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Sustainability and the impact of Chinese policy initiatives upon construction

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The environment has been perceived as an international issue, and ways of attaining sustainability are becoming important for countries seeking sustainable development. The international community has been active in developing policy frameworks towards achieving the sustainability, such as an ecological modernization approach and environment assessment. Developing countries deserve special attention in the effort to make sustainability an operative criterion in their development activities. Given the difficulties that developing countries are facing, their perceptions of the concept and principles of sustainability differ in various contexts from those of developed countries, and the attainment of sustainability is much more difficult. Therefore, the establishment of a global partnership is important for the vision of sustainability to be realized and operationalized in the world. The current stage of economic development in China provides an opportunity to incorporate environmental provisions into the national development strategies from a relatively early stage, rather than attempt retrofit to strategies. However, at present China's policy initiatives expressed in its Agenda 21 remains only a visionary concept. A comprehensive policy framework and realistic implementation measures are needed. The environmental impacts of the construction industry are extensive, particularly in developing countries. However, as in many developing countries, China's sustainable construction is still at its primary stage and current practice is unsatisfactory.

Keywords: sustainable development, policy, construction, China

Introduction

During the last 20 years, the environment has been perceived as an international issue, referred to a global economy and the extent to which economic growth has been both influenced by and in turn itself influences environmental quality. Over the same period, significant changes in political ideology in a number of parts of the world saw the move, by some previously centrally planned economies, to the development of a market-led economic approach, a shift which further underpinned the concept of a global economy. These two factors, recognition of a global economy and an increase in the number of nation states pursuing market economic approaches, high-light the inadequacy of analyses focusing solely on environmental concerns. The interdependence evident between national economies, whether developed or developing, which has prompted the notion of a global economy is equally valid in identifying a global environment.

Following the United Nations Conference in 1992, the international community has been active in developing policies which address the global environmental consequences of individual national industrial, commercial and social activities. The People's Republic of China has contributed to the international debate via the publication of its Agenda 21 (State Council, 1994). The importance of China in the world economy and its potential impact on the global environment prompt the study of its strategies to secure sustainable development.

This paper commences by studying the concept and principles of sustainability and sustainable

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construction, and the understanding and attainment of sustainability in developing countries. The argument is supported by providing a case study of China's sustainable construction practice and China's Agenda 21 with regard to the Chinese Government's policies and initiatives towards environmentally sustainable development.

Sustainable development and sustainable construction

Sustainable development

Over the course of this century, rapid advances in scientific and technical knowledge, together with population growth, have resulted in significant exploitation of non-renewable natural resources. Pollution, environmental degradation and natural resource development have been increasing, and these are crucial to the long term future of humanity.

In the developed world, public concern for the environment became increasingly evident in the 1960s. International concern was expressed at the United Nations Conference on the Human Environment, which was held in Stockholm in 1972. The idea which emerged from this conference was 'an approach to development aimed at harmonizing social and economic objectives with ecologically sound management' (Sachs,1978).

In 1987, the World Commission on Environment and Development produced a publication entitled *Our Common Future* (WCED, 1987). It clearly identified that the essential needs of vast numbers of people were not being met, and warned that a world where poverty and inequity were endemic would be prone to ecological and other crises. It described the concept of sustainable development as meeting the basic needs of all people and extending to all the opportunity to satisfy their aspirations for a better life without compromising the ability of future generations to meet their own needs. Sustainable development placed more emphasis on the social and economic goals of society, particularly in the developing countries, but stressed that the attainment of these was linked intimately with the achievement of environmental goals.

The operationalization of sustainable development remains contentious because of difficulties in assessing the carrying capacity of supporting ecosystems and the inherent difficulties of identifying the factors which undermine ecosystems. Accusations between developed and developing countries concerning the other's impacts on the carrying capacity of local and global systems have become habitual, as evidenced by the 1992 United Nations Conference on Environment and Development, which was referred to as the Rio Summit.

A comprehensive and pragmatic approach to sustainability was proposed by the economist Solow (1993), who argued that development inevitably causes drawdown of current stocks of non-renewable resources, and that sustainability should mean more than just the preservation of natural resources. To maintain the capacity to meet future generations' needs, there is a requirement to consider society's total capital by taking into account substitution possibilities between natural and other forms of capital. Solow proposed that fairness towards future generations demands that some of the proceeds from the exploitation and depletion of non-renewable resources must be invested in other assets. These could include social or human-made capital (e.g. education and factories), to maintain productive capacity to meet the needs of future generations.

Sustainable construction

The environmental impacts of the construction industry are extensive and readily identifiable. One-tenth of the global economy is dedicated to construction, operating and equipping homes and offices. This activity accounts for roughly 40% of the materials flow entering the world economy, with much of the rest destined for roads, bridges and vehicles to connect the buildings (Roodman and Lenssen, 1994).

The First International Conference on Sustainable Construction in Tampa, Florida, in 1994 addressed the progress in the new discipline of 'sustainable construction' or, as it has inevitably been dubbed, 'green construction'. By extension, sustainable construction adopted the concept of sustainability and relates it to building and construction activities. Originally the term 'sustainable construction' was proposed to describe the responsibility of the construction industry in attaining 'sustainability'. Sustainable construction was tentatively defined as 'creating a healthy built environment using resource-efficient, ecologically based principles' (Kibert, 1994). Generally it is used to describe a process which starts well before construction in the planning and design stages and continues after the construction team have left the site. It also includes managing the serviceability of a building during its lifetime and extends to its eventual deconstruction and the recycling of resources to reduce the waste stream usually associated with demolition (Wyatt, 1994).

The development of policy framework towards achieving sustainability

Sustainable development is a vague concept in that, at one end, it offers a comprehensive, consensual and

conservative approach which is able to weld together disparate and conflicting interests in the environment and development (Blowers, 1992), but at the other end, its implications have been poorly understood, and therefore in practice it offers few clear solutions. Anyone can sign up for sustainable development so long as it requires no specific commitment to do anything, which threatens his or her material interests.

However, it has been recognized that the variety and intensity of the threats of environmental pollution have increased and these can have an exceedingly long-term impact on conditions (UNCHS, 1996). There is greater awareness and understanding of environmental problems and their wide-ranging and far-reaching effects (MoE, 1991; Ofori, 1992; Hawken, 1993). At least, several issues are clear today including: 1. analytical techniques of both the quantitative and qualitative kinds, as well as the necessary information being available for addressing environmental problems (Val Pelt, 1993); 2. there should be changes in thinking, behaving, producing and consuming (Hawken, 1993; UNCHS, 1996); and 3. action is required at several national and international levels (Ofori, 1998).

Therefore, it is particularly important to look at the ways in which the vision of sustainability can be realized or operationalized. Two important policy-oriented developments towards the attainment of sustainability are studied here.

Ecological modernization approach

What is being sought as a popular topic around the world is a model or policy framework, which assists in informing the debate around and the development of policy in the context of sustainability. One interesting and important policy-oriented development is the adoption of an 'ecological modernization approach'. Roberts (1996) identified the value of ecological modernization being that it is possible to integrate the goals of economic development and environmental protection. Merely integrating these two goals is not a pain free route to achieving sustainable development. Choices and compromises occur and require resolution.

Hajer (1996) identifies three different interpretations of ecological modernization: 1. as institutional learning – in which industrial and administrative organizations learn from critiques of conventional industrial society put forward by the environmental movement, and from this develop modes of economic development which are compatible with the environment – this interpretation assumes that existing institutions can internalize ecological concerns; 2. as a technocratic project – in which radical environmentalists argue that the ecological crisis requires more than social learning by existing organizations and that ecological modernization as institutional learning offers a false solution to very real problems – this interpretation argues that without fundamental structural changes in the economy, environmental problems are left unaddressed; and (3.) as cultural politics – this reading of ecological modernization sees the debate on environmental problems as a reflection of wider debates on the preferred social order – this interpretation emphasizes the nature and processes of social and political debate about what sort of society and environment is wanted and how to negotiate social choice in order to arrive at the preferred option. Each of these responses represents a stage towards what is referred to as the necessary and feasible harmony between man and nature, society and environment.

The critique advanced in Hajer's second interpretation, ecological modernization as a technocratic project, points to the inherent weakness of end-of-pipe solutions, or the assumption that new technologies can be relied upon to counter new environmental damage. This implies that positive action, based on the precautionary principle and the desirability of prevention rather than cure, is the guiding principle of practice which should be emphasized. By comparison, although the merits of this second interpretation are self-evident, they do not, in themselves, provide a basis for progressive change in most western societies. Rather, it is the first and third of Hajer's interpretations that represent the most fertile soil in which to cultivate a new mode of regional and urban planning.

The first interpretation, ecological modernization as institutional learning, is the most commonly adopted mode of reorientation. At the core of this interpretation is the need to break with the past, to move away from a reactive mode of response to environmental problems and towards a mode of operation that avoids the need for reaction through the adoption of anticipation. This implies, in Hajer's view, that environmental degradation should not simply be viewed as an external problem, but instead environmental concerns should be integrated within policy-making.

However, despite the substantial progress which has been made in the manufacturing sector in some countries towards the achievement of ecological modernization in accord with the conditions of the first interpretation, further progress inevitably means moving towards the conditions specified by Hajer in his third interpretation: ecological modernization as cultural politics. The third mode suggests that there are choices to be made as to what sort of nature and society is wanted. In defining and determining these choices the role of discourse is central. Through discourse, future scenarios can be constructed and, having demonstrated the implications of such scenarios, alternative goals and pathways can be identified.

Environment assessment practice

Another important policy-oriented development of attaining sustainable development is to implement policies via an environment assessment practice (or what might be called a 'sustainability assessment') (Hill and Bowen, 1997). This is increasingly incorporated as a factor in environmental planning during the developmental and design stages of projects. Efficient environmental management is crucial during the life of a project, for example during construction operations and the decommissioning phase of a construction project. Environmental planning brings together two distinct elements. 'Environmental' means all the physical (natural and manufactured) resources that support human activities. 'Planning' is intended to convey a political system that is able to create and coordinate policies over different time periods and spatial scales, that can identify targets and methods for implementing them, and that is capable of monitoring and evaluating outcomes. Environmental planning is a comprehensive approach to environmental management, which has three basic features: it takes account of future uncertainty by a precautionary approach; it reflects the integrated nature of environmental processes and policies; and it takes a strategic approach to decision-making (Hill and Bowen, 1997).

The attainment of sustainability in developing countries

The environment-related problems in developing countries are acute. Most of them have fragile environments (UNCHS, 1996), being faced with high levels of land degradation (erosion, aridity, desertification, drought, flooding, alkalinization and salinization), acute shortage of fresh water, loss of forests, and rapid urbanization with its associated problems of air pollution and pressure on existing infrastructure such as waste management systems. These countries lack the managerial experience, the financial resources, and the legal and administrative systems for promotional activities, formulating and enforcing regulations, and giving incentives to encourage appropriate behaviour.

Another important issue is the volume of physical resources which will be required to meet the backlog of infrastructural and building needs in developing countries. It is estimated that more than 600 million people in the world's urban areas are homeless or live in life- and health-threatening situations (UNCHS, 1996). As these countries develop and their populations are able to afford the physical facilities necessary to improve their living standards, this will strain the world's available key construction resources. This highlights the critical need for the sustainable management of construction resources in these countries.

Furthermore, the fact that more people rely on natural resources makes the sustainability in resource use even more critical in developing countries. For example, it is estimated that 40 million people in rural India rely on the forests for their livelihood (Gupta, 1993). This puts the issue of the use of timber in construction and its relationship with deforestation into perspective. Moreover, low labour and capital mobility makes it difficult for people to move from affected areas. The generally low incomes and undeveloped national social insurance and security systems leave individuals with only little reserve to risk unsustainability.

Under these circumstances, it is not surprising that perceptions of the main elements and principles of sustainability are different in various contexts. It is noted that the indigenous rural population in Qaxaca, Mexico, who struggle to regain control over their physical and social resources, do not consider their problem to be 'environmental' in the Western terms of soil erosion and deforestation alone. Instead, they view these ecological factors as symptoms of a wider crisis including falling production, lack of credit, a disadvantageous marketing system, repression, insecurity of land tenure and threatened cultural environments.

In terms of the principles of sustainability, Hill and Bowen (1997) suggest four attributes of sustainable construction: social, economic, biophysical and technical. However, there are other aspects of sustainability which are relevant in the context of developing countries. For example, managerial sustainability is important to ensure that construction products, especially large and complex ones undertaken by foreign companies, remain in effective and efficient use throughout their lives. Also important is community sustainability in contexts where major development projects are planned and constructed without consulting, or attending to the needs of, people in their locations or their environments, leading to loss of livelihood and disruption of social links owing to resettlement, among others (Ofori, 1998).

The implementation of policy framework towards achieving sustainability also has different understanding in developed and developing countries. For example, the education of the participants and the giving of incentives by governments are two factors suggested in developed countries with regard to the implementation of the environmental management framework (Hill and Bowen, 1997). However, the latter is unlikely to be adopted effectively in the developing countries, given their current financial constraints, although the role of the government would be paramount in attaining sustainability.

All the above factors, the worse environmentally related problems, the different aspects of the principles of sustainability and the difficulties of implementing sustainable policies in developing countries, promote the urgent need for the study of policies and practices towards attaining sustainability in developing countries. Detailed case studies of policy progress and good practice would be particularly useful. This paper provides a case study of the Chinese policy initiatives towards sustainability and its current sustainable construction activities.

Current sustainable construction practice in China

Environmental and resource degradation are not exclusively the consequence of high levels of economic development. A rapidly expanding economy can be shown to be equally environmentally damaging. For example, agricultural land inevitably gives way to urban sprawl with its associated transport and other infrastructural demands, whereas industrial and commercial expansion places increased demands on energy usage. This is not to argue, however, that there is a simple choice to be made between development and the environment, but rather it is the case that there needs to be a mechanism whereby measures are adopted to restore, sustain and protect natural systems and maintain environmental quality during the early stages of the development process (World Bank, 1992). With these comparisons between 'developed' and 'developing' in mind, what makes an analysis of China's environmental strategy so interesting is the fact that the geography of the country, coupled with differential rates of economic growth in different provinces and cities, means that the conditions which characterize both a limited development economy and a rapidly expanding economy can be observed simultaneously within one national context. It is against these contrasting rates of development that China introduced its Agenda 21 in 1994 as a contribution to the international debate on sustainable development (State Council, 1994).

The importance of China in the development of sustainability derives from, on the one hand, the extraordinary economic growth, personal consumption trend, population pressure, consumption of natural resources and agricultural production, and on the other hand, its severe and worsening environmental problems including land degradation, shortage of fresh water, deforestation, air and water pollution and pressure on existing infrastructure (State Council, 1994; World Bank, 1998).

The construction industry has played a leading role in China's rapid economic development (Chen, 1997). Frequently China is described as a huge construction site. Therefore the environmental impacts associated with construction activity are extensive (World Bank, 1998). The construction industry, as a consequence, has a major responsibility in securing sustainability. The creation of an environmentally sound built environment represents a significant challenge to the Chinese construction industry.

China's sustainable construction is at an early stage of development. Most construction projects continue to use traditional building materials and processes, which make energy efficiency much less than that of developed countries (Xu, 1996). Furthermore, the wasteful usage of resources and environmental degradation also are direct results.

The Chinese government has realized the environmental impact brought about by construction activities. Policies and regulations have emerged in recent years at both national and provincial levels, although implementation is still not achieved systematically. In *The 1997 National Report on Sustainable Development*, sustainable development has been taken as a major strategy of China's development, and sustainable construction has been added to the agendas of Chinese government administrations and research and design institutes (State Council, 1997). Government agencies are being established to accelerate the implementation of policies. Technical standards are being revised to meet the requirements of sustainable construction during the design and construction phases and special software packages are now available to simulate and evaluate the environmental impacts of projects. The major technical developments towards achieving sustainability at a practical level include: innovation in external wall design, research into passive solar-energy-heating buildings and improvement of traditional earth buildings which are the cave dwellings on the loess plateau and mud brick dwellings in the rural area of North China.

Innovation in external wall design

Solid clay brick has been used as the main external walling material in buildings for the past 2200 years. It is still the main building material in China. The need for innovation in solid brick walls was announced in 1992 (Xu, 1996). The major objective of the innovation is to use lightweight walling materials, such as concrete made with lightweight aggregates and the lightweight blocks in which the aggregate has a porous and cellular nature, to replace solid clay brick in order to cut down the use of cultivated land for brick production, to reduce the air pollution caused by brick production and to improve the energy efficiency of the building.

The Chinese government has made an effort to accelerate the progress of external wall design. In 1992, the State Council enacted a regulation on speeding up innovation in external walling material and the Ministry of Construction enacted a corresponding regulation on restricting the use of solid clay bricks in frame-structured projects on both national and local levels, establishing organizations to monitor the implementation of the regulations, developing new standards and codes for design and construction and applying financial incentives (Bo, 1997). For example, there has been strict prohibition in Beijing since July 1997 on building enclosing walls using solid clay bricks. More than 100 small brick kilns were forced to close down in Anhui Province in July 1997.

However, it is unrealistic to expect that rapid progress is being made throughout the country. The progress of implementation of the policies and regulations has been very slow. New lightweight walling materials accounted for only 13% of total walling materials used in China in 1996, that is 87% of construction projects still use solid clay brick (Bo, 1997). The main reasons include the following.

Deep-rooted traditional ideas. Despite the merits of new lightweight walling materials with good insulation and energy-saving features, most local contractors still have a prejudice in favour of solid clay brick because of its availability and familiarity.

Unreasonable price system. The use of solid clay brick has a dominant position in the building material industry because of its low production cost and low price. However, the production scale of new walling materials is very small, which causes the prices of new walling materials to be high, since there are as yet few economies of scale.

Lack of economic motives. In underdeveloped areas in China, solid clay brick is the main financial resource for local government. Frequently local government prefers to produce and use solid clay bricks rather than make an investment in the production of new walling materials.

Research into passive solar-energy-heating buildings

There has been a growing concern about the energy consumption of buildings and its implication for the environment. Improvement of living standards in China has resulted in a substantial increase in energy consumption. For example, it was an extravagant hope for common people to have a room air-conditioner 10 years ago, but today the use of air-conditioning has become popular and widespread in many urban areas (Zheng and Lu, 1997).

Passive solar-energy-heating buildings have been built widely in China since the 1980s. Strictly speaking, most of them are sun-tempered buildings which collect heat through south-facing window glass. High energy efficient houses are characterized by maximizing integration of energy saving options, including passive solar energy, heavy insulation, and integration of ventilation and heating combined with heat recovery. In order to improve design and technology, a research project on optimum design for passive solar-energy-heating buildings is included in the National Program of Science and Technology of the Eighth Five-year Plan (Ouyang, 1997; Zheng and Lu, 1997). The main aspects of this research project include the following.

Classifying the solar energy resource divisions in China. A meteorological model has been developed and a database, which consists of meteorological parameters of four divisions in China, has been established as a base of optimum design software.

Developing optimum design of software packages for passive solar-energy-heating buildings. The form and mass of a building, its internal layout and orientation decide how the building reacts to airflow, heat loads, daylight and sound. These measures are the essence of passive design which allow the building to harmonize naturally with its surroundings whilst providing acceptable conditions for work and living. Another important consideration of the application of this technique is the price, which often claims precedence over all other technical factors in China. Therefore, the optimum model is defined to minimize the annual consumption of normal heating and cooling energy and the application cost. Computer aided design software packages have been developed and tested which will be used for the four different divisions and different types of buildings.

Establishing demonstration buildings. Demonstration buildings have been designed and constructed in the four different divisions, for example, residential blocks which have an area of 2340 m^2 and are located in Maanshan City, Anhui Province (middle China) (Ouyang,1997), and classrooms which have a total area of 2600 m^2 and are located in Yingkou Province (north China) (Zheng and Lu, 1997). It has been observed that the mean daily room temperature in the south-facing rooms of the demonstration buildings was 27.3 °C in summer and 12 °C in winter, while the temperature in other buildings in the same area was 2.5 °C higher in summer and 3 °C lower in winter (Ouyang, 1997; Zheng and Lu, 1997). This has reduced the use of central heating and air-conditioning. It has shown also that the construction cost of demonstration buildings was only 11% higher than that of other traditional buildings,

which was much lower than the cost of increased-use of central heating and air-conditioning (Ouyang, 1997; Zheng and Lu, 1997). Therefore, it is feasible to apply this so-called passive solar-energy-heating building to other parts of China where it is possible from both environmental and economical considerations.

Improvement of earth buildings

There are various forms of earth buildings in China, such as cave dwellings and mud brick dwellings. Cave dwelling is the basic and major type of building in the rural Northwest loess plateau in China, which covers an area of 380 000 km^2, and has very dry weather. Cave dwelling has been a traditional way of rural Northwest Chinese solving their housing problem over the centuries. Most of the remaining cave dwellings in China are in their original form. Although the materials used in cave dwellings are sustainable and economical, the living conditions of the traditional cave dwellings are very basic and uncomfortable not only by Western standards but also by those of modern Chinese peasants (State Council, 1997).

There have been efforts to improve the standard of cave dwellings while retaining the essence of cave dwellings. Various more modern construction technologies have been combined and integrated with these primitive forms of building to improve quality, standards and comfort through the use of concrete materials to enhance the building strength, the use of mechanical ventilation, such as fans, to reduce the indoor humidity and the use of indoor finishing materials to improve lighting conditions.

The above picture shows that although the Chinese government has realized the environmental problems resulting from the construction activities and has introduced some sustainable policies and regulations, the progress of implementation so far is disappointing. This reflects the constraints that most developing countries have in attaining the sustainability and the difficulties the Government is facing in achieving consensus between interested parties. Due to the lack of detailed facts/statistics, it is not possible, at this stage, to quantify the extent to which sustainable construction practices are implemented in China. This also reflects the fact that, at present, the policies are only a formality to a certain degree; both the Government and the people have not really taken the environmental consideration into account. The gaps in effective policies, people's awareness, research and the availability of information are apparent

China's policy gaps and initiatives towards sustainable development

China's responses and policy gaps

In policy terms, environmental protection is still a relatively new item on China's political agenda, emerging as it did as an issue just after the end of the Cultural Revolution in the late 1970s. Although it is the case that heavy industry, manufacturing and infrastructural projects have necessitated environmental impact statements as part of their development from the early 1980s, such statements have been somewhat cosmetic. Environmental protection legislation stipulates that environmental assessments are to be carried out for large construction projects, but there is no similar requirement for smaller scale developments. The process is also not readily open to external scrutiny.

Despite environmental protection legislation being introduced in 1989, China has yet to implement fully a programme of environmental policies. Where attempts are being made, the momentum appears to be slowed by attempts on the part of central government to achieve consensus between interested parties. In addition, uneven distribution of natural resources and population further complicates attempts to formulate policies at the national level.

An integrated policy approach has had demonstrably beneficial effects. For example, technological improvement can make a major contribution to achieving sustainable development. Energy efficiency was improved during the 1980s as one element of Chinese economic reform whereby investments in improving the technological capabilities of State-owned enterprises bridged the technology gap, thereby enabling the Central Government to administer and implement environmental regulation (Polenske and Lin, 1993). However, in general, the technological capabilities in China, in terms of minimizing environmental damage, is much lower than those in developed countries (State Council, 1997). A significant amount of investment is needed to increase China's technology levels. The current financial constraints provide obvious barriers (Chen, 1997).

Despite the appearance of market mechanisms during the 1980s, political pressure from local government remains the main driving force in encouraging investment in environmental control, since raw materials remain artificially underpriced. However, market mechanisms have helped to control some aspects of environmental degradation, in particular pollution in the state-owned industries (State Council, 1997). To deal with problems associated with rural industry, however, will necessitate considerable government investment coupled with regulation and effective

policing. Given the relatively slow return on this in economic terms the government is reluctant to prioritize this as a policy initiative.

As mentioned earlier, the more people are aware of the environmental impact of development, the more easily environmental policies can be adopted and implemented. In China, the general public including many professionals are not aware of the severe environmental degradation and the concept of sustainable development. Educating people through both media campaigns and a strengthening education system are needed.

China's prospects and policy initiatives

It may be the case that the current stage of development of the Chinese economy provides an opportunity to incorporate environmental provisions into the national development strategy from a relatively early stage, rather than the 'retrofit strategies' which characterize, for example, the European Union. It is possible, despite its considerable environmental difficulties, for China to make a significant contribution to global sustainability, at the present, merely by taking on board appropriate strategies and technologies at an earlier stage in its development than has been possible elsewhere.

China has recognized clearly the importance of their sustainable development strategy for the rest of the world. At the Rio Summit, the Chinese Government stated that China has made environmental protection one of the basic state policies and made unremitting efforts towards achieving this end. In its Agenda 21, China has indicated a vision of a strategy of synchronized developmental and environmental planning; a strategy which would bring harmony of economic, social and environmental, returns (State Council, 1994). The legal system in respect of environmental protection is improving. Relevant organizations at various levels and an inter-ministerial coordination agency at the national level have been established (State Council, 1994).

However, there is inherent tension between economic development and environmental protection, which China is facing, and this also has been stated explicitly in China's Agenda 21. It states that 'for a developing country like China, the precondition for sustainable development is development. Only when the economic growth rate reaches and is sustained at a certain level, can poverty be eradicated, people's livelihoods improved and the necessary forces and conditions for supporting sustainable development be provided' (State Council, 1994). This emphasizes clearly the need to implement a development strategy which simultaneously facilitates China achieving a level of economic activity which creates and supports these necessary conditions but which incorporates effective environmental checks and balances.

In China's Agenda 21, the principal policy instruments proposed in achieving the above strategy are predicated on: scientific data collection and evaluation; and legislation and regulation; management and organization (State Council, 1994). These are being accompanied and reinforced by economic measures, such as fines and penalties, and the market mechanism.

It is apparent that the attainment of sustainable development, not only in China but also in all of the developing world, will need the active cooperation of the international community in terms of both the capital and expertise of developing and applying systems for economic and environmental strategies which developing countries are seeking to implement. On the other hand, without the efforts of developing countries towards achieving sustainability, global sustainable development cannot be attained either. Therefore, the establishment of a global partnership is important for the vision of sustainability to be realized or operationalized world-wide.

Conclusion

The sustainable development may be better described as a continuum of perspectives representing differing degrees of sustainability. However, it is the way in which the vision of sustainability can be attained that remains contentious and has attracted world-wide attention. Many countries, particularly developed countries, have tried to develop appropriate policy frameworks towards achieving sustainability. One notable development of policy framework is the ecological modernization approach, which represents a harmony between man and nature, society and environment; another is to implementing the policies via an environment assessment practice, which brings environment planning and management into an integrated discipline.

Developing countries deserve special attention in the effort to make sustainability an operative criterion in their development activities. Given the difficulties that developing countries are facing, which include the low level of economic development, lack of government initiatives and incentives, low technology and education levels and, most important, financial constraints, it is not surprising that their perceptions of the concept and principles of sustainability differ in their various contexts from that in developed countries. Consequently, making sustainability to be realized and operationalized in developing countries is much more

difficult than in developed countries, and clearly it needs the cooperation of the international community. On the other hand, without the efforts of developing countries towards achieving sustainability, global sustainable development cannot be attained either. Therefore, the establishment of a global partnership is important for the vision of sustainability to be realized and operationalized in the world.

China plays an important role in maintaining world sustainability. By reviewing China's Agenda 21, it can be concluded that the current stage of economic development in China provides an opportunity to incorporate environmental provisions into the national development strategies from a relatively early stage, rather than attempt to retrofit strategies. However, at present, China's Agenda 21 remains only a visionary concept, which lacks a comprehensive policy framework and realistic implementation measurements.

The environmental impacts of the construction industry are extensive, particularly in developing countries. As a case study, China's sustainable construction practice has been reviewed. The picture shows that, although the industry is aware of its environmental impacts, progress towards sustainability so far is disappointing. China's sustainable construction is still at its primary stage. Although efforts have been made in terms of innovation of solid brick, research on passive solar-energy-heating buildings, improvement of earth buildings and development of demonstration ecological villages, the progress is far from satisfactory. The built-in defects of the economic system, lack of an effective legal system, lack of public awareness and government bureaucracy contribute to the difficulty of putting the vision of sustainable construction into practice.

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