New Senior Secondary Liberal Studies

Teacher's Manual - Knowledge Enrichment Series

Issues of Science, Technology and the Environment in Perspective

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Foreword

In the 2009 / 10 school year, the Education Bureau commissioned the service of Conducting Professional Development Programme New Senior Secondary (NSS) Learning and Teaching Strategies for Liberal Studies – in Modules 5 & 6 (Web course) to the Hong Kong Institute of Education. The web course was well received by Liberal Studies teachers. In order to provide Liberal Studies teachers with a handy reference for preparing learning and teaching materials for issues related to "Public Health" and "Energy Technology and the Environment", the Education Bureau published this resource material based on the contents of the aforementioned web course.

The issues described in this booklet are examples that Liberal Studies teachers can use to facilitate students' enquiry. Teachers may also choose other appropriate issues with reference to the examples described here. In addition, the analytical framework suggested in this booklet can facilitate students' analysis of social issues which are not restricted to the scope of public health as well as energy technology and the environment. Chapter 1-5 of this booklet describe the main focuses of learning and teaching of issues related to the "Public Health" and the "Energy Technology and the Environment" Modules. Chapter 6 suggests learning and teaching strategies that can be adopted in Liberal Studies lessons to help students conduct issue enquiry and construct conceptual and contextual knowledge related to the issues.

We hope this booklet could enhance Liberal Studies teachers' professional capacity in using issue-enquiry approach to nurture students' critical thinking skills.

Chapter 1: Introduction

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Overview

- Technology refers to any methodology or artificial construct created by people to accomplish their goals and satisfy their needs, which include their probability of survival, and control over the environment (Alcorn, 2003; Nickerson, 2005).

- Although technology can help satisfy human needs, it always comes with a price. Development of technology often requires huge amount of capitals. Besides, its implementation and operation may have an adverse impact on the environment and the interests of certain groups of people.

- Development of technology is closely associated with social needs, public support, benefits to humanity and adequacy of capital and resources. Careful consideration of these factors is necessary for maximizing the benefits of a technology. This lecture will adopt the following model for analysis (Figure 1-1)

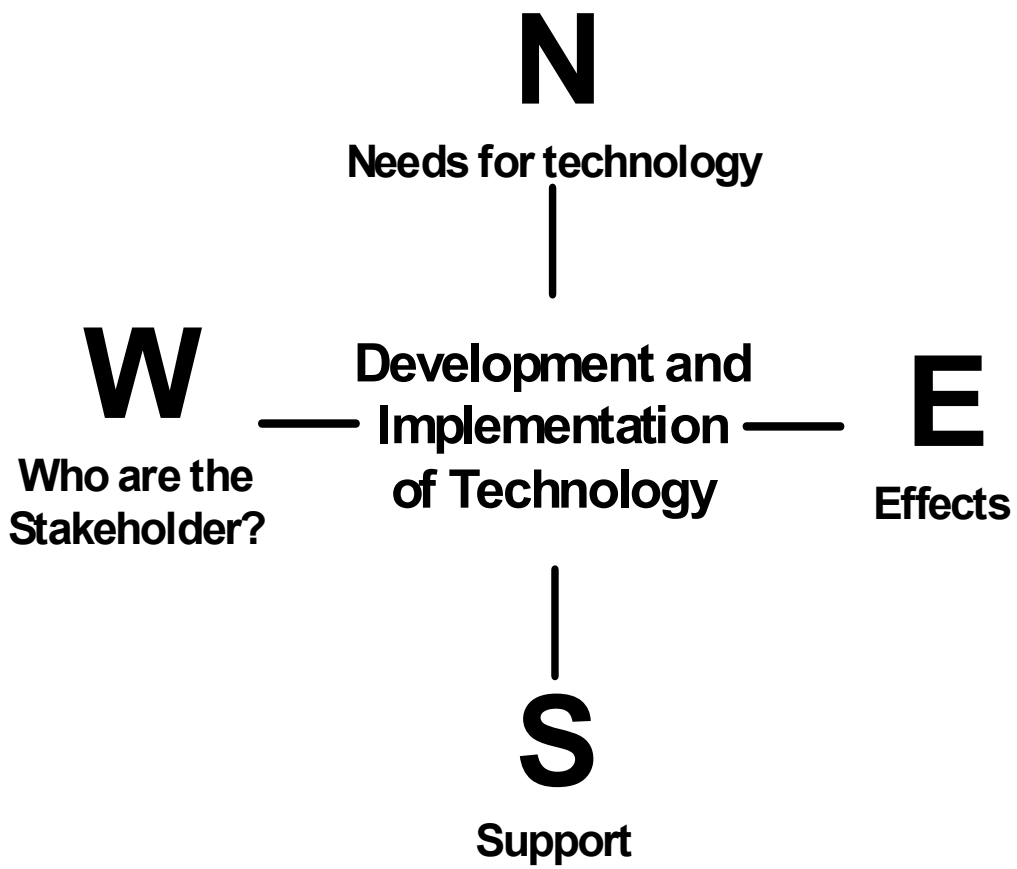

Figure 1-1. Model of analysis of technological development and implementation of technology.

1. Needs for technology

Technology helps people to satisfy their desires and needs. It has been an inseparable part of our life since as the ancient times. Our ancestors made tools out of stones. The primitives drilled wood for fire. And nowadays, we use vaccines to combat epidemics. In many cases, technology is important for our survival.

Advancement has extended the application of technology from satisfying survival needs to improvement of quality of life. Besides, technology plays a major part in driving the welfare of the society and of the world.

1.1. Personal level

- Technology is essential to the survival and improving the quality of life of people. It relates to the four basic necessities of life, namely clothing, food, shelter, and mobility, in the following ways.
  - Textiles and clothing manufacturing technology provides people with protective and comfortable attires
  - From primitive times when people learned to make fire, to modern when farming, food processing and storage undergo continuous improvement, technology has been helping people gain better access to nutrition and water
  - Development of building technology provides comfortable housing for people
  - Transportation technology allows safer and quicker access to destinations
- Technology also helps people improve their quality of life:
  - Development in technology results in new products, including those for entertainment and leisure
  - Development in communication technology such as the telecommunication and the internet has expedited the exchange of information
  - Computers and the internet have enhanced not only communication between people but also the efficiency of daily work

1.2. **Societal level**

- Technology satisfies different social needs, including:

  - The communication technology for promulgating news and information
  - The medical technology for enhancing public health and increasing the life expectancy of the population (See Lectures 2 and 3)
  - The energy technology for supporting utility services (See Lecture 4)

- Examples of technological applications at the societal level in Hong Kong:

  - Provision of various vaccines to reduce infant morbidity and mortality
  - Introduction of ultra low sulphur diesel to the market to reduce the level of respirable suspended particulate (RSP) and sulphur dioxide (SO_2)

1.3. **National level**

- Technology can also promote national development through enhancing stability and prosperity. For example:

  - Military technology safeguards national security
  - The setting up of professional research institutes attracts foreign investment (See Lecture 3)
  - The building of roads and railways can boost economic development and increase job opportunities (See Lecture 5)
  - Building environmentally-friendly facilities can improve environmental quality in the country (See Lectures 4 and 5)

- In addition, advancements in technology can promote the international status of a nation. For example, China is now renowned for its rapid advancement in space technology following numerous astronomical activities held in recent years.

1.4. **Global level**

- Technology plays an important role at the international level, as many innovations have brought peoples to better living standards as a whole. Examples of applications on a global scale include:

- Vaccines has successfully prevented the spread of diseases such as smallpox, and promoted an increase in people's life expectancy
- The internet allows people to communicate and exchange information conveniently across borders
- Astronomical technology and satellites have enabled precise weather forecasting and the issuing of timely alerts to adverse weathers to minimize losses

2. Who are the stakeholders?

"Stakeholders" refers to any party that would likely be affected by certain decisions, policies or activities (Button & Ryfe, 2005), which may range from the development of specific technologies, to projects, events, etc. The affected party may refer to individuals, organisations, groups or communities. Generally, a decision, policy or activity will have different impacts on different stakeholders.

2.1. Classification of stakeholders

- Stakeholders are often classified according to their geographic location, gender, age, political affiliation, socio-economic status, or other attributes. Developments or applications of technology often affect various parties in different ways, while the effects on one particular group may not necessarily be noticed by the others. For example, the introduction of advanced machines by a food processing company to replace labour would affect different parties in the following ways:

  - The company may enjoy improved efficiency and higher productivity
  - Workers who are laid off need to seek other jobs
  - Workers remained have to adapt to changes in the working procedures
  - Machine suppliers obtain a profit from selling the equipment
  - Individuals or organizations may be concerned about the effects on food quality
  - Governments and authorities which are in charge of quality assurance of food have to inspect whether the production process is up to the standard

(Further examples are given in the later lectures. Examples related to public health and medical technology will be introduced in Lectures 2 and 3 respectively; examples of energy-related projects and sustainable development will be discussed in Lectures 4 and 5 respectively.)

2.2. Civic engagement

- Technological development often results in controversies and substantial social and political ramifications. Stakeholders, as citizens, should have the rights to be informed of these changes and developments and express their views.

- Civic engagement is "an organised process by which government takes the initiative to involve citizens in every stage of policy development so as to clarify their values and interests for exploring policy alternatives and prioritising different proposals" (Bauhinia Foundation Research Centre, 2007). During this deliberative process, policy makers would consult the public on certain issues, projects or developments. Other than informing the public of the related issues, public consultation aims to collect the public opinion on specific policies and decisions so that the policy makers may make necessary revisions and amendments to the original proposal to better facilitate the policy implementation.

- The following are some of the characteristics of effective civic engagement:

  - Inclusive and organised processes steered by an advisory committee which brings key stakeholders together
  - Providing opportunities for different stakeholders to exchange their views so as to arrive at a most generally acceptable proposal
  - Complete transparency of the information promulgated to the public
  - Adequate public access to information channels and resources as well as feedback channels
  - Adequate time for the whole consultation process (Bauhinia Foundation Research Centre, 2007; Depoe, 2004)

- Effective civic engagement and deliberation help bring just and rational outcomes which the majority will perceive as fair and legitimate. Apart from collecting public feedback, civic engagement encourages positive values by encouraging mutual respect through rational communication and negotiation to form a consensus (Gastil & Levine, 2005).

3. Effects on the economy, society and the environment

Although technology helps people satisfy their needs and enhance their quality of life, it usually comes with a price. While technology can help boost productivity, extend life expectancy, transport people to destinations in a faster way, and enhance data management and storage efficiency, it also leads to different problems, such as ethical ramifications and environmental pollution.

3.1. Effects on the economy

- Technology helps promote economic growth through enhancing production, communication, data management and administration to promote economic growth.

- Technology has created enormous knowledge capital. Professor Baruch Lev from the New York University has assessed and estimated knowledge capital among various industries in the United States (Table 1-1).

Table 1-1. Knowledge capital in the United States in 1999 (Westland, 2002)

Industry	Knowledge Capital (US$ million)
Aerospace & national defence	23,447
Computer hardware and software	88,765
Food/beverages	18,565
Home products	19,296
Industry	23,132
Media	16,759
Motor vehicles	13,413
Oil	24,559
Pharmaceuticals	75,224
Telecommunication	81,221

- On the other hand, technological development requires an enormous amount of resources and capital, resulting in a financial burden for a nation.

- In the United States, the budgets for research and development on national defence exceeded US$80 billion in the fiscal year 2008 (Erwin, 2007). This spending would no doubt burden its national debt which has already exceeded US$10 trillion.

3.2. **Effects on society**

- Technology helps enhance social stability and people's quality of life. For example:

  - Advances in technology have boosted military strength, thereby promoting social security and stability.
  - Medical technology helps decrease morbidity and mortality through precise diagnosis and effective treatment. Vaccines and various technological findings protect humans from infections, such as the eradication of smallpox.
  - Energy technology has enabled the exploitation of fossil fuels, which have been the major sources for combustion and the generation of electricity. Energy technology is important as global energy use tripled in the past 50 years along with the doubled world population (Hjorth, Eichler, Khan & Morello, 2003).

- However, technology has also given rise to different controversies in the community. For example:

  - The use of some technology carries a certain degree of risk. Despite its low probability, technological accident can be disastrous to a community. Until the Chernobyl disaster, nuclear energy was thought to be one of the most reliable and clean sources of energy. Other than the potential of accidents, there are also growing concerns about the storage and disposal of radioactive waste (Khan & Eichler, 2003).
  - If the technology of bio-weapons falls into the hands of terrorists, it may be used for terrorist attacks.
  - Some technologies such as in-vitro fertilization have triggered ethical and moral concerns about the roles of scientists and users, and the possible consequences brought about by the technology.

3.3. Effects on the environment

- Despite enhancing the quality of life, the use of some technologies causes environmental pollution. For example:

  - Chlorofluorocarbons (CFCs) are chemicals which are frequently applied in refrigeration, insulation and packaging. When released into the atmosphere, they would drift up into the stratosphere and release chlorine through chemical reactions. Under ultraviolet light, each chlorine atom would break down about 100,000 molecules of ozone. Evidence of the destruction is drawn from the "ozone holes" near both poles (Hjorth et al., 2003)
  - The burning of fossil fuels has been the major contributor of greenhouse gases in Hong Kong (62% of total emissions in Hong Kong). Greenhouse gases are both the major causes of climate change and global warming (HKSAR Environmental Protection Department, 2005).

- On the other hand, advancement of technology has made green technology possible. Renewable energy, such as wind and solar power, is much more environmentally-friendly than fossil fuels and other traditional methods of energy generation.

4. Supports

Abundance of capital, knowledge and resources is often the precondition for the development of technology. Whether it is systemic or technological innovation, or research and development of a new product, capital, knowledge, time, natural and human resources are required at every developmental stage.

4.1. Capital

- Research and development (R&D) often requires a huge amount of capital. For example, the average cost of developing a new drug is estimated at US$800 million (DiMasi, Hansen, & Grabowski, 2003).

- The Hong Kong Government is committed to promoting innovation and technology by supporting various programmes run by the Innovation and Technology Commission (Table 1-2).

Table 1-2. Estimates of expenditure of the Innovation and Technology Commission 2008-2009 (HKSAR Innovation and Technology Commission, 2008).

Programme	Financial Provision (HK$ million)
Support for research and development	22.4
Fostering university-industry collaboration	6.6
Promotion of technological entrepreneurship	7.7
Planning for innovation and technology development	37.3
Infrastructural support	76.3
Quality support	57.4
Subvention: Hong Kong Productivity Council, Hong Kong Applied Science and Technology Research Institute Company Limited	302.9
Total	507.9

4.2. Natural resources

- Many construction projects require natural resources such as water and lumber as raw materials.

- The availability of land and other geographical components may also decide the feasibility of technology, especially in the case of energy-related projects (Table 1-3).

Table 1-3. Example of geographical requirements for some energy-related projects.

Projects	Requirement
Oil field	Presence of oil reservoirs
Wind power	Sufficiently strong wind and abundant space in highland areas
Hydroelectric power	Presence of rivers or streams
Solar power	Abundant sunlight

4.3. Human resources and time

- Invention and innovation require human talent and efforts. Advancement is built upon multiple ideas and theories from different people rather than individual effort. For example, Watson and Crick's model of DNA may not be successful without the advice from other scientists such as Chargaff and Donohue. (National Library of Medicine, 2005)

- Technological development does not happen in the blink of an eye. Most of the advances have in fact taken a long time-span before promising results ensue. For example, a new drug takes approximately 10 years to develop before it is ready to be released into the market.

Conclusion

Technological development involves numerous aspects, including social needs, stakeholders' interests, economic, social and environmental impacts and supports. Each aspect has a role in determining the feasibility of technology. Careful analysis of each of them would minimise social costs and adverse impacts upon the affected groups in the process of satisfying the needs of society.

- The following lectures will focus on how to analyse socio-scientific issues in different fields:

    - Lecture 2: the relationship between understanding of health, health situations, and stakeholders' views; and their interconnection with the principles of public health
    - Lecture 3: analysis of benefits, cost, controversies involved in medical technology and relevant policies
    - Lecture 4: demands for energy technology and analysis framework for energy-related projects
    - Lecture 5: principle of sustainable development and analysis of the three comprising aspects: economic, social, and environmental

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Chapter 2: Understanding of Public Health

Overview

Public health is the study and practice of managing threats to the health of a community. This lecture starts with a brief review of an "Understanding of Health" and then focuses on the factors influencing the decisions on health issues.

- Health decisions often involve not only considerations on quantitative indicators, but also stakeholders' views and the public health situations at that time.

- Public health is the science and art of preventing disease, prolonging life and promoting health. The practices require formal and informal participations of individuals and communities in making relevant decisions.

- Decisions regarding public health issues can be divided into the local, national and global levels. Thus governing bodies at the corresponding levels are involved.

- Decisions on health issues usually interact with people's understanding of health, health conditions, and stakeholders' views (Figure 2-1).

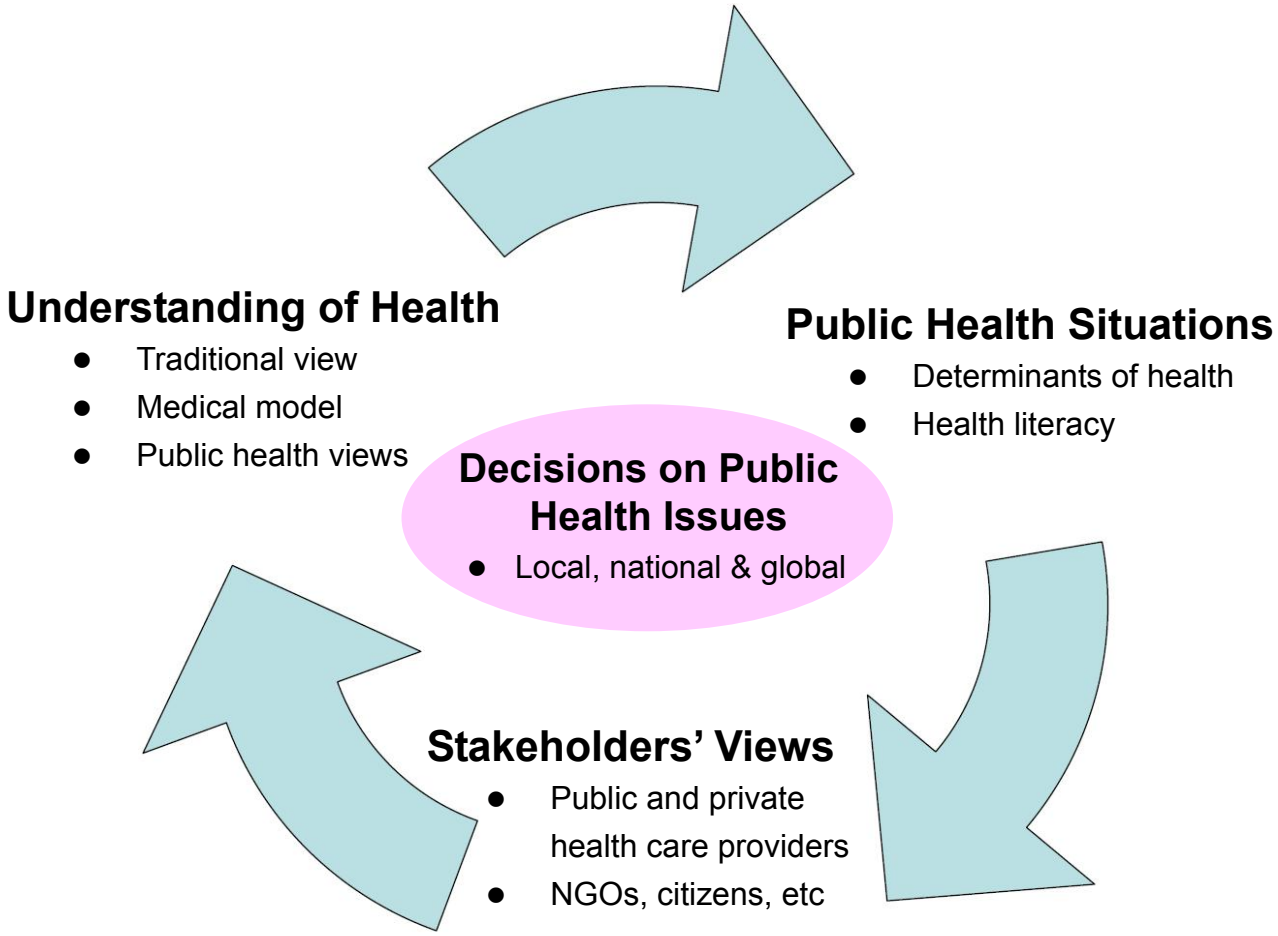

Figure 2-1. Interactions among the factors affecting decision making on public health issues.

Decisions on public health issues

Public health issues are closely related to the public health situations. Decisions on public health issues may affect people's health. These decisions include the making of health policies and regulations on movements and campaigns related to public health. In general, the practices of public health often involve decisions at the local, national and global levels.

- **Local level**

  Local government and departments are responsible for:
  - updating and reporting the health conditions of their populations
  - proposing health-related measures and budget to the national government for approval in response to certain health issues and concerns
  - executing approved policies and measures

- **National level**

  The national government and departments are responsible for:

  - promulgating health related news, information and decisions
  - adopting suitable health-related policies and regulations
  - examining and approving health-related budget of the local government

- **Global level**

  International organizations and governing bodies are responsible for:
  - promoting global public health
  - establishing directions and goals for health related issues at the international level
  - enhancing regional and international collaborations on health-related issues
  - formulating the research agenda and stimulating the generation, translation and dissemination of valuable knowledge about public health
  - monitoring public health situations and assessing health trends.

- Under the principle of "One Country, Two Systems" and Article 138 of Basic Law, 'the Government of the Hong Kong Special Administrative Region (HKSAR) shall, on its own, formulate policies to develop Western and traditional Chinese medicine and to improve medical and health services. Community organisations and individuals may provide various medical and health services in accordance with law.' Thus the HKSAR Government is responsible for decision making regarding health issues on its own. However, it should work in close collaboration with the Central People's Government on regional health issues such as epidemics and food safety.

Case study: Tainted milk powder

Many infants in the mainland were affected by tainted milk powder. Milk products of numerous brands were found to be contaminated with toxic melamine, which may result in kidney stones and acute kidney failure when it is consumed beyond a certain level. This food quality scandal had damaged the reputation of the milk manufacturers in the mainland and their products on a massive scale as contaminated samples were found in export locations such as Hong Kong and Singapore. The following table illustrates how governing authorities of different levels handle the issue.

Table 2-1. Decisions at the local level (HKSAR), national level (PRC) and the global level (WHO) governing bodies in the tainted milk powder incident (Sources: Centre for Food Safety, 2008; 澳門日報,Sept 24,2009; The Standard, Sept 23, 2008).

Level / Duties	HKSAR	PRC	WHO
Report and promulgation	● locating and investigating into contaminated samples ● promulgating the latest news to the public	● locating and investigating into contaminated samples ● promulgating the latest news to the public	● promulgating the latest news globally
Policy and regulation	● enacting legislation to prohibit the sale of food products contaminated with melamine ● recalling sold milk products	● prosecuting offenders ● ordering a nation- wide check of all baby powder manufacturers ● recalling sold and exported milk products	● demanding the Chinese Government to fully investigate the incident

Decisions on health issues, from the local to the national and global levels, are always affected by the interactions between public understanding of health, public participation, and stakeholders' views.

1. Understanding of health

The understanding of public health and its interventions are often influenced by different factors such as the religious, cultural and scientific ones. A solid scientific foundation is essential for understanding human health and disease, and for training scientists and practitioners in the medical and health care professions. The evolution of scientific knowledge has been both dominating and confining people's understanding of health for a long time. Since the 1980s, the understanding of health has been changing from a medical model to a holistic view. Apart from individual behavior, the holistic view of health also considers social issues such as inequality, poverty and education.

People's understanding of health has changed from the traditional view to the medical model and then to public health view. These are reflected in the practices of managing threats to the health of a community.

1.1. Traditional view of health

- Before the discovery of germs, the understanding of disease or other ailments was often associated with religious and cultural beliefs. The health interventions of different ethnic groups resulted in corresponding amendments to health policy beyond those based on scientific findings.

- Religious and cultural beliefs are important components in the life of many people. The following case study of smallpox is used to illustrate how religious and cultural beliefs affect people's understanding of health and the way they cope with diseases.

1.1.1. Case study: Smallpox

Until the World Health Organization (WHO) announced that smallpox had been completely eradicated in 1980, the disease had been one of the most terrifying germs in human history. Smallpox is a highly infectious and fatal disease with symptoms of fever and pustules growing all over the skin surface. The disease killed as many as 30% of those infected and once threatened 60% of the world population (WHO, 2008). The survivors may suffer from complications. For example, smallpox could lead to permanent blindness if the eyes were affected, and is believed to be the cause of a third of all cases of blindness in Europe in the 18th century (Glynn & Glynn, 2004). The following shows the different understanding of smallpox and the associated health interventions in different cultures.

I. China

In China, smallpox became endemic during the Northern Song period and was regarded as the "gate of life or death" for children (Chang, 1996). Chinese physicians tended to apply the theory of Five Phases and Six Qi（五運六氣） to explain the causes of smallpox. The patient was advised to stay undisturbed in a well-ventilated room to avoid harm from filthy "qi" from visitors (Chang, 1996).

Dou Zhen Niang Niang（痘疹娘娘或天花娘娘）was the most renowned smallpox goddess in pre-modern Chinese society. The patient and the family had to follow a strict regime to avoid offending the goddess. An example is the magnificent ritual to worship the smallpox goddess following the death of the Qing Emperor Tongzhi in 1874 (Chang, 1996).

The Jennerian vaccination, introduced into China in the 19th century, was not widely accepted by the public at first due to strong opposition from Chinese practitioners (Chang, 1996). Supporters thus set up institutions to provide free vaccinations, education and guidelines for the public so as to publicise vaccination. This helped the public recognize the advantage of vaccinations over variolation. In addition, thorough modifying and combining the ideas and methods of vaccination with traditional Chinese medicine, this method of preventing diseases was developed and widely adopted (Chang, 1996).

II. India

Smallpox had been endemic in India for several centuries. Sitala, the goddess of smallpox, was worshipped throughout the subcontinent and the delta regions of Bengal (Stewart, 2002) and was also known as the "cooling mother", with worshippers often enticing her with plates of cooling foods such as cold rice and pots of water (Tucker, 2001). Offerings were made at shrines dedicated to the goddess, while annual festivals were held on her feast day in March (Tucker, 2001). The goddess was so popular that some believers resisted smallpox vaccination as they feared to defy her will.

These religious beliefs affected the government's policy and approaches to promoting vaccination. Besides meeting with Indian spiritual leaders and persuading them to support vaccination, members of WHO also set up surveillance posts at Sitala shrines (Tucker, 2001). The WHO and the Indian government also offered a reward of 100 rupees to any medical and health-care worker or villager for reporting a fresh case of smallpox, so as to increase the efficiency of surveillance (Tucker, 2001).

1.2. Medical model

- The medical model tends to interpret disease and illness in terms of the malfunction of individual organs, cells and other biological systems. Health is interpreted as the absence of disease and illness. Intervention focuses on killing germs and preventing their spread. The eradication of smallpox symbolized a great achievement in terms of this view.

- The medical model, however, fails to explain the causes of non-contagious diseases such as cardiovascular diseases.

- The medical model is strongly influenced by scientific methods. The process involves formulating, hypothesising, planning and conducting controlled experiments which can be repeated by others, and the drawing of conclusions from the analysis of the results.

- The development of scientific studies, such as anatomy and germ theory, have enhanced people's understanding of health and diseases and contributed much to the medical model of health.

- Anatomy

  - Early secular understanding of health and diseases was based on Hippocrates' theory of Four Humours and Galen's theory of the blood system. These theories carried authority until the Enlightenment when they were questioned during the emergence of anatomical practices. Anatomy has contributed significantly to the modern understanding of human physiology, including an understanding of the structure and function of organs. The study of inflamed organs, tumours and parasites became possible, and enhanced the understanding of diseases. The invention of the microscope also enhanced studies of the structure of the skin and other organs. Other scientific principles such as the laws of physics aided to explain body functions such as muscular contraction (Porter, 1996).

- Germ Theory

  - Epidemics remained frequent despite scientific and technological advancements during Industrialization. Before germ theory was proposed, some people believed that epidemics were caused by vapors known as "miasmas", which rise from rotting refuse and are transmitted through the air (Cottrell, Girvan, & McKenzie, 2006). Herbs and incense were used to perfume the air to prevent the inhalation of any miasmas (Duncan, 1988). Germ theory was proposed by Louis Pasteur in 1862, identifying microorganisms as the infective agents for a host of specific diseases. The principle states that germs take hold within the body of an individual, multiply, and result in disease. Pasteur's discovery introduced advancements in bacteriology and vaccination.

1.3. **Public health view**

- In recent decades, people's understanding of health has transformed from the medical model to the public health view. Instead of basing solely on the presence or absence of disease, the WHO has defined health from a more holistic perspective. In studying public health and the possible risks on people's health, different perspectives including sociological factors (political and economic dimensions) and environmental factors (environmental quality and pollution) have to be assessed.

- The public health view emerged with a modern analysis of ecosystems and environmental risks to human health. It emphasises the effects on personal health of socio-economic status, educational and multiple environmental factors. In many aspects, this view is similar to traditional views such as those of the ancient Asian and Greek philosophers. They associated health with harmonious interaction with fellow creatures and the environment. In particular, as the environment changes, one's interaction with it must change to remain in harmony. Illness is interpreted as the disharmony of human and environmental interaction.

1.3.1. Case study: Tuberculosis

The case of tuberculosis (TB) can illustrate different understandings of diseases and how these understandings lead to certain actions and practices. TB was a common fatal disease until the turn of the 20th century. Before Robert Koch's finding that bacillus is the cause of TB, some patients viewed the disease as punishment attracting divine wrath on an individual. Consequently, some patients would visit witch doctors or sacred places to immerse themselves in "healing water" (Riddell & Wright, 1996).

Risk factor of tuberculosis

Many have drawn correlations between the peak of TB in England in 1780 with the Industrial Revolution, a period when massive migration from rural to urban areas resulted in overcrowding and conditions of poor hygiene. Another example of the relationship between TB and environmental hygiene can be seen in the towns of the gold mining area during the mid-1800s in Australia. Overcrowding resulted in poor sanitation, together with dust inhalation and poor ventilation which made TB a major killer (Riddell & Write, 1996).

Public health measures

The early preventive measures of TB focused on improving public hygiene. In 1899, the Chairman of the Commission of Public Health, Australia, adopted measures including advocating adequate housing and the erection of "Do not spit" signs in public areas (Riddell & Write, 1996). During the mid-20th century, the Australian government launched the Conmmonwealth Anti-Tuberculosis Campaign, including the provision of Bacille Calmette Guerin (BCG) vaccines to school children, and funding for regular compulsory community X-ray surveys (Riddell & Write, 1996). The following table compares the traditional, medical and public health views of the causes of tuberculosis and the corresponding measures (Table 2-2).

Table 2-2. Comparison amongst the different views of the causes of tuberculosis and the corresponding measures.

Views / Causes & Measures	Traditional view	Medical model	Public health view
Causes of Tuberculosis	● punishment of sin	● infection of bacillus	● poor hygiene and living conditions ● Crowded living environment
Corresponding Measures	● visit sacred places and witch doctors	● vaccination	● advocate adequate housing ● improve public hygiene

1. Health situations

In promoting public health, the policies are not only shaped by the understanding of health, but also by the assessment of public health situations. There can be two dimensions of health situations: determinants of health and health literacy. Determinants of health refer to the economic, social and environmental conditions in which people live. In recent years, health organizations such as the World Health Organization, the Public Health Agency of Canada and the European Commission have developed lists of health determinants assisting governments to formulate health policies. Health literacy is the capacity to obtain, process and understand health information in order to make decisions and take appropriate actions. Individuals with poor health knowledge may encounter difficulties in accessing health services and maintaining a healthy lifestyle.

2.1. Determinants of health

- The economic and social conditions under which people live determine their health. Most diseases are primarily caused by exposure to health risks.

- In many countries, the governments formulate their health policies with reference to the health determinants. Thus the lists of health determinants vary amongst different health organizations. The lists are usually controlled by political parties who come to power with a set of ideological beliefs concerning the nature of society and the role of governments.

- Although the details and analysis of health determinants exhibit variations among different health organisations, the determinants can be categorised into five areas (Table 2-3):

  - Demographic factors
  - Health status
  - Health environment
  - Health services
  - Health promotion

Table 2-3. Areas covered by determinants of health

Examples of Determinants of Health	Examples of Public Health Policies in Effect
Demographic factors ● Age ● Unemployment rate ● Educational attainment	Commonly used demographics include gender, age, income, educational attainment, home ownership and unemployment rate ● Adopt programmes to encourage people to give births and provide assistance ● Adopt financial aid programmes to help the unemployed gain access to health services ● Promulgate health information to the public
Health status ● Incidences of diseases ● Number of injuries in the workplace	Data on the occurrences of illnesses, diseases and injuries helped the government to decide what kinds of programmes are to be adopted ● Adopt programmes to promote a smoke-free environment since smoking is known to be a major cause of lung cancer ● Promote and enforce occupational safety measures in the workplace
Health environment ● Air quality ● Water quality ● Food quality	Environmental factors such as water, air and food quality which may pose health risks to the public ● Restrict emission of air pollutants from power stations ● Restrict disposal of waste water from construction sites ● Monitor imported poultry to guard against avian influenza

(Cont'd)

Examples of Determinants of Health	Examples of Public Health Policies in Effect
Health services ● Medical staff working hours ● Health expenditure	Provision of health services, such as medical technology and facilities, vaccination coverage for children and human resources, indicates whether the services provided are adequate ● Provide additional staff to ensure satisfactory and quality health services ● Balance spending and revenue, avoid overspending or under-spending
Health promotion ● Health information survey ● Public feedback	Programmes, campaigns and any activities which enhance public health and the public's understanding of health ● Disseminate health information in a more comprehensive way ● Review and amend ineffective policies

2.2. Health literacy

- The health literacy of individuals often influences their understanding of and views on health promotion and policies. To effectively promote the health of a community, the government should provide the public with the knowledge of health issues and foster a sense of personal responsibility for healthy behavior.

- With the dissemination of health information or running of certain health campaigns, individuals may make changes in their decisions and personal lifestyles, such as improving personal hygiene, having a healthy diet, doing regular exercise, paying attention to occupational safety, reducing smoking and alcohol consumption. These changes help reduce risks of suffering from diseases and improve their health status as a whole.

- Personal health decisions determine an individual's exposure to risk factors. Healthy individuals not only have the privilege of enjoying better quality of life, but also reduce the burden on the public health system. Participating in and supporting health movements and campaigns may also increase the effectiveness of the programme and uplift the health status of the community.

- In terms of people's knowledge of and their motivation to participate in the medical and healthcare system, their attitudes towards public health can be classified into four categories, as shown in Table 2-4.

Table 2-4. Categorising people's attitude towards health and the healthcare system in two dimensions

People's motivation to take action on their health & the healthcare system / People's knowledge of health & the healthcare system	**Informed**	**Uninformed**
Active	They are informed about health matters and the system; they are also keen to do something for both their own health and the reforms of the healthcare system.	While motivated, these people lack a knowledge base about health and the system. They are the kind of "loose cannons" who are easily taken in by a food fad, a single factor theory about weight loss or an ill-conceived proposal to reform the healthcare system.
Passive	They are knowledgeable about health matters and the system but they lack the will to take action to improve their health or participate in reforming the system.	These are the classic dependent patients who neither know nor concern about their personal health or the healthcare system.

- Assessing the distribution of the different categories of individuals would be useful in formulating health policies. Strategically, we should encourage more people to become informed and active citizens and thus assume more personal and social responsibilities for promoting health in the community.

- People's behaviours towards health are often rooted in their perceptions and knowledge. Personal health knowledge may be acquired from family and peers, ethnic groups, religious beliefs and health information. Health information is available from various sources such as health education in schools, government pamphlets, and advertisements. Nowadays, methods of dissemination have become increasingly significant as information is shared at a rapid rate and people are eager for information (Table 2-5). Besides the printed and traditional electronic media, the internet is also a major channel of access to health information.

Table 2-5. Channels of dissemination of health information

Channels for disseminating health information	Descriptions
The printed media	The printed media are important channels for transmitting information. They include journals, magazines, pamphlets and newspapers. They can be categorised into three types of sources: ● Primary sources: published studies written by people who have conducted the studies themselves. Examples include research articles and autobiographies. ● Secondary sources: reviews of primary sources by people who are not part of the study team. Examples include journal review articles and editorials. ● Tertiary sources: authentic information which is viewed as fact by the scientific community. Examples include pamphlets and guidebooks published by government organisations. (Cottrell et al., 2006)
The electronic media	The inventions of radio and television have provided channels for transmitting health data to the illiterate. Due to common access and popularity, government organisations and other sectors often use radio and television to disseminate information.
The internet	Besides enhancing the rapid exchange of information, the internet also enables convenient searching for information across multiple disciplines. The convenience and freedom of access to the internet, however, allow just about anyone to post information online without being verified, thus leading to the transmission of inaccurate and false information. One should evaluate the information retrieved from the internet in terms of the following aspects: ● Content: whether the materials are verified or referred when sources are cited; whether the information is intended for commercial purposes. Addresses ending in ".edu", ".gov", or ".org" indicate professional organisations ● Authority: whether authors or the organisations are clearly presented and contacts are provided ● Documentation: whether sources and documentation are provided to prove the validity of findings

2.2.1. Case study: Credibility of advertisement

The Television Advertising Code was enacted to govern and monitor the authenticity of Hong Kong's advertisements. The code stated that "No advertisements may contain any descriptions, claims or illustrations which expressly or by implication depart from truth or mislead about the product or service advertised or about its suitability for the purpose recommended" (Consumer Council, 2006). However, while the code specifically controls advertisements, sponsored television shows fall outside its coverage. In 2004, the Consumer Council found the advertisement of a body lengthening machine on television to be "misleading, untrue and without medical proof" (Consumer Council, 2006).

The following questions may be helpful in determining whether the health information is reliable:

- Who provides the health information?
- Who pays for the advertisement?
- What is the purpose of the advertisement?
- Where does the health information come from?
- How is the health information selected?
- How updated is the health information?

3. Stakeholders' views

Public health policies are made to ensure better health conditions and promote health literacy in the community. However, the policies and measures may contradict some stakeholders' interests. Stakeholders involved in a health issue may include:

- the government
- public medical and health-care providers
- private medical and health-care providers
- the business sector
- patients
- taxpayers, etc.

3.1. Conflicting interests

- Due to different roles and backgrounds, different stakeholders tend to view certain decisions differently. Under a well-organized governing structure, stakeholders may voice their concerns about certain public health policies, and the government shall make appropriate amendments in response.

3.2. Roles of policy maker

- The HKSAR Government has striven to improve various aspects of public health. The following table lists some of the health policies adopted by the government in response to certain health conditions and situations reflected by the determinants of health (Table 2-6).

Table 2-6. Examples of Hong Kong's health decisions in response to health determinants (Food and Health Bureau, 2008; Transport and Housing Bureau, 2003; Department of Health, 2008)

Examples of Determinants of Health	Examples of Public Health Policies Adopted by the HKSAR Government
Demographic factors ● Income ● Education level	To improve public's access to health services by raising the socio-economic status and education level of the public by: ● Adopting the Comprehensive Social Security Assistance Scheme to assist individuals who cannot sustain their basic needs ● Adopting the Social Security Allowance Scheme to grant a monthly allowance to residents who are severely disabled or aged 65 or above ● Extending free education from 9 years to 12 years
Health status ● Number of smokers and 2nd hand-smoking patients ● Number of casualties due to traffic accident ● Number of casualties due to drink driving	To elevate public health status by: ● Amending the anti-smoking regulations to ensure indoor and public areas are smoke-free ● Extending the seat belt legislations to cover rear seat passengers of private cars and taxis ● Tightening the legal limit of alcohol concentration in the blood of drivers
Health Environment ● Air pollution index ● Number of problematic imports	To improve the quality of the environment to protect the public from health hazards by: ● Launching the Action Blue-Sky to improve air quality ● Passing legislation to restrict the amount of melamine in milk powder

(Cont'd)

Examples of Determinants of Health	Examples of Public Health Policies Adopted by the HKSAR Government
Health services ● Public health expenditure	To operate public health services in a sustainable manner to reduce financial burdens in the long term by: ● Proposing health care reforms to promote public-private partnerships in healthcare ● Proposing supplementary financing options to enhance the public's preparation for future medical needs
Health promotion ● Students' diet ● Number of incidents of drug abuse	To promote healthy diet and lifestyle by: ● Issuing guidelines to school lunch suppliers to prepare fresh vegetables and fruits everyday and reduce the amount of fat, salt, and sugar in the meals ● Disseminating comprehensive information on healthy lifestyle, including a series of advertisements to discourage substance abuse and smoking

Conclusion

Health decisions, regardless of whether they are taken at the local, national or global levels, are affected by the public understanding of health, health situations, and different stakeholders' views. The above three dimensions provide important information for policy-makers to prioritise health issues and make appropriate decisions under the constraints of resource and time. Although aimed to improve the health status of everyone in the community, a policy can rarely benefit every stakeholder equally. It may even negatively affect the interest of some stakeholders. Nevertheless, health decisions and policies are essential to prevent infection and to develop the treatment of diseases. The effectiveness of health decisions relies on public participation and social engagement. In order to enrich the understanding of health, the public should be aware of the current health issues and capable of differentiating between true and false information.

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Chapter 3: Development of Medical Technology

Overview

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References

Overview

Advancements in medical technology have increased people's life expectancy and improved their health conditions. Nevertheless, some of the technologies and methods have raised not only ethical and moral concerns, but also controversies on expensive costs and additional burdens on health expenditure. This chapter will use numerous case studies to analyse the social needs involved, the controversies raised and related policies adopted by the government in balancing different stakeholders' interests.

- People's general life expectancy has increased with the advance of medical technology.

- Development of medical technology requires huge amounts of capital. Enormous medical and health expenditure often results in a financial burden for society.

- Medical technology may raise ethical and moral concerns since some of the inventions may cause conflict of values.

- Hence, when considering the use of some medical technologies, policymakers have to assess different factors, such as social needs and the possible concerns and controversies they might raise.

- The policymakers should also formulate appropriate policies and regulations to protect different stakeholders' legitimate interests (Figure 3-1).

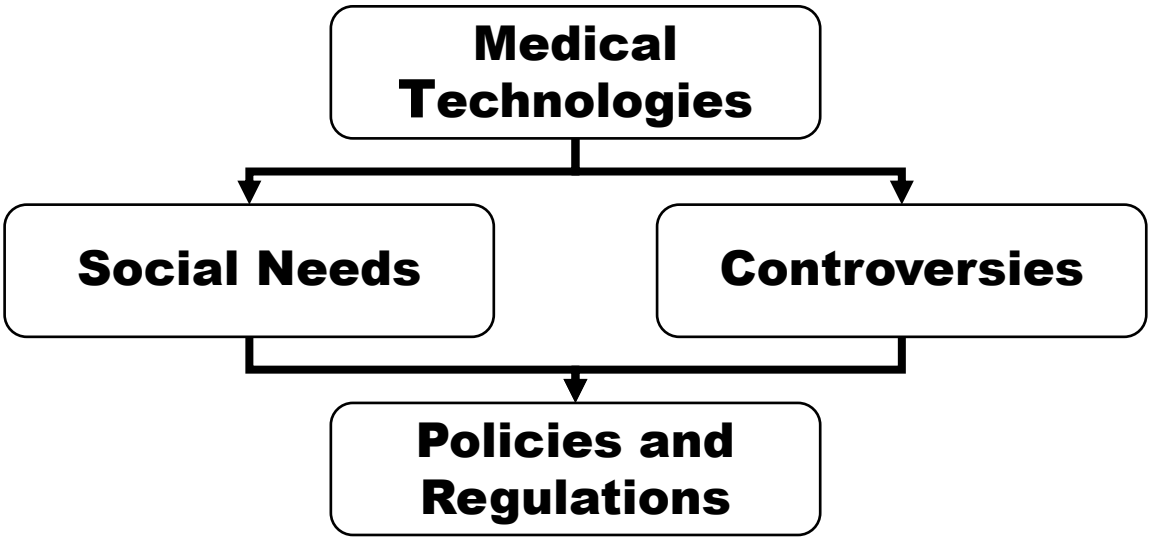

Figure 3-1. Aspects to consider when analysing medical technologies

1. Medical technology

1.1. Benefits of advancements in medical technology

- Medical technology has developed rapidly in the last 50 years. There have been rapid advances in diagnosis, prevention and treatment of diseases. As a result, a better quality of life has been achieved for people in some countries and the world population has been experiencing longer average life expectancy at birth (Figure 3-2). In developed countries, the occurrence of infectious diseases has declined remarkably and there are increasing concerns about the prevention and treatment of non-communicable diseases, such as lifestyle-related diseases and cancers. However, some infectious diseases are still prevalent in developing countries.

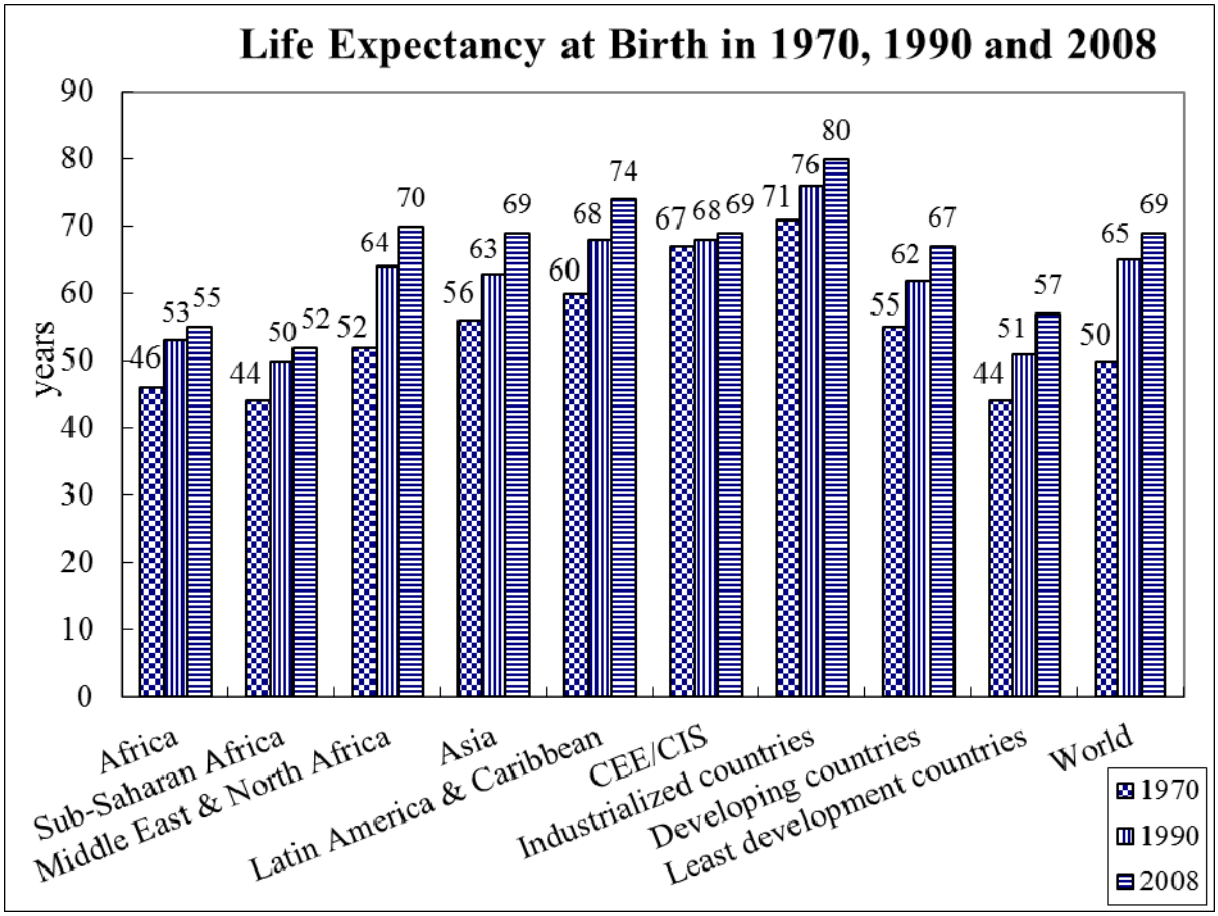

Figure 3-2. Life Expectancy at Birth in 1970, 1990 and 2008 (UNICEF, 2003).

- Advancements in medical technology have resulted in longer life expectancy and a healthier population through the provision of better health care services. These in turn generate greater productivity and economic development. In addition, advancements in medical technology help lure capital and investment and thereby stimulate economic growth for the country.

1.2. Cost of developing medical technology

- Research and development of medical technology requires the input of large amount of resources. These resources come from taxation and private investment (Figure 3-3). In addition, the health departments may purchase drugs and equipment to provide better health services.

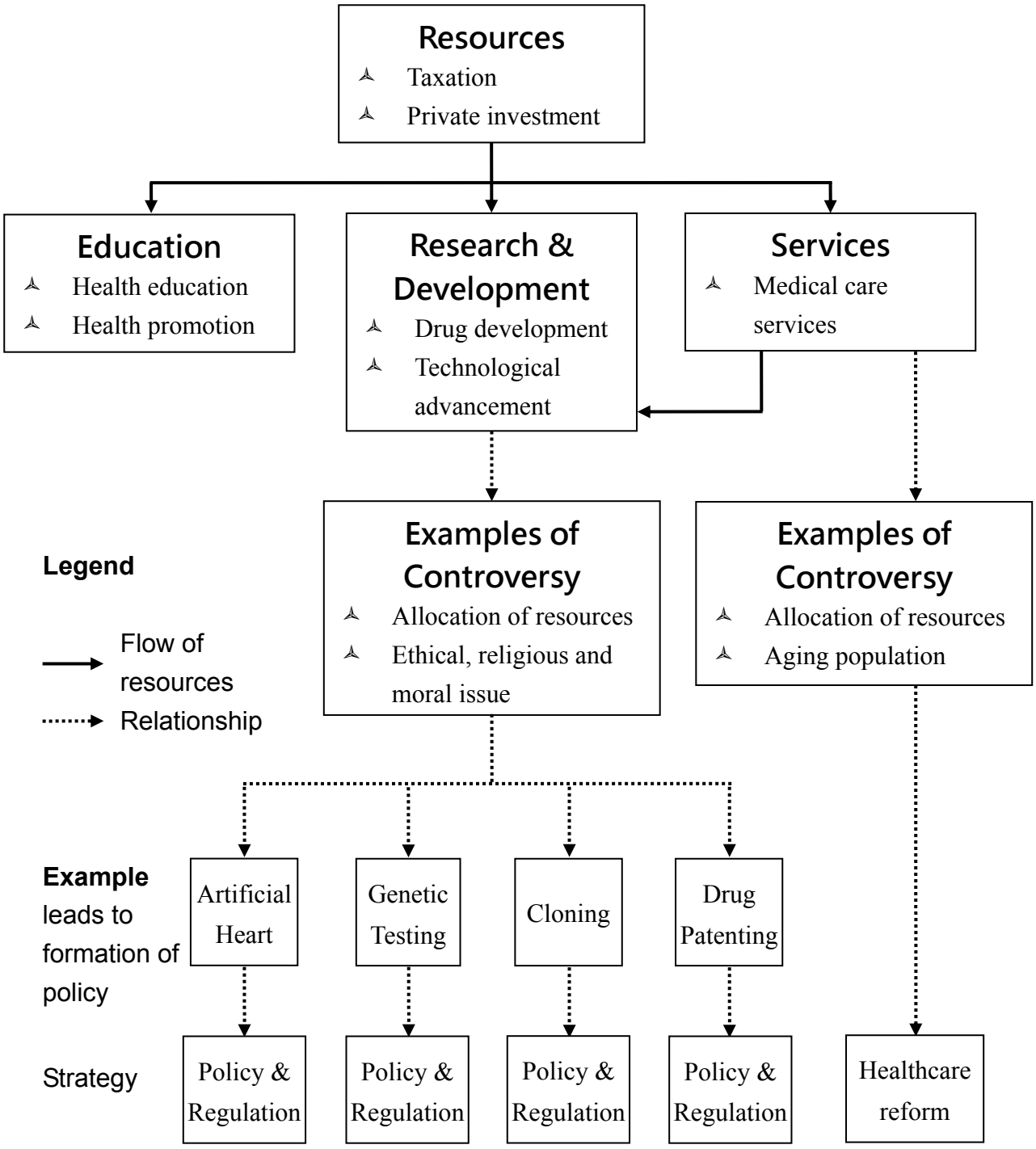

Figure 3-3. Allocation and flow of resources

- Besides inflation, the pursuit of effective medical products and apparatus also contribute to the increase in medical care expenditure. For example, in the United States, driven by the growth of echocardiography and imaging services, the volume of cardiovascular services experienced an increase of 5.5% per capita in 2004-2005 (Redberg, 2007) and its annual expenditure amounted to US$403.1 billion. Since 1960, medical spending of most of the countries, particularly the developed countries, has increased along with their gross domestic product (GDP) (Table 3-1).

Table 3-1. Health expenditure's percentage of GDP in selected OECD countries (Organization for Economic Cooperation and Development, 2007)

Country	1960	1970	1980	1990	2000	2005
Australia	4.1	4.6	7.0	7.8	9.0	9.5
Canada	5.4	7.0	7.1	9.0	8.9	9.8
France	3.8	5.4	7.1	8.6	9.3	11.1
Germany	4.8	6.2	8.7	8.5	10.6	10.7
Greece	N/A	6.1	6.6	7.4	9.9	10.1
Iceland	3.0	4.7	6.2	8.0	9.3	9.5
Japan	3.0	4.5	6.5	5.9	7.6	8.0
Korea	N/A	N/A	4.2	4.5	4.7	6.0
Mexico	N/A	N/A	N/A	4.8	5.6	6.4
Norway	2.9	4.4	7.0	7.7	7.7	9.1
Switzerland	4.9	5.5	7.4	8.3	10.4	11.6
UK	3.9	4.5	5.6	6.0	7.3	8.3
USA	5.0	6.9	8.7	11.9	13.1	15.3

- Hong Kong, similar to the countries listed in Table 3-1, has been facing increasing health expenditure, and it has been predicted that there will be an even greater expenditure in the coming decades due to the aging population and the demand for higher quality medical apparatus:

  - Health expenditure's percentage of GDP is expected to increase from 5.3% in 2004 to 9.2% by 2033 (Food and Health Bureau, 2008).
  - HK$494 million was spent on purchasing property, plant and equipment in 2006-2007 (Hospital Authority, 2007), and it was increased to HK$699 million in 2008-2009 for the purchase of better quality apparatus (Legislative Council, 2008) and the provision of various vaccines to prevent infant morbidity and mortality.

- The Hong Kong government is seeking appropriate measures to implement healthcare reform and deal with the increasing health expenditure.

1.3. Controversies and dilemmas

- Although medical technology helps increase life expectancy, some innovations often raise ethical, religious and social concerns.

- Every innovation has different impacts on different stakeholders. Section 2 begins with the case of the artificial heart, a device which can extend survival and provides valuable additional time for patients, albeit having limited success and requiring enormous input of public resources. Then, ethical, religious and moral issues will be examined through practices involving genetic engineering, which raise concerns of confidentiality and discrimination. The case of cloning will then illustrate the religious and moral concerns regarding the role of scientists and the impact of bio-technology on human values. Drug patenting, the final example, will conclude this chapter by looking at the dilemma of fulfilling the interests of different stakeholders.

1.4. Policies and regulations

- In response to the above controversies and in order to prevent abuse and misuse of technology, governments have formulated regulations and policies to control certain practices. The following section will take a close look at some of these corresponding policies and strategies.

2. Artificial heart

2.1. Social needs: What social needs are addressed by this technology?

- Coronary heart disease is very common in the United States. It was estimated that there were 1.2 million new or recurrent coronary attacks in 2004. Heart transplantation is often the last hope for patients who cannot be treated by less drastic surgery. However, the number of transplant candidates is always higher than the number of available donors, resulting in candidates spending a long time on the waiting list. The overall death rate among patients awaiting heart transplantation was 22.7% in 1997 (Mulligan, Shearon, Weill, Pagani, Moore, & Murray, 2008)

- An artificial heart was believed to be the answer for those on the waiting list. Prior to its first implantation in 1982, the United States Congress had estimated that it could prolong the recipients' life for an average of 0.6 years (210 days), providing them with the opportunity to have more valuable time with their family and friends. Some even believed that some of the recipients would be capable of returning to work after the operation. However, it turned out that most of the recipients experienced even greater sufferings as a result of the implantation.

2.2. Controversy: Should resources be allocated for treatment or prevention?

- There are different ways to alleviate the prevalence of certain diseases, including public education on disease prevention, public screening for early diagnosis, and treatment of the disease after it manifests itself. There are debates on how public resources should be allocated to these different aspects of disease control. The following elaborates the debate on artificial heart.

- Prior to the first implantation of permanent artificial heart in 1982, there were already concerns about the cost-effectiveness of the technique:

  - In 1982, the Congress estimated an average cost of US$28,000 for each surgery, with 33,600 implantations to be done each year.
  - On top of the accumulated annual cost at US$941 million was the continuing care cost of each patient at US$2,000 each year.
  - Consequently, the total cost of artificial heart implantations was predicted to increase and would approach US$1 billion annually.

- Since it was uncertain that an artificial heart could serve as a permanent replacement for the biological heart, some argued that the resources should be spent on other more promising programmes such as promoting smoking cessation. The Congress estimated that health education could help reduce risk factors affecting public health and increase citizens' life by an average of 3.7 years. More importantly, it would only cost US$150 million per year.

- This case demonstrates a major controversy in public health: should the resources be allocated for prevention or treatment of disease? A prevention programme may benefit everyone in the community, while an artificial heart will benefit only one person on the waiting list of heart transplantation.

- On the other hand, although it may help to prolong the recipients' lives, it is difficult to weigh the value of their last moments. It is often difficult to come up with a policy decision or a programme which can satisfy all stakeholders in the community.

- The limited success of artificial hearts has also raised significant controversies:

  - The first recipient of a permanent artificial heart transplant, Barney Clark, suffered a series of seizures a few days after the operation.
  - The implanted heart began to lose its function on the 13th day. He suffered pneumonia, recurrent kidney disease, gout, epididymitis, and an intestinal ulcer before his death on the 112th day.
  - Although the second recipient fortunately survived for 620 days, most of the subsequent 90 recipients did not live for more than half a year.
  - As a result, the United States Food and Drug Administration (FDA) banned the use of artificial hearts.

  (New York Times, 1986; New York Times, 1993; Schlumberger Excellence in Education Development, 2011; University of South California, 2011)

- It was not until 2006 that the implantable replacement heart (AbioCor) showed promising results and was approved by the FDA to serve patients who are not suitable for a heart transplant and are unlikely to live for more than a month without intervention (Food and Drug Administration, 2006).

2.3. **Policies and regulations: What policies and regulations are implemented; balance of interests among different stakeholders**

- The FDA strictly regulates the use of the newly approved AbioCor device. Eligible recipients are confined to those proved to be unlikely to live for more than a month without intervention. In addition, the company is required to fully inform the recipients of the benefits and the risks of using the device.

- Due to the risks involved and other factors, artificial heart operations did not come under Medicare coverage. It was not until recent years that the Centers for Medicare & Medicaid Services (CMS) was convinced by scientific proof of the use of artificial hearts. In 2008, CMS announced a final National Coverage Determination expanding Medicare coverage to artificial heart operations.

3. Genetic testing and screening, and the human genome project

3.1. Social needs: What social needs are addressed by this technology?

- Genetic diseases, cancers and some other untreatable conditions / traits have raised public concerns and imposed a great burden on public medical expenditure in some developed countries. Genetic engineering has paved the way for the development of the following:

Table 3-2. Genetic testing and screening, and the human genome project (Burgess, 2001; Ross & Moon, 2000)

	Genetic testing and screening	Human genome project
Uses	● can be used in *in vitro* fertilization, prenatal diagnosis, new born screening, inspection for children and adults ● can be used for screening diseases in large populations	● determines the sequence of the whole human DNA
Benefits	● provides timely and accurate diagnosis to enhance better preparation for the onset of disease ● newborn screening can be drawn from the screening for sickle cell disease, in which morbidity and mortality can be reduced by dosing penicillin prophylaxis	● provides valuable information for research and developing treatments of genetically related diseases, such as breast cancer and Alzheimer's disease

3.2. Controversy: Ethical and moral issues

- Although prenatal tests help prevent the birth of babies with disabilities, the procedure also paves the road to abortion, which is a serious moral concern. Undoubtedly, terminating the birth of an abnormal infant can help reduce health expenses. However, it also raised concerns about the rights of the unborn child. Genetic testing and abortion are complex issues, as they contradict some of the religious and moral values. Parents, patients, scientists, religious groups and policy makers hold different views towards this new technology.

- Besides, genetic testing raised concerns about the ownership of the information and protection of privacy. For example, an insurance company may deny coverage to individuals because of their genetic testing results (Schneider, 2006). Discrimination in the workplace may result when an employer refuses to employ individuals based on their genetic information (Jonsen, Veatch, Walters, 2001).

3.3. Policies and regulations: What policies and regulations are implemented; balance of interests among different stakeholders

- Concerns of misuse of genetic information and the potential of discrimination have drawn the attention of authorities in some countries. In 1997, the Council of Europe passed the Convention on Human Rights and Biomedicine which restricted predictive genetic tests and scientific research to health purposes only, and prohibited any form of genetic discrimination (University of Cambridge, 2005). The treaty was signed by 18 nations and later ratified by 13 of them.

- In terms of legislation, Belgium was the first country to enact laws to prohibit the use of genetic information for insurance underwriting purposes, followed by Denmark and France. Using genetic testing for employment purposes also became illegal in France, Austria, Norway, the Netherlands, and Belgium (Institute on Biotechnology and the Human Future, 2008b).

- Although the United States did not sign the 1997 treaty, the Congress enacted the Genetic Information Nondiscrimination Act in May 2008 to prohibit health insurers and employers from discrimination on the provision of genetic information (The White House, 2008). The Act will likely encourage employees to undergo genetic testing for diseases without having to worry about losing their jobs, so that they can have a better chance to receive timely treatment if necessary.

- Abortion laws vary among nations :

  - Abortion is permitted in 56 countries including China, Canada, the United States, Russia, and the majority of European countries.
  - On the other hand, some countries, such as Ireland, Chile, and the Philippines, have adopted stringent laws to prohibit abortion except when the life of the mother is endangered.
  - In some countries, such as Spain and Thailand, abortion is legal if fetal defects are found.

- Great Britain, Japan, Finland and Australia are a few of the 14 countries which permit abortion for socioeconomic reasons (Center for Reproductive Rights, 2009).

4. Cloning

4.1. Social needs: What social needs are addressed by this technology?

- The genome of a progenitor (parent) cell can be cloned to produce a near-identical copy. In 1997, the first cloned mammal, known as Dolly the Scottish cloned sheep, was born. The practice was soon regarded as a promising method to replicate livestock for food production, and to replicate endangered species. More importantly, the success has allowed the emergence of the human cloning technique. In general, there are two types of cloning:

Table 3-3. Therapeutic and reproductive cloning

	Therapeutic cloning	Reproductive cloning
Description	● involves production of embryonic stem cells, for transplantation of tissues or organs	● involves growing a living person who shares the same genetic makeup of the progenitor
Benefits	● provides a healthy copy of an individual's tissue or organ for transplant in case of future need	● may enable replication of individuals with talents and exemplary qualities, which may further generate social wealth and productivity

4.2. Controversy: Ethical and moral issues

- Many religious leaders have expressed opposition to both types of cloning. The Roman Catholics believe cloning severs reproduction from sexuality. Protestants believe that cloning has made humans become "co-creators" with God, and therefore should be prohibited (Evans, 2002). Some religious leaders expanding on the opposition suggest that cloning is an act of lessening genetic diversity. Other groups have also expressed concerns about the low success rate in animal cloning as there is high mortality of embryos during gestation, and newborn clones are often abnormal or die at an early age.

- Most importantly, the success of Dolly has raised concerns about the possibility of human cloning. Many have already expressed objections while numerous countries have already banned it to avoid future problems. In most cases, the opposition focuses on the status of embryos and the value of human life. Some believe that human cloning will diminish respect for and the worth of human life. The rights of the cloned and the parental role have also raised controversy about whether designing a perfect baby is ethical, and the possible detrimental effects on a cloned individual when he or she finds the designed traits harmful rather than beneficial.

4.3. **Policies and regulations: What policies and regulations are implemented; balance of interests among different stakeholders**

- Many countries have expressed concerns about human cloning and have prohibited such practices:
  - 30 countries, including Canada, Mexico, and Germany, have enacted cloning prohibitions (Genetics and Public Policy Center, 2005; Library Index, 2011)

- In the United States:
  - The California legislature first issued prohibition of reproductive cloning in 1997
  - 12 other states soon joined to prohibit productive cloning
  - 6 states have also banned therapeutic cloning
  - Arizona and Missouri have enacted laws to restrict funding for cloning research (National Conference of State Legislatures, 2008b).
  - In 2003, the Congress passed the Human Cloning Prohibition Act of 2003, which banned human cloning across the nation.

Table 3-4. Brief description of the legislative status of cloning in different countries

Country	Brief description of the legislative status
China	● human reproductive cloning is banned ● therapeutic cloning research is allowed
Germany	● development of human embryos and transfer of embryos into women are prohibited
France	● human reproductive and therapeutic cloning are prohibited
The United Kingdom	● transfer of human embryo which is created (other than by fertilization) into a woman is prohibited ● research cloning is allowed as long as the cloned embryo is destroyed within 14 days

- In search of a comprehensive ban on human cloning, the United Nations General Assembly, by vote, adopted the United Nations Declaration on Human Cloning to enforce Member States to prohibit all forms of human cloning in 2005 (United Nations, 2005).

5. Drug patenting

5.1. Social needs: What social needs are addressed by this technology?

- Medical drugs have played a significant role in preventing, curing, treating, and diagnosing diseases. However, their discovery and developmental processes are lengthy and risky, and require a huge amount of funding. In general, the discovery stage, developmental process and regulatory review of a drug often takes a minimum of 10 years and involves more than 3,000 participants (Table 3-4) and US$800 million (DiMasi, Hansen, & Grabowski, 2003).

Table 3-5. General model of drug development (Commission on Intellectual Property Rights, Innovation and Public Health, 2006)

Stage		Length	Research involved	Participants
Discovery		Year 1-3	● Chemical development (starting year 1) ● Pharmaceutical development (starting year 2.5) ● Toxicology and pharmacokinetic studies (starting year 3) ● Long-term animal testing (starting year 5)	N/A
Development	Phase 1	Year 4		200-400 volunteers
	Phase 2	Year 5-6		400-600 patients
	Phase 3	Year 7-9		3000+ patients
Regulatory review		Year 10	● Marketing application and approval of product launch	N/A

- In order to protect intellectual property rights and foster the incentive to research and develop, many countries have adopted drug patenting. A patent is a legal right conferred by the government to the inventor for exclusive use, production and sale of the innovation. It serves to foster scientific development and medical research in the following ways:

  - Assures appropriate returns to inventors by monopolising the invented product for a period of time
  - Encourages the emergence of the market of technology for the production and manufacturing process
  - Ensures the disclosure of related information when the patent period expires

- According to the WHO's Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS), most patents confer 20 years of exclusivity to the inventor.

5.2. **Controversy: Fighting infectious disease vs. incentive for R&D, exclusivity**

- Although patents encourage medical innovation by legally protecting intellectual property rights, the monopolising approach has also raised concerns about impeding the poor's access to the invented products. This has become a perennial issue for developing countries which, despite their great need, have low "demand" for the products due to their inability to afford the highly priced products. The 3D innovation cycle below illustrates how the lack of demand will impede discovery and development of products (Figure 3-4).

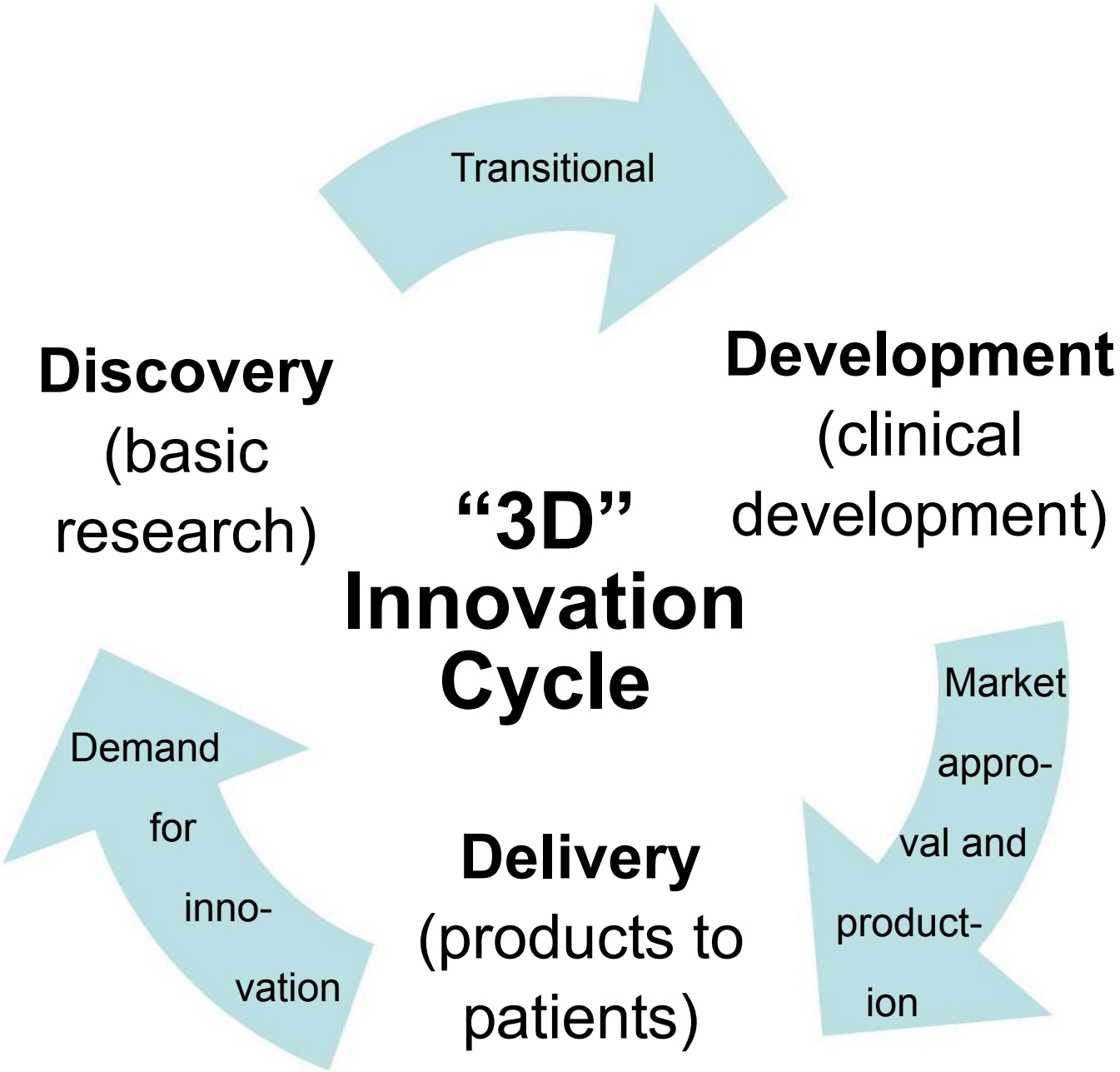

Figure 3-4. The "3D" innovation cycle of medical research and development (Commission on Intellectual Property Rights, Innovation and Public Health, 2006).

- Take HIV and tuberculosis as examples, both classified as type II diseases by the CIPIH:

  - Both have over 90% of cases occurring in developing countries.
  - Occurrences in developed countries have resulted in the discovery and development of preventive measures and treatment.
  - Nevertheless, some of these diseases such as HIV exist in different types in developing countries.
  - While vaccines are available for the types of diseases in developed countries, developing countries often cannot benefit from them.

- Patent exclusivity has also raised the issue of market monopolisation, especially when there is great demand for the product. The situation can be illustrated by the case of Tamiflu:

  - Tamiflu is an effective drug to treat and to prevent influenza. It enables a shorter length of recovery when compared with other drugs.
  - The drug was discovered and developed by Roche Pharmaceuticals and the patent granted it exclusivity for 20 years.
  - Many countries experienced outbreaks of avian influenza in 2005 and requested orders of Tamiflu from Roche, as it was the most effective drug to treat influenza at that time.
  - Many developed countries, including the United Kingdom, Canada, the United States and Australia, made massive orders for the drug.
  - The expensive price of Tamiflu (US$60 / 10 pills) and the policy of “first come first served” made some of the developing countries, such as Vietnam, unable to receive the drug immediately, despite them being the hotspots of the outbreak.
  - Some countries such as Taiwan, Thailand, Brazil, and India were also potential outbreak hotspots of avian influenza but also faced supply shortages of the drug. Although these countries are capable of developing generic versions of Tamiflu, which would give identical function and efficacy to the patent protected drug, they are prohibited from manufacturing without official consent from Roche Pharmaceuticals.

5.3. Policies and regulations: What policies and regulations are implemented; balance of interests among different stakeholders

- The WHO's Agreement of Trade-Related Aspects of Intellectual Property Rights allows member states to produce generic versions immediately after notifying the inventor during an emergency or crisis. Other than the above exceptions, the member state should follow the agreement and respect intellectual property rights. Two of the major types of patents are the "first to invent" approach used by the United States and the "first to file" approach used by the Europeans, illustrated as follows:

Table 3-6. Types of drug patenting systems (Cook, 2002; United States Patent and Trademark Office, 2006).

	"First to file"	"First to invent"
Principles for granting patent	● Patent will be granted to the party which applies first	● Patent will be granted to the party which invents the product first by examining log books, date of production of prototypes and other related materials
Advantages	● Requires less time and work	● Favours smaller businesses which lack experience of patent application

- In order to assist developing countries to gain access to patented drugs, the WHO has initiated the mechanism of compulsory licences, which allows developing countries to manufacture generic drugs to fight epidemics including HIV/AIDS, tuberculosis and malaria (Fergusson, 2003). The licence allows the developing countries to manufacture generic drugs at affordable prices.

- The Brazilian government has opted for compulsory licences to produce generic efairenza, an anti-AIDS drug patented by Merck, because Merck's pricing of US$1.10 per pill was too expensive for the government (Associated Press, 2007). Although the country is a member of the WTO and is required to follow the Trade-Related Aspects of Intellectual Property Agreement, it is listed as a developing country and hence is allowed to claim compulsory licences for combating HIV/AIDS.

- Although compulsory licenses allow developing countries to obtain patented drugs at lower prices, it may significantly discourage research and innovation. In addition, the low price of and return from generic drugs discourage manufacturers from producing the product. As a result, a drug may never be manufactured, even though a compulsory license has been issued.

- Governmental authorities are responsible for regulating and reviewing new drugs to protect the public. In the United States, the FDA acts as a watchdog for the drug industry and has implemented stringent regulations and interpretation of regulations (Spilker & Cuatrecasas, 1990). The FDA may appoint an advisory committee of outside scientists to review the data on a new drug and has the authority to decide whether to accept or reject the recommendation.

Conclusion

Medical research and technology have, without a doubt, improved our quality of life and prolonged our life expectancy. However, there are prices to be paid for the advancement of technology. Other than the allocation of resources, some practices have raised social, ethical and religious concerns. In order to protect human dignity and values, international bodies and governments have adopted a series of policies and legislation to guide and restrict certain practices. Nonetheless, policies and legal rights may sometimes lead to further controversies, as illustrated in the case of drug patenting.

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Chapter 4: Analysis of Energy Technology

Overview

Development of energy technology aims to provide sufficient energy for a community to support its socio-economic development. Energy-related projects are developed and implemented at both local and global levels. Major considerations in energy development include cost, impact on society and the environment. This chapter starts with a discussion of the needs for energy development and then focuses on the criteria used to evaluate energy-related projects.

- Energy is very important to people. The need for energy can be demonstrated throughout history, from the usage of fire in primitive societies to the combustion of fuel in vehicles today.

- Development of energy technology is the ongoing effort to provide sufficient primary energy sources and secondary energy forms to support the world economy. The primary energy sources, such as fossil fuels, wind and sunlight, are valuable natural resources in the world. They are transformed into secondary energy forms, such as electrical energy, to allow people to use the energy conveniently.

- The primary energy sources are usually classified into two categories: renewable and non-renewable. Renewable energy, such as solar energy and wind energy, can be naturally replenished. Non-renewable energy, such as fossil fuels, is generated from substances which take millions of years to form.

- Apart from seeking more energy sources, energy technology also involves research and development of new energy and installation of facilities such as mining fossil fuels, refining fuels, installing power lines and inventing power-saving electrical appliances.

- Major considerations in energy-related project planning include cost, energy efficiency and impact on the environment and society. Thus energy-related projects can be analysed from economic, environmental and social perspectives (Figure 4-1).

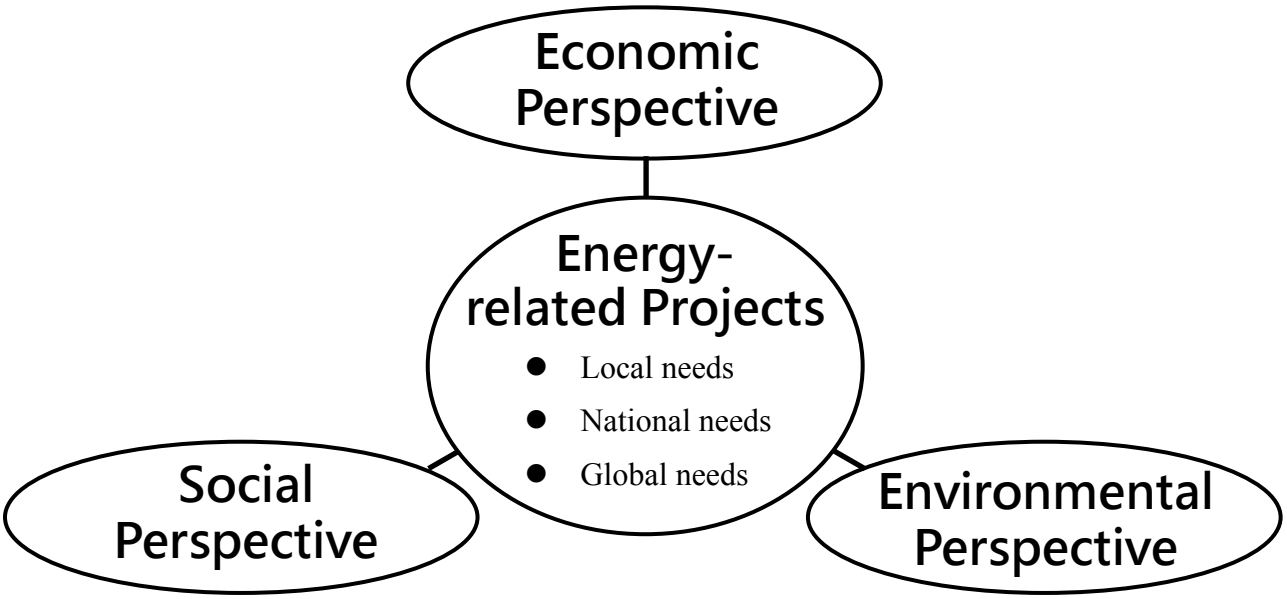

Figure 4-1. Major aspects to be considered when analysing energy-related projects

1. Energy needs

Energy plays a significant role in human history. Before the Industrial Revolution, people depended primarily on human or animal power and biomass for their energy needs.

The Industrial Revolution in the late 18th and early 19th centuries changed the manual-based manufacturing to machine-based manufacturing. The introduction of steam engines (fuelled by coal) and other machinery had greatly enhanced production capacity. On the other hand, technological advancement also enhanced the construction of energy distribution infrastructure and improved people's lives. For example, gas pipes were built to transmit natural gas into cities for domestic uses such as cooking, home illumination, and street lighting. Water pumps powered by steam engine were constructed to pump water into homes, and sewage away from homes. In addition, the inventions of the Industrial Revolution provided the equipment to further mine or drill the already visible deposits of energy sources such as coal and oil.

Transmitting energy in the form of electricity is a milestone of development in energy technology for modern life. With electrical networks, energy could be transported from one place to another easily and effectively. Thus, electricity became affordable for and accessible to all households with the use of wires. As a result, our standard of living was raised. However, it also led to a great increase in the consumption of energy and electricity in the past century.

1.1. Energy and city development

- In Hong Kong, the common energy sources are electricity, town gas, liquefied petroleum gas (LPG), oil and coal products (Figure 4-2). Electricity is commonly used for air conditioning, lighting and refrigerating. Town gas and LPG are commonly used for cooking and heating water at home. Oil and coal products are the most common fuels for means of transportation such as passenger cars, ships and heavy vehicles. With the advancement in energy technology, people in Hong Kong can often choose from various energy sources for the same applications. For example, some use electricity to cook or heat water while others use town gas or LPG.

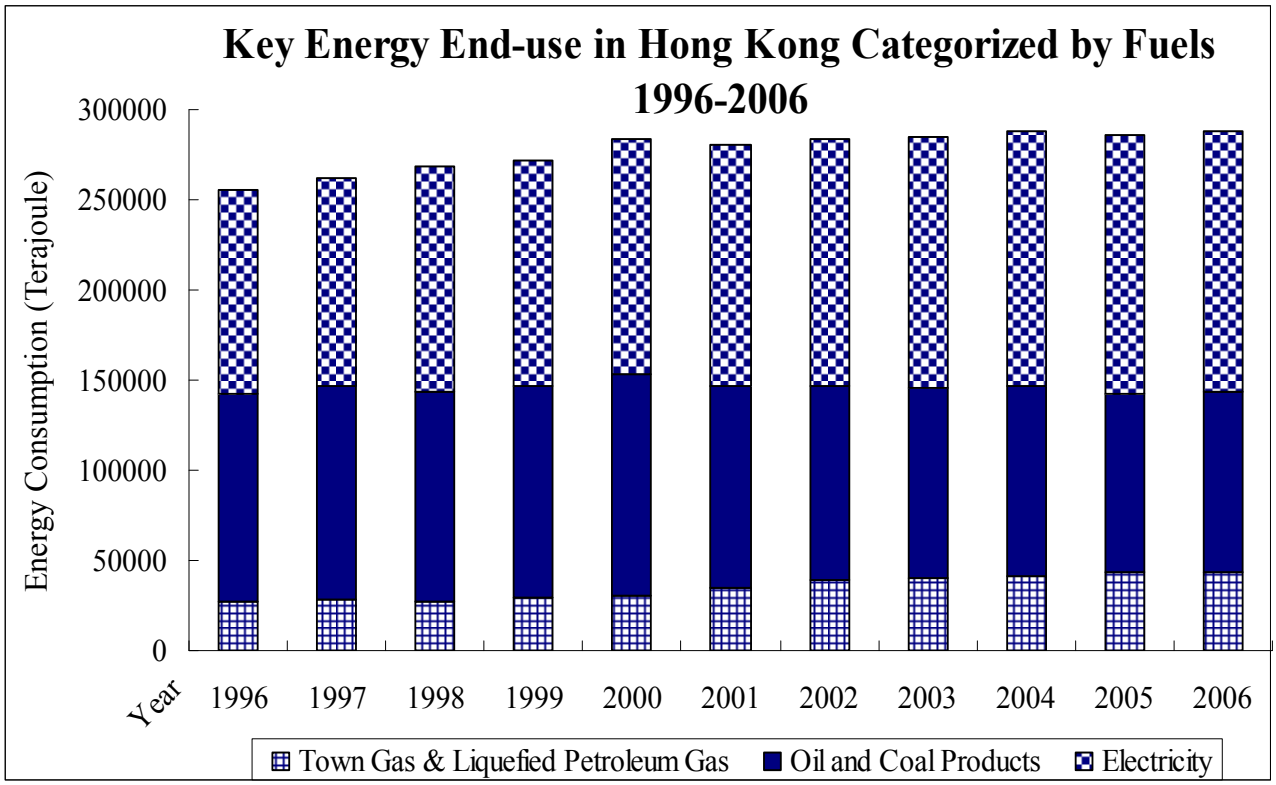

Figure 4-2. Key energy end-use in Hong Kong categorized by fuels between 1996-2006 (HKSAR Electrical and Mechanical Department, 2008)

- Energy and utility services are vital to the development of a society. Well-organized electricity networks and adequate energy supply are necessary for business and industry to operate. Expansion of residential, commercial and industrial sectors will result in city development, which in turn will increase energy consumption as a whole. In Hong Kong, energy consumption has increased with economic growth and development (Table 4-1).

Table 4-1. Hong Kong's electricity consumption & Gross Domestic Product (GDP) from 1970-2005 (Census and Statistics Department, 2010a; Census and Statistics Department, 2010b)

Year	GDP in chained (2008) dollars (HK$ million)	Electricity Consumption (Terajoule)
1970	176,470	16,023
1975	241,069	23,126
1980	418,158	40,427
1985	552,290	61,120
1990	800,998	92,271
1995	1,032,904	112,817
2000	1,176,290	134,928
2005	1,440,343	160,363

- The use of energy by different sectors can also reflect the changes in economic development. In Hong Kong, the decline in the industrial sector can be reflected by the energy consumption pattern (Figure 4-3).

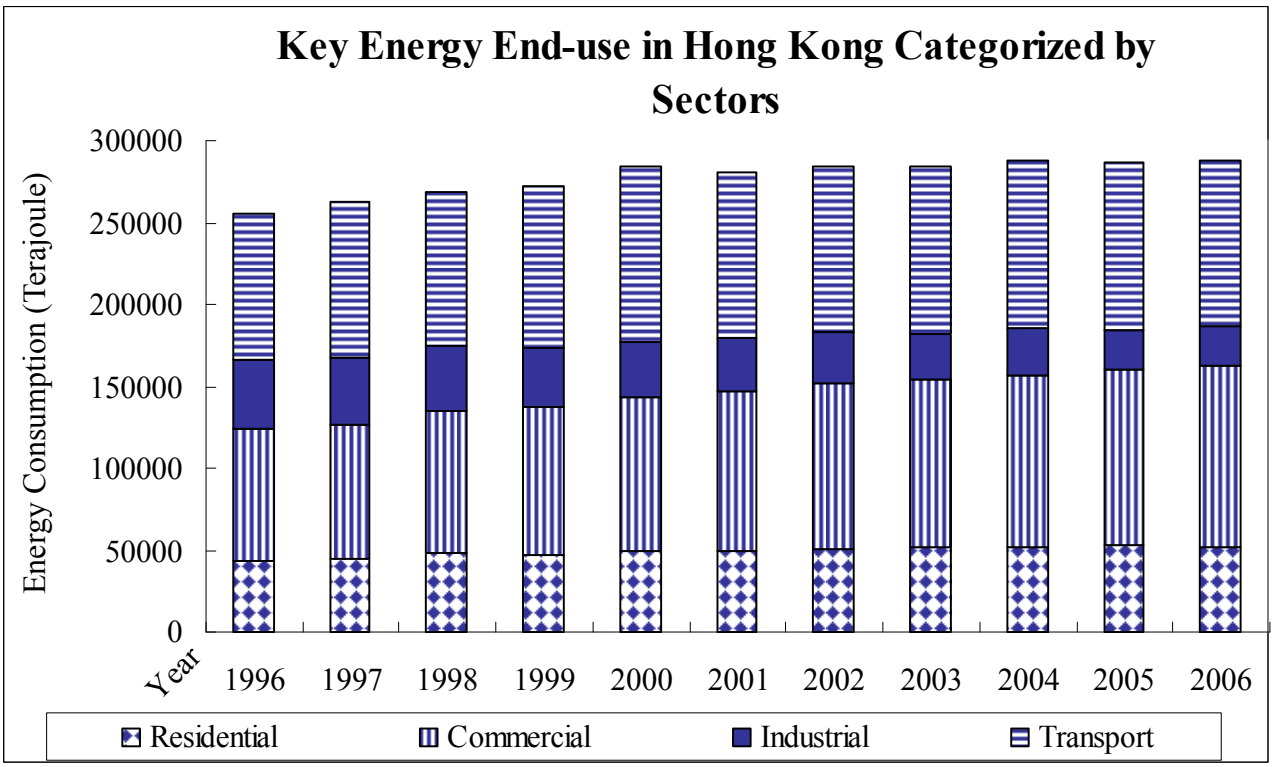

Figure 4-3. Key energy end-use in Hong Kong categorized by sectors 1996-2006 (HKSAR Electrical and Mechanical Department, 2008)

1.2. Energy and national development

- Energy is vital to national development as both commercial and industrial development require huge amount of energy. This can be illustrated by the relationship between the Human Development Index and energy use. The Human Development Index combines normalized measures of life expectancy, literacy, educational attainment, and GDP per capita for countries worldwide. It can be used to rank countries by level of "human development", which also determines whether a country is a developed or developing country. As shown in Figure 4-4, developing countries score much lower on the index and they use less energy than developed countries. However, continuous rapid economic growth and increase in living standards in developing countries with large populations, like China and India, are dependent on a rapid and large expansion of energy production capacity.

Table 4-2. Key for Figure 4-4.

Country	Associated Number	Country	Associated Number
Norway	1	Cambodia	21
Canada	2	Pakistan	22
Finland	3	Nepal	23
Sweden	4	Uganda	24
U.S.	5	Rwanda	25
Australia	6	Ethiopia	26
New Zealand	7	Guinea-Bissau	27
Japan	8	France	28
Singapore	9	Netherlands	29
Germany	10	U.K.	30
Hong Kong	11	Italy	31
Russia	12	South Korea	32
Argentina	13	Poland	33
Mexico	14	Chile	34
Brazil	15	Saudi Arabia	35
China	16	Spain	36
Iran	17	Kazakhstan	37
Indonesian	18	Ukraine	38
Egypt	19	Congo (Kinshasa)	39
India	20		

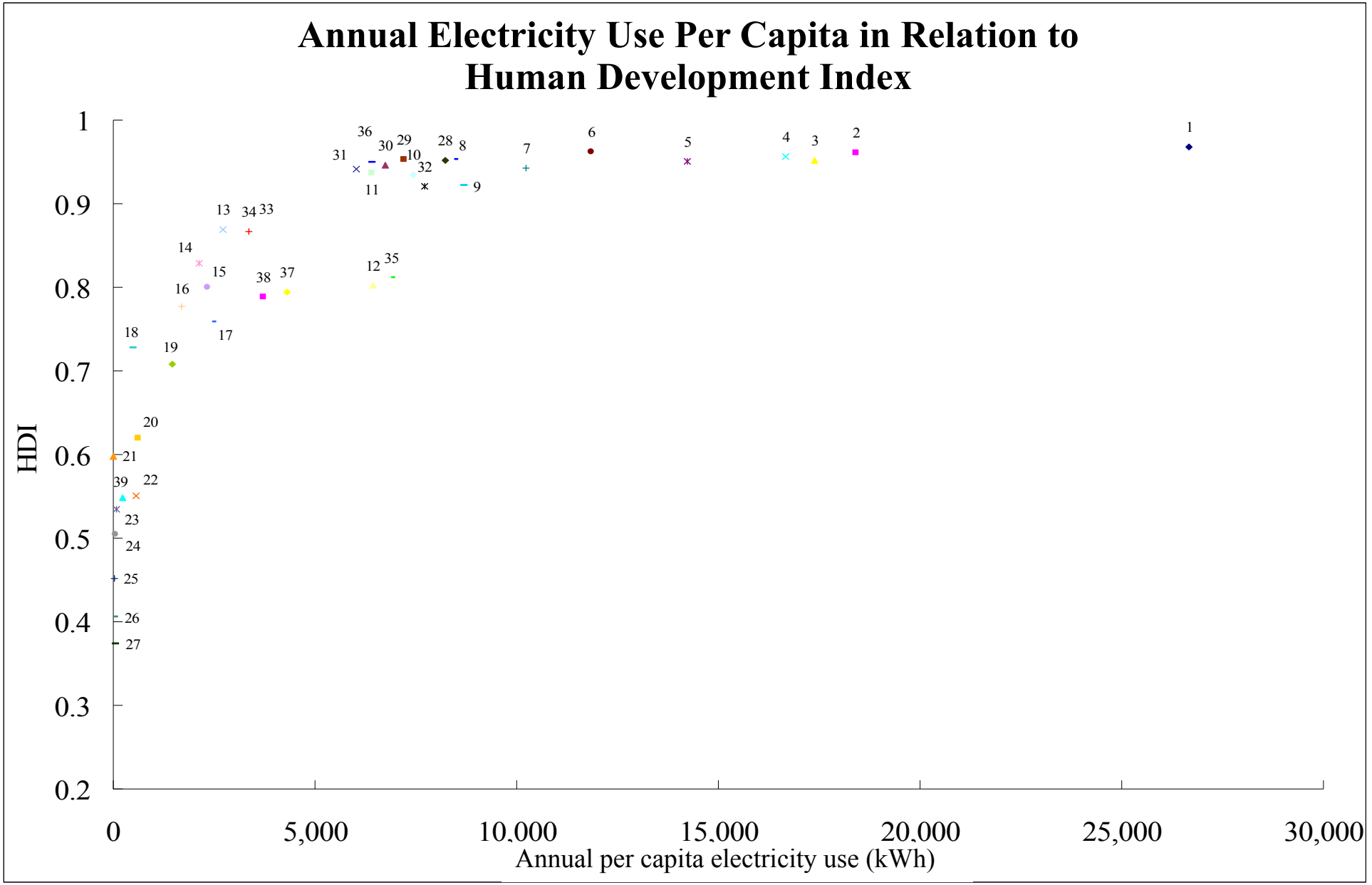

Figure 4-4. Annual electricity use per capita in relation to Human Development Index

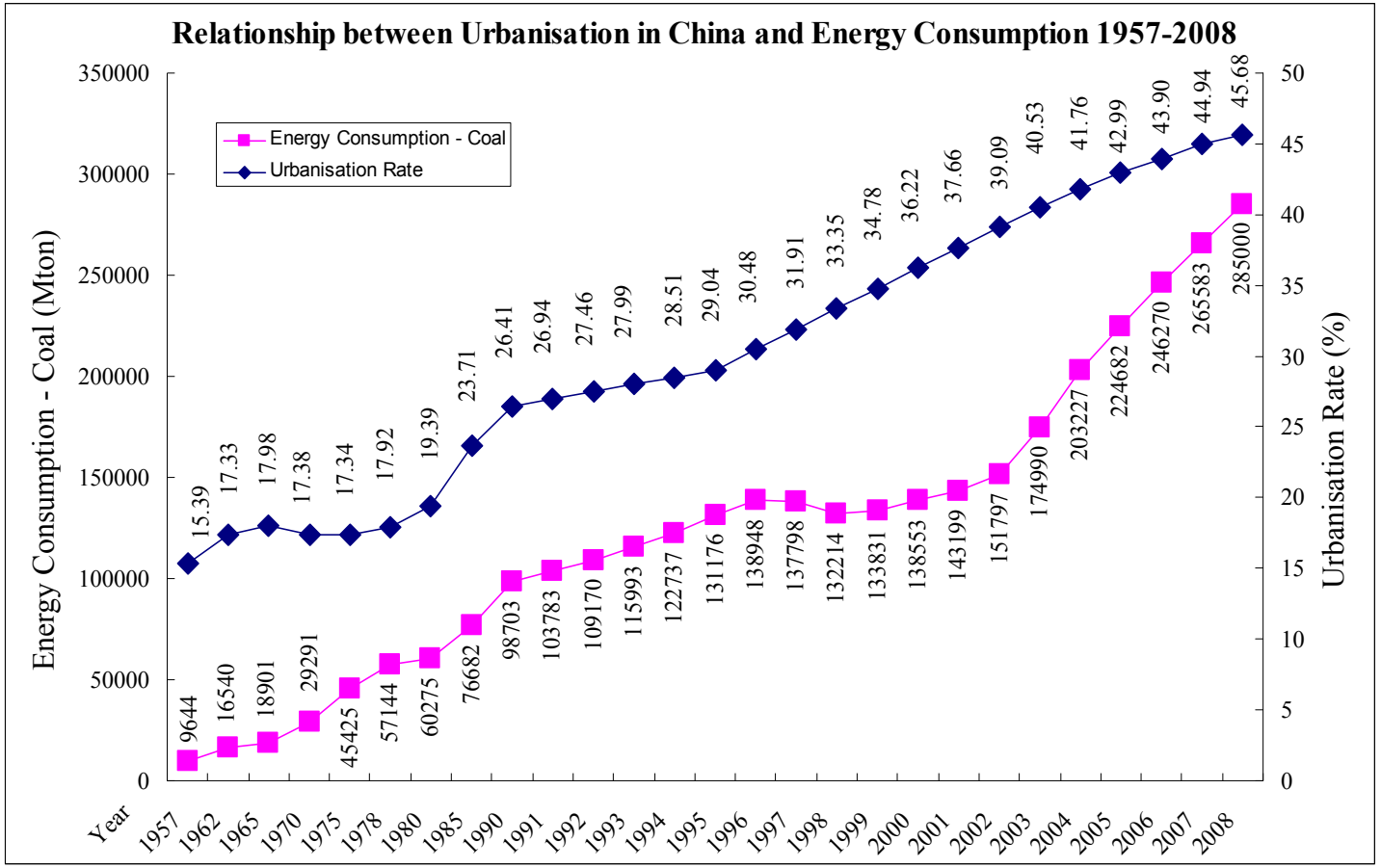

Figure 4-5. Urbanisation rate and energy consumption in China

- The need for energy can be demonstrated by the rapid urbanisation in China in recent decades (Figure 4-5). The graph shows that energy consumption is positively related to the urbanisation rate. Along with the predicted rapid urbanisation in the upcoming decades, the International Energy Agency had predicted that China would overtake the United States to become the top energy consumer and carbon dioxide (CO_2) emitter by 2010. To deal with this, the Chinese Government has established a long-term plan for energy conservation by restricting the development of industries with high energy intensity such as coke, steel, concrete and aluminium. The Government has also opted to increase energy efficiency standards for products such as automobiles and electrical appliances.

1.3. Energy and global development

- Due to its importance to the society, energy has become a major global issue and the direct cause of numerous international conflicts. For example, the Persian Gulf War was caused by Iraq's request to Kuwait to raise the price of oil through the oil production of the Organization of the Petroleum Exporting Countries (OPEC). Kuwait, however, increased production to lower the price instead, which triggered Iraq's invasion (Democracy Rising, 2005).

- Under the common goal to improve quality of life, energy issues have served as a platform to enhance international collaboration. Many countries have shown commitment to reduce energy-induced pollution and concern by signing the Kyoto Protocol. The mechanism of emission trading enhances international collaboration to reduce emissions by allowing countries to sell excess capacity in emissions to countries that are over their targets (United Nations Framework Convention on Climate Change, 2008).

- The International Energy Agency (IEA) is an international organisation promoting energy security, economic development and environmental protection. The organisation publishes energy analysis and recommendations on a regular basis, and enhances energy technology collaboration between countries, especially major energy consumers such as China, India and the OPEC countries.

2. Analysing energy-related projects from economic, social and environmental perspectives

Energy-related projects refer to projects and developments associated with utility and power generation. These projects usually focus on the development of certain energy technologies, such as building a dam to generate hydro power, to fulfill energy needs at the local, national, and global levels. Below are two of the most renowned projects:

- The Guangdong Daya Bay nuclear power station is one of the most recent energy projects undertaken near Hong Kong. The power station came into service in 1994 and has generated over 10 billion units of electricity annually. The quantity of electricity generated replaces over 3 million tones of coal per year and has reduced a significant amount of pollutant discharge.

✦ The Three Gorges Dam is one of the most renowned energy projects in China in recent decades. It had been the largest hydro-electric power station in the world up to 2009 and generates over 100 gigawatts of power annually. Other than power generation, the facility provides a solution for flooding, which has been a perennial problem along the Yangtze River.

These projects not only involve a great amount of resources, but also induce risks and concerns to society. Therefore, before the implementation of energy-related project, its possible impacts on the economy, society, and the environment should be carefully analysed.

2.1. Economic perspective

- Cost effectiveness often dictates the feasibility of an energy technology. For example, solar power has been considered as one of the most environmentally friendly technologies, yet the solar photovoltaic cells are very expensive. However, the energy generated is far much less than that by the combustion of fossil fuels. Besides, the resources involved in the construction and operation of the facilities and the value of the land occupied should also be taken into account. This issue will be of particular importance in places with scarce space for development, such as Hong Kong. In addition, the area of land required for forestation to absorb the additional carbon dioxide (CO_2) emitted by the use of the technology should also be considered. Besides, consumption of water resources should be taken into account for hydroelectric power.

- The cost-benefit model is often applied to analyse the economic efficiency of a particular energy technology. The cost involved and the benefits generated change with time (Table 4-2).

Table 4-3. Examples of short-term and long-term benefits and cost of the Three Gorges Dam

Economic efficiency	Short-term	Long-term
Benefit	● Provides job opportunities (construction)	● Provides huge amounts of electricity and enhances city development ● Reduces economic loss caused by flooding ● Enhances tourism

(Cont'd)

Economic efficiency	Short-term	Long-term
Cost	● Total cost of about US $22.5 billion	● Maintenance cost and environmental costs ● Value of land and water resources

2.2. Social perspective

- Energy-related projects can be beneficial to the society. Energy and utilities are survival essentials in a developed community and their adequate provision is required in order to maintain social stability. Apart from generating electricity, energy-related projects can also provide job opportunities, especially during the construction phase, and thereby enhance the socio-economic status of the community.

- On the down side, some energy-related projects may draw concerns from social groups and stakeholders. Despite their rarity, there have been cases of catastrophic accidents involving energy technology. The Chernobyl nuclear plant explosion was one of the most severe accidents. It aroused public concern about the potential risks of the once promising nuclear technology. Apart from the possibility of causing disasters to the community, there are also growing concerns that energy facilities may become targets of terrorist attacks. An example of this occurred in March 2008, when a power station in a southern Afghan province was attacked by Taliban terrorists.

- Another major social concern related to energy-related projects is the possible increase in electricity charges. For example, as stated in the 2008-2009 Policy Address, the Hong Kong government targeted to increase power generated from natural gas from 28% to about 50%. Many speculated that electricity charges would increase as a result since natural gas is 28-50% more expensive than coal.

2.3. Environmental perspective

- The implementation of energy-related projects often leads to environmental pollution. The emission of particulate matters (PM), nitrogen oxides (NO_x), sulphur dioxide (SO_2) and carbon dioxide (CO_2) during the combustion of fossil fuels are the major causes of air pollution, acid rain and global warming (Hjorth, Eichler, Khan, & Morello, 2003) (Table 4-3). CO_2 is one of the greenhouse gases which may lead to global climate changes, while inhalation of NO_x and SO_2 may cause respiratory illnesses and irritations. Apart from fossil fuel, other energy technologies also pose a threat to the environment. For example, the use of nuclear power may give rise to leakage hazards and hydroelectric power may cause ecological disturbance to aquatic life.

Table 4-4. Carbon dioxide emissions (million metric tons) from energy generation and industry in the United States (Source: Energy Information Administration, 2004).

Year	Petroleum	Coal	Natural gas	Renewable energy
1990	2,180.8	1,771.6	1,026.0	3.5
1995	2,194.9	1,876.5	1,182.4	3.0
2000	2,475.0	2,114.8	1,237.8	3.0

- Apart from pollution, energy-related projects may also directly affect the ecological balance of the environment. For example, construction of energy facilities usually requires deforestation, causing habitat destruction. The HKSAR Government has enacted the Environmental Impact Assessment Ordinance to require certain projects such as utility pipelines, storage of fuels and energy supply, to conduct environmental impact assessment before construction.

- Based on the environmental impact assessment report, developers need to select one of the three approaches to deal with the possible impacts to the environment: avoidance, minimization, and compensation, of which avoidance should be treated as the prioritized approach and compensation as the last resort (Table 4-4).

Table 4-5. Approaches to be taken when dealing with impacts to the environment

Priority	Approach	Remarks and examples
Preferred ↓	**Avoidance**	● Avoid disturbance or impact on the site by taking alternatives in the development ■ Changing the location of a power station in order to preserve a Specific Scientific Site of Interest (SSSI)
	Minimization	● Efforts are made to minimize the inevitable disturbances to the environment ■ Building noise barriers to protect residents and sensitive receivers from the traffic noises
Lease Preferred	**Compensation**	● If the inevitable disturbance to the environment cannot be minimized, efforts should be made to compensate the losses ■ Transplanting or replanting trees elsewhere to compensate for the removal at the selected site

3. Analytical framework

Analysis of energy-related projects involves considering the economic, environmental and social aspects. Table 4-5 provides a preliminary analytical framework which divides economic factors into benefits and cost, environmental factors into risks and mitigation measures, and social factors into needs and public concerns.

Table 4-6. Analytical framework for energy-related projects

Factors		Remarks
Facilities		Basic mechanism of operation and facilities
Existing example elsewhere		Existing example of implementation around the world
Economic	**Benefits**	How the project benefits the community
	Cost	Cost of development and the area needed
Environmental	**Environmental risks**	Potential risks to the environment and the ecosystem
	Mitigating measures	Measures taken to alleviate the adverse effects
Social	**Needs**	How the facilities provide for the community's needs
	Public concerns	Potential concerns of the social groups and stakeholders

3.1. Case study: Biofuel

- Biofuel means any fuel originating from organisms, including agricultural products, animal refuse and other organic refuse. The following introduces two kinds of biofuels commonly used in vehicles: bioethanol and biodiesel. Table 4-6 compares the source materials and refining processes of the two biofuels.

Table 4-7: Bioethanol's and biodiesel's source materials and refining processes (Electrical and Mechanical Services Department, 2009)

	Bioethanol	Biodiesel
Source material	● Crops with sugar, starch or fibre, like sugar cane, wheat, barley, potato, corn	● Organic oils, like vegetable oil, recycled kitchen oil, fat
Refining process	● Decompose substances into glucose with steam ● Produce ethanol through hydrolysis and fermentation ● Remove water and other impurities by distillation	● Esterify the organic oil with methanol and catalyst ● Remove glycerol in the oil molecules to form biodiesel

- Refined ethanol can be used by itself or mixed with diesel as vehicle fuel. For vehicles, if the proportion of ethanol in the mixed fuel exceeds 10%, the engine has to be modified. Many new model vehicles have mix fuel injection system, which enables them to use gasoline or a fuel mixing gasoline with up to 85% ethanol.

- The use of bioethanol in transportation is becoming more common. In 2005, Brazil produced 15 billion litres of bioethanol fuel, which made up 40% of the fuel for transportation in the country (Electrical and Mechanical Services Department, 2009). In fact, Brazil's demand for bioethanol can be traced back to 1975, when the embargo of Arabian oil led to the upsurge of transportation fuel prices, with the nose dive of sugar prices at the same time. To cut the demand for imported oil and expand the market for sugar products, the government began to promote the production of ethanol through policies and market mechanisms.

- The Brazilian government also gave tax privileges to vehicles with mix fuel injection systems, and thus raised the sales proportion of these vehicles from 1% in 2001 to 53% in 2005. The US produced 15 billion litres of ethanol fuel in 2005, which made up 3% of the gasoline used in the US in terms of volume (Electrical and Mechanical Services Department, 2009). Since biofuel's viscosity is higher, the US vehicles with mix fuel injection systems usually use the fuel called E85(with 85% ethanol and 15% gasoline by volume), so that the engines can be started more easily in winter time.

- Recently China has also been promoting the use of ethanol as fuel. In 2005, about 0.92 million tons of ethanol was produced (Electrical and Mechanical Services Department, 2009). The Central Government set the target to raise the production capacity of ethanol to 4 million tons in 2010, and hope to replace 15% of transportation fuels with biofuel by 2020. Table 4-7 below shows the ethanol production in countries around the world in 2005. Besides the abovementioned countries, many countries around the tropics have been joining the line of developing biofuel one after another, taking advantage of their longer cultivation season, and hope to earn profits by exporting biofuel to other countries with less arable land.

Table 4-8: Ethanol production in various countries around the world (in million gallons) (International Food & Agricultural Trade Policy Council, 2006).

Countries/ Regions	Production amount		Countries/ Regions	Production amount		Countries/ Regions	Production amount
USA	4,264		Canada	61		Guatemala	17
Brazil	4,227		Poland	58		Ecuador	14
China	1,004		Indonesia	45		Cuba	12
India	449		Argentina	44		Mexico	12
France	240		Italy	40		Nicaragua	7
Russia	198		Australia	33		Zimbabwe	5
Germany	114		Saudi Arabia	32		Kenya	4
South Africa	103		Japan	30		Mauritius	3
Jamaica	93		Sweden	29		Swaziland	3
Britain	92		Pakistan	24		Other countries	710
Thailand	79		Philippines	22			
Ukraine	65		South Korea	17		Total	12,150

- The global production of biodiesel increased from 2.1 billion litres to 3.9 billion litres in 2004-2005 (Electrical and Mechanical Services Department, 2009). The main producers of biodiesel were the US and European Union countries, while China was still in the stage of researching and testing this technology

- Advantages of biofuel

  - Besides being a substitute for gasoline as a transportation fuel, biofuel also has the following advantages:
    - It is biodegradable and non-toxic, causing less pollution to soil and underground water
    - Its consumption emits less greenhouse gases, sulphur dioxide and particulates than traditional fuels for vehicles
    - Its development brings economic benefits, including opening up new markets, expanding export, creating employment and cutting oil imports, etc.
    - It is an option in the handling of solid waste

- Limitations and disadvantages of biofuel

  - However, there are also limitations and disadvantages in using biofuel as a transportation fuel:
    - Production cost is higher than traditional fuels.
    - Biofuel emits 10% more nitrogen oxide than traditional diesel.
    - Large amount of crops is needed to produce the fuel, leading to reduction of food supply.
    - Large acres of land are needed for cultivation, this may lead to large scale deforestation, and thus lower the capacity of the environment in absorbing carbon dioxide.
    - Import and export of biofuel may cause disputes among countries. Therefore, WTO or other international organisations have to lay down monitoring policies.
    - Governments may need to implement a series of measures, like teaching the peasants to choose the better breeds of crops, and subsidizing the peasants.

- The use of biofuel is becoming more and more popular. The US signed a bill in 2007 which stipulated the use of ethanol to be raised six times in the country by 2022. The Japan Airline Company had tested using biofuel for aviation. However, whether biofuel is beneficial or harmful to the environment is still being questioned (Table 4-8). The Boeing Company's director for environment had estimated that a piece of land equivalent to the size of Belgium would be needed solely for cultivaton if aviation industry's demand for biofuel was to be satisfied (Spiegel Online, 2009).

Table 4-9: Analysing biofuel as a transportation fuel from economic, social and environmental perspectives (bioethanol and biodiesel)

Factors		Explanations
Facilities		● The land for cultivating the source materials ● Facilities for solid/liquid separation, hydrolysis, distillation, etc.
Examples		● The US, Brazil, Japan, China and some European Union countries are using biofuel ● Japan Airline has tested its use
Economic	**Benefits**	● Replacing traditional fuels and reducing oil import ● Developing export markets for biofuel ● Creating local employment, especially in the agricultural sector
	Cost	● Higher cost than traditional fuels ● Land needed for cultivation ● Use of crops to produce biofuel may cause food shortage or rise in food prices
Environmental	**Risks**	● Opening up large acres of land may need deforestation, reducing the capacity of the environment in absorbing carbon dioxide, and destroying the habitat for wild animals. Biofuel's emission of nitrogen dioxide is 10% higher than that of traditional fuels
	Mitigation Measures	● Minimization: Restricting the area of land for cultivation and minimizing the effect on the environment; adding additives to the biodiesel to reduce nitrogen dioxide emission ● Compensation: Planting trees in other places according to the number of trees cut
Social	**Needs**	● Stable supply of biofuel, substituting fossil fuel with cleaner renewable fuels for transportation
	Concerns	● Rise of fuel prices ● Rise of food prices ● Food shortage ● Whether the governments will implement relevant measures to help the peasants ● Whether international organisations will lay down monitoring policies to resolve the trade disputes among countries over biofuel

4. Roles of Policy Makers

When implementing energy-related projects, policy makers are generally responsible for the following:

- Ensuring safety
- Ensuring steady provision of energy at reasonable prices
- Maintaining environmental quality above a satisfactory level

4.1. Security and safety

- Policy makers are responsible for protecting the public from potential risks and hazards. The Hong Kong government has formulated stringent regulations (Chapter 51B) to ensure the safety of gas supply. Illegal suppliers are prosecuted. The government has also laid down specific emergency plans for certain energy facilities.

4.1.1. Case study: Daya Bay Contingency Plan

Two nuclear power plants, the Guangdong Nuclear Power Station and the Lingao Nuclear Power Station, are located about 50 km from the urban areas of Hong Kong. Despite the minimal chance of nuclear accidents, their serious adverse effects are still a big public concern. Should there be radiation leakage, people will be harmed by direct exposure to radiation, or intakes of contaminated air, water and food.

The Hong Kong government has laid down the Daya Bay Contingency Plan to prepare for possible nuclear accidents. The key measures of the contingency plan are summarized below:

- Inform the public of the incident and radiation levels in Hong Kong immediately
- Implement full countermeasures against direct exposure to radiation or inhalation of contaminated air at targeted zone of up to 20 km from the nuclear power station
- Implement countermeasures against ingestion of contaminated water, food and milk at targeted zone of up to 85 km away from the nuclear power station
- Radioactivity scanning of any individual arriving from the mainland at the border points

- Radioactivity monitoring of water, food, cargoes and livestock coming from the mainland
- Collect water samples from reservoirs in Hong Kong to ensure the water safety for human consumption (HKSAR Security Bureau, 2004)

4.2. Steady provision at a reasonable price

- It is the policy makers' duty to ensure the steady provision of energy at a reasonable price in order to reduce the burden on the public. The Hong Kong government has set regulations to limit the profits of energy providers. The government implemented the Electricity Charge Subsidy Scheme, which came into effect in September 2008. The scheme provides a subsidy of HK$300 to each domestic tariff electricity account registered with China Light and Power Company Limited and Hong Kong Electric Company Limited.

4.3. Environmental quality

- The policy maker is also responsible for collaborating with the governments of neighbouring regions and energy suppliers to reduce the adverse environmental impacts by the generating facilities. In 2002, the Hong Kong Government reached a consensus with the Guangdong Provincial Government to reduce the emission of SO_2, NO_x, respiratory suspended particulates (RSP) and volatile organic compounds (VOC) by 40%, 20%, 55% and 55% respectively in the Pearl River Delta region by 2010 (Environmental Protection Department, 2006). In order to reach the emission reduction targets, the government has imposed a set of emission caps on the energy suppliers. Failure to observe the emission cap will result in non-renewal of licenses, fines and other penalties.

Conclusion

Energy is the basis of the world economy and quality of life (Aubrecht, 2006). Energy technology has expanded the sources of energy. However, it has also raised concerns about depletion, high costs, and environmental pollution. Developing energy technologies requires careful consideration of the social needs, benefits, and the potential risks involved including economic efficiency, social concerns and environmental risks. The government and the authorities should collaborate with the energy supplier to guarantee a stable supply of energy to the public at reasonable prices. Besides, the government should make every effort to protect the public from potential hazards and reduce the adverse impacts and pollution.

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Chapter 5: Sustainable Development

Overview

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Overview

Sustainable development is a set of values, policies and practices at all levels (from individual to global) promoting developments that meet the needs of the present without compromising the ability of future generations to meet their own needs.

- Sustainable development emphasises the dynamic balance between economic, social, and environmental dimensions. It also stresses that we should not pursuit our needs at the expense of the ability of future generations to meet theirs.

- Sustainable development is rooted in the concept of sustainability, which is a set of values to be exercised from individual to national and then global levels.

- International organisations are responsible for laying down the direction of sustainable development. National governments are responsible for practicing the principles of sustainable development in projects and developments. Its effectiveness, however, also relies on public engagement and participation.

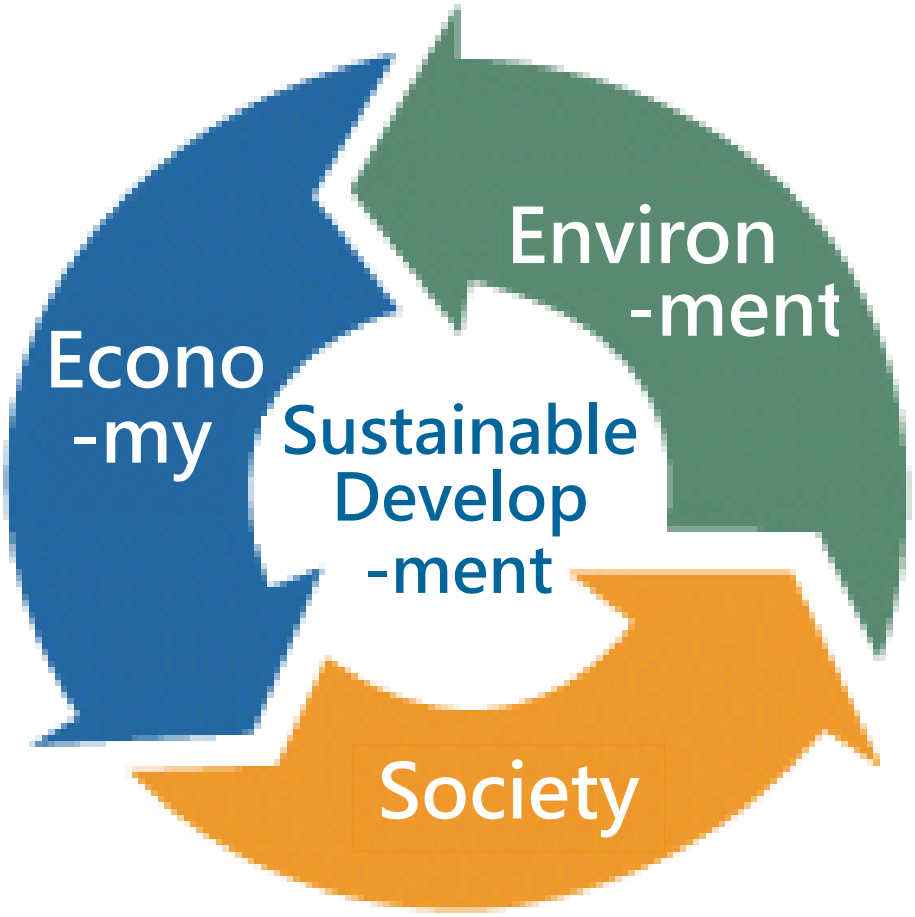

Figure 5-1. Principles and major dimensions of sustainable development (HKSAR Sustainable Development Division, 2008a)

1. The concept of sustainable development

1.1. Development history

- The concept of sustainable development has been evolving continuously. Earlier scholars such as Malthus suggested the possibility of resource depletion if the increasing rate of population growth remained unchecked. Despite the prosperity and rapid economic growth experienced in the post-war era, environmental and social concerns have drawn many to question the future of humanity and to what extent we are compromising our life support systems to accomplish the growth (Rogers, Janal, & Boyd, 2006). The following timeline briefly illustrates the evolution of the concept of sustainable development in the past decades (Figure 5-2).

1962 – A book entitled Silent Spring by Rachel Carson pointed out the adverse effects of agricultural pesticide on the environment and human health.

1968 - Intergovernmental Conference for Rational Use and Conservation of Biosphere was held by the United Nations Educational Science and Cultural Organisation (UNESCO) to discuss the concept of ecological sustainable development.

1971 – The *Founex Report on Development and Environment* was released suggesting underdevelopment and poverty as the causes of environmental problems related to consumption and production.

1972 - United Nations Conference on Human Environment was held to discuss regional pollution and the acid rain problem in Northern Europe. The conference led to the establishment of the United Nations Environment Programme (UNEP) and numerous national environmental protection agencies.

1983 – The World Commission on Environment and Development (WCED) was established.

1987 – WCED published Our Common Future (*Brundtland Report*), giving a comprehensive definition of sustainable development for the first time.

1987 – The Montreal Protocol, which monitors substances that deplete the ozone layer, was signed by a number of countries.

1992 – The United Nations Conference on Environment and Development (UNCED) was held in Rio de Janeiro (The Earth Summit). Agenda 21 was published and The Convention on Biological Diversity and the Framework Convention on Climate Change was signed by different countries.

1997 – A number of countries signed the Kyoto Protocol as an undertaking to reduce greenhouse gas emissions.

2002 – The World Summit on Sustainable Development was held, resulting in declarations related to sustainable development and the establishment of partnership between different countries.

Figure 5-2. Sustainable development timeline (International Institute for Sustainable Development, 1997; Heinrich Böll Foundation, 2003)

The concept of sustainable development has been evolving in the past decades. In the 1970s, the concept was relatively vague and, despite the establishment of numerous environmental protection agencies, development policies paid little attention to environmental issues. The *Brundtland Report* in 1987 was a milestone in the evolution of sustainable development. It proposed that environmental issues are integral parts of all development policies (Rogers et al., 2006). A few years later, Agenda 21 confirmed the definition by giving equal importance to the environment and development.

1.2. **Definition**

- The *Brundtland Report* provided a comprehensive definition of sustainable development: the development that meets the needs of the present without compromising the ability of future generations to meet their own needs (World Commission on Environment and Development, 1987). In the Earth Summit in 1992, Maurice Strong, the former Secretary General of UNCED, suggested a more detailed definition of sustainable development as a process of deep and profound change in the political, social, economic, institutional, and technological order, including the redefinition of relations between developing and developed countries (Rogers et al., 2006).

- Sustainable development can be divided into three major dimensions: economy, society, and the environment (Figure 5-3). The dynamic balance between the three dimensions is essential in the context of development which meets present needs without compromising the ability of future generations to meet their own needs.

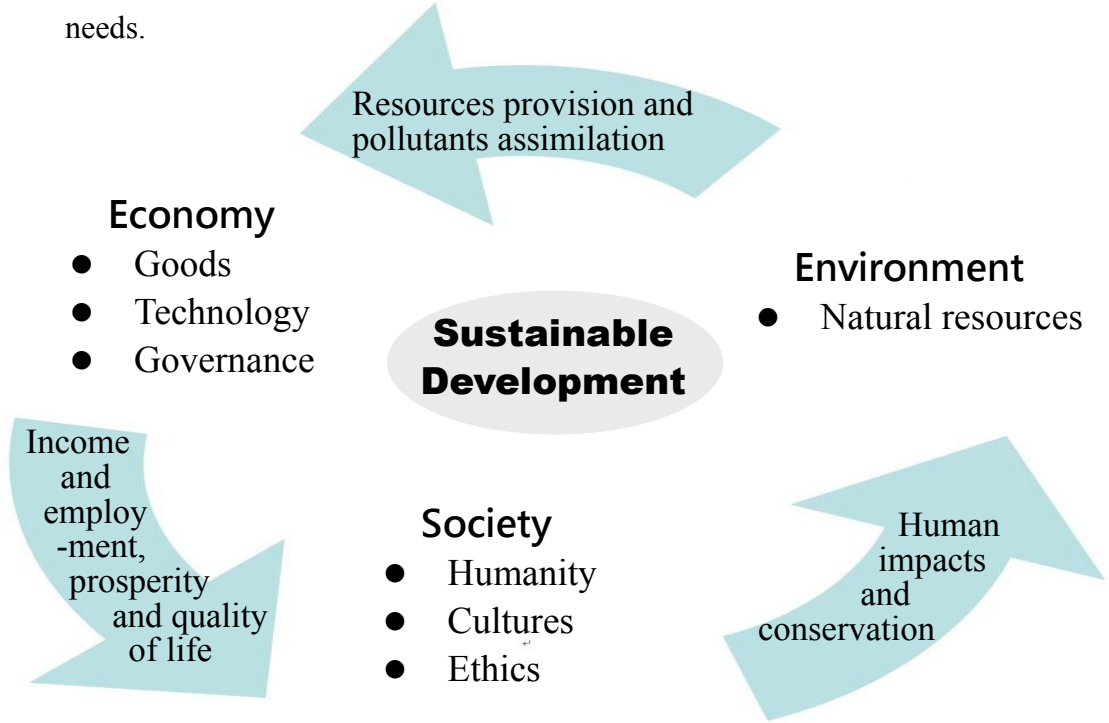

Figure 5-3. The three dimensions of sustainable development (University of Leeds, 2010)

- Economic dimension

  - The core idea of economic growth is to maximise income and profit while maintaining a constant or even increasing stock of capital (Rogers et al., 2006). Economic sustainability focuses on constant growth in the future rather than short term profits. The objective cannot be attained without considering environmental and social constraints, since economic growth relies heavily on environmental components such as environmental quality and the availability of natural resources, as well as social components such as social stability and human resources.

- Environmental dimension

  - Environmental sustainability refers to the maintenance of essential ecological processes and life support systems, the preservation of genetic diversity, and the sustainable utilization of species and ecosystems (World Wide Fund for Nature, 2005; Rogers et al., 2006). Environmental objectives are dependent on economic components such as investment and capital, as well as social components, such as public awareness and education.

- Social dimension

  - Social sustainability focuses on stability and continuous improvement in social aspects, such as socio-economic status, education level, health care services, provision of utility, and equality among ethnicities and between genders. Social objectives depend on economic components, such as funding, and environmental components in relation to living conditions and health.

1.3. **Sustainability at different levels**

- Sustainability is a set of values, policies and practices at all levels, from the individual to the global (Sustainable Development Communication Network, 2007).

- Individual level

  - Promoting sustainability at the individual level is important since its success and effectiveness rely on efforts from everyone in the community through public participation. In Hong Kong, the Council for Sustainable Development is devoted to facilitating community participation and promoting public awareness and understanding of the principles of sustainable development (HKSAR Sustainable Development Division, 2008a). In addition, the government has established the Sustainable Development Fund with a sum of $100 million to provide a central source of financial support for initiatives that will help develop strong public awareness and understanding of the principles and to encourage sustainable practices in Hong Kong (HKSAR Sustainable Development Division, 2008b).
  - The ecological footprints concept was developed in recent decades to enhance public knowledge of the impacts they have on the planet. The system focuses on comparing human demand, such as diet, energy consumption and discharge of waste with the planet's ecological capacity to regenerate. Many organisations have set up ecological footprints calculator to raise public awareness of the issue and to encourage changes in people's lifestyle. Methods of calculation set up by some environmental groups are available in the following websites:
    - http://www.earthday.net/footprint/index.html
    - http://www.conservation.org/act/live_green/Pages/ecofootprint.aspx

- National level

  - The government is responsible for promoting sustainability across the nation through formulating policies and measures. To promote economic growth, the government may intervene and stabilize the market. For example, the United States' Emergency Economic Stabilization Act of 2008 authorized the Secretary of the Treasury to spend up to US$700 billion on restoring confidence in the credit markets. To promote social harmony, the government may encourage human rights and equality such as protecting freedom of speech and enacting laws against racism and sexism. To ensure better environmental quality for the future, the government may enact and enforce ordinances to prohibit the illegal discharge of pollutants.

- Global level

  - Sustainable development at the global level is promoted through different organisations and events such as the International Symposium on Sustainable Development. Other than focusing on sustainable development as a whole, international collaborations are active in each of the economic, social and environmental dimensions.

Table 5-1. Examples of international organisations promoting sustainability in economic, social and environmental dimensions

Dimensions	Organisation	Responsibilities
Economic	Organisation for Economic Co-operation and Development (OECD)	● Provides economic and social statistics with analysis and forecasts ● Provides a platform for governments to share policy experiences and coordinate international policies
	World Trade Organization (WTO)	● Deals with the rules of trade between nations ● Establishes agreements between member states and encourages their parliaments to ratify the signed agreements
Social	United Nations Educational, Scientific and Cultural Organization (UNESCO)	● Establishes universal agreements on ethical issues and encourages respect for different ethnics and cultures ● Promotes human rights, mutual respect and alleviation of poverty
	International Committee of the Red Cross (ICRC)	● Provides protection and assistance to the wounded and sick and civilians affected by wars and conflicts ● Strengthens humanitarian laws and principles
Environmental	United Nations Framework Convention on Climate Change (UNFCCC)	● Committed to alleviating global warming and climate change ● Establishes international agreements, such as the Kyoto Protocol, to encourage global reduction in greenhouse gas emissions

1.4. Challenges

- There have been questions and challenges to the concept of sustainable development. Some do not believe that conservation and development can co-exist, while others do not believe that balancing the three dimensions would result in the optimal condition. For example, measures for environmental conservation and policies beneficial to the society would result in additional expenditure and would affect profitability. As a result, many have found the term "sustainable development" contradictory since it hinders growth to a certain extent. In addition, some think that sustainable development encourages protectionism which favours developed countries but hinders developing countries. While some consider sustainable development as simply a myth, there have been successful stories which show that conservation and development can co-exist, and the balance of the three dimensions has produced favourable results.

1.5. Case study: Eco-tourism in Costa Rica

- Costa Rica is one of the most bio-diverse places in the world with about 6% of all species in the world residing in the country. The government has been greatly devoted to environmental protection, including targeting to become carbon neutral (zero carbon emissions by balancing carbon released and amount sequestered) by 2021 and enforcing 25% of its land to be protected from development.

- With such a rich diversity of species and vast natural areas, the government actively promotes eco-tourism, which typically involves travel to natural attractions and cultural heritage sites while minimizing the impacts to the environment (The National Biodiversity Institute, 2011). Costa Rica has written one of the most successful stories in eco-tourism. About 1.7 million tourists visited the country in 2005 which generated about US$1.6 billion in revenue (Hutchinson, 2007). The story connotes that the co-existence of conservation and development is possible and that growth in one dimension does not necessarily hinder the others.

2. Implementation of sustainable development in projects and developments

The implementation of sustainable development depends on various factors (Table 5-2). Healthy economic growth, adequate resources and technology, and well-organized policies are the preconditions for implementing sustainable development.

Table 5-2. Assessment of a specific project with regard to sustainable development

Challenges of sustainable development		Dimensions facing challenges			Remarks
		Economic	Social	Environmental	
Living Standard	**Basic necessities of life**				
	Economic development				
Resource limitations					
Technological concerns					
Policies and regulations					

2.1. Living standard – Basic necessities

- Poverty is a major challenge to sustainable development as the poor often pollutes the environment out of the necessity of survival. Overgrazing, overfishing or deforestation may be the only option for some to make a living. In addition, the poor may not be able to afford machinery and technology and thus needs to rely on human labour, resulting in overcrowding and other social burdens. Hence, improvement in their socio-economic status is necessary to encourage them to earn their livelihood in a more sustainable manner.

2.2. Living standard – Economic development

- Economic development often impedes the implementation of sustainable development, especially in developing countries as their economy relies heavily on exporting exploited natural resources. Many governments focus primarily on economic development and regard it as the precondition for managing the environment and society. With insufficient financial resources, it is likely that the government will need to tolerate the use of energy which emits a greater amount of pollutants, and will have fewer resources to improve public education and health care services.

2.3. Resource limitations

- The availability of resource often determines the feasibility of certain projects. One of the major limitations is land, especially in crowded places like Hong Kong. Besides, some energy-related projects require the presence of certain natural resources. For example, hydro power requires the presence of rivers or falls, while wind power requires highlands to obtain higher wind speed. Minerals and lumber are also important raw materials for production and manufacturing. Countries lacking these resources have to import them from other countries, thus incurring high production costs.

2.4. Technological concerns

- The implementation of sustainable projects often requires technology for conducting research and development. In the absence of local technology and facilities, some countries have to import them or contract manufacturing in other places. Besides, information technology is also very important as it helps save time and resources for projects and developments.

2.5. Policies and regulations

- Policies and regulations affect the role of sustainable development in a society. A well organised set of policies emphasising the balance of the three dimensions would pave the road to sustainable development. Legislation and enforcement help to maintain standards in every aspect (economic, social and environmental) at a stable and satisfactory level.

2.6. Stakeholders' views

- Stakeholder refers to any party that may be affected by a certain project or development, such as:

  - the government
  - non-governmental organisations (NGOs), such as environmental and social groups
  - the business sector
  - the public

- Due to different roles and backgrounds, different stakeholders tend to view certain decisions differently (Table 5-3). Under a well organised governing structure, stakeholders may voice their concerns about certain policies and the government shall make appropriate amendments in response.

Table 5-3. Stakeholders involved in and their views regarding specific projects

Challenges to stakeholders		Stakeholder A	Stakeholder B	Stakeholder ...
Living standard	**Basic necessities of life**			
	Economic development			
Resource limitations				
Technological concerns				
Policies and regulations				
Aspects which concern the stakeholders	**Economic**			
	Social			
	Environmental			

2.7. Case study: Development at Long Valley

- In 1999, former railway corporation, Kowloon-Canton Railway Corporation (KCRC), proposed to construct the Lok Ma Chau Spur Line to enhance cross-border travelling. After reviewing the environmental impact assessment (EIA) report submitted by KCRC and listening to different stakeholders (Table 5-4), the Environmental Protection Department (EPD), referring to the EIA Ordinance (EIAO), disapproved the proposed route on the ground of possible damage to Long Valley, a wetland area considered to be of high ecological value (Table 5-5) (HKSAR Transport Bureau, 2001).

Table 5-4. Stakeholders involved in and their views regarding the proposed route

Challenges by stakeholders		Vill-agers	KCRC	Environ-mental group	The Govern-ment	Hong Kong Tax-payers	Cross-border Com-muters
Living standard	Basic necessities of life						
	Economic development	X	X		X	X	X
Resource limitations		X	X		X		
Technological concerns			X		X		
Policies and regulations			X	X	X		
Aspects which concern the stakeholders	Economic	X	X		X	X	X
	Social	X			X	X	X
	Environmental			X	X	X	

Table 5-5. Assessment of the original proposed route of the Spur Line

Challenges of sustainable development		Dimensions facing challenges			Remarks
		Economic	Social	Environmental	
Living Standard	**Basic necessities of life**				The presence / absence of the project would not affect the survival of the public
	Economic development	X	X		Needs to relocate some of the residents, buy their properties and pay them compensations
Resource limitations				X	Due to geographical constraints, the rail has to pass through Long Valley
Technological concerns				X	Railway would disturb the ecosystem of Long Valley
Policies and regulations				X	The proposed route was disapproved by EPD according to the EIAO

- The Spur Line case resulted in one of the strongest public engagements in environmental management and sustainable development in Hong Kong's history. Upon EPD's disapproval, the KCRC had to alter its plan and spend an additional HK$20 million to construct an underground tunnel to minimise disturbance to the wetland. The proposal was later approved and implemented.

- The government collaborated with the Conservancy Association to promote sustainable development in Long Valley. Funded by the Sustainable Development Fund, the Conservancy Association launched the Action Model on Sustainable Development in Long Valley, which aims to engage the community in sustainable development through a series of programmes, including restoration of woodlands, modifying traditional farming methods, creating green market places and developing eco-tours (Table 5-6).

Table 5-6. Main programmes of the Action Model on Sustainable Development in Long Valley (The Conservancy Association, 2005)

Programme	Economic	Social	Environ -mental	Remarks
Remove Mikania（薇甘菊）and restore fung-shui wood	X		X	Improves the ecological value of the area and promotes eco-tourism
Modify traditional farming methods	X	X		Promotes more efficient farming methods and local agriculture
Create green market place	X	X		Promotes local economic development and creates job opportunities for local residents
Develop eco-tourism	X	X	X	Promotes local economic development and creates job opportunities for local residents; increases public understanding of and concern for the area

2.8. Case study: Kai Tak Development

- Kai Tak, located at the southeastern part of the Kowloon Peninsula, has been utilized for various public and private purposes, including airport terminals in the past decades (Figure 5-4).

- The Kai Tak Planning Review has proposed several major facilities, such as a railway station, stadium and cruise terminal, in the area (Figure 5-5). The development is expected to add dynamics to the surrounding areas, including Kowloon City and To Kwa Wan, which are regarded as relatively old districts. On the other hand, the development emphasises sustainable development and environmental quality (Table 5-7).

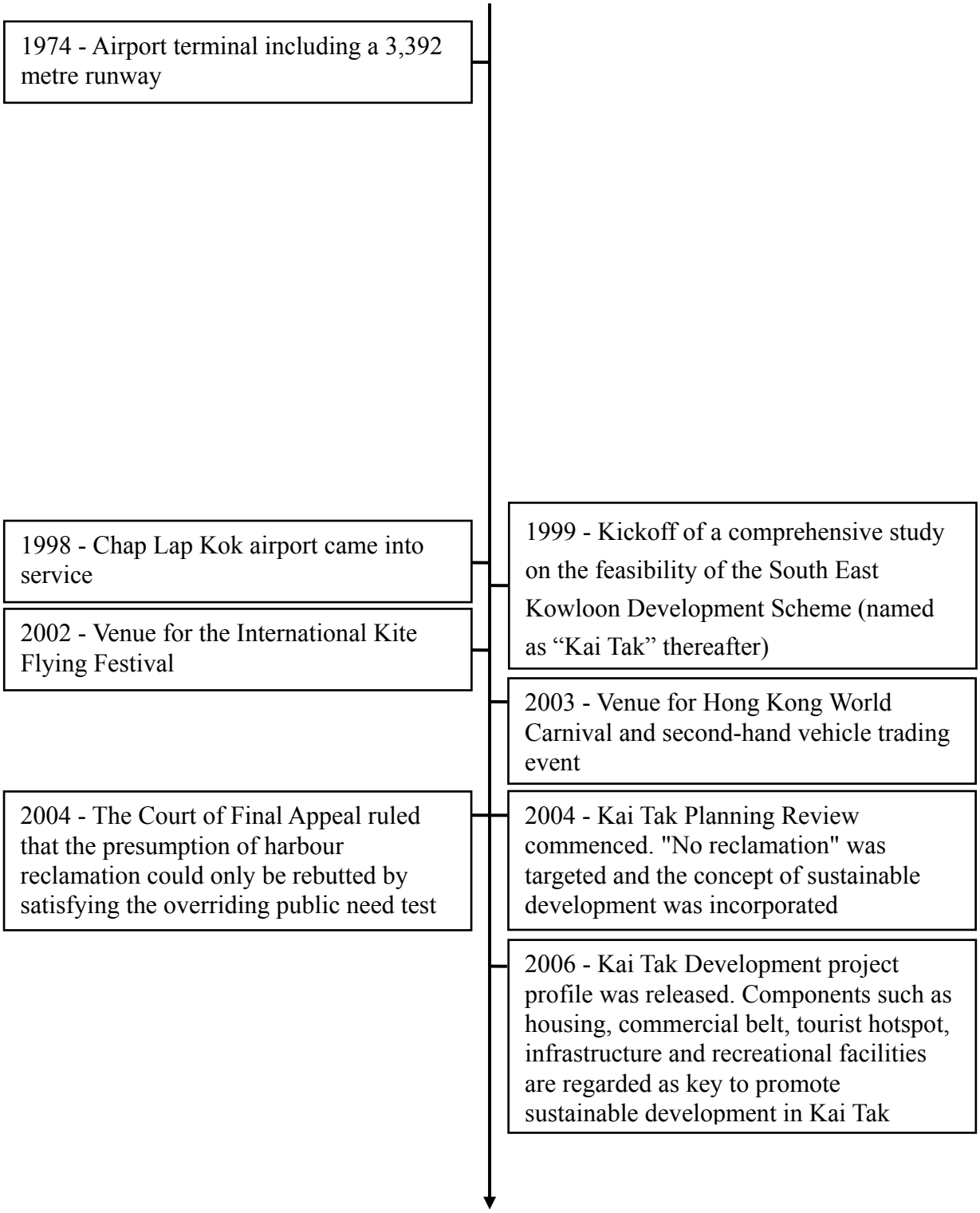

Figure 5-4. Timeline of utilisation and development of Kai Tak

Table 5-7. Assessment of the Kai Tak Development

Challenges of sustainable development		**Dimensions facing challenges**			**Remarks**
		Economic	Social	Environmental	
Living Standard	**Basic necessities of life**				The presence / absence of the project would not affect the survival of the public.
	Economic development	X	X		The project may affect the property pricesand other demographic factors of the existing neighborhood.
Resource limitations		X			Development cost, excluding the cost for the commercial area, has been estimated at about $2.4 billion.
Technological concerns				X	Construction would generate solid wastes and waste water, and would cause air pollution and noise pollution affecting the neighbourhood.
Policies and regulations				X	Due to the decision of the Court of Final Appeal, the project altered its target to zero reclamation.

Figure 5-5. Proposed facilities from the Kai Tak Planning Review

- The Kai Tak Development compromises various projects, prompting the area to become one of the most dynamic areas in Hong Kong in the coming decades. Proposed projects include public housing, residential, commercial and hotel belt and cruise terminal. Public housing and the residential belt will help cater for the need of housing while the commercial belt, hotel belt and the cruise terminal will serve as tourist hotspots, enhancing the business sector and tourism. In terms of environmental quality, the Chief Executive has assured the provision of water-cooled air-conditioning for future occupants. It has been predicted that this HK$1.4 billion project can help save 85,000 kilowatt-hours annually, resulting in a reduction of 60,000 tonnes of carbon dioxide (CO_2) when compared with conventional cooling (Chui & Chen, 2008) (Table 5-8).

Table 5-8. Major proposed projects in the Kai Tak development.

Proposed projects	Economic	Social	Environ -mental	Remarks
Public housing and residential belt		X		Provides housing for Hong Kong's growing population
Kai Tak station	X	X		Improves transportation access to the area and promotes growth in property value
Commercial and hotel belt	X	X		Boosts economic development and creates job opportunities
Stadium and cruise terminal	X	X		Enhances tourism and international recognition
Metro park		X		Provides recreational facilities and encourages appreciation of the environment
Kai Tak approach channel			X	A 600m opening at the former runway has been proposed to improve water circulation and quality
Noise mitigating measures			X	Offers buffer distance and considers depressed road and roadside barriers
Water-cooled air-conditioning system	X		X	Expected to save 85,000 KW/hr per year and emit 60,000 less tonnes of CO_2, saving 20% of users' costs

Conclusion

The concept of sustainable development encourages developments meeting present needs without compromising the ability of future generations to meet theirs. Values, policies and principles of sustainability should be practised at all levels and the balance between economic, social, and environmental dimensions should be emphasised. International organisations have promoted collaboration between nations and encourage the governments to carry out related policies. The governments are also responsible for applying the concept in projects and developments. Besides, the public should incorporate sustainability into everyday life since public engagement and participation are vital in making the world a better place for future generations to live.

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Chapter 6: Pedagogies

Overview

This chapter is on the choice of appropriate issues and pedagogies for Liberal Studies lessons, including field learning and cooperative learning, and the ways for helping students to enhance critical thinking skills and interests in active learning. Applications of different pedagogies are illustrated with examples related to the topics in Module 5 and Module 6 in Liberal Studies.

1. Designing Liberal Studies lessons

When designing Liberal Studies lessons, teachers should know about students' learning experiences and abilities. Teachers should then make use of different learning and teaching strategies to provide an appropriate learning environment, ensure that the students' learning experiences are consistent with the curriculum goals, and help students construct knowledge and develop generic skills in the learning process.

1.1. Considering students' prior knowledge of the topic

- As Liberal Studies emphasises being "student-centred", teachers should consider students' prior knowledge of the related topics before preparing lessons. Without relevant prior knowledge, students could not conduct in depth quality discussions. Therefore, students should not be required to conduct learning activities like role-play, multi-perspective thinking and interactive discussion before they have acquired an understanding of the relevant concepts and the enquiry skills needed. Teachers should start by proposing an issue and let students find out the relevant concepts. They may then carry out different enquiry activities.

- Let's take "food additives" as an example. Teachers may start by proposing the issue, such as, "the positive and negative effects of using food additives", "setting the safety standards for food additives", "the principles and methods of regulating food additives", etc. In addition, before discussing the relevant issues, teachers can guide students to find out the concepts related to food additives and the knowledge that can help them enquiring into the issue, like, "What are food additives?", "What are the different kinds of food additives?" and "Why do we use food additives?". Teachers may also let the students start from collecting information of their eating and drinking habits and the food that they encounter in their daily life, so that they know more about the topic. If the students are not familiar with the topic, the teachers should elaborate more on

the background first. When introducing the topic, teachers may arouse students' interest in doing the enquiry through giving them information from various media, like newspaper cuttings, periodicals, science reports, websites, graphics and videos. Table 6-1 below lists out different sources that can be used when introducing the topic "food additives". Teachers may encourage the students to get hold of the relevant information through cooperative learning, so that they have a better understanding of the topic.

Table 6-1. Examples of information for introducing the topic "food additives"

Topic	Food Additives
Newspaper Cuttings	1. 〈食物添加劑　添益？添害？〉(2009)《星島日報》，2 月 23 日。 2. 〈味精鹽食得多損記憶〉(2007)《太陽報》，10 月 8 日。 3. 〈含三聚氰胺致嬰患腎石〉(2008)《東方日報》，12 月 25 日。 4. 〈插鐵絲竹籤　加化學成分　四成冬蟲夏草食壞人〉(2009)《am730》，7 月 31 日。
Website	1. 食物環境衛生署 (2002)〈食物添加劑　知多一點點 Part 1 & Part 2〉。取自 http://www.cfs.gov.hk/tc_chi/multimedia/multimedia_pub/files/know-more-addive_c.pdf (瀏覽日期：2011 年 5 月 23 日) 2. 食物環境衛生署食物安全中心 (2007)〈食物添加劑消費者指南〉。
Video	1. 廣州 TV (2009)，中國大陸鮮果汁。〔相關報導：〈多種添加劑混成「除了水，都是毒品」廣州人造果汁長飲致癌〉(2009)《蘋果日報》，4 月 18 日。〕

1.2. Choosing appropriate issues

- Liberal Studies adopts the issue-enquiry approach. In doing issue enquiry under teachers' guidance, students are given the opportunity to link up the various modules in Liberal Studies and with other subjects, and make reasonable judgments by themselves through analysing different information. In designing Liberal Studies lessons, it is necessary to consider what kind of issues and enquiry processes are appropriate for nurturing the students' multi-perspective thinking and cross-curricula vision. The issue should be related to the curriculum and the focus of the discussion should be explicit. Meanwhile, teachers should also evaluate whether the issue can nurture the students' thinking and enquiry skills, and facilitate students to acquire the related knowledge, skills and values in the enquiry process. Since Liberal Studies encompasses a wide range of issues, teachers can choose within the scope depicted in the Curriculum and Assessment Guide with reference to the following guidelines:

- They can be past, current or future issues
- They should be controversial that can trigger reflections (Controversies originate from different understandings and points of view of different stakeholders and different solutions involved)
- There are no “right” or “wrong” answers for the issues but some solutions may be more desirable than others
- Students can provide debatable and supported answers for the issues and comment on the “feasibility” and “effectiveness” based on their own values, experiences and knowledge backgrounds
- Students can make use of their personal experiences in the process of issue enquiry
- The following lists the directions and perspectives that can be considered when choosing the issues for “Public Health”(Module 5) and “Energy, Science and Technology”(Module 6) (Curriculum Development Council and Hong Kong Examination and Assessment Authority, 2007):
  - Module 5
    1. The influences of outbreaks of epidemic diseases, such as Severe Acute Respiratory Syndrome (SARS), Swine Flu, on the understanding of disease and public health, and public responses
    2. The influence of the advancements of modern technology and scientific knowledge on the understanding of disease and public health, e.g. the production and use of vaccine, drug patenting, curing of cancer
    3. Changes in people’s understanding of health e.g. growing popularity of body slimming and plastic surgery, regulations on food additives and trends in drug abuse
  - Module 6
    1. Uses of renewable and non-renewable energy, and the impact on the environment of pollutants generated by the use of energy, such as impact of use of biofuel, climate change caused by use of fossil fuel, air pollution caused by emission from growing number of vehicles
    2. The influences of planning, managing and regulating energy resources on the use of energy and the environment, e.g. statutory ban on idling vehicle, increasing use of nuclear energy for electricity generation, environmental conservation
    3. The balance between quality of life, economic and social development, and environmental conservation, e.g. recycling of solid waste, levy on plastic bags

- Using the levy on plastic bags as an example, the students can enquire into the impacts of disposing excessive quantity of plastic bags through the issue-enquiry process:

  - Starting with personal experiences to reflect on how their own daily life style affects the environment
  - Understanding the dispute brought about by the levy on plastic bags from different stakeholders' perspectives, like individual users, retailers, environmental concern groups, the government, plastic bag manufacturers and recycle bag manufacturers
  - How to balance among people's quality of life, economic and social development and environmental conservation
  - Suggesting feasible and effective solutions through analysing past and present situations
  - Evaluating the effectiveness of the levy on plastic bags

1.3. **Post-lesson summary**

- After the discussion, teachers may give the students some homework, or related questions for reflection. It helps students better understand the issues and provides them with an opportunity to reflect on the relevant concepts. Besides, it also helps prepare students for examinations by training their writing and organizational skills. At the beginning, teachers may allow students to answer questions in a few short sentences. As time goes by, teachers may progressively ask the students to extend their answers, organise them into paragraphs and present their own opinions systematically. The following is an example of a homework on "levy on plastic bags":

Box 6-1. An example of post-lesson exercise

Read the following data carefully:

Production and usage of plastic bag one month after the implementation of the levy on plastic bags			
	production	**order**	**usage**
vest bag (levied)	↓40%	↓40%	dispensed amount reduces by 80%
garbage bag, even weibag (not levied)	↑30%	↑50%	used amount increases by 50%
non-woven bag (recycle bag)	↑50%	↑50%	sale amount increases by 50%
Source: excerpted from Apple Daily, 8 Aug 2009; Sing Pao Daily News, 10 Aug 2009			

1. With reference to the above data, discuss to what extent the levy on plastic bags can reduce the abuse of plastic bags.
2. "The implementation of levy on plastic bags can help reduce solid waste." Do you agree with this view? Explain your answer.

2. Examples of teaching methods in Liberal Studies lessons

2.1. Enhancing critical thinking skills

- What is critical thinking?

1. Formal or informal thinking, avoiding unreasonable inference or explanation
2. Problem identification and problem solving
3. Supported with evidence
4. Knowing when problems will arise
5. Judging the credibility of information
6. Agreeing or disagreeing with an issue
7. Identifying the differences among facts, opinions and values
8. Judging the validity of reasoning
9. Identifying trends and biases
10. Identifying logical fallacies
11. Judging contradictory explanations or argument

- One of the ways to enhance critical thinking skills is to use critical thinking tools. The following table (table 6-2) demonstrates how FRISCO, an analysis tool suggested by Robert H. Ennis (1996), can be applied to analyse the case of electric vehicles.

Table 6-2. Example of application of FRISCO

Flow	Footnotes	Guiding questions for students' thinking
Focus	Identifying the incidents, main points, issues, problems or difficulties. (Foci can usually be found in the conclusions part.) • For example, in the case of electric vehicle, the issue is whether the use of electric vehicle can help to protect the environment and enhance economic development at the same time.	What is the main issue? What is the real problem? What has happened?
Reasons	Reasons, or arguments supporting the conclusions can come from logical analysis or be based on empirical evidence • Students can give reasons for or against certain viewpoints based on different information, but they must ensure the validity of the reasoning by considering the following: ➢ Source of the information (government institutions, academic / research institutions, commercial institutions or individuals) ➢ Whether the information is fact or opinion ➢ When the data / information was collected / generated	What are the reasons and arguments supporting the conclusion? How many reasons are provided? Are they derived from experiences, evidence or logical inferences? Is the argument reasonable and acceptable?

(Cont'd)

Flow	Footnotes	Guiding questions for students' thinking
Reasons	● Check the accuracy of information from other sources. For example, "yet some vehicle manufacturers opined that as Hong Kong uses coal for electricity generation, which has low energy-efficiency, the use of electric vehicle is not environmentally friendly" is a reason against the use of electric vehicle. But whether it is acceptable depends on other evidences, such as the empirical data comparing the energy efficiency of electrical and gasoline vehicles.	
Inference	The process of getting conclusion from reasons. There are two most commonly used inference methods. ● Deduction: Based on the logical relationship between the premises and the conclusion, it can be deduced that if the premises are true, the conclusion is also true. For example: ➢ Premise 1: the suspended particles worsen the air quality ➢ Premise 2: Using electric vehicles can reduce the emission of suspended particles ➢ Conclusion: Using electric vehicles can improve air quality ● Induction: Based on the fact that subjects of a particular category under observation all possess a certain characteristic, it can be induced that all members in that class possess that characteristic.	What method do you use in inferring the conclusion from the reasons? Is your reasoning correct and logical? Can the reasons support the conclusions? If yes, how strong are the reasons?

(Cont'd)

Flow	Footnotes	Guiding questions for students' thinking
Inference	➢ After using electric vehicles, the USA's air quality improves. ➢ After using electric vehicles, Japan's air quality improves. ➢ After using electric vehicles, the European Union countries' air quality improves. ➢ Conclusion: After using electrical vehicles, Hong Kong's air quality will improve. ● Usually, deduction carries more strength than induction, and the strength of induction depends on the number of subjects that are observed.	
Situation	Liberal Studies emphasizes the ability to discuss issues on social level. To master an issue, students have to understand the macro situation in which the issue takes place (i.e. social situation) apart from focusing on the issue itself. Students have to understand an issue from a macro perspective, and identify the different stakeholders involved. (The following is the suggested answers for the questions listed on the right) 1. Citizens use motor vehicles to enjoy convenience and improve their quality of life. 2. Motor vehicles emit exhaust fume, causing air pollution. Experiences in foreign countries show that air quality improves with the use of electric vehicle. 3. Hong Kong's air quality is getting worse and worse. Hong Kong people are more informed and concerned with the health problems associated with air pollution.	What are the situational causes behind the controversy and issue? Teachers and students can make use of the following questions to guide students to think from the citizens', environmental, economic and technological perspectives. 1. Why do citizens use motor vehicles? 2. What negative effects do motor vehicles bring to the environment? Can the use of electrical vehicles improve the situation?

(Cont'd)

Flow	Footnotes	Guiding questions for students' thinking
Situation	4. At present, the production cost of electric vehicles is still higher than that of motor vehicles. However, as the technology of electric vehicles and its supporting facilities are getting more mature, the use of electric vehicles will be more cost effective in the future. Teachers may then ask students to identify different stakeholders from the above answers, and think about how the stakeholders perceive the situation, how the situation affects their interests and how it affects their attitudes towards the issues in turn. The followings are examples of different stakeholders' interests and their attitudes toward the issue: ● Citizens: if citizens are concerned with their health and the environment, they will support the use of electrical vehicles. ● Environmental concern groups: They are concerned with how electricity is generated for the use of electrical vehicles. For example, electricity generated by coal pollutes the air and may use up even more energy. These will affect their stance on the use of electric vehicles. ● Motor vehicles and electric vehicles manufacturers: They will evaluate the difference in costs of producing electrical vehicles and motor vehicles; whether electric vehicles can help the company explore new markets and bring new business opportunities.	3. How is the air quality in Hong Kong now? What opinions do Hong Kong citizens hold for this? 4. What is the difference between the production cost of electric vehicles and that of motor vehicles? How is the development of the production technology of electric vehicles? List out the area of concern of different stakeholders, and how their preferences affect their attitude towards the issue. How do the factors considered by different stakeholders lead to the problem/controversy?

(Cont'd)

Flow	Footnotes	Guiding questions for students' thinking
Situation	Teachers may guide students to list out all the factors affecting the stakeholders, and think of possible solutions to the problems. Teachers can also request students to explain how the proposed solutions strike a balance among the interests of different stakeholders and elaborate the possible impacts on society.	
Clarity	There must be clear understanding of the terms related to the issues. If different people understand the same word or phrase differently, then it must be fully clarified to prevent any confusion. ● Do electric vehicles include hybrid vehicle? How to judge whether something is environmentally friendly? How can it be measured? ● For example, usually the comparison of energy efficiency of electric vehicles and motor vehicles only concentrate on the vehicles themselves (that is, how much kinetic energy is converted from chemical energy in a motor vehicle, and how much kinetic energy is converted from electricity in an electrical vehicle). Yet motor manufacturers think that the amount of electricity changed from chemical energy in a power plant should also be taken into account when considering the energy efficiency of electric vehicle. Since the efficiency of electricity generation from coal is low in Hong Kong, the use of electric vehicle is not environmentally friendly.	Are the meanings of wordings for the foci, arguments and situations clear? Are the understandings of different people to the words or phrases the same? Is your understanding the same as others?

(Cont'd)

Flow	Footnotes	Guiding questions for students' thinking
Overview	After finishing the above 5 steps, one should reflect again on the coherence among them, and investigate into the self-contradictory points or other fallacies from a third person's perspective.	Are the 5 steps coherent with each other? Is there any contradiction among them? Is there any fallacy in the process?

2.2. Field learning

- Field learning provides students with the opportunities to expose themselves to community resources related to the topics, so that they will get a more authentic experience and a better understanding of the topics. Teachers may ask students to collect first hand information, thereby training their observational and analytical skills, and apply the knowledge they have learnt to complete their enquiry.

- Learning Outcomes

  - Complementing classroom learning and constructing new knowledge through field observations, inspections or visits.
  - Enhancing students' understanding of social, natural, environmental and economic phenomena and characteristics.
  - Developing effective inductive and enquiry skills, like observation, questioning, predicting, hypothesising, data analysis and decision making.

- Planning a Field Trip

  - In order to foster students' understanding of the topics, the themes of the field trips should relate closely to students' daily life. The designed contents should also be in line with the curriculum's goals and be engaging to students. The plan should cater for learner diversity and students' prior experiences. Students should be helped to understand the relevant concepts, and to acquire the enquiry skills. Teachers can also divide students into groups for searching information in different aspects, so that more comprehensive information can be obtained and brought back to school for use.

- Before going on the field trip, teachers should establish the directions, foci, themes and scopes of the enquiry activity by briefly introducing the place, or help students to collect the needed information from documents, libraries, the Internet, museum guides. This enables the students to have a clear goal and timeline when collecting information. Teachers can also make some interview and research record forms for students' use according to their chosen enquiry topics, so that they can carry out discussion afterwards. Teachers should pay attention to the following when preparing for field trips:
  - Understand the process of collecting information and method used for observation and ensure that the process and method are in line with the aims of the visit.
  - Coordinate preparation work with colleagues, and discuss the administrative arrangements (like swapping of lessons and transportation arrangements)
  - Inspect the venue for field trip and pay attention to students' safety
  - Submit and explain proposals for outdoor learning plans to the school administration and related committees
  - Draft "letters to the parents" to explain the goals and detailed arrangements of the learning activities
  - Prepare learning resources and equipment, like maps, photographic equipment and observation record forms
  - Provide opportunity for students to raise questions, and allow flexibility in the activities schedule

- During the field trip, teachers should guide the students to have systematic observation, formulate questions, set up hypothesis and collect information, re-test the hypothesis and establish generalisation or conclusion in the end. Teachers can guide the students to carry out the field trip by referring to the questions listed in table 6-3 below.

Table 6-3. Questions and their uses in field activities (Banks, 1990)

Question	Usage	Example (Lam Tsuen Wishing Tree)
What have you observed?	Inducing curiosity and concern	Some trunks of the Wishing Tree have been broken and withered. Now tourists can only make wishes to the wishing scaffold and plastic wishing tree.
What is the phenomenon?	Identifying problem(s)	Tourists excessively throw joss paper onto the Wishing Tree. The tree also suffers from pest problem. It is withering gradually.
What questions / feeling come up in your mind when you see the phenomena?	Argument - value	How is the progress of recovery of the Wishing Tree? Are the existing measures in reducing the harm to the Wishing Tree effective? Self reflection on how human activities affect the natural environment
How do you explain the emergence of the phenomena? Can you give a tentative explanation?	Formulating hypothesis	1. The government' s measures for conserving and managing trees are inadequate 2. Humans disregard trees' health because of living and traditional customs
How can you be sure that your arguments hold? What information do you need establish your arguments?	Defining terms or concepts Collecting information	Look for relevant information, for example 1. Ordinances and government departments responsible for managing trees. At present there are eight departments responsible for managing trees, among which duties and authorities are not clearly defined, and communication is inadequate. There is also no ordinance and maintenance system for trees. (Hong Kong Commercial Daily, 2009-06-06)

(Cont'd)

Question	Usage	Example (Lam Tsuen Wishing Tree)
		2. In order to throw the joss paper easily onto the Wishing Tree, people tie heavy objects like oranges onto the joss paper. Yet it is these heavy objects that harm the Wishing Tree most. (Hong Kong Commercial Daily, 2007-01-09; Ta Kung Pao, 2009-07-12)
Where can you find these information? How can you ensure that the information collected is correct?	Evaluating and analysing information	Government websites, news reports, websites or reports of environmental concern groups, interviewing experts about trees, listening to the opinions of the residents and traders in Lam Tsuen. Check whether the related information is supported by evidence, for example, checking research reports, observing how people throw joss papers on the spot
How do you analyse and make use of the information collected? How do you sum up your inference?	Testing the hypothesis Summing up the inference and postulations	Test whether the hypothesis is valid, and consider whether there is any argument that may reject the hypothesis based on the information and evidence collected. If the hypothesis is rejected, a new hypothesis has to be formulated and a new study should be conducted. After making conclusions on the inference, one can explore into the following issues: 1. How should the Government enhance the present policies for protecting trees? 2. How can trees be protected without infringement of traditional customs? 3. How to enhance people's awareness of protecting trees?

- Students' foundational knowledge about the issue is the prerequisite for issue-enquiry learning. Field trips allow students to discover problems and examine the magnitude of the problems through first person observation, thus arousing students' interest to conduct enquiry. Through the above example of Wishing Tree, students can understand the current situation of the tree, including the degree to which the tree is harmed, the progress of its restoration and recovery. Students may also record the amount and frequency of the tourists' throwing of joss paper, measure the weight of joss paper and explore what it is made up of. They can also observe the tree hole caused by pests, and talk to the traders and residents in Lam Tsuen to understand their opinions about the Wishing Tree. Through these activities, students can get a better understanding of the issue, identify different stakeholders involved and collect their opinions, and analyse the differences and controversies among them. Together with information collected from other channels, students can examine whether the solutions suggested by different stakeholders are feasible and analyse the pros and cons of each suggestion. Teachers may also encourage the students to suggest other solutions, or further enquire into other incidents of trees collapse in Hong Kong.

- After the field trip, teachers should ask students to summarise their enquiry results through written reports, proposals, videos, creative writings or presentation with models or pamphlets for tourists.

3. Enhancing students' learning motivation

3.1. Arousing students' interest in learning

- Issue-based learning is a student-oriented mode of learning, the purpose of which is to enable students to become self-motivated in their studies. Through enhancing students' interest and motivation to learn, students are inspired to do enquiries, so that the objective of independent learning is achieved.

- Choosing Appropriate Issues

  - As Liberal Studies curriculum covers a wide range of areas, teachers need to choose appropriate issues so as to arouse students' learning interest effectively. For example, before issues-enquiries, teachers can guide students to start from things they are familiar with or use current affairs as example, so that students will pay more attention to the things happening around them.

- After students have selected topics that they are interested in and are related to their life, teachers may guide them to develop the topics into issues for enquiry. Take the use of the Internet as an example, teachers may encourage students to share their experiences of using the Internet, e.g. using blogs and discussion forums as well as meeting friends online. Teachers may also ask students to search for related news, e.g. celebrity porn scandal, cyber-bullying, and anti-Internet piracy. It can stimulate students to think of the advantages and disadvantages of using the Internet, and relate the use of the Internet to social, legal and personal values. It also helps them to turn current affairs into enquiry issues, e.g. "how to regulate the flow of information on the Internet", "the moral standards of using the Internet", "true and fictitious online interpersonal relationships". The rationale behind this method of selecting issues is that it can save time of searching for or reading basic information and make learning more efficient as students should already have a certain degree of understanding of the background information about the issues. Moreover, students can apply knowledge acquired in the process of enquiry to solve problems in real life.

- Classroom Discussion Time

  - Apart from choosing suitable issues, the roles of teachers, especially in classroom discussions, are also very important to enhance students' interest in enquiry. Teachers should take up the role of facilitator and give guidance to students so that they know what to discuss. Teachers should also ensure that sufficient time is provided for discussion. Otherwise, the discussions will be superficial and boring. As a result, students' creativity and imagination would not be stimulated. In addition, when preparing reference materials for students, teachers should cut or revise the texts where necessary. The function of the reference materials is to introduce the issues to the students and enable them to have a primary understanding of the background before participating in independent learning such as collecting and analysing data, or conducting project learning.

- Quality Feedback

  - Finally, teachers should give quality feedback to students during classroom discussions and enquiry process. They may praise students for the parts they have done well, thus encouraging them to complete the rest of the enquiry. It also enables other students to know what "good" discussion is, and stimulates them to participate more actively and give more quality opinions.

However, whether it is independent enquiry learning or classroom discussion, teachers should explain to students what "good" is and how to become "good" apart from giving praises to students. They should enable students to understand the requirements of the enquiry tasks, make improvements on the imperfect parts and set improvement objectives.

- Summary

  - Although students' interest to learn can be aroused by starting from issues of their concern, teachers cannot assume that they have already had a deep understanding of the issues. Teachers should ensure that students have been equipped with sufficient knowledge and skills before conducting issue-enquiry. Teachers should also anticipate what difficulties students may encounter and provide assistance to facilitate students' involvement in preparing the enquiry.

3.2. Cooperative learning

- In cooperative learning, students are divided into small groups to achieve a common learning objective under teachers' guidance. Through face-to-face interactions and cooperation among group members, students can improve their presentation skills and academic performance. They can also apply social and interpersonal skills to achieve the common goals of learning (Johnson and Johnson, 2002). The ideal size for a cooperative learning group is 3-4 students. Teachers should assess students' performance in the group individually and ensure that each student has equal opportunities to learn and share the outcomes of learning.

- The roles of teachers

  - A facilitator who acts as an advisor and activity coordinator (Watson, 1991)
  - Setting the learning objectives
  - Deciding on the size of the group and combination of students
  - Assigning role to each member, e.g. recorders, inspectors
  - Arranging classroom settings, such as the positioning of tables for group work
  - Designing learning materials

- Common cooperative learning methods include Small Teams Achievement Division (STAD), Group Investigation, Co-op Co-op and Jigsaw (陳建生、陳錦榮, 2001).

- Example of cooperative learning method - teaching procedures of Jigsaw:

  - The learning materials are divided into small parts and assigned to different members of the Home Group. Each member in the Home Group will first study their parts and group the main points by themselves. Then, members of different Home Groups studying the same part will be reshuffled to form Expert Groups, and conduct in-depth discussions and sharings. After discussions, they will return to their Home Groups and report the main points of their parts of the teaching materials to their groupmates.
  - During the Home Group stage, teachers can ask students to record the main points of the assigned teaching materials and consider whether there is any other parts that need particular attention. Then Expert Groups are formed by members from various Home groups who have to handle the same learning parts.
  - During the Expert Group stage, teachers can ask students to share enquiry outcomes of Home groups and discuss the similarities and differences of the main points and of their views on the teaching materials. As members of the Expert Groups are later required to return to their Home Groups to teach and assist other members in learning the materials, they also have to discuss how to enable them to better understand the main points of the materials, e.g. discussing which part of the material will be more difficult to understand, and how to explain it to the members of the Home Groups. They should also anticipate questions that may be raised by members of the Home Groups and discuss how to respond to those questions.
  - In the following, food additives are used as an example to illustrate the application of the Jigsaw method. Box 6-2 introduces how to divide students into groups and lists some instructional questions for teachers' reference. The following are the reference materials for the activities:
    1. 食物環境衛生署（2002）〈食物添加劑　知多一點點〉。取自 http://www.cfs.gov.hk/tc_chi/multimedia/multimedia_pub/files/know-more-addive_c.pdf（瀏覽日期：2011 年 5 月 23 日）
    2. 〈零食防腐劑人造色素兒童常吃易患過度活躍〉（2008）《am730》，3 月 13 日。
    3. 〈測試 80 包餅　九成三有問題椰絲　奶油包勁含「反式脂肪」〉（2007）《星島日報》，10 月 16 日。
    4. 〈味精鹽食得多損記憶〉（2007）《太陽報》，10 月 8 日。
    5. 〈國家質檢總局列入黑名單，港產出前一丁唔新鮮〉（2008）《太陽報》，1 月 20 日。
    6. 〈深無良商販毒料漂白蓮藕〉（2008）《東方日報》，10 月 18 日。
    7. 〈廣東產品半數不合格　驚慄年貨〉（2009）《都市日報》，1 月 16 日。

8. 〈品客薯片含致癌物　港超市即時回收〉(2007)《頭條日報》，12月5日。
9. 〈茶葉茶包抽檢揭含農藥及鉛〉(2009)《頭條新聞》，1月16日。
10. 〈添加劑危害食安　衛生部誓長期整治〉(2009)《文匯報》，1月1日)。

Box 6-2. Group division and question instructions

Cooperative Learning (Food Additives)

Four students form a Home Group, and they are numbered as 1, 2, 3 and 4.

1. Before reading the articles, students have to know what they have to do with the materials.
   - Note down the main points after reading the information
   - Consider if there is any other part that requires particular attention
2. The four students use 5 minutes to read the article and find the following information.
   - Student 1: What are food additives? Why are they added to food? What are the benefits? (Reference information 1)
   - Student 2: What are the adverse effects of food additives on our health? (Reference information 2, 3 and 4)
   - Student 3: Use an example to explain food processing by food manufacturers and the impacts (Reference information 5, 6 and 7)
   - Student 4: Describe the situation of food additives monitoring in the Mainland and Hong Kong (Reference information 8, 9, 10)
3. After reading the articles, students with the same number from different Home Groups form the Expert Groups and discuss the following questions (10 minutes is allowed):
   - Each student first explains the main points he / she noted down. Is there any difference in understanding of the information by different members in the group?
   - Is there any information that is important but may be hard for other members of the Home Groups to understand? Can we provide relevant information to facilitate them to understand it?
   - Think of the questions that other members may ask. How would we answer the questions?
   - How can we make the main points of this piece of information easier for other members to understand?
4. After the discussion of the Expert group, students return to their own Home groups and each student uses 3 minutes to explain the information and articles assigned to them.
5. After reporting, discuss if there is any other useful information not mentioned in the article.

- When students return to their Home Groups, teachers would remind them to listen carefully in the sharing, note down the main points and ask for clarification when necessary. When members share information in the Home Group, other members can pool together the different parts of the information and establish their views on the relevant social and current issues. In the example of food additives, the materials for Student 2 are mainly about the adverse effects of food additives. Therefore, his/her impression on food additives may be rather negative. However, upon the explanations of other members, Student 2 may get to know the function of food additives from different perspectives, and reflect on whether the regulations on the use of food additives should be formulated, and understand the relevant legislations and the situation of their implementation in Hong Kong and the Mainland.

- After all members have shared their information, teachers may ask them to conduct the following discussion (Box 6-3).

Box 6-3. Suggested questions for discussion and answers

Cooperative Learning (Food Additives)
(Note: the parts in italics are suggested answers for teachers' reference only.)

1. What is wrong with the monitoring measures adopted by the Hong Kong and mainland authorities in solving the problem of food additives?

The Hong Kong government

- *The Food and Environmental Hygiene Department (FEHD) said that it would ask the relevant departments in the mainland for further information after Hong Kong's product Demae Itcho failed to pass the tests in the Mainland. The test conducted by Consumer Council revealed that the lead contents in a brand of Oolong Tea Leaves and the fertilizer residue contents in a brand of Tie Guanyin Tea were over the allowed limit. In addition, the carcinogenic substance potassium bromate found in imported chips is not regulated by any law in Hong Kong at present. (Reference information 5, 8, 9)*

The mainland authorities

- *The peroxide value (POV)* in Hong Kong's product Demae Itcho was found to exceed the allowed limit and three lots of imported potato chips were found to contain the prohibited food additive potassium bromate. In December 2008, China started to curb the use of food additive by food manufacturers and fight against the illegal addition of inedible materials, but the effectiveness of these efforts was limited. Illegally processed foods were still found. (Students can freely express their views based on the information.) (Reference information 5, 8, 10)*

* The peroxide value is a measure of the extent to which rancidity reactions have occurred in oil or fat.

(Cont'd)

2. Many countries have their agricultural products and food processed in order to maintain sufficient food supply. However, it may lead to food safety problems. Discuss the possible negative consequences using the situation in the mainland and Hong Kong as examples.

   - *The potassium bromate in potato chips and the residual fertilizer and lead in tea leaves are carcinogenic. They may suppress the central nervous system, causing deafness, acute renal failure or acute poisoning. Eating lotus root bleached by magnesium sulfate and citric acids may lead to stomachache, diarrhea, heartbeat slowdown and shock. In addition, there are red wine and fake peanut oil that contain excessive preservatives and sweeteners. (Reference information 6, 7, 8, 9)*
   - *Artificial colour and the preservative benzoate may increase the chances of getting Attention Deficit Hyperactivity Disorder, while excessive salt and MSG may lead to decline of memory. Bread, pies and French fries made of hydrogenated oils contain trans fats, which increase the risk of vascular sclerosis. (Reference information 2, 3, 4)*

3. With reference to the above question, discuss why food additives are commonly used.
   - *The addition of hydrogenated oils can extend the period of food preservation and lower food prices. Adding potassium bromate into bread or potato chips can produce a nice chewy gesture. Breached lotus root has an attractive appearance.*

4. Does the use of food additives necessarily affect food safety? How can we balance between food supply and food safety?
   - *Students are free to give any answer.*

- The above discussion enables students to further analyse the views of different stakeholders. For example, food manufacturers use food additives to reap higher profits. The monitoring measures on food additives implemented by the mainland and Hong Kong authorities reflect whether the governments take food safety seriously enough. During the discussion, students should support their stances with evidence and judge whether using food addictives is good or bad. Students can also explore how food additives should be used to maintain food supply and what monitoring standards the government should adopt to ensure food safety.

Conclusion

This chapter introduces how teachers can start from issues of students' concern and select suitable issues to conduct issue-based enquiry in Liberal Studies lessons. Before the enquiry, teachers need to ensure that students have acquired necessary knowledge and skills, anticipate the difficulties students may encounter and give them relevant guidance. Then, teachers can deepen students' understanding of the issues and enhance their motivation through various teaching methods, e.g. field study and cooperative learning. Teachers can also use critical thinking tools to develop students' critical thinking skills during students' enquiry. At the same time, teachers can give students timely and quality feedback, so as to enable students to improve their learning. After group discussions, teachers can ask students to do some simple homework so as to consolidate their understanding of the issues and enhance their writing and organisational skills.

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