average water consumption on residential building.²²

²⁰ <http://www.wwf.org.uk/sustainablehomes> Assessed on 5-2-2004

²¹ Carillion, 'We look at the bigger picture.' Sustainability Report 2002 available online:

<http://www.carillionplc.com/sustainability/2kover/2kover.htm> Assessed on 10-3-2004

²² http://www.greenwich-village.co.uk/beta_rc1/default2.htm Assessed on 8-3-2004

The concept of sustainable construction is well-developed in United Kingdom. Many researches are carried out on sustainable construction by governments, construction firms as well as Non-Governmental Organizations such as Building Research Establishment Ltd. The UK Government has identified and implemented sustainable construction in its national policies and improving the environmental performance of the construction industry is already a stated objective of the UK Government.

Chapter 3 - The current situation of sustainable construction in Hong Kong

3.1 Introduction

One of the first official works on the subject of sustainability was a government commissioned consultancy study in 1997, the Study on Sustainable Development for the 21st Century (SUSDEV 21), which generated the following definition:

‘Sustainable development in Hong Kong balances social, economic and environmental quality, locally, nationally and internationally, through the efforts of the community and the Government.’

In Hong Kong, the best path to achieving sustainable development is unclear and the existing regulatory system is currently being questioned. Hong Kong seems to have adopted a cautious position as regards developing sustainability strategies consistent with Agenda 21. This position is reflected in a recent Government study carried out by the Planning Department: 'The Study on Sustainable Development for the 21st Century in Hong Kong' (SUSDEV21)

This study is said to be a 'first step', focusing on promoting public discussion of sustainable development rather than developing an actual strategy for its implementation or of the principles set out in Agenda 21. The study is thus preliminary in nature, directed toward making recommendations for change and

laying the groundwork for developing practical means to integrate sustainable development considerations into Government decision making and its institutional framework.

What is happening on the international stage in terms of sustainable construction and how do these developments affect Hong Kong? How is Hong Kong contributing to leading edge green construction? What about potential changes to the environmental regulation of the construction industry in Hong Kong? These and other questions are hot issues in Hong Kong's construction industry as Government and local industry strive to keep pace with global trends in meeting the challenges of sustainable development.

Sustainable construction is a relatively new concept in Hong Kong. At present a number of new factors are contributing to an emphasis on sustainability in the Hong Kong construction industry. Most significantly, the Government is taking steps toward developing practical means to integrate sustainable development considerations into decision making. It is thought that by doing so some 'competitive advantage' too might be gained from creating ecologically sound development projects and communities. Contributing to this thinking and interest has been a growing number of innovative partnerships and international competitions and conferences on sustainable construction.

What is the current situation of sustainable construction in Hong Kong? The answer to this question is summarized below.

3.2 Laws and Regulations

a) Environmental Legislation

The 1980s saw the introduction of a series of environment laws to control air, water and noise pollution, as well as provision of a framework for regulating waste disposal. Most of them can be categorized as command and control legislation, in that they prescribe polluting activities, impose penalties for breach of provisions and grant exemptions through issue of licenses. These ordinances have addressed the environmental problem generated from construction industry, especially construction site. They are enforced by the Environmental Protection Department (EPD), which included the followings,

i.) Air Pollution Control Ordinance (Cap. 311) 1983

This ordinance empowers the EPD to control air pollution from industry, commercial operations and construction work.

The contractor is required to implement a series of dust control measures to suppress dust emission arising from construction activities under the Air Pollution Control (Construction Dust) Regulation. The Regulation provides a detailed list of dust control measures namely, hoarding, water spraying facility, proper cover or enclosure, vehicle washing facility, etc for which the contractor has to implement for the specific type of work. The contractor is also required to observe other requirements under the Air Pollution Control Ordinance that are relevant to construction work, e.g. specified process, open burning, etc.

ii.) Noise Control Ordinance (Cap. 400) 1989

Neighbourhood noise and noise from construction, industrial and commercial activities are controlled by the Noise Control Ordinance. Neighbourhood noise in the context of providing quick relief to the public is generally controlled by the police.

With reference to construction noise, noisy construction work and the use of powered mechanical equipment in populated areas is not allowed between 7pm and 7am or at any time on general holidays, unless prior approval has been granted by the EPD through the Construction Noise Permit System. Hand-held percussive breakers and air compressors must comply with noise emissions standards and be issued with a noise emission label from the EPD. Percussive pile-driving is allowed on weekdays only with prior approval, in the form of a Construction Noise Permit from the EPD.

iii.) Waste Disposal Ordinance (Cap. 354) 1980

It is prohibited to dump waste in public places or on Government land, or on private premises without the consent of the owner or occupier. Waste normally generated from a construction site includes inert construction and demolition (C&D) materials (e.g. rock, soil, brick and debris), which should be disposed of at public filling areas, non-inert C&D waste (e.g. timber, glass, bamboo and other mixed materials), which should be disposed of at landfills

However, Landfills only accept C&D waste that contains less than 30% by weight of inert materials. C&D materials containing more than 30% by weight of inert materials will be rejected by the landfill gate staff. EPD recommends on-site sorting of construction waste before disposal. After sorting, the inert portion of construction waste (i.e. C&D materials) should be disposed of at designated public filling areas.

Under the Waste Disposal (Chemical Waste) (General) Regulation, anyone who produces chemical waste or causes it to be produced has to register as a chemical waste producer. Common examples of chemical waste generated from a construction site are spent lubrication oil, paint, organic solvent, battery acid, alkali and asbestos. The waste must be packaged, labelled and stored properly before disposal. Only a licensed collector can transport the waste to a licensed chemical waste disposal site for disposal. Chemical waste producers also need to keep records of their chemical waste disposal for inspection by EPD staff.

iv.) Water Pollution Control Ordinance (Cap. 358) 1980

All discharges, other than domestic sewage to a foul sewer or unpolluted water to a storm drain, must be covered by an effluent discharge license.

Construction site effluent may contain silt, sand, gravel or many other types of pollutants. Indiscriminate discharge of untreated or partially treated wastewater will have a major adverse impact on the receiving water bodies. Common pollution threats include silts in drainage pipes that may lead to blockage and eventually flooding risks; hazard to aquatic life and increase in turbidity of the receiving water, which may adversely affect the ecosystem.

The main types of discharge of concern at a construction site would include

- a) Excavation work / Bore piling - muddy water, bentonite
- b) Dust control - site washing and vehicle washing

- c) Site Facilities - canteen and toilet effluent, other than domestic sewage into foul sewers
- d) Surface run-off - contaminated rainwater.

If a construction site makes a discharge including any of the above types of discharge, a licence from the Environmental Protection Department is needed.

v.) Ozone Layer Protection Ordinance (Cap. 403) 1989

This ordinance controls the production, import and export of products containing ozone-depleting substances, and the recycling of ozone-depleting substances.

vi.) The Environmental Impact Assessment Ordinance (Cap. 499) 1998

The Environmental Impact Assessment Ordinance is to avoid, minimise and control the adverse impact on the environment of designated projects through the application of the environmental impact assessment process and the environmental permit system.

The Ordinance comes into operation on 1 April 1998. Designated projects specified under Schedule 2 of the Ordinance, unless exempted, must follow the statutory environmental impact assessment (EIA) process and require environmental permits for their construction and operation.

Schedule 2 of the EIA Ordinance covers major development projects including infrastructural projects, reclamation, power plant, etc. and projects close to environmentally sensitive areas like Country Parks, Site of Special Scientific Interest. Residential development of not less than 2000 flats and not served by public sewage networks by the time a flat is occupied also needs to have an EIA Study.

Designated projects specified under Schedule 3 of the Ordinance require approved environmental impact assessment reports but will not require environmental permit. The provisions of the Ordinance are enforced by the Director of Environmental Protection.

Once approved, the EIA report will be placed on the Register established under the Ordinance, and could be referred to in subsequent applications. The public and the Advisory Council on the Environment (ACE) will have the opportunities to be involved at an early stage of the statutory EIA process.

There will also be an opportunity under section 7 of the Ordinance for the public and ACE to comment on the EIA report before it is approved.

The above ordinances provide the statutory framework to protect our environment. However, they are criticized about apparently the lack of enforcement since these ordinances are enforced by the Environment Protection Department. The EPD has other major functions besides a prosecutor. Also, the EIA reports are so technical that public and even councilors cannot understand the contents.

Although the HKSAR Government has had a later start than other countries such as the UK and the US in terms of environmental regulation of the construction industry, it is argued that Hong Kong lacks an integrated pollution control approach to environmental regulation of the construction industry. It indicates that Hong Kong may be somewhat behind in its approach to environmental regulation.

At present, rather than using an integrated approach to pollution control, Hong Kong uses a medium by medium system of control. Essentially, pollution is regulated according to five large categories or media: air, waste, noise, water and land. According to this approach there is a penalty and registry system for respective media. The Government has been criticised for using this system and for its associated complexity. (Chan, 2000)

However, despite the existing fragmentation, some claim that environmental regulations are moving toward increased integration. For example, the recent Environmental Impact Assessment Ordinance (Cap 499) has been described as a major step forward in integrating environmental controls and dealing with pollution in a more rational way.

b) Building energy codes in Hong Kong

For energy efficiency in buildings in Hong Kong, the 1990s is a period of fundamental change in policy instruments and agency responsibilities. For instance, the Energy Efficiency Advisory Committee was set up in 1991 (it was later transformed into the Energy Advisory Committee in 1996) and the Energy Efficiency Office, the government's technical agency, was established in 1994. A number of tools and programmes have been implemented to encourage energy awareness (Hui, 1999).

Building (Energy Efficiency) Regulation (Hong Kong Government, 1995), which came into operation on 21 July 1995, is the first set of legislation in Hong Kong to control energy-efficient design in buildings. It specifies statutory control on the design of building envelope of new commercial and hotel buildings by using the overall

thermal transfer value (OTTV) method (Building Authority, 1995). Lam and Hui (1996) have reviewed and analyzed the method, which is also being used in Singapore, Malaysia, Philippines and Thailand. It was found that the OTTV method emphasizes the control of solar heat gain and is applicable, in principle, to warmer climatic regions of the world, which have large energy requirements for air-conditioning. As compared with some comprehensive building energy standards which adopt a whole-building energy budget approach, the OTTV method is easier to understand and simpler to implement.

Apart from the building envelope standard, four sets of energy efficiency codes of practices for building services design have been prepared. The following table shows the current status of the building energy codes. These building energy codes were implemented initially on a voluntary basis, but they will be examined whether they should be put on a mandatory basis in the coming future.

Table 3.1 Building energy codes in Hong Kong

Code	Year implemented	Status	Scope
OTTV (building envelope)	1995	Mandatory	Commercial buildings and hotels
Lighting	1998	Voluntary	All buildings except domestic, industrial and medical ones
Air-conditioning	1998	Voluntary	All buildings except domestic, industrial and medical ones
Electrical services	1999	Voluntary	All buildings except special industrial process
Lifts and escalators	2000	Voluntary	All buildings except special industrial process

Source: Energy Efficiency and Environmental Assessment for Buildings in Hong Kong

c) Joint Practice Notes

To protect and improve the built and natural environment, the Buildings Department (BD), the Lands Department (LandsD) and the Planning Department (PlanD) promote the construction of green and innovative buildings by issuing a series of Joint Practice Notes. The first Joint Practice Note was issued in Feb 2001. Following by that, the second was issued in Feb 2002. The third came into effect in Aug 2003.

The First Joint Practice Note (JPN1) sets out the incentives government would provide to encourage the incorporation of these features in building development, and the procedures for application for them under the Buildings Ordinance, the Lease Conditions and the Town Planning Ordinance, where relevant.

Under JPN1, Green features may be excluded from Gross Floor Area (GFA) and/or Site Coverage (SC) calculations. These features include balconies; wider common corridors and lift lobbies; communal sky gardens; communal podium gardens; acoustic fins; sunshades and reflectors; wing walls, wind catchers and funnels.

However, the cumulative GFA exemption for all the green features, excluding sky and podium gardens, should not exceed eight per cent of the total permitted GFA.

Where an exemption results in an increase in building height/SC which exceeds the restrictions under the town plan, application to the Town Planning Board for minor relaxation, if there is such a provision under the plan, would be required.

The Second Joint Practice Note (JPN2) also sets additional green features that may be exempted from Gross Floor Area (GFA) and/or Site Coverage (SC) calculations. These features included non-structural prefabricated external walls, utility platforms, mail delivery rooms with mailboxes, Noise barriers and communal sky gardens for non-residential buildings.

The Third Joint Practice Note (JPN3) is set to provide a client-oriented service in helping applicants to obtain the relevant planning, land and building approvals. A task force comprising senior officials of the three departments has been formed to study measures to re-engineer and streamline approval process. Thus, innovative design can be submitted early and processed in a faster way.

Then, someone may argue that the government offers incentives for private developers. In other words, HKSAR government uses taxpayers' money to benefit the developer. The interest of general public is derived from the loss of revenue generated from the GFA lost. This violates the social principle of the sustainable development.

However, there is another view. The general public benefits from having a better environment for their own enjoyment. Also the government is playing a leading role to make Hong Kong as one of the sustainable cities on the world. Therefore, the general public also enjoys the reputation gained.

Unfortunately, existing legislation appears to be ineffective. As the situation stands at the moment, it is still cheaper to pay a fine of a few tens of thousands of dollars for an offence than to incur a penalty for not finishing a contract on time. Month after month, the same companies appear in court including Gammon, Paul Y-ITC, China State Construction Engineering Corporation and other large contractors, which are some of the worst repeat offenders.

3.3 Partnerships

a) Environmental Protection Department and Hong Kong Construction Association

Besides enforcing the environmental legislation, another major policy adopted by the Environmental Protection Department (EPD) is partnership with local industries.

EPD and Hong Kong Construction Association (HKCA) in 2001 recognized the need to intensify the co-operation and therefore formalize a Partnership Programme targeting issues for the changing environment. The Partnership Programme, aiming to help minimize environmental nuisance and public complaints, improves the environmental conditions at construction sites.

A website of Green Construction Example has been developed under the Construction Partnership Programme, which is led by the Hong Kong Construction Association and the Environmental Protection Department, and sponsored by the Business and Services Promotion Unit of the Commerce, Industry and Technology Bureau.

It aims to provide a platform for construction companies and developers to share with the trade and the public the positive measures they have taken to reduce the dust, noise, waste and water pollution associated with construction activities.

However, it seems not an effective measure to promote green construction. There are only 16 examples, which are divided into 5 categories, namely air, noise, multimedia, water and waste. In the category of air, only one green construction example is shown. The extremely low submission cases reflect the inertia of construction industry. Also, the information shown on the website is very limited. It looks like showing green construction examples to the public rather than for contractors to make use of that information to make their decision.

Another example of the partnership's activities is the Green Construction Equipment Website. It is an information centre for green construction equipment, to which construction companies and developers can refer for identifying equipment suitable for reducing environmental pollution associated with various construction activities. However, none of the construction equipment manufacturers or vendors have posted their green equipment information onto the Green Construction Equipment website.

Other activities arising out of the partnership programme includes:

- i.) a handy pocket handbook containing useful green tips for quick reference by frontline construction workers;
- ii.) a 'Train-the-Trainer' compliance assistance CD-ROM package to facilitate the construction companies to conduct their in-house staff training;

- iii.) the first of a series of videos on environmentally-friendly good construction practices - Construction Dust Minimization (in collaboration with the Vocational Training Council);
- iv.) a tailor-made course for site foremen on the requirements of the environmental legislation (in collaboration with the Construction Industry Training Authority);
- v.) a workshop in July 2002 for the launching of the educational packages for the industry;
- vi.) a series of theme posters to promote environmental awareness;
- vii.) the Best Practice Guide for Environmental Protection on Construction Sites;
and
- viii.) a conference in November 2002 as the highlight of the Partnership Programme

b) The INTEGER Hong Kong Pavilion Project

The INTEGER Hong Kong Pavilion is an exhibition demonstrating how intelligent and green technologies can deliver better value and performance in housing. Its main themes are innovation in construction, technology and environmental performance. It was initiated by the Hong Kong SAR and the British Government, INTEGER Intelligent & Green Ltd., Swire Properties Ltd., Gammon Skanska Ltd., CLP Power Hong Kong Ltd., the Hong Kong Housing Authority, the Hong Kong Housing Society and The Hong Kong Jockey Club. Among them, these founders raised some HK\$40 million to allow construction of one of the most innovative buildings in the world to commence in January 2001.

The Pavilion features two demonstration flats, a lift lobby, a sky garden and an exhibition area that promotes and demonstrates energy and water conservation, control of the internal environment, pre-fabricated building systems and new technologies.

Construction of the INTEGER Hong Kong Pavilion took place over ten months, and at the beginning of November 2001 the completed building was opened on the historic Tamar Basin site until 31 December 2002, and was used as the focal point for an extensive research, education and communications programme showcasing the best intelligent and green buildings in the world.

Environmental features showcased in the INTEGER Hong Kong Pavilion include:

- i.) Computer-controlled energy efficient central air conditioning
- ii.) Photovoltaic cells to generate electricity
- iii.) Special sun shading louvers
- iv.) Natural ventilation
- v.) Infra red filtering glass and special sun shading louvers to reduce the need for air conditioning
- vi.) Grey water recycling and water efficient taps and sanitary fittings
- vii.) Centralized recycling waste disposal

Prefabricated building methods also substantially reduce construction waste and water usage, minimize noise pollution and cut on-site construction time by up to 15 percent.

The INTEGER has incorporated many innovative ideas into construction, sustainable materials, green technologies, intelligent systems, and the layout, orientation, shape

and appearance of a residence. The INTEGER is meant to showcase the technologies of the future while serving to educate both professionals and the public on a variety of topics including 'intelligent services', environmental technology and 'social change and housing'. It is an important milestone in Hong Kong towards sustainable construction.

3.4 Environmental Assessment Methods in Hong Kong

With more and more people concerning the environmental impacts of building and construction, some methods have been developed in the world for the evaluation of building environmental performance (Cole, 1999). The assessment of building environmental performance covers a wide range of issues and may involve a number of technological, ecological and socio-cultural factors (Hui, 2002). Although there is still a lack of agreement on the scope of assessment, the building's energy efficiency or performance usually forms a key element in the assessment process.

In the past few years, several methods have been developed and/or used in Hong Kong for assessing the environmental performance of buildings or building projects. The following table shows a summary of the assessment methods and their related websites on which further details can be downloaded. Although the general goal is similar, the specific approach and criteria taken by each method can be very different.

Table 2.2 Environmental Assessment in Hong Kong

Assessment method	Year
Hong Kong Building Environmental Assessment Method (HK-BEAM) http://www.hk-beam.org/standards/buildings.php i.) New building developments (Version 4/03) ii.) Existing building developments (Version 5/03)	1999 (Revised at 2003)
Green Building Tool (GBTool), 2000 & 2002 versions (used for assessment of building projects for Green Building Challenge) http://greenbuilding.ca	2000 & 2002
SPeAR (Sustainable Project Appraisal Routine) (used for assessment of some housing projects) http://www.arup.com/environmental/HTML/WhatWeDo/SPeAR.htm	2000

Source: Energy Efficiency and Environmental Assessment for Buildings in Hong Kong

a) Hong Kong Building Environmental Assessment Method (HK-BEAM)

The Hong Kong Building Environmental Assessment Method (HK-BEAM) was developed and implemented since 1996. It is derived from the Building Research Establishment Environmental Assessment Method (BREEAM) in UK and has been adapted with local settings (Baldwin, *et al.*, 1998). Three versions of HK-Beam were launched in the past few years, which covered new and existing office buildings and residential buildings. At present, some 80 buildings have been assessed, comprising over 3.6 million m² of office space and 30,000 residential units. ²³

With the introduction of the latest HK-BEAM standard, its scope has been expanded to cover all building types, including commercial, residential, institutional, hotels,

²³ Website of HK BEAM Society <http://www.hk-beam.org/certified/buildings.php> Assessed by 13-3-2004

composite and naturally ventilated buildings for which new building designs are certified under HK-BEAM for New Building Developments (Version 4/03) and existing premises are assessed under HK-BEAM for Existing Building Developments, (Version 5/03).

The HK-BEAM framework of best practice environmental criteria appraises and promotes building design, construction and management innovations on a life cycle basis.

- i.) Site Planning and Layout including noise, air and water pollution, ecological value, accessibility and the local micro-climate;
- ii.) Building & Premises Design including solar heat gains, daylight, ventilation, energy efficiency, flexibility, waste recovery, and landscaping
- iii.) Material Use & Specification to encourage more sustainable, recycled and recyclable materials, and avoid ozone damaging and hazardous ones
- iv.) Construction Practice using an Environmental management plan to control noise, air and water emissions and solid wastes
- v.) Operation and Maintenance including testing and commissioning, maintenance facilities, and Tenant/Owner Handbook

b) The Green Building Tool (GBTool)

The Green Building Tool (GBTool) is the software implementation of the Green Building Challenge (GBC), which aims to develop a comprehensive, generic framework for sustainability assessment (Cole, 2001). Through international collaborative efforts, case study buildings from different countries have been

evaluated and discussed. Hong Kong has participated in the GBC in 2000 and 2002. Therefore, a few building projects in Hong Kong have been selected and assessed using the GBTool.

c) The Sustainable Project Appraisal Routine (SPeAR)

The Sustainable Project Appraisal Routine (SPeAR) was developed by a private consulting firm in UK (Arup) and was adapted by its branch office in Hong Kong for the assessment of some housing projects. The projects were scored using a set of indicators, originally based on the criteria set out in UK and have been tailored to suit the task of appraising the sustainability of individual projects. Each indicator is scored on a scale ranging from 'optimum case' to 'worst case' scenarios. (Hui, 2003)

Chapter IV The Questionnaire Survey

In the previous chapters, the concept of sustainable construction and related issues are reviewed. The major developments of sustainable construction in Hong Kong are also reviewed. The next step is an in-depth study on the current status of sustainable construction in Hong Kong.

4.1 Research Objectives

The questionnaire survey is developed with the aim of investigating the current situation of sustainable construction in Hong Kong. As the concept of sustainable construction is theoretically reviewed in previous chapters, it is desirable to gain an insight of the perceptions held by construction practitioners who have real experiences on these issues. Therefore a questionnaire survey is conducted with the main objectives being:

- i.) To investigate the general knowledge of sustainable construction in construction professionals
- ii.) To review the response from practitioners regarding Hong Kong SAR government's initiatives
- iii.) To explore the strategy adopted by construction firms in sustainable construction
- iv.) To investigate the attitude of construction professionals towards sustainable construction

4.2 Research Methodology

A total number of 100 questionnaires are sent by facsimile to architectural firms, contractors, structural engineering firms and quantity surveying firms to gather the opinions of different professions in order to achieve the above objectives. Developers are excluded from target groups since the number of developers in Hong Kong is very few.

Most of the questions are closed-ended questions and the respondents only need to tick the boxes next to the answers. The questions are designed to be short, simple and straightforward with sufficient guidance in answering the questions so as to avoid ambiguity and vagueness.

Apart from this, some questions are set by a scale called the Likert Scales. It is used to assess the attitudes or values of the statements by asking the respondents to rank the choices so that their ranking can show their preferences. In case of this type of questions, the corresponding numbers representing the choices are added up. A circle in the bracket enumerated 1 (not significant) is given a score of 1 whereas a circle in "5" (the most significant) is given a score of 5 and so forth. The summation of all the numbers give the overall score in total which are then divided by the total number of respondents to give the average score (AS) of that particular option.

4.3 Structure of the Questionnaire

This questionnaire is divided into five parts,

Part I – Background

The first part of the questionnaire helps to collect background information of the selected companies. Questions about the size of the companies and the post of the respondents were asked.

Part II – General knowledge

This part focuses on the general knowledge of sustainable construction in professionals. As sustainable construction is a new concept, questions such as the terms related to sustainable construction and the elements in sustainable construction were asked.

Part III – Government support

This part focuses on the impression of Hong Kong SAR government on sustainable construction. Questions such as any incentives received by respondents regarding sustainable construction were asked.

Part IV – Strategy

This part focuses on the strategy adopted by the respondents' firms in sustainable construction.

Part V – views/comments

The respondents were requested to give some views/comments on issues related to sustainable construction. At the end of the questionnaire, there is an open-ended space for the respondents to give their comments.

4.4 General information of the respondents

A total number of 22 questionnaires were completed and returned, representing a response rate of nearly 20%. There are 11 completed questionnaires from architectural firms, 9 completed questionnaires from main contractors, 1 completed questionnaire from a structural engineering firm and 1 questionnaire received from a quantity surveying firm.

Therefore, the questionnaire results are divided into 2 categories, 1) Architectural and 2) Construction to represent two different sectors in the construction industry.

4.5 Results and Analysis of the Questionnaire Survey

The data collected from the returned questionnaires is summarized for analysis in the following paragraphs. For dichotomous questions, such as ‘yes’ or ‘no’ responses, the responses are analyzed in terms of number of respondents or percentage. For questions using Likert Scales, diagrams or graphs are used to indicate the natures of distributions of the data.

a) Part I – Company background information

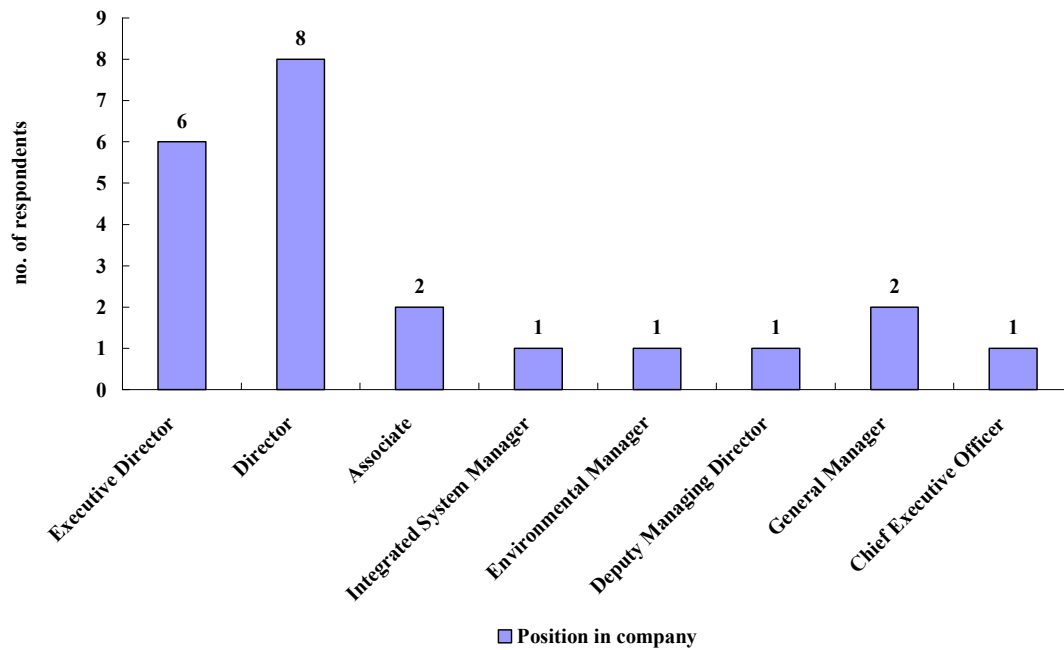


Fig. 4.1

Figure 4.1 shows that all respondents are at the managerial level of their company. Among those respondents, there is one environmental manager and one integrated system manager. It reflects a small portion of companies have shown their interest in environment and thus they have created those posts in their companies, amounting to 10% of the respondents.

Size of Company

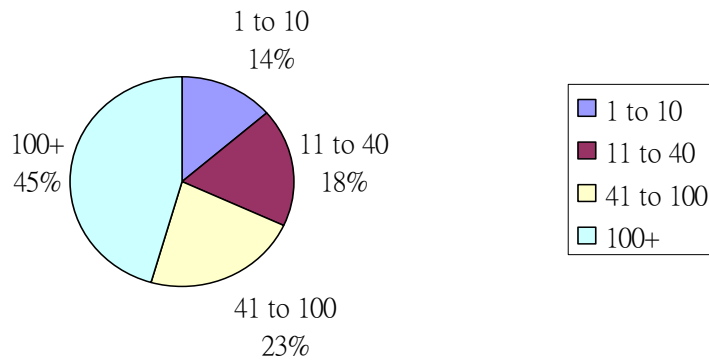


Fig. 4.2

Figure 4.2 shows the distribution of size of firms from the respondents in terms of employees. Nearly half of the respondents come from those large firms in Hong Kong with over 100 employees.

b) Part II - General knowledge

Understanding of terms used in sustainable construction

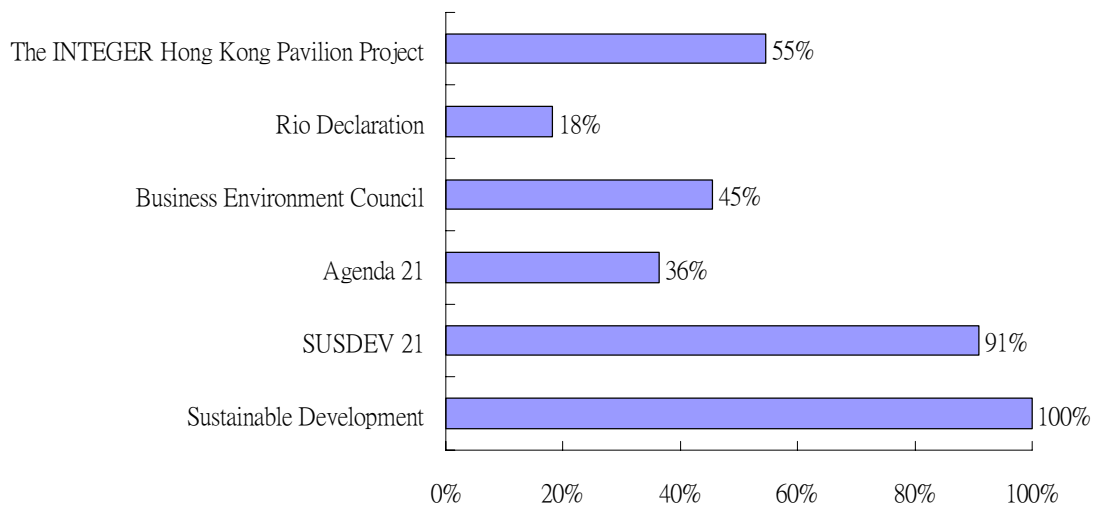


Fig. 4.2a (Architectural sector)

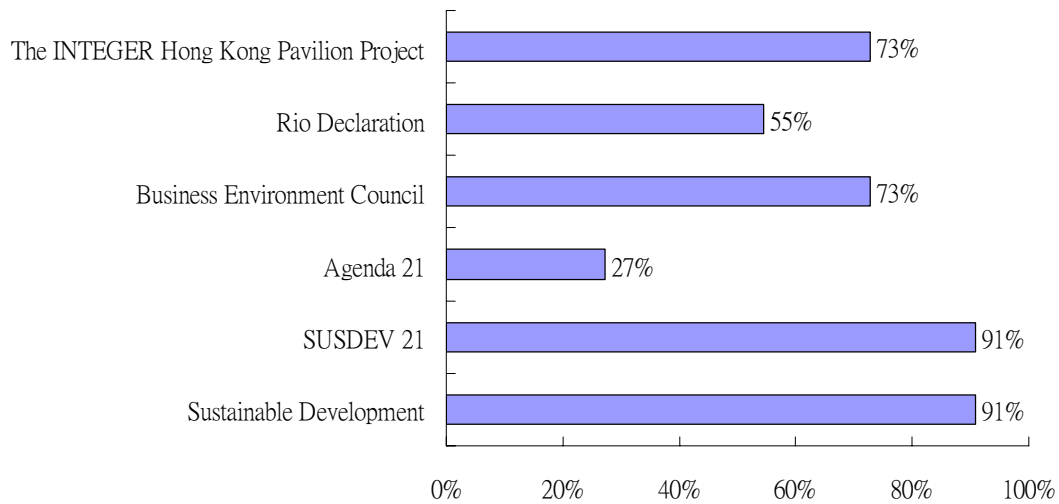


Fig. 4.2b (Construction sector)

The charts show that over 90% of respondents have heard about the terms sustainable development and SUSDEV21. Other terms such as Rio Declaration and Agenda 21 were not recognized by construction professionals and less than 50% of respondents have heard those terms on average. This can be explained by the lack of understanding of global issues among Hong Kong construction professionals. When asking about the local organization Business Environment Council, there were still over 50% of architectural firms that did not heard about it, whereas 30% of construction firms neither. Business Environment Council is a non-profit organization, which provides support for organizations to achieve sustainable development. They have established a centre of sustainable buildings and construction which is offering information to construction professionals.

Definition of sustainable construction

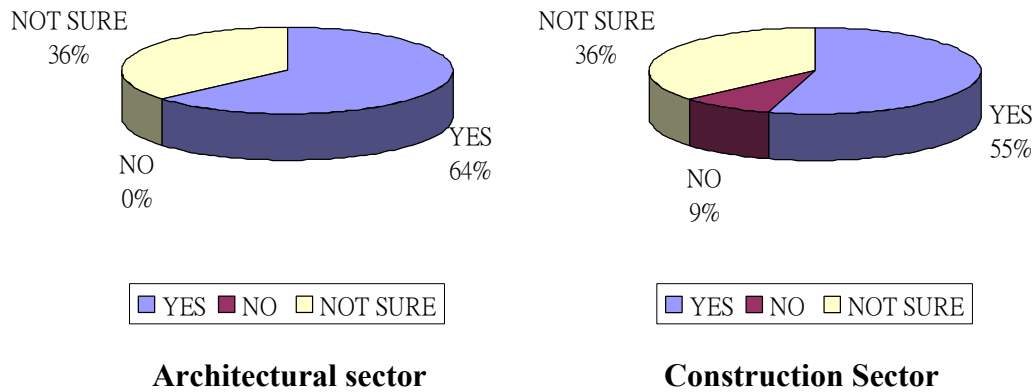


Fig. 4.3

When asking about the definition of sustainable construction, 36% of respondents are not sure about the definition. Again, it reflects the lack of general knowledge of sustainable construction among professionals. Except one respondent, others agreed to the definition used in this study, sustainable construction means, “creating a healthy built environment using resource-efficient, ecologically-based principles”.

Have they read any materials related to sustainable construction?

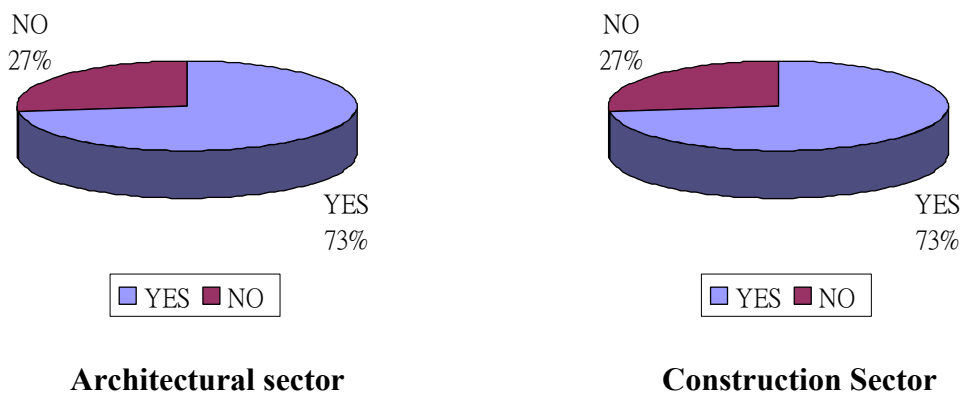


Fig. 4.4

Fig. 4.4 shows that both sectors have 27% of respondents have not read any materials related to sustainable construction. It is consistent with the view that sustainable construction is a new concept in Hong Kong.

c) Part III – Government support

Views from respondents on Government's attitude

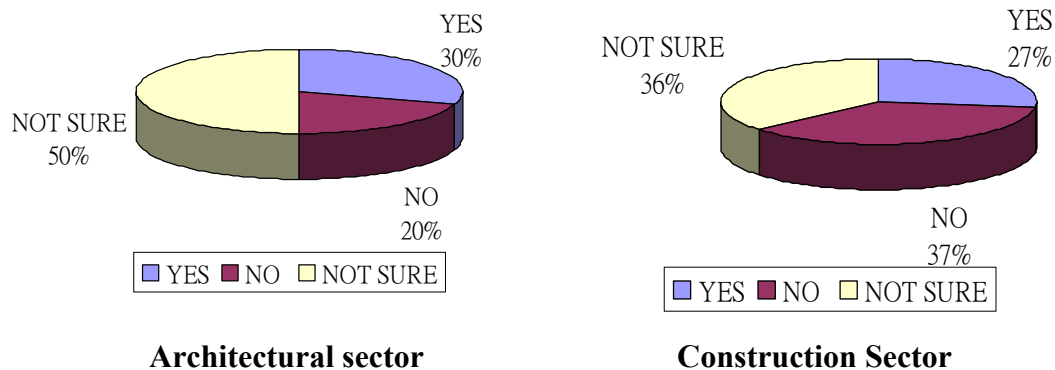


Fig. 4.5

Only 30% of respondents from architectural sector and 27% of respondents from construction sector think that Hong Kong SAR Government is moving towards sustainable construction. One respondent from architectural sector comments the Government as “appear to be, but not fully aware of the methodology”.

8 out of 11 respondents from construction sector, representing a 73% in total, indicates they follow the “Best Practice Guide for Environmental Protection on Construction Sites” issued by the Environmental Protection Department. On the other hand, only 27% of respondents from construction sector have joined the “Green Contractor Award Scheme” organized by the Architectural Services Department. These two questions are not applicable to architectural sector.

Incentives offered by Government

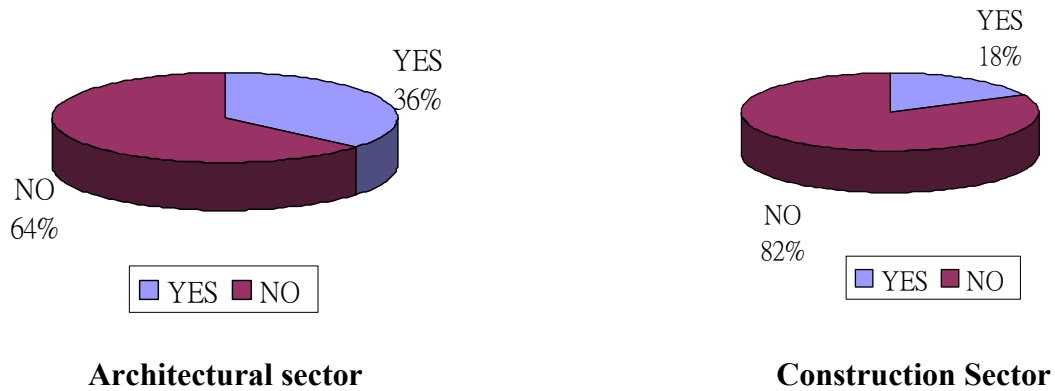


Fig. 4.6

The charts show the majority of respondents did not receive any incentives offered by the Hong Kong SAR Government related to sustainable construction.

Efforts by Government

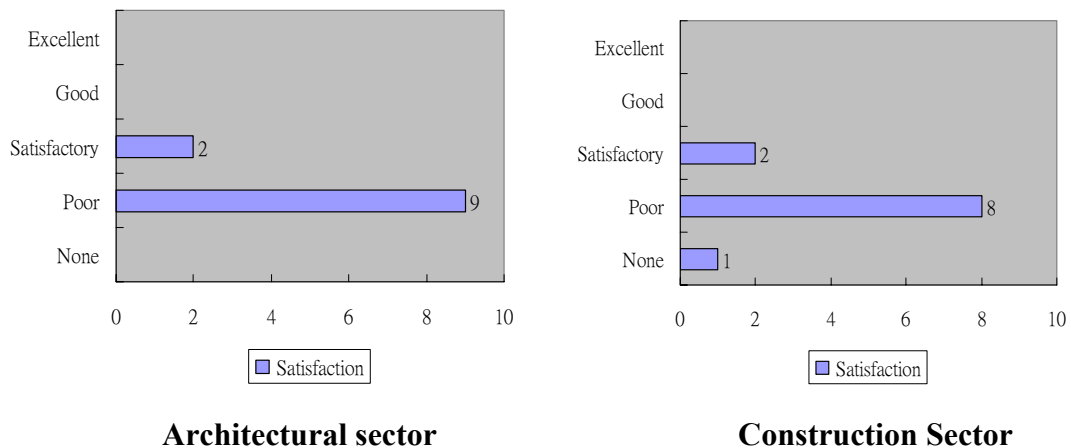


Fig. 4.7

When asking about the efforts made by the Hong Kong SAR Government in promoting sustainable construction, 17 out of 22 respondents, about 77%, regard the Government has poor performance in total. Only 4 respondents are satisfied with the Government's performance whereas 1 respondent said nothing has been done by Government to promote sustainable construction.

d) Part IV – Strategy

Are Hong Kong construction firms environmental friendly?

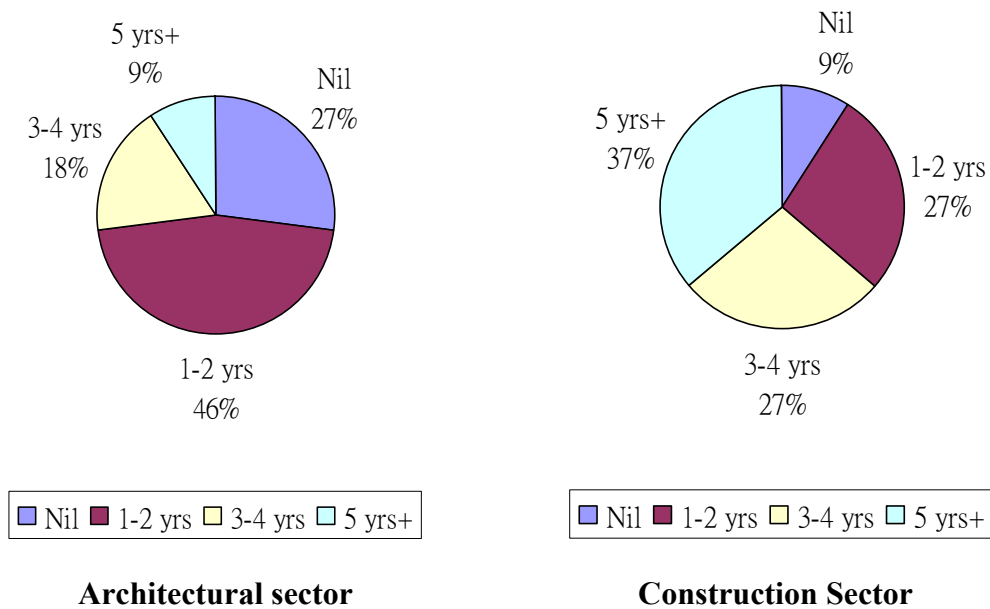


Fig. 4.8

The charts show that 37% of respondents from construction sector have adopted an environmental approach in their companies for more than 5 years, compared to 9% in architectural sector. Overall, the majority of firms have only 1-2 years experiences of practicing green in their companies. There are still 27% of architectural firms and 9% of construction firms not considering environment in their company's strategy.

ISO 14001 accreditation

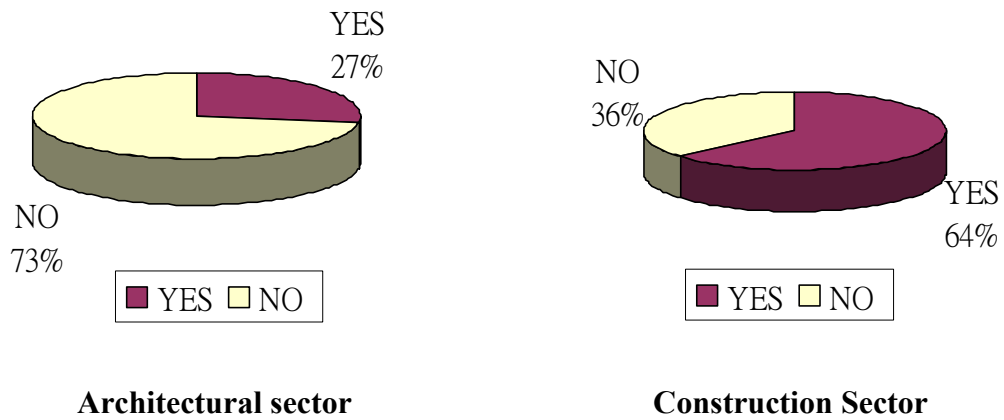


Fig. 4.9

Again, 64% of respondent's firms from construction sector have achieved ISO 14001 accreditation, whereas only 27% of architectural firms have achieved the accreditation too.

For construction firms, 81% of them have attempted to re-cycle materials on construction projects and 91% separate recyclable and non-recyclable materials in their waste. These figures represent recycling is already a common practice in our construction industry.

Training courses on environment

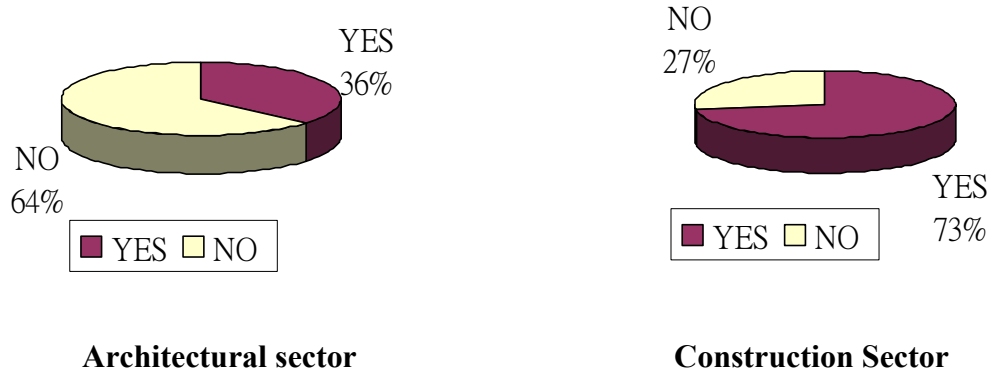


Fig. 4.10

The charts show that over 70% construction firms have provided training courses regarding environment to their employee. However, only 36% of architectural firms have provided such training courses.

e) Part V – views/comments

Priority of Economic, Environment and Social

Priority in decision making	Level of significance expressed in AS
Economic	2.7
Environment	1.9
Social	1.4

Architectural sector

Priority in decision making	Level of significance expressed in AS
Economic	2.7
Environment	1.9
Social	1.4

Construction Sector

Fig. 4.11

The respondent's views on the 3 aspects, namely economic, environment and social, on decision making are as expected. The economic consideration ranks the highest priority in decision making (AS=2.7), next comes the environment consideration (AS=1.9) and the last is the social considerations (AS=1.4).

Importance of elements in sustainable construction

Importance in sustainable construction	Level of significance expressed in AS		
	Architectural	Construction	Average
Government Policy	4.6	4.8	4.7
Laws and regulations	4	4.5	4.3
Public-private agreements	3.4	3.5	3.5
Financial incentives	4.3	4.1	4.2
Demonstration projects	2.6	2.6	2.6
Design tools	3.1	3.4	3.2
Assessment methods	3.6	3.2	3.4
Research & Development projects	3.9	3.5	3.7
Waste management	3.6	4.2	3.9
Best practices in sustainable construction	3.7	4	3.9
Education	4.6	4.4	4.5

Fig. 4.13

It is worth to note that government policy is considered to be the most important element in sustainable construction. (AS= 4.7 on average) Next important element is education whereas laws and regulations come in the third. Financial incentives are the fourth most important element.

The least important elements considered by respondents are demonstration projects (AS=2.6), design tools (AS=3.2 on average) and assessment methods (AS=3.4 on average).

Improvements needed for sustainable construction

Improvements needed for sustainable construction	Level of significance expressed in AS		
	Architectural	Construction	Average
Government should offer more incentives for green measures	3.6	4.2	3.9
Provide adequate knowledge by means of seminar/workshop	3.7	3.2	3.5
More guidelines on sustainable construction site practice	3.5	3.5	3.5
More research is needed in sustainable construction	3.9	3.5	3.7
Effective delivery of Government policy	4.2	4.2	4.2
Raise the public awareness of sustainable construction	4.2	3.9	4

Fig. 4.14

The above table shows the respondents' ranking among different aspects of sustainable construction that are needed for improvement.

In general, all choices have an AS score higher than 3.5, showing that all areas are significant and need improvement. The effective delivery of Government policy is considered to be the most important area which needs improvement, (AS=4.2 on average) followed by raising the public awareness of sustainable construction (AS=4 on average) and government should offer more incentives for green measures (AS=3.9 on average).

The least important areas for improvement are providing adequate knowledge by means of seminars/workshop and issuing more guidelines on sustainable construction site practice. (Both with an AS score=3.5 on average)

Respondents' attitude towards sustainable construction

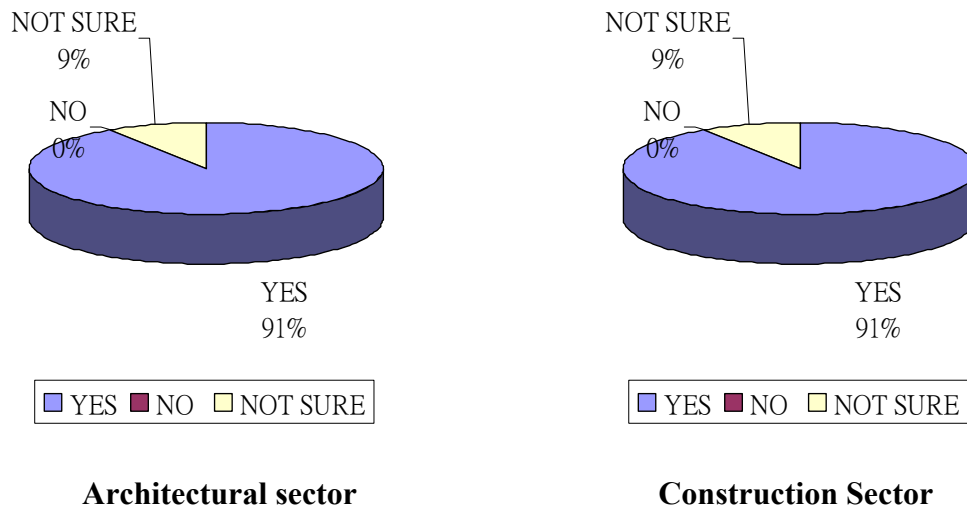


Fig. 4.15

When asking about the respondents' attitude towards sustainable construction, over 90% of respondents said they will try/continue sustainable construction in the future. Only 2 out of 22 respondents are not sure about their future strategies.

Moreover, 100% of respondents from architectural sector and 91% of respondents from construction sector do not satisfy with the current situation of sustainable development in Hong Kong construction industry. Among all respondents, only one satisfies with the current situation.

Comment from respondents

At last, one respondent comments the current valuation of development does not effectively include whole life costing, e.g. real demolition costs, decommissioning, energy costs, social values, etc.

4.6 Discussion on the survey result

Overall, the survey findings are consistent with the literature review. The survey reveals that poor understanding of sustainability related issues among professionals. Besides some specific terms used in academic or international context, local activities such as The Integer Hong Kong Pavilion Project are still not known to many construction professionals. This suggests that professionals in Hong Kong are not sensitive to sustainability issues that are widely spread in the international context.

Since all respondents are at the management level of their companies, they are the policy makers of their firm. If managers or directors cannot understand the issues, the lower level staff in their companies will follow suits. Although sustainable construction is a new concept, approximately one-third of respondents have not read any materials related to sustainable construction. The reason may be due to the fact that they do not know what sustainable construction is or there is lack of materials that focuses on sustainable construction in Hong Kong.²⁴

The survey results show that contractors are generally performing better than architectural firms, in terms of number of firms achieving ISO 14001 and providing trainings for their staff. This may be due to the fact the contractors are directly related to construction sites, the implementation of an Environmental Management System can significantly reduce their pollutants generated such as noise control, treatment of polluted water, waste recycling and reusing, and so on. The benefits to them are obvious.

²⁴ Extracted from interview with Mr. Mak, Gammon Skanska Ltd.

For government initiatives, most of the respondents are not satisfied with the performance of government and they are not sure whether the government is moving towards sustainable construction. Although The Chief Executive has expressed the government's intention to promote sustainable development in Hong Kong(Policy Address 1999) and sustainable construction should be an important component of creating a sustainable development (L. Bourdeau, 1999), practitioners commonly thought that they did not feel any support from government.

In addition, the majority of respondents have not received any incentives offered by the Hong Kong SAR Government related to sustainable construction.

According to discussion with Mr. Chapman, this may due to several reasons,

- i.) There are too little incentives offered by the government
- ii.) The incentives only benefit a small group of people who are not included in my questionnaire sample
- iii.) Those incentives are not effectively implemented
- iv.) The incentives offered are not favor by construction professional

Overall, the result indicates that not many respondents have gained benefits from the Government in practicing sustainable construction.

There is good side of the results. Almost all respondents alleged that they will try or continue sustainable construction practice in the future and they are not satisfied with the sustainable development in the Hong Kong Construction Industry. This indicates that construction professionals in Hong Kong are moving towards sustainable construction, at least, in their minds.

Chapter V - The Interview Survey

5.1 Introduction

As Patton (1987) suggests, interviewing allows the evaluator to enter another person's world, to understand that person's perspective. The evaluator is seeking to find out what and how that person views that program under study.

In order to contribute the findings of the previous studies, an interview survey with a sample of 6 people in total, they were the representatives from a contractor, the Buildings Department, the Architectural Services Department, the Environmental Protection Department, the Business Environment Council and a real estate developer. Due to the different roles they take in sustainable construction, they may perceive the issue at different angles and come out with different conclusions. Therefore, the interviews seek to overview the impact of the subject on society.

In order to make the interviewing more effective and to save the time of the interviews, the purpose of the interview and the need of the research are communicated to the interviewees before the interview through a sample list of questions developed and sent to the interviewees. The interviews are conducted in an open, semi-structured manner, allowing the respondents to introduce whatever information is felt to be relevant, but within the topics identified from the literature review.

5.2 Research Objectives

From the results of questionnaire survey, the current situation of sustainable construction is revealed and the strategies commonly adopted by construction firms are examined. The interviews look into greater detail and try to find out the reasons behind the responses to the questionnaire. The objectives are

- 1) To examine and analyze the views of different parties towards sustainable construction practices
- 2) To investigate the strategies adopted by different parties in the building construction industry
- 3) To examine the role of different parties towards sustainable construction

5.3 Results and Analysis of the Interview Survey

In the following paragraphs, the interviewee will be first introduced with their personal profile. Some noteworthy points made by the interviewees are highlighted under the corresponding headings and some of them have been referred to in previous sections. These opinions are invaluable source of information which facilitates deeper understanding of key issues and help to justify and supplement the findings of the literature with real life experiences in Hong Kong.

a) Information from contractor

Name of interviewee: Mr. Patrick Mak

Company Name: Gammon Skanska Ltd.

Position: Senior Managing Quantity Surveyor

Views of current situation

Mr. Mak has admitted that the construction industry is regarded as the pollution generator in Hong Kong and has been named “black sheep” of Hong Kong family. He mentioned that the starting point to realize the problem was 1980s by means of environmental ordinances. Since then, the condition of construction sites was improved. For example, traditional timbers used in formwork are replaced by metals, which can be recycled, or harder softwoods, which is grown faster and in colder regions. However, compared to other advanced countries like United States, Hong Kong is at the infant stage in sustainable construction. As Gammon Skanska Ltd. is an international company, many staff come from other countries. They have brought their experiences and techniques to Hong Kong and that’s why Gammon is more concerned about sustainability than other local contractors in Hong Kong. Mr. Mak recalled from his memories that he has seen some video tapes demonstrate the construction practices in other countries, and he wondered why the environment in foreign construction site is so comfort and tidy. In Hong Kong, we are at the stage where some organizations are beginning to take corporate responsibility for the construction of sustainable buildings.

Initiatives taken by Gammon Skanska Ltd.

Mr. Mak mentioned that from 5 years ago, Gammon has already incorporated environmental issues into their business strategies. Gammon is also one of the construction firms that achieved the ISO 14001 accreditation and adopted an environmental management system to tackle environmental issues. One obvious benefit is the reduction of penalties from the environment ordinances whereas the brand name effect is another. They have put up their own factories, workshops and warehouses in Tseung Kwan O. 70% of them are constructed by precast concrete technique, such as columns, beams, walls, which have a great saving on wastage and reduce environment impact when compared to traditional cast in-suite method.

Views on Government policy

When talking about government policy, there are joint initiatives organized by the Hong Kong Construction Association and The Environmental Protection Department, such as some guidelines, but not much has been done. Mr. Mak emphasized that contractors certainly need incentives and self-regulation will not happen in business world. If there are no incentives, it is very difficult to get contractors or developers involved in sustainable construction.

In public sector projects, the current contractor performance index used in which environmental pollution controls are introduced to protect the environment. However, Mr. Mak views that the system only focuses on bad issues. Can contractors improve the score by introducing environmentally friendly equipments and materials during construction projects? In that way, there may be some innovative ideas coming out from contractors.

Mr. Mak recalled there are government contracts recently having a clear environmental focus in the tendering process, so contractors have to address those issues otherwise they will lose the tender.

Major barriers in sustainable construction

As the construction of buildings involved a large number of parties, such as developers, contractors, sub-contractors, sub-sub-contractors, consultants, Nominated-sub-contractors, etc, they are only concerned with their part of business, i.e. their profits. It is not enough for those large corporations to take the responsibility of improving the built environment. All parties must be working together towards sustainable construction.

Another barrier to sustainable construction he mentioned is culture. Traditionally, Chinese are interested only in their own livelihoods, so they are reluctant to think about the next generations.

Recommendations

To change the cultural environment, Mr. Mak believes that education is very important. Not only educate the professionals, but also the construction workers. For safety, all construction workers now are required to attend a safety course in order to enter construction site. The principle may apply to environmental issues too. However, education is not an easy task. The government has spent over 10 years to educate construction workers to wear safety helmets. Perhaps more time is needed for environment.

b) Information from Non-Government Organization

Name of interviewee: Mr. Calvin Leung

Company Name: Business Environment Council

Position: Specialist – Sustainable Buildings and Construction Division

Background of Business Environment Council (BEC)

BEC has evolved since the 1980s as the leading environmental partner for business and industry in Hong Kong. BEC helps large and small business successfully address all environmental issues such as to minimize waste, to cut excessive energy consumption, to use scarce resources more efficiently, and to achieve world-class standards in environment, health, safety and corporate responsibility.

They built consensus on the local and regional approach towards sustainable development, and on encouraging the uptake of environmentally sound and socially responsible policies. Their work involves engagement and dialogue with a view to creating sufficient momentum for Hong Kong to take up the issues that face business and the wider community.

Their council members include Gammon Skanska Ltd., Hong Kong Housing Society, Jardine Pacific Ltd., Sino Land Company Ltd, Sun Hung Kai Properties Limited and The Swire Group. The interview focuses on construction industry only.

Daily work of BEC regarding construction industry

i.) HK-BEAM certification

One of the major duties of BEC is to assess and certify buildings with the Hong Kong Building Environmental Assessment Method (HK-BEAM) on behalf of the HK-BEAM Society. As mentioned by Mr. Leung, the objectives of HK-BEAM are to set environmental targets/standards for building design, construction and management, to increase awareness of developers, designers, builders and users and to stimulate demand for 'eco-friendly' building. More than 70 commercial and residential developments have so far adopted this scheme. Mr. Leung considers HK-BEAM a good system as credits are given to building at different stages, from the design stage to the completion of building. In order to achieve excellent rating under the scheme, all stages in the development must be considered. The most obvious benefit of HK-BEAM is the effect of Green Labelling. In the past, no mechanisms were provided to recognize the efforts of developers put into environment. Nowadays, they can choose HK-BEAM to label what they have done. According to statistics, private and public sector make up around 70% and 30% of all buildings assessed, respectively. Mr. Leung views the large proportion of private sector buildings was due to the fact that the volume of buildings built by private sector is more than by Government.

ii.) Organizer

BEC organizes trainings, seminars and working groups to promote and raise the awareness of sustainable development. A large proportion of those activities are organized for construction because construction industry has a greater influence on environment than other businesses.

Training courses are held upon requests from organizations. For construction, Mr. Leung recalls requests only come from those large developers. Seminars are initiated by BEC, they collect information from different sources and invite guest speakers at seminars. Usually, the number of audiences is around 40-80, but it largely depends on the topics and quality of guests. The Working groups are organized by BEC to provide a place for corporate leaders to share experience and ideas on sustainability.

iii.) Provide advice

BEC provides advice to organizations related to sustainability matters, such as the establishment of an environmental management system to achieve ISO 14001. BEC has particular expertise in ISO 14001. For example, they successfully help Aoki Corporation Ltd., Dickson Construction Company Ltd., Hip Hing Construction Company Ltd., Hong Kong Housing Society and Hong Yip Service Company Ltd, etc to achieve the ISO 14001 standard.

Views on construction industry

Compared to other sectors, Mr. Leung thinks the construction sector has more care for the environment. They are more interested in environmental issues because of the pressure from the public, the existing regulations and the pollutants they generated which are far more than other sectors. The construction sector has the largest influence on our environment and thus there are many things they can do. Similar to other business, Construction companies are also business oriented, they always want to maximize their profits. Nowadays, they realized that adopting environmentally friendly measures could improve their revenue. For example, Mr. Leung points out

the fact that wastes in construction site are now separated and much of the metals, glass, woods are recycled, because contractors can sell the waste to recycling companies and reduces the overhead expenses in waste disposal.

Major barriers to sustainable construction

Mr. Leung thinks the most serious barrier in sustainable construction is the tradition. For example, the choice of construction materials is still based on the traditional valuation technique, which considers only the initial cost of material and does not take the life-cycle costing of materials into account. Therefore, more researches and development are needed in life-cycle costing analysis. Another barrier he mentioned is that clients do not generally realized the benefits from environmental friendly measures.

Future activities

BEC will establish a Centre for Sustainable Buildings and Construction, which offers information for professionals and the public as well as for research and seminars. Mr. Leung said they are collecting information from different sources and the centre is still in the feasibility stage.

c) Information from Buildings Department

Name of interviewee: Mr. Lee Kin-hong

Department: Buildings department

Position: Structural Engineer (Building Innovation Unit)

Background of Building Innovation Unit in Buildings Department

Building Innovation Unit (BIU) was established to facilitate the private sector in constructing environmental friendly buildings, which is in line with the policy of the Housing, Lands and Planning Bureau.

The functions of BIU are i) exploring latest technologies and environmental designs, ii) reviewing current building legislations and standards, iii) considering assessment system for green proposals and iv) providing support to the Working Group on Green and Innovative Buildings.²⁵

Initiatives taken by Buildings Department

i) Modernizing the legislation

Buildings Department is conducting a review on the Buildings Ordinance and allied regulations to facilitate the improvement of environmental performance of buildings. Mr. Leung added that the amendments to Buildings Ordinance are progressing and expected to pass Legislative Council soon.

²⁵ It was established in 1999 and was chaired by the Director of buildings and comprised building professionals, developers, contractors and government officials from various departments

Buildings Department is also conducting a review on building and construction practices in terms of construction efficiency and waste control to explore means to enable the construction activities to be carried out in an environmentally responsive manner. For example, Code of Practice for Precast Concrete Construction was published in October last year and Practices Notes for Authorized Persons (PNAP) for Recycled aggregates was issued in February last year.

ii) Publishing Environmental Report

Starting from 1999, Buildings Department started to publish environmental reports, which lay down their achievements in that year and targets for next year. The environmental reports aim at inviting general public to monitor the performance of Buildings Department and demonstrate the efforts they have put in enhancing the built environment.

iii) Joint Practice Notes

Since the issue of the 1st Joint Practice Notes in 2001 and the 2nd Joint Practice Notes in 2002 to provide incentives in the form of gross floor area and site coverage exemption for specific green features, Buildings Department has approved 134 projects²⁶ with one or more of these features.

Major barriers to sustainable construction

Mr. Leung thinks the most important thing is to change the public attitude towards sustainability. For example, when people buy a flat, the usual considerations are the

²⁶ From the period of March 2001 to February 2004

size, view, price, location of building and quality of finishes, they seldom consider the construction methods and the energy efficiency of buildings, whether or not the buildings have achieved the excellent rating under HK-BEAM scheme. There exist a small amount of knowledgeable customers who care for the environment.

Future development

One of the major tasks on sustainable construction in BIU is the consultancy study to derive a **Comprehensive Environmental Performance Assessment Scheme (CEPAS)** to gauge the performance of buildings in Hong Kong. This study is characterized by the widespread consultation and involvement of various sectors of the stakeholders from an early stage. The main features of the preliminary framework are sustainability, holistic life cycle approach, modular structure and flexible application. The scheme will be developed for all types of new and existing buildings. Assessment and labeling may be obtained from individual components and entire building development at a certain stage of the life cycle or the whole life cycle. The main aim of the consultancy study is to prepare a tailor made environmental performance assessment scheme for Hong Kong, taking into consideration the local characteristics. Mr. Leung added that the preliminary framework of CEPAS has been established but further consultations with stakeholders are being carried out at the moment.

d) Information from Environmental Protection Department

Name of interviewee: Mr. Wang Yuen

Department: Environmental Protection Department

Position: Senior Environmental Protection Officer

Special features of Environmental Impact Assessment Ordinance (EIAO)

i) Designated project

Only designated projects are controlled under EIAO. They are specified under Schedule 2 and 3 of the EIAO. Projects under schedule 2 normally require environmental permits for their construction and operation but not schedule 3. As explained by Mr. Yuen, this is because Schedule 3 of EIAO regulates the feasibility study of large scale urban development projects at an early stage, such as The Further Development of Tseung Kwan O Feasibility Study. Then, if the development of Tseung Kwan O involves Road work at a later stage and the Road work falls within schedule 2, an environmental permit for the construction of road work is required.

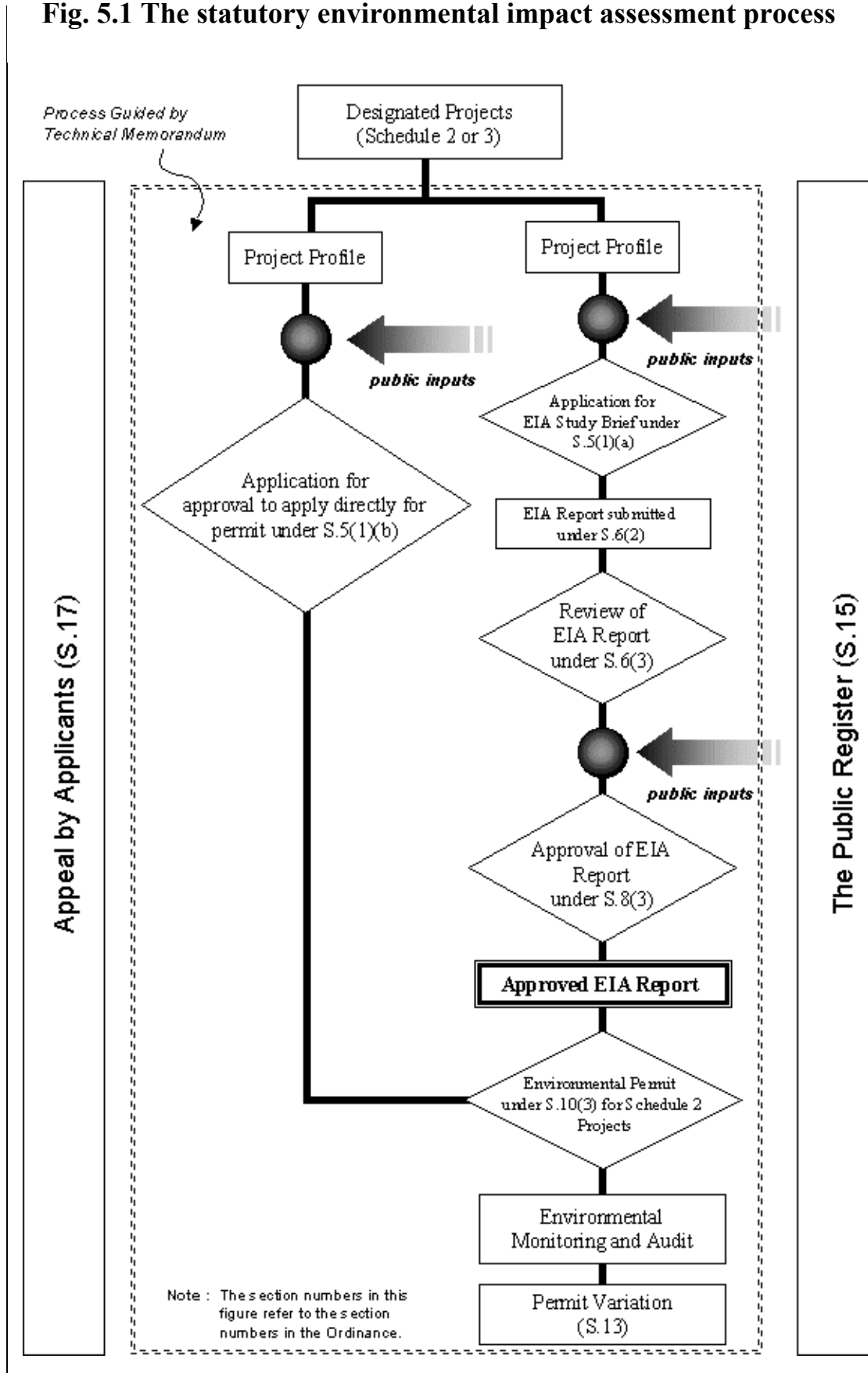
Figure 1 shows the simplified form of the statutory EIA process.

ii) Penalties

The EIAO ordinance imposes heavy penalties for offenders,

- For first offence: maximum fine of \$2 million and maximum imprisonment of 6 months;
- For second offence: maximum fine of \$5 million and maximum imprisonment of 2 years; and
- Continuing offence: maximum fine of \$10,000 per day

Fig. 5.1 The statutory environmental impact assessment process

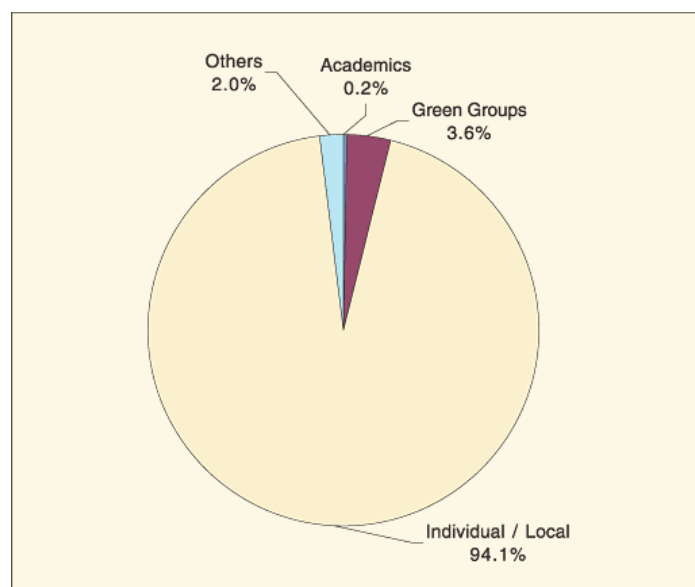


Source: A Guide to the Environmental Impact Assessment Ordinance

iv) Public consultation

As shown in Fig 5.1, there are 2 opportunities for the public inspection and comments. The first opportunity for the public to be involved in the statutory EIA process comes at an early stage. Public input is sought on the project profile before an EIA study brief. The public is informed about the application and the availability of the project profile through an advertisement, which must be placed by the applicant in two widely, circulated newspapers (one Chinese and one English) on the day following the lodging of the application. The second opportunity comes after the submission of an EIA report, the applicant is required to advertise the availability of the EIA report and make it available at specified locations for the public for a period of 30 days and 60 days respectively. The public can send their comments using on-line facilities or by post or fax to the EIA Ordinance Register Office using the public comment form. All EIA reports are available on the website of EIAO and viewed by public.²⁷

Fig. 2 The distribution of public comments is shown in (Apr 1998 – Dec 2001)



Source: The Operation of Environment Impact Assessment Ordinance in Hong Kong April 1998 – December 2001

²⁷ <http://www.epd.gov.hk/cia/english/register/aciara/all.html>

It can be seen that most of comments are from individual and local groups. Mr. Yuen added that comments are varying from projects to projects. There may be one or two comments for a particular EIA study but several hundreds for another. Sometimes, owners join together and employ experts to give comments. All comments are considered by the Director of Environmental Protection.

Enforcement of EIAO

Enforcement under the EIA Ordinance plays an essential role in achieving the Ordinance's deterrent effect and its ultimate goal of protecting the environment. The current enforcement strategy divides resources into four areas:

- (1) Satellite Photographs
- (2) Survey Maps and Photographs
- (3) Aerial and Land Based Surveillance
- (4) Site Inspection/Evidence Collection by EPD Staff

A total of 43 warning letters were issued during the first 3-1/2 years(1998-2001) of operation of the Ordinance to warn permit holders of minor issues.

Mr. Yuen recalled there are 2 prosecution orders issued by EPD but one was turned down by the Department of Justice as not enough evidence. The other was defeated as the affected area is not under control of EIAO.

Exclusion of residential/commercial projects

Under Schedule 2 of EIAO, only 1) Residential development of not less than 2000 flats and not served by public sewage networks by the time a flat is occupied and 2) residential or recreational development, other than New Territories exempted houses, within Deep Bay Buffer Zone 1 or 2 are needed to have an environmental permit.

Almost all residential or commercial projects are excluded from EIAO. Mr. Yuen explains that the list of designated projects is formalized based on past experience of EPD. They have considered the balance of resources and social needs, and then figured out those projects, which were most likely to affect the neighborhood environment. He added that EPD might consider including residential or commercial projects under EIAO, if there are any demands from public.

Public VS private applications

The majority of applicants (about 70%) come from public sector, such as civil engineering department, highway department whereas the remaining applicants (about 30%) come from private sector. Mr. Yuen thinks it was because most civil engineering and infrastructure projects are taken by government itself.

Variations in construction projects

When the need for variation of conditions of an environmental permit arises, the permit holder could apply for a variation of an environmental permit under section 13 of EIAO. If there is no material change to the environmental impact of designated project, then the director may approve the variation without the need for another environmental impact assessment report.

Comments on EIAO

Mr. Yuen thinks that the ordinance gives EPD more power to monitor the environment. Unlike existing legislations, EIAO prevents possible pollutions before they occur. The high transparency of EIAO reduces the number of enquires from mass media or public and lets more people realize their works. So far there is no any adverse comment on the ordinance. However, Mr. Yuen also added that sometimes the demand from public is hard to satisfy and pressure of work is increased among their officers.

e) Information from Architectural Services Department

Name of interviewee: Ms. Cheng Ka-lai

Department: Architectural Services Department (Quality and
Environmental Management Unit)

Position: Senior Building Services Engineer

Background of Architectural Services Department (ArchSD)

Being the Government's architect, ArchSD is responsible for the design, procurement and maintenance of all government buildings and facilities excluding housing estates.

Initiatives taken by ArchSD

i) Adoption of environmental management system

ArchSD began the implementation of an environmental management system (EMS) in 1997 and was the first government department to be certified to ISO 14001. A Quality and Environmental Management Unit is established and responsible for the administration of the Department's quality and the environmental management system.

ii) Award scheme

A Sustainable Design Award Scheme for in-house project teams was launched to promote design innovation and raise the awareness of sustainability inside their department. ArchSD also makes use of HK-BEAM guidelines at the design stage to maximize the inclusion of environmentally sustainable designs in buildings. They also explore and promote the use of renewable and clean energy through the application of high performance building services installations in projects where possible.

iii) Policy on contractor

Clauses requiring contractor's commitment on environmental protection are included in ArchSD's construction tender documents. Non-compliance with environmental standards or legislations would be taken into consideration in future tenders.

A 'Green Contractor Scheme' has been launched since 2001. The purpose of the award scheme is to encourage contractors to pay more attention to the environmental aspects so as to achieve a higher standard of environmental performance on construction sites. Statistics show that there are considerably less environmental convictions on ASD sites than on other construction sites in Hong Kong.²⁸

For waste management, all ArchSD contractors are required to incorporate a Waste Management Plan in all construction contracts by mandating on-site waste sorting and proper waste management.

A "trip-ticket" system, which specifies the destination of waste generated, is used to control and record the disposal of construction and demolition (C&D) material at public filling facilities or landfills.

iv) Environmental / Health / Safety Report

Since 1998, ArchSD has started to publish environmental report every year. From 2002 onwards, the environmental report was changed to Environmental / Health / Safety Report with an aim to communicate with their stakeholders what sustainable development means to them and how ArchSD are integrating sustainability principles into their operations. The report includes their initiatives in environmental, health and safety issues and achievements, as well as their performance on key operational and social aspects of their activities.

²⁸ Environmental/Health/Safety Report 2003, Architectural Services Department

Role of ArchSD in sustainable construction

ArchSD plays a leading role in sustainable construction. They set up examples of projects implementing sustainable concept design and sustainable construction practices on site, such as The Hong Kong Science Park (Phase 1), The Public Health Laboratory Centre and The North Point Government Offices. All achieved “Excellent” in HK-BEAM rating scheme. They also promote sustainable construction by requiring their consultants or contractors to implement sustainable design and sustainable practice on site. Through these efforts, they aim at improve the sustainability of the built environment in Hong Kong.

Views from Ms. Cheng

Ms. Cheng views that although the Hong Kong SAR Government has expressed their intention towards sustainable development in the policy address, there is no clear guideline on the implementation of policy. She also views that advanced countries like United States and some European countries perform better than Hong Kong in sustainable construction. The technology and materials used in construction need to be improved. She suggests universities may co-operate with ArchSD in research and development where the universities carry out the research and ArchSD put them into practice.

f) Information from developer

Name of interviewee: Mr. Tom Chapman

Company Name: Swire Properties Ltd.

Position: Environmental Affairs Manager

Background of Swire Properties Limited (SPL)

The Swire Group has an enlightened view about the environment and is a member of the Hong Kong Business Coalition for the Environment and has been elected to the United Nations Global 500 Role of Honour in recognition of their contribution in this field. Swire Properties Limited (SPL) is also the environmental co-ordinators for the Hong Kong Business Coalition for the Environment.

SPL believes good environmental performance is consistent with their image and brand and also that as good corporate citizens they have a responsibility to minimise any impacts caused by the business activities.

Initiatives taken by Swire Properties Limited (SPL)

i.) Contractual arrangement

Mr. Chapman pointed out that a part of SPL's contract conditions required a construction contractor to prepare a project specific for Environmental Management Plan and Waste Management Plan and these documents are submitted for approval via the SPL project manager. They must implement those plans on site and regular environmental audits are undertaken which include checking on site performance against the commitments made in the plans. The plans must be updated every 3 months to include any significant changes subject to circumstances.

ii.) Environmental Affairs Manager

Swire Properties was the first property developer to have an Environmental Manager in Hong Kong. The role of environmental affairs manager included the following:

- Providing environmental awareness training for all SPL staff. This can be either in-house training or through utilising external training courses and events.
- Keeping staff informed of environmental issues through writing articles in the company Newsletter – CornerStone or on the company intranet’s Bulletin Board.
- Chairing the SPL Environment, Health and Safety Steering Committee, which meet on a monthly basis.
- Undertaking annual environmental compliance audits for the 7 major operational centres and producing an Environmental Audit Report for each.
- Managing the Swire Group Environmental Health and Safety Database which records many items including energy and fuel consumed, chemicals used, wastes produced, recycling, green house gas release, No of accidents, sick leave etc.
- Representing Swire Group at the Business Environmental Committee’s Board meeting and on their Sustainable Development Working Group

iii.) Environmental performance of contractors

For most of the divisions in Swire Properties, such as Projects Division, which appoints architects and main construction contractors for new developments, the contractor’s environmental performance is monitored while they do SPL’s jobs. Any bad performance, including prosecution by EPD, will cause them to be excluded from future tenders of SPL’s projects.

iv.) Participation in HK-BEAM scheme

Mr. Chapman provided that Swire Properties decided internally several years ago to aim for HK BEAM excellent rating on all future commercial and residential property developments. This has been successful and has resulted in excellent ratings for about our last 8 developments, included achieving the highest ever HK BEAM rating and one of the few excellent ratings for a residential project.

Swire Properties was one of the founding members of HK-BEAM scheme. They believe it is important that buildings are designed, built and operated in an environmentally conscious manner. It is part of the Swire image and reputation to have high quality and environmentally aware development. According to Mr. Chapman, it seems that many customers increasingly appreciate this.

Mr. Chapman views that the HK-BEAM scheme also affects their decision making in many ways. For example it determines the level of recycling of demolition waste, influences the choice of building materials, makes us adopt low environmental impact construction methods and makes energy and resource saving initiatives a must to achieve excellent rating.

Major barriers in sustainable construction

Mr. Chapman thinks that there are still many barriers in sustainable construction. For example, to be sustainable, it usually does cost more and can take longer to build. Not enough incentive and the extra effort involved can be a deterrent. Moreover, it is not clear that the various stakeholders, e.g. government, customers etc, value the benefits sufficiently.

Role of developer in sustainable construction

Mr. Chapman thinks that developers play a key role in sustainable construction because they are at the ‘top of the food chain’ and thus can request their architects, contractors, etc, to do the right things. He believes developers have a responsibility to take sustainable construction into account as buildings can last for at least 50 years.

Views from Mr. Chapman

Mr. Chapman explains that they are not convinced of the tangible benefits of ISO 14001 accreditation thus Swire Properties will consider developing an ISO 14001 accredited Environmental Management System in the future but will not make any decision now.

His view on the CEPAS scheme currently developing by the Buildings Department was only an alternative to HK-BEAM rather than adding to it. This seems to be a complete duplication and waste of government’s time and resources.

5.4 Discussion on the interview result

All interviewees are experts in their professional fields with substantial experiences. Their real life experience supplements and confirms the literature findings. Their comments provide some valuable information regarding the current activities of sustainable construction practices in Hong Kong.

In summary, some initiatives are taken by different parties in Hong Kong towards a sustainable built environment. However, those initiatives are still at experimental or infant stage. They are the exception rather than normal practice and only large companies would consider those measures. Although the issue of sustainability has been raised by the Government for several years, sustainable construction practice is still not a commonplace in Hong Kong.

In the eyes of interviewees, the Integer Hong Kong Pavilion Project mainly serves education and promotion purposes rather than real practice in construction. The techniques used in The Integer are still not mature and little progress has been made to transform those innovative ideas into practice.

For government bodies, construction-related responsibilities within the Government are dispersed among several bureaus and departments. The absence of a co-ordination mechanism has sometimes led to conflicting regulatory requirements and ineffective communication between the Government and industry. Every department works on their own and their efforts are rather fragmented. There is seldom communication between departments to share their experiences. In addition, there is no public or

political pressure towards implementing effective sustainable construction policy. Therefore, the Government's progress of work is still insufficient.

Gammon Skanska

As one of the leading and reputable contractors in Hong Kong, it can be seen that they have put their effort to improve the built environment. However, the use of sustainable construction techniques is still the exception rather than general practice, such as the precast construction technique, aluminum formwork etc. Most construction works still follow traditional methods of construction. Revolution is needed in construction practice. Foreign companies can bring their mother country's knowledge to Hong Kong as well as modern techniques in construction, which serves as an important source of sustainable construction practice.

Business Environment Council

The Business Environment Council is the only non-governmental organization that targets sustainable development in Hong Kong but they do not solely focus on the construction industry. Compared to the BRE²⁹ and CIRIA³⁰ in Britain, they offer much wider range of services and have done a lot of research and consultancy work in sustainable construction, whereas BEC is relatively small in size and not all professionals in Hong Kong recognize their existence. Their participation in Research and Development is relatively less than other similar organizations in foreign countries.

²⁹ <http://www.bre.co.uk/>

³⁰ <http://www.ciria.org.uk/>

The Centre for Sustainable Buildings and Construction is a good idea but the format of the centre is very important. A similar idea has been put forward by the Environmental Protection Department, i.e. the Green Construction Equipment Website, but it seems not very effective to promote sustainable construction in Hong Kong.

Buildings Department

For Buildings Department, the establishment of BIU undoubtedly is a first step towards sustainable construction. However, not many works have been done by BIU and many works are in progress, such as amendments to Buildings Ordinance and allied regulations to facilitate the improvement of environmental performance of buildings, as stated in their environmental report last year. The slow progress of policy is a common scene in the Hong Kong SAR Government.

After releasing Joint Practice Notes, almost all new residential buildings are incorporated with a “green” balcony because of the exclusion in Gross Floor Area (GFA) calculations. As the green features listed in the Joint Practice Notes are voluntary in nature, developers only choose those incentives which are attractive to them, i.e. give them GFA enhancements, others like noise barriers, acoustic fins, which do not affect their saleable floor area, are seldom included in new buildings. The other drawbacks of Joint Practice Notes are they discourage developers to try other green features that do not have incentives. Moreover, details of the green features strictly regulated in the Joint Practice Notes to prevent the misuse of incentive, but it also prohibits innovative designs. In addition, sometimes due to the

innovative designs, the processing time by Buildings Department may be longer than for standard design.

The CEPAS scheme mentioned by Mr. Lee is still in the consultation stage.

The Environmental Impact Assessment Ordinance

For EIAO, it is a good ordinance to prevent pollutions occurs at the inception stage with its aim to protect the environment as a whole for present and future generations. It is also the first ordinance to consider public comments during its operation.

The statistics show that major applicants are government departments, like civil engineering department, drainage services department, contributing to 70% of the total applications, EIAO seems an ordinance regulating government itself. All developers in Hong Kong fall outside its control because EIAO regulates large scale infrastructure works only but not building works.

It is the author's opinions that residential and commercial developments, which amount to quite a large number of construction works in Hong Kong, should be included in the category of designated projects and regulated under EIAO. The pollutants generated under the building works are more or less the same to the infrastructure works. Although building works may affect the ecology to a lesser extent, construction site of residential or commercial developments still generate a lot of pollutants and affect neighbourhood environment. To have a better built environment, EIAO should include residential or commercial development projects.

Another problem associated with most projects developed by government is that government must care for the environment no matter there is EIA or not because they are accountable to the general public. It is wondered this ordinance is used for education or publication purpose rather than protecting the environment.

Because most applicants are government departments and government will not prosecute itself. Therefore, if one of the government departments violates the ordinance, they will receive some sort of 'internal regulations' only. The heavy penalty of the ordinance seems useless.

Since there is no restriction placed on the employment of consultants in the EIAO, applicants can employ their own consultant to carry out the EIA study. As the client-employer relationship exists, consultants will try all means to satisfy their client otherwise they will lose their job. They will tend to comply with the ordinance but not to protect the environment.

The Architectural Services Department

For ArchSD, their success within the Department is mainly due to the special nature of itself. Profit is not an objective of the Department. The projects are funded by taxpayers' money. The Department can afford to allocate resources to green designs. Furthermore, government buildings have no need to worry about vacancy rate, since the major tenants are other government departments.

Indeed, to promote environmental awareness by setting examples to the rest of the industry seems to be the only reason behind their effort. It is possible that the rest of

the construction industry would progress even more slowly in the development if government has not taken the first step. The policy adopted by ArchSD is a step in the right direction.

The clauses used by ArchSD requiring contractor's commitment on environmental protection are included in their construction tender documents, but they are only limited to comply with the Building Energy Codes and relevant environmental protection legislations. There are no further clauses to encourage the contractors to think beyond the requirement.

Non-compliance with environmental standards or legislation would be taken into consideration in future tenders. However, there is no credit system to reward those contractors who perform well in the environmental aspects, though a 'Green Contractor Scheme' has been launched in 2000. This is because the scheme mainly looks at the management system within the contractor's organization, rather than their performance during their work. Also, extra manpower is needed to monitor their work and to make sure that they comply with environmental standards of ASD.

Swires Properties Limited

Through contractual arrangement, creation of an environmental affairs manager, participation in HK-BEAM, close monitoring of environmental performance of contractors, Swire Properties has shown its support to sustainability-related activities. Together with Gammon Skanska discussed earlier in this chapter, they have set good examples for construction companies to follow. It is delighted to note that, as pointed

out by Mr. Chapman, more and more people now appreciate their efforts put in preserving the environment of Hong Kong. However, it seems that their efforts put in sustainable construction are not recognized by general public at large because the lack of environmental alertness among Hong Kong citizens is very common.

From the discussion of Mr. Chapman, the EIAO ordinance does not affect developers because most property developments do not regulated by the ordinance.

Chapter VI - A case study on The Science Park

A case study on The Hong Kong Science Park (Phase I) is conducted to illustrate the practical application of sustainable construction practice in Hong Kong. The Science Park is selected because of its size and many innovative and sustainable technologies used to build The Science Park. It also serves the purpose of demonstrating the ability of construction industry in Hong Kong.

6.1 Background

Project name: Hong Kong Science Park Phase I

Location: Pak Shek Kok, New Territories, Hong Kong

Developer: Architectural Services Department

The Hong Kong Science Park is developed by Architectural Services Department as the Project Manager and the Chief Architect whereas the masterplan was developed by Simon Kwan & Associates. The construction of The Science Park involved major contractors in Hong Kong, such as The China State Construction Engineering Ltd., Shui On construction Ltd., Dickson construction Ltd., etc. Phase 1 of The Science Park consists of 3 zones: **The Core Building Zone** provides 3 core buildings with ideal locations for tenants requiring premises less than 20,000 sq. ft. and provides ancillary facilities such as restaurants, gymnasium, etc., **The Campus Buildings**

provides 2 campus buildings for medium-sized companies who require 20,000 – 50,000 sq. ft. and **The Corporate Building Zone** provides 4 corporate buildings aimed at larger users who want an individual image.³¹

6.2 Sustainable Designs

i) Planning

The planning of the Science Park has addressed the social impact of buildings on tenants. The overall development is to create a park-like setting with a relaxed, interactive and pleasant working environment. Inside Buildings, informal seating in the atriums and common areas is provided to encourage greater social interaction among staff.

ii) Maximize use of natural daylight

The design of Buildings in Science Park is intended to maximize the use of natural daylight. For example, Buildings 4a and 4b (under corporate building zone) are both designed with central services cores and the building depth in most parts of the offices does not exceed 10.5m from the external or atrium walls, thus allowing better daylight penetration. They also have a landscaped atrium roofed under a skylight, which allows daylight to reach the centre of the buildings.

iii) Building integrated photovoltaic (BIPV) panels

Building integrated photovoltaic (BIPV) system on the glass curtain walls and roof of buildings supplies clean, renewable solar energy with an approximate 200 kilo-Watt

³¹ See Appendix I for the site layout

output. This system reduces pollution from the generation of electricity and is estimated to save approximately 250 MWh of electricity consumption annually.

iv) Building facades

The facades of buildings in the corporate zone are clad with a combination of aluminum panels, double glazed window units and building integrated photovoltaic (BIPV) panels. Sustainable shield directs sunlight penetration, reducing heat gain to the offices. The use of double glazed window units with low-e coated clear glass enhances thermal and acoustic performance. The use of clear glass in lieu of reflective glass avoids light reflection disturbances to neighbouring buildings. All these measures combine to achieve an OTTV of 23w/m^2 , which is lower than the statutory requirement of 30w/m^2 .

v) Precast

Most buildings in The Science Park are made up of the standardized modular structures, which allows for the use of prefabricated structural elements such as semi-precast floors, pre-cast beams and staircases, and the use of metal formwork. According to Ms. Cheng, the standardized planning can reduce the need for timber during construction, reduce in situ wet trades and at the same time improve workmanship and shorten the construction programme.

6.3 Sustainable materials

Ms. Cheng added that building materials whenever possible were selected with the criteria of durability, maintenance, environmental friendliness and recyclability considered. Examples of green materials selected are recycled glass ceiling tiles and insulation boards, low-VOC paint and flax core timber doors.

6.4 Energy Efficiency Building Services

The main theme of building services of The Science Park is “service-on-demand”. For health growth of plants and reduction of water used for irrigation, a computer-controlled automatic irrigation system with local rain sensors will be provided for effective control of the water supplied to landscaping areas. This will provide suitable micro-environments for different types of plantings and avoid unnecessary irrigation during wet days. For water saving features, water taps and urinals are operated by infra-red sensor control. Energy efficient installations such as water-cooled air-conditioning systems, heat recovery systems, automatic office lighting controls and “service-on-demand” lifts and escalators are provided to minimize the energy consumption and to comply with the latest energy codes issued by the Hong Kong Government.

6.5 Waste Management

The Science Park makes use of a system called The Centralized Automatic Refuse Collection System (ARCS) that links all buildings and automatically collects and segregates common commercial refuse and recyclable paper through separate, vertical vacuum chutes and automatic discharge valves. The direct collection of refuse in concealed chutes and tunnels eliminates the handling of refuse in the building and open area, thereby minimizing odour and nuisance, enhancing environmental hygiene, minimizing within-Park refuse transportation fuel use and emissions, and reducing visual impacts. (EHS report 2003)³²

The system consists of dual vertical chute, one for normal refuse and one for recyclable materials. Two outlets will be provided at every floor of the buildings and waste materials are transferred through vacuum tubes connected to the central refuse collection point via underground service tunnels. The user friendly approach helps to recover recyclable materials for re-use.

³² Environmental/Health/Safety Report 2003, Architectural Services Department

6.6 Beyond Statutory Requirements

In addition to complying with the statutory codes such as the Code of Practice for Overall Thermal Transfer Value by Building Authority and Technical Guidelines and Memoranda by Environmental Protection Department, the design also aims to fulfill the recommendations in the non-statutory codes or under the incentive schemes on environment and energy including:

- Environmental targets of Architectural Services Department;
- Energy codes by Electrical and Mechanical Services Department;
- Guidance Notes for the Management of Indoor Air Quality in Offices and Public Spaces by the Hong Kong Government;
- Demand Side Management Scheme of the Power Company.

6.7 Discussion on the case study

Succinct considerations on sustainable building practices and environmentally friendly measures have been applied in the architectural and building services design of the Phase 1 development of the Hong Kong Science Park. Also various innovative and creative ideas including new products and advance technologies are applied in The Science Park to enhance the environmental effectiveness. However, those advanced technologies and innovative designs have been applied in The Science Park are exceptions rather than normal practices in Hong Kong.

The Science Park has shown its strength in environmental and social considerations. However, to be sustainable, economic consideration is also an important factor. Since The Science Park is newly established, its economic benefits cannot be verified now.

With the experience of the Science Park, Hong Kong's building professionals will be better prepared to face the challenges of providing a better quality building both in terms of functional designs and environmental performances in this new millennium.

The success of The Science Park is due to several reasons. First, it is being funded by the Hong Kong SAR government and thus the problem of high initial cost of sustainable designs is solved. Second, in the Policy Address 2000, the Chief Executive further set out the policy on the initiatives to improve the environment in addition to the gearing up for the knowledge economy. These policy objectives laid down the goals and have been the targets in the building of The Science Park in Hong Kong. Third, the objective of Science Park is to promote the development of innovation and technology in Hong Kong, thus incorporating sustainable designs and constructions can raise the image of Hong Kong.

Chapter VII Conclusions and Recommendations

7.1 Summary of findings

Based on the findings from the literature review, questionnaire survey, interview discussion and the case study, conclusions are drawn in the context of the objectives stated in Chapter I of this dissertation.

In order to fulfill the first objective as well as other objectives, the meaning of sustainable construction is firstly introduced in this dissertation. After reviewing relevant literatures, there seems to be no common definition on sustainable construction and definitions vary from country to country.

This dissertation adopted the Kibert's definition of sustainable - "creating a healthy built environment using resource-efficient, ecologically-based principles". Other issues related to sustainable construction are also introduced in Chapter 2. They are the taxonomy used in sustainable construction, the significance of sustainable construction and its benefits, barriers to sustainable construction, the importance of Government in sustainable construction and some examples of foreign practices are also reviewed.

Objective 1: To review the current status of sustainable construction activities in Hong Kong.

Fulfillment of this objective is discussed in Chapter III by reviewing relevant government documents, journals, newspaper and past researches in Hong Kong. Supplementary information of sustainable construction activities is provided in Chapter IV in the context of questionnaire survey and in the result of the interview in Chapter V.

In summary, there are not many sustainable construction activities in Hong Kong. The government policies on environment mainly rely on regulations, such as code of practices, ordinance, and they are prescriptive in nature rather than performance-based provisions. Also, small amount of penalties makes no threat to local construction enterprises. Activities include The Integer Pavilion Project and The HK-BEAM scheme are undertaken by private sector related to sustainable construction in Hong Kong. Lack of knowledge, poor performance of Government and initiatives usually taken by large corporations are characteristics of sustainable construction in Hong Kong.

Objective 2: To critique current sustainable construction practices adopted by developers, architects, contractors and government bodies.

After reviewing the current situation of sustainable construction, the fulfillment of this objective is presented in the discussion of questionnaire survey and interview result in Chapter 4.5 and Chapter 5.5 respectively.

To sum up, there are some initiatives taken by contractors. Some of them have already applied an Environmental Management System to achieve ISO 14001 accreditation in their company. They are not satisfied with the current situation and most of them will try or continue sustainable construction practices in the future.

For architects, their performance is similar to contractors. There are some initiatives taken by architects. They also do not satisfied with the current situation and most of them will try or continue sustainable construction practices in the future.

However, both of contractors and architects generally lack knowledge in sustainability related issues. Most construction methods and designs are still traditional instead of new environmentally friendly techniques. Sustainable construction practices are exceptions rather than practices.

For Developers, a few of them take the initiative to participate in the HK-BEAM scheme. But it appears that some developers are not aware of the benefits of sustainable construction. Only those larger developers participate in the HK-BEAM scheme.

For Government, there exist some policies related to sustainable construction, such as the partnership scheme with Hong Kong Construction Association, the Joint Practice Notes, The Environmental Impact Assessment Ordinance, etc. However, they are fragmented and generally not effective from practitioners' point of view.

Construction-related responsibilities within the Government are dispersed among several bureaus and departments. Every department work on their own and their efforts are rather fragmented. There is seldom communication between departments to share their experiences.

The Architectural Services Department has set some good examples of practices for private sector to follow suit. ArchSD aims to achieve sustainable, environmentally friendly and energy efficient designs with less disturbance to the environment, less consumption of natural resources, less dumping, less emissions to the atmosphere, optimum energy efficiency and the use of new and clean energy technology. (EHS report 2003)

Objective 3: To identify major barriers towards sustainable construction.

The major barriers towards sustainable construction in Hong Kong are identified and illustrated in detail in Chapter 4 and Chapter 5. In summary, they are

- 1) Lack of knowledge among professionals
- 2) Lack of incentives from government
- 3) Traditional culture
- 4) Benefits are not recognized
- 5) Public attitudes
- 6) Lack of Research & Development
- 7) High initial cost

Objective 4: To demonstrate the ability of the Hong Kong building industry in the area of sustainable construction

The ability of Local construction is demonstrated by a case study in Chapter 6. Although the science park is a government project, it included a large number of private participants because its scale is large. The Science Park makes use of many sustainable construction techniques available in Hong Kong. Succinct considerations on sustainable building practices and environmentally friendly measures have been applied in the architectural and building services design of the Phase 1 development of the Hong Kong Science Park. Also various innovative and creative ideas including new products and advanced technologies are applied in The Science Park to enhance the environmental effectiveness.

Objective 5: To recommend further measures to achieve a sustainable built environment in Hong Kong.

To overcome the difficulties in achieving sustainable construction, the following recommendations are drawn after analyzing and synthesizing the findings from literature review, questionnaire survey and case study.

i.) Establishing a centre for sustainable construction in Hong Kong

An independent non-profit making organization should be established to serve the function as a centre for sustainable construction in Hong Kong. The objectives of the centre are to gather all the information related to sustainable construction and act as an advisor for all parties. The following activities are recommended to make Hong Kong become a sustainable city.

1.1) Research and Development

Research is a key driver to steadily improve the overall performance of the construction industry through technology upgrading. Investment in construction research should be significantly increased to promote an innovation culture in the industry. (CIRC, 2001) With the establishment of a sustainable construction centre, it sets clear objectives, directions and priorities for local construction research, to raise awareness of research results and to facilitate their practical application. The centre also provides a place to promote and publish all academic research done in all tertiary institutions related to sustainable construction.

1.2) Exchange of ideas

The centre can act as a channel to communicate with foreign organizations to facilitate exchange of ideas, results, and experience in sustainable construction. It also makes Hong Kong keep pace with international so that Hong Kong would not lag behind.

1.3) Setting up a database

One most important barrier pointed out by interviewees is the lack of information in sustainable construction. Clients do not know what methods are available and contractors do not know what construction methods, either. The information provided by the EPD and HKCA partnership is too fragmented and they depend on the private sector to supply information. The database lets material suppliers have a place to promote sustainable materials.

Comparisons between different construction methods and different materials are available if the database is well-established. The centre needs to take a pro-active

approach to gather information, not only from local, but also from foreign advanced countries and academic researches.

ii.) A green registration scheme

A green registration scheme, closely monitored by professional bodies and government, can recognize and raise the environmental standards of contractors or subcontractors. Moreover, clients can make use of this scheme by requiring their contractors to engage registered green contractors only. Training can be provided by the centre mentioned above to those contractors who are committed to improving themselves.

iii.) Corporate Reporting

To raise the motivation as well as awareness of sustainability, corporations should not only report on the finance, but also health, safety and environment issues. A sustainability report contains the achievements in that year as well as targets for next year. Therefore, it forces corporations to set their own standards and targets. The Buildings Department and Architectural Services Department have already set good examples. The Carillion Group in the United Kingdom, the leading provider of integrated business and construction in the United Kingdom with turnover of £2 billions and over 17,000 employees, has already produced its corporate sustainability report since 2000.

They foresee the benefits of sustainable solutions are commercial and immediate as well as long term. It is recommended that the sustainability report should be independently audited to avoid the creation of data.

iv.) Education

To change the culture as well as to raise the knowledge of all parties is the most important issue in sustainable construction. Severe lack of knowledge among professionals has been revealed by the questionnaire survey. Not only the managers need education, less educated construction workers also need education. Moreover, education of the end-users is also important to create market demand for environmentally friendly construction. Various means are recommended to educate people to pay more attention to sustainability, they are:

4.1) Seminars, Workshops and Symposiums

Hong Kong already has seminars, workshops and symposiums organized by various professional bodies in these years, such as the Built Environment Symposia 2003/04 organized by HKU space has spent one-fourth of time on sustainable construction. The Symposium on Green Building Labelling is also an event on sustainability co-organized by Professional Green Building Council and HK-BEAM Society. They trigger local professionals thinking of more sustainable built environment whereas the foreign speakers also bring along their experience to Hong Kong as well. With the help of the Sustainable Centre, more events can be held in Hong Kong in a large scale.

4.2) International Conferences

We have excellent exhibition infrastructures in Hong Kong. The Hong Kong Convention & Exhibition Centre provides a state-of-art environment to hold international conferences. If international events such as The Green Building

Challenge are going to be held in Hong Kong, the knowledge and horizon of local construction industry surely will be broadened.

4.3) Educational institutions

In this modern era, everyone lives within the buildings; all of us spend most of the time within buildings. Therefore, everybody should have an understanding of the impact of buildings on health and environment. If they have these ideas in their mind, they may decide to choose those buildings that incorporated environmentally friendly design so as to achieve a sustainable development in Hong Kong. Public education by government or professional bodies is important. As children are the future pillars of our society, it is recommended to provide courses or extra-curricular activities for them to know more about sustainable buildings in Hong Kong.

v.) Promotion

The construction industry in Hong Kong has been relying heavily on traditional building technology. To change the culture of construction industry, it is suggested that more promotion of sustainable development in construction should be made by professional bodies, the Government and related organizations. When more people talk about sustainability, the response to demands for sustainability in the construction industry will be crucial, and companies are likely to come under increasing political, public and economic pressures to become more sustainable. It is also a way to create market demand for sustainable buildings.

vi.) A supportive regulatory framework

A robust and comprehensive regulatory framework is necessary to ensure effective performance of the construction industry. But care should be taken that regulatory controls do not become an impediment to the industry's drive towards excellence. (CIRC 2001) From the discussion earlier in this dissertation, the environmental impact assessment ordinance should include residential or commercial developments because the impacts of building projects on environment are similar to infrastructure projects. It is also recommended to substitute prescriptive provisions with performance-based ones, such as the CEPAS scheme mentioned by Mr. Lee of Buildings Department. With adoption of performance-based standards set up by government, owners and manufacturers will benefit from the increasing opportunities to apply new materials and new technologies.

vii.) To create a Sustainable Town

The Government should partner with the private sector in a larger scale, not just organizing seminars, creating websites, etc. It is recommended that a large scale real example of sustainable construction, such as a new town, should be created jointly by government and private sectors. Sustainability cannot rely on just building individual sustainable building, instead a whole sustainable village with all considerations to the social, economic and environment at the start, built by incorporating all sustainable construction technologies. This has been proven successful in many countries, such as The Millennium Village in the Britain and The Leidse Rijn in the Netherlands. The successful experience of The Science Park in Hong Kong is valuable to make such development possible in Hong Kong.

viii.) Recommendations to Government

The result of questionnaire survey shows that practitioners are not satisfied with the performance of government. They also express that government policy and incentives are important factors in sustainable construction. It is recommended that Government should appoint a lead agency to maintain an overview of all matters concerning local construction and to maintain collaboration among bureaus and departments on construction-related issues. Government should act as a leading role in sustainable construction, to make clear its objectives, guidelines and direction towards a better built environment in Hong Kong.

One recommendation on the building approval process has been put forward by Mr. Leung from Business Environment Council that developers should put forwards its project with all the various factors they have considered for the next 20 or 30 years. Not just leave the sites after the building works deceased and then sell the property within a couple of years.

Incentives certainly are drives for change. They should be more flexible and available for all parties such as architects, contractors, but not just the developers can benefit from The Joint Practice Notes. For example, incentives should be offered to encourage the use of more environmentally friendly, reused and recycled materials in construction.

The Architectural Services Department is recommended to continue its policy to achieve sustainable, environmentally friendly and energy efficient designs with less disturbance to the environment, less consumption of natural resources, the use of new and clean energy technology.

ix.) Recommendations to contractors

Contractors should consider wider use of recycled materials and modern construction methods (such as the use of system formwork and prefabrication) to reduce construction waste.

It is recommended that all contractors in Hong Kong should adopt an environmental management system for the benefits of themselves as well as the environment. The implementation of environmental management in construction has a direct contribution to environmental protection. It involves allocating a variety of resources for practicing various environmental management methods such as noise control, treatment of polluted water, waste recycling and reusing, and so on. (Shen and Tam, 2002) The application of these methods leads to an increase in labour use, materials handling costs, but they can reduce the production of wastes, and reducing the use of materials and techniques that could have harmful effects on the environment. Moreover, contractors also save fines associated with convictions as a result of complying with environmental legislation.

x.) Recommendations to architects

When designing a building, architects should consider a 'team' approach, involving the customer, contractor, engineer, and also other non-construction professionals as appropriate, possibly human scientists and ecologists. Incorporating their opinions as well as objections to the design can definitely make buildings more sustainable.

xi.) Recommendations to developers

The change for the construction industry should be driven by market forces as far as possible. In this regard, clients, in particular public sector clients, play a critical role in driving the construction industry to improve its operations through quality-oriented procurement strategies and contractual requirements. Knowledgeable clients who remain closely involved during project implementation and who demand quality output are an important driving force of this culture change. It is recommended that a significantly greater level of client participation in the design process is essential, and experiences of the early stages of occupation of a building should be used to provide feedback to the designers.

7.2 Limitation of the study

Sustainable construction is a broad concept and it involves everybody in construction industry. In this dissertation, only government bodies, developer, contractors, architects and Business Environment Council are studied. Other parties such as material suppliers, planners, sub-contractors, construction workers, engineering firms, professional bodies, government departments such as The Hong Kong Housing Authority and Housing Department, Lands Department, Planning Department are not included in this study because of the time and resources constraint, hence only those having significant effects and responses are selected to be the subject of this study.

For the questionnaire, the targeted companies are chosen arbitrarily. Due to the small sample size of the questionnaire and the low response rate, the result of questionnaire may be biased and may not be a good representation of the general view of the whole building construction industry.

Though interviews are conducted to identify the real practice of sustainable construction in Hong Kong, interviewees usually are less reluctant to disclose their unsustainable practice as this may affect their company's image. It is difficult to identify the real situation and practice of the building industry in Hong Kong.

Moreover, 6 interviews are conducted representing different organizations. Only one company is conducted for each sector thus it may not represent the standpoint of the sector as a whole. Also, no interview conducted with architects to collect their views

because of lack of responses from architectural firms, thus conclusion is drawn based on the questionnaire survey.

In addition, the author attempts to conduct several case studies of sustainable construction practice from public sector as well as from private sector. Unfortunately, the author fails to do so due to the time constraint and the response from targeted private companies. The author thus only carries out one case study of The Science Park, which may not fully demonstrate the ability of construction industry in Hong Kong.

7.3 Recommendation for further study

As this dissertation aims to present an overview of sustainable construction in Hong Kong, this dissertation can be used as a starting point for future researches on different kinds of topics under sustainable construction, such as built environment and the ecologic, resources saving, sustainable indicators, social sustainability issues surrounding buildings, etc in order to identify each topics' contribution to sustainable construction and suggest appropriate recommendations to make our built environment more sustainable.

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Appendix I

Hong Kong Science Park Phase 1

