Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.
Cultural shift towards sustainability in the construction industry of Hong Kong

C.P. Yip Robin, C.S. Poon*
Department of Civil and Structural Engineering, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong

1. Introduction

The sustainable development concept established in the Brundtland Report (WCED, 1987) attempts to support continuous development of human societies for the present and future generations: the concept also emphasizes balance of growth in social, economic and environmental aspects, which are regarded as the key attributes that support the development of a sustainable society.

As defined in the World Conservation Strategy (1991), which was jointly developed in partnership by The World Conservation Union (IUCN), United Nations Environmental Programme (UNEP), and World Wide Fund for Nature (WWF), the nine principles of a sustainable society are:

1. Respect and care for the community of life.
2. Improve the quality of human life.
3. Conserve the Earth's vitality and diversity.
4. Minimize the depletion of non-renewable resources.
5. Keep within the Earth's carrying capacity.
6. Change attitudes and practices.
7. Enable communities to care for their own environments.
8. Provide a national framework for integrating development and conservation.
9. Create a global alliance.

Item 6 of the Principles calls for “Change of attitudes and practices”. Change of attitudes and practices meant a transformation of mind-set and actions. These criteria demand for changes in the established basic assumptions, values, beliefs and behaviour that are present in the established culture of a society. To genuinely achieve sustainable development in a society is to nourish a sustainable code of conduct favorable to sustainability requirements in terms of basic assumptions, values, beliefs and behaviour favorable to sustainability. This code of conduct is defined as the sustainable culture, which is the driving force towards a sustainable society.

Governments always play an important role to effect changes in sustainable culture. In 1999, the Chief Executive of the Government of Hong Kong Special Administrative Region (HKSAR) introduced the sustainable development concept to Hong Kong. His Policy
Address (1999) outlined a plan for implementing sustainable development. The concept has since been used as one of the guiding principles for governance, policymaking and future development of Hong Kong.

Subsequent to the 1999 Policy Address, The Government of HKSAR established the Sustainable Development Unit (SDU) in year 2001 to initiate studies and implementations of activities for sustainability. Activities related to the construction industry included but are not limited to:

- The CIRC studied problems existing within the construction industry of Hong and proposed improvement actions in year 2001 (CIRC Report, 2001).
- The Issue of Joint Practice Note (JPN) numbers 1 and 2 with incentive schemes in year 2001 and 2002 to uplift sustainable construction (JPN, 2001, 2002).
- Modifications in tender assessment criteria in Procurement of Public Works towards more sustainable issues in year 2002 (PCICB, 2002).
- The increasing use of recycle aggregate in structural concrete in government projects starting from year 2003.
- The implementation of landfill charges for disposal of construction waste in landfill in year 2005 (Cap. 354, 2005).

Stakeholders of the construction industry might have performed voluntarily and involuntarily in the implementation of sustainable rules and regulations, however, through the years of practice may have changed their mind-set subconsciously towards sustainability. Such change is considered as a change in sustainable culture which is considered as one of the fundamental drivers for sustainability (Rethinking Construction, 2002).

This study focuses on investigating the culture movement within the construction industry of Hong Kong since the implementation of the sustainable development policy in year 2000.

2. The background of the construction industry of Hong Kong

For many decades, the construction industry has been a key leading establishment in Hong Kong. Rowlinson and Walker (2003) indicated that “The construction industry has always played a major role in Hong Kong’s economy and if its contribution to gross domestic product is analyzed in detail it can be shown that its peak property and construction contributed almost 25% of Hong Kong’s GDP…… In 2000 the gross value of construction work undertaken in Hong Kong was over HK$120 billion (US$15 billion)”, the construction industry is therefore a major contributor to the Hong Kong economy. The number of persons employed in the construction industry accounted for 7.4% of the total work force in Hong Kong (C&S&D, 2008). However, the construction industry also generates a large amount of waste that pollutes the environment. According to a report by the Environmental Protection Department (EPD, 2007), construction waste amounted to 29,884 tonnes per day in 2006, 27% (4,125 tonnes per day) of the total construction waste were disposed of at landfill sites in Hong Kong. It is obvious that the construction industry fundamentally encompasses on issues related to economic, social and environmental attributes which are important to the sustainable development of Hong Kong.

3. Measuring sustainable culture of the construction industry

To implement the sustainable development policy, the Government of the HKSAR has promulgated a number of relevant rules and regulations. How do members of the construction industry respond to these rules and regulations? What improvements in sustainability have been achieved? How much have these rules and regulations changed the attitudes and practices of practitioners? The answers to these questions are directly related to the developments in sustainable culture among stakeholders via implementation of these rules and regulations. Sustainable culture is not static, but changes with time according to social demands for sustainability and global tendency in sustainable development. The extent of change in sustainable culture (Cultural Shift) is represented by the essence and magnitude of change in attitudes and behaviours within a designated time frame.

Sustainable construction, as conceptualized by Kibert (1994), is to minimize consumption of basic resources (energy, water, materials and land) throughout the life cycle performance of built facilities. It is also a goal of the construction industry of Hong Kong. The Construction Industry Review Committee (CIRC) itemized the requirements of sustainable construction in Hong Kong and a number of relevant initiatives have been implemented (CIRC Report, 2001). Tables 1–3 exhibit some examples which demonstrated the fact that Hong Kong has been taking an active role to realize sustainable construction in various areas. The outcomes as shown in these tables elucidated the responses from the construction participants to the rules and regulations set up for achieving sustainability. These achievements also reflected chronologically the movements of sustainable culture among them.

| Table 1 |
|---|
| **Activity** | **Nature of Activity** | **Year** | **Initiated Organization** | **Outcome** | **Reference** |
| Use of recycled aggregate | Pilot test of using recycled aggregate as road subbase and ready mixed concrete | 1997 | HK Polytechnic University (HKPU) | Reduced and reuse C&D waste, recycled aggregate is widely used in concrete in government projects | Poon (1997) |
| Review on Low-waste construction technologies | Research on various low-waste construction technologies | 1999 | HKPU | Making low-waste construction technologies to stakeholders | Poon et al. (1999) |
| Reuse building stock | Research on reuse of building stock | 2000 | The Hong Kong Institution of Engineers (HKIE) | Some building stock reused | Koenig and Kwan (2001) |
| Guidebook for minimizing C&D waste | Published two guidebooks for minimizing C&D waste | 2001 and 2002 | HKPU | Enhanced adoption of low-waste technologies in the construction industry | Poon et al. (2001) and Poon and Jaillon (2002) |
| Study modular construction | Research on application of modular construction | 2002 | HKIE | Enlarge the extent of research on modular construction | Tam (2002) |
| Reduce construction waste on site | Review on reducing building waste in construction site | 2004 | HKPU | Promotion of reduction of construction waste | Jaillon et al. (2004) |
| Promote adoption of prefabrication | Research on reform construction method | 2005 | Construction Industry Institute (CII) | Promote application of prefabricated building components | Yeung et al. (2005) |
3.1. Attributes of sustainable culture

Sustainable culture is the driving force for sustainability among stakeholders in the construction industry. It constitutes attitudinal and behavioural components and is categorized into awareness, concern, motivation and implementation (Blank, 1996; Poon and Yip, 2005).

**Awareness** is defined as the sense of detection about the needs to change an unsatisfied condition or an unease state of mind (Blank, 1996). It is an inner vision in a state of mind to provoke change to rectify the unsatisfied condition. When construction industry stakeholders are aware of the negative impacts, e.g. create unnecessary wastage (environmental), neglect construction safety (social), and disregard product quality (economic) that their current practices and performances may have caused impairs to human society, their eagerness to improve grows stronger.

**Concern** is defined as bringing the anxious feelings of the unsatisfied condition or the unease state of mind into conscious attitudes integrated with judgments (Fazio, 1990). Concern arises as a result of awareness on scenarios which arouse desires for improvement (Eagly and Chaiken, 1993). Concern of sustainability is an emotion of care developed on the judgments according to negative impacts and consequences. The attitude of concern would be constructed from cognitions, affective responses and behaviour.

**Motivation** implies a stimulus impelling to act, to move and to improve. It is the desire to take action to work for the defined objectives in alleviating the undesirable consequences of the unsustainable acts. Motivation must have direction (Blank, 1996). The eagerness to change is the intention that tries to modify the status quo of the construction industry. The promotion of sustainability in the CIRC Report (2001) is a good example that showed motivation with a defined direction for improvement. The Report suggested a holistic approach that would help to motivate changes to the long existing malpractices of the construction industry of Hong Kong.

**Implementation** is the result of behavioural intent (Ajzen, 1991). Unlike the attitudinal attributes of awareness and concern, implementation is dynamic rather than static in the construction industry. It is the willingness of construction industry participants to spend time, energy, effort and money to initiate changes in order to achieve sustainable construction.

Change in the attributes and behaviour signifies an increase in the cognition of sustainable construction and a willingness to practice the same within the work environment. The former is represented by the change of cognitive attitudes in Awareness and Concern, whereas the latter is exhibited through behavioral actions in Motivation and Implementation. Measuring individually the movement of these attitudinal and behavioral components over a period of time will provide a picture on the change in essence and

### Table 3

Examples of achievements in project development and construction.

| Project | Year of Completion | Sustainability Driving Organization(s) | Outcome | Reference |
|---------|--------------------|----------------------------------------|---------|-----------|
| The Orchards | 2003 | Developer and Contractor | Pioneer of Designer sustainability in private residential project | Fong et al. (2004) |
| The Charter | 2004 | Developer and Contractor | Partnering | Uebergang et al. (2004) |
| EMSD Headquarter | 2004 | Architectural Service Department HKSAR | Re-develop old building for new use | Mak (2005) |
| Wetland Park | 2005 | Architectural Service Department HKSAR and Contractor | A sustainable design and construction project that aroused public awareness of ecosystem | Li et al. (2005) |
| One Peking | 2004 | Architectural Service Department HKSAR and Contractor | Green design project using photovoltaic (PV) panel to operate electrical blinds | Tam (2004) |
| Kadoorie Biological Sciences Building | 2000 | The University of Hong Kong (HKU) | Green design project with energy saving up to 44,070,000 KWH and CO2 reduction 26,880 tonnes in 50 years life span | http://www.hku.hk/mech/sbe/case_study/case/hku-kadoorieindex.html |
| Hong Kong Community College (HKCC) | 2007 | Developer and Designer | A pilot building project extensively use pre-cast concrete units in structural elements | Not Available |
magnitude within the measured time frame. A synthesis of the changes in these four components will show the combined effect of a culture shift, which is regarded as the result of the enforcement of rules and regulations for sustainable development.

3.2. Why measurement of culture shift

In order to enhance sustainable construction, numerous researches have been conducted to explore new materials, equipment and construction management systems. Others conducted studies in measuring achievements of environmental building. Ding (2008) introduced the concept of developing a sustainability model for project appraisal based on a multi-dimensional approach. However, very few researches have been conducted to explore the movement of sustainable culture and its trend that influences the output of construction participants. It would be very interesting and indeed necessary to assess how the enforcement of rules and regulations designed for sustainability in Hong Kong has changed the culture of construction industry practitioners. Most importantly, the measurement provides reliable references for decision-makers both in government and private sectors to understand the effectiveness of the current rules and regulations, so that areas of deficiency and mismatch can be identified, improvement considerations and follow up actions can be carried out accordingly.

4. Measuring cultural shift – the T-model

To evaluate the extent of cultural shift within the construction industry is equivalent to measuring the trend of movement of cultural components in awareness, concern, motivation and implementation that have occurred among stakeholders. However, these cultural components are abstract concepts which may be difficult to quantify and are subject to change under different conditions in different time frames. In this paper, a method, the T-model, is explicitly designed to capture such changes. An illustration of the T-model is elucidated in Section 4.2. Poon and Yip (2005) have validated the T-model via a pilot test in Hong Kong to measure cultural shift.

4.1. The stakeholders of the construction industry of Hong Kong and their influential power that affects sustainability

Stakeholders of the construction industry of Hong Kong perform professional and supervisory works are responsible for various duties at different levels. These can be categorized into five groups according to their functional roles and professional disciplines:

(i) government;
(ii) developers;
(iii) architects, structural engineers, electrical and mechanical engineers, surveyors (collectively the consultants);
(iv) main contractors, subcontractors, suppliers (the contractors);
(v) site agents, site supervisors, foremen (the non-professionally recognized participants, or the NPP).

Stakeholders from different disciplines perform different roles and discharge different functions and duties. Certain stakeholder groups create more sustainable output; while others yield less sustainable results.

The power that influences the extent of sustainable output is referred to as the “influential factor” of sustainability. Each stakeholder group exerts different influential power according to their distinctive roles and functions. The higher the influential factor, the greater the magnitude in achieving sustainable construction. The government group initiates sustainable rules and regulations which govern the works of other stakeholder groups. The developers, who invest on development projects and employ consultants and contractors to design and construct according to development schemes, influence the outputs and performances of the consultants and contractors as well as the NPPs. The hierarchical order of influence is generally established, however, the magnitude of influence of each stakeholder group that affects the sustainable effect of the built assets, however, is to be explored in this study by means of questionnaire surveys and the T-model.

4.2. Measurement of cultural shift by using T-model

Cultural shift is the combined result of the movement of individual cultural components comprising awareness, concern, motivation and implementation with respect to a selected research time frame, i.e. between the base year and the research years. A questionnaire is exclusively designed to survey the attitudinal and behavioral changes of respondents in the areas of awareness, concern, motivation and implementation. Appropriate scores were assigned to each question (a sample questionnaire with score allocation is attached in Appendix 1 for reference). Data collected from the questionnaire surveys were input in the T-model to work out the movement of cultural components. To capture the movement of the cultural component “awareness” within the government group, the scores obtained from questionnaire surveys related to the awareness of the government group are sorted out according to the marking scheme setup in the questionnaire. The sorted scores of awareness are then multiplied by the influential factor ($a_i$) of the government group, the product is the cultural value of awareness of the government group. This cultural value of awareness of the government group can be added up with the cultural value of awareness of other groups being worked in the same way to form the total score of awareness of construction participants. Similar approaches are applied to other cultural components to obtain the total concern, total motivation and total implementation of construction participants. Formulae 1 and 2 of the T-model which are demonstrated below express how the data are handled.

The T-model is a tool which consists of two formulae and a space diagram. Formula 1 calculates the score ($S_i$) of each cultural component for every stakeholder group (i), and Formula 2 sums up the total score ($T$) of each cultural component of all stakeholders. A space diagram (Fig. 1) then integrates all the total scores of every cultural component into a cultural shift curve. The following illustrates the mechanism of the T-model:

Awareness ($x$), concern ($y$), motivation ($z$) and implementation ($w$) are abstract elements that comprise the culture of the construction industry and these elements in turn show the attitudinal direction and behavioral action of ideological mind-set and practice.

The score of a particular cultural component towards sustainability of any stakeholder group “i” is represented by $S_i$. To evaluate the cultural shift of each stakeholder group, the influential factor ($a_i$) of each group must be taken into account. Therefore, the score of cultural component of a specific stakeholder group in any year is

$$S_i = a_i x y z w$$  \hspace{1cm} (1)$$

Where $S$ = Score of Cultural Component towards Sustainability; $i$ = Stakeholder Group; $a_i$ = Influential Factor; $x_i$ = Awareness; $y_i$ = Concern; $z_i$ = Motivation; $w_i$ = Implementation

Summation of the scores of the five stakeholder groups would indicate the total cultural score $T$, which represents the value of stakeholders of the construction industry in professional and
supervisory levels performing various construction duties within their respective disciplines.

\[ T = \sum_{i=1}^{5} S_i \]

Where \( T \) = Total Cultural Score

\[ T = \sum_{i=1}^{5} S_i = \sum_{i=1}^{5} a_i |x, y, z, w_i| \]

(2)

Since a series of survey can be carried out periodically in different research years, data of cultural components \( \{x, y, z, w\} \) obtained from different research years can be converted into scores and input into formulae 1 and 2 to work out the value of each respective cultural score \( T \). The values of the \( T \)-model are used to plot the space diagram (Fig. 1). All points representing the cultural components comprising awareness, concern, motivation and implementation are rightly placed in the space diagram and linked up by straight lines to form a quadrangle on the same plane with the cultural component at the apex. The area of each quadrangle can be calculated numerically and represents the synthesized value of sustainable culture of the research year. Comparing the area of the quadrangle bounded by cultural components in every research year plane with the area of quadrangle of the base year plane, the difference in area is the numerical value of cultural shift of the research year with respect to the base year. Consecutive investigations that take place at suitable intervals would uniformly provide a series of cultural values reflecting the tendency of the cultural shift. Since cultural shift is a continuous process, measurements should be conducted regularly.

4.3. Questionnaire survey

The design of the questionnaire was based on recent research studies on changes in attitudes and behaviours for sustainability within the construction industry. Theories of human behaviour and behavioural changes developed by Allport (1935) and Ajzen (1991) were used as the basis. Ideas on construction culture were also drawn from the CIB study (Abeysekera, 2002). The studies of Poon (1997), Epstein and Roy (2001), Formoso et al. (2002), Poon et al. (2003), Jaillon et al. (2004), and Wong and Yip (2004) on topics relating to planning and design for sustainability, sustainable construction, waste minimization, recycling of construction & demolition materials were duly referenced. Other than collecting demographic information of the respondents, the questionnaire is separated into five parts. Each part tries to tackle individually the changes in attitudes and behaviours of the respondents.

Part 1 of the questionnaire aims at collecting information on the level of “awareness” of sustainability. The questions target at identifying the level of understanding and the sources of sustainable information. These included key sustainable indicators established by the government and how these indicators affect the sustainability of Hong Kong. One of the questions seeks the views of the respondents on the influential power of each stakeholder group and how this power may affect the sustainability of the construction industry in Hong Kong.

Part 2 of the questionnaire addresses the respondent’s “concern” about sustainability. The New Environmental Paradigm (NEP) developed by Dunlap and Van Liere (1978) in their 12-NEP scales that measure “paradigmatic” shift was adopted. NEP deals with human concern about environmental protection, limited industrial growth, and population control.

Part 3 of the questionnaire was designed on the ground that concern of sustainability is built up among the construction participants and the extent of acquiescence and mentality of acceptance of sustainability is sufficiently mature. Autonomous “motivation” for sustainability will start to take place when they perform their duties in their respective disciplines. Their willingness in considering the use of sustainable materials and applying sustainable construction methods with higher initial construction costs can be viewed as evidence to reflect their “readiness to change” in attitudes and behaviours.

Part 4 of the questionnaire investigates the magnitude of “implementation” of sustainability. What were the physical works that the respondents have implemented might have helped to realize sustainable construction? How much additional cost would they be prepared to spend in order to achieve the aimed purpose? These are the indispensable indicators of implementation of sustainability and formed the focus of this part of the questionnaire.

To measure the cultural shift achieved in the researched years with respect to the base year, part 5 of the questionnaire provided a selection scale for the respondents to review retrospectively their changes in attitudes and behaviours. The respondents are requested to revisit their performances over the years in discharging their duties within the research period.

Surveys were conducted separately in 2004 and 2006 by using the same questionnaire with the numbering of the year slightly changed as required. Year 2000 was selected as the base year for the study because this would have matched with the sustainable development policy stipulated in the year 1999 Policy Address for sustainable development. Samples in these two separate surveys were randomly selected from construction participants in Hong Kong at both professional and supervisory levels. The questionnaires were sent by emails, post and personal contacts to government departments responsible for construction project development, as well as private sector organizations such as developers, consultant firms, general and specialist contractors. A total of 446 and 317 valid responses were received in the 2004 and 2006 surveys respectively. The Statistical Package for the Social Sciences (SPSS) was used to analyze the data obtained from questionnaire surveys conducted in the two research years of 2004 and 2006.
5. Data analysis

5.1. Respondents' profile

The respondents of the questionnaire surveys conducted in year 2004 and 2006 were random samples. Demographic information of these random respondents displayed in Table 4 showed that the majority of the respondents were affiliated to professional bodies of Hong Kong including the Hong Kong Institution of Architects (HKIA), the Hong Kong Institution of Engineers (HKIE), the Hong Kong Institution of Surveyors (HKIS) and the Hong Kong Institute of Construction Managers (HKICM). Most of them had over 15 years of practical working experience in the construction industry in Hong Kong, and some of them had over 20 years of experience. This showed that the respondents were very experienced in the local construction industry and their views and opinions were therefore representative.

5.2. Reliability test: Cronbach's alpha

A reliability test using Cronbach’s alpha was first applied to test the internal consistency and reliability of the survey instrument (Norusis, 2002). The standardised Cronbach's alpha is defined as:

\[ \alpha = \frac{N \cdot \bar{p}}{\bar{p} + \left( N - 1 \right) \bar{v}} \]  

Here \( N \) is equal to the number of items, \( \bar{p} \) is the average inter-item covariance among the items and \( \bar{v} \) equals the average variance (Cronbach, 1951).

Cronbach's alpha coefficients range in value from 0 to 1 and were used to describe the reliability of factors extracted from dichotomous and/or multi-point formatted questionnaires or scales (Santos, 1999), the method is compatible in testing the multifarious nature of the cultural components comprising awareness, concern, motivation and implementation. The closer Cronbach's alpha coefficient is to 1, the greater the internal consistency of the items in the scale and therefore the more reliable the adopted scale is. F-test devised by Hsu and Feldt (1969) is used to test the significance of this reliability analysis.

5.3. The influential factors (\( a_i \))

As expressed earlier, different stakeholder groups bear different influences in the course of construction and hence the final built asset. It is interesting to note that although the 2004 and 2006 surveys were conducted at different timeframes with different sample respondents, the outcome of \( a_i \) revealed little variance. The small variation in influential factor shown in Table 6 demonstrates that the respondents from each stakeholder group shared equal perception about their influential power. The values of \( a_i \) for various stakeholder group obtained from both surveys are suitable for use as multipliers for the respective cultural scores.

5.4. The cultural value

Based on the cultural values obtained from both surveys, the extent of cultural shift for each group has been identified and was shown in Tables 7 and 8 respectively. All stakeholder groups indicated certain shifts in sustainable culture within the study period. Positive shifts were found in most of the stakeholders groups, these shifts are evidences of improvements in sustainable culture among stakeholders. The presence of a few negative shifts that included the developer group in implementation, the consultant group in concern, and the NPP group in awareness and concern. These negative shifts represent deteriorations within these groups, proper corrective actions that may transform attitudes and behaviours of the respective stakeholder groups could yield significant and persistent improvements to sustainability in the construction industry. The cultural values of the government group and the contractor group positively increased in all the cultural components, the former is the policy making party which promotes sustainability and the latter is the execution party which is obliged to perform according to statutory requirements and regulations.
5.5. Synthesis of cultural by space diagram

The scores of each cultural component tabulated in Table 7 summarized the survey result of 2004. They were integrated in the space diagram in a two-years interval. Fig. 2 synthesized all the cultural components in years 2002 and 2004 with respect to the base year 2000.

Furthermore, the scores of cultural components of the 2006 survey are handled in the same way as shown in Table 8. The scores of each cultural component were placed in space diagram Fig. 3 showing the shift between the years 2004 and 2006.

The areas of the quadrangles developed in Figs. 2 and 3 are displayed in the space diagrams with areas formed by the four cultural components the corresponding years. To derive the cultural shift of the studies, square root the area of each quadrangle will provide a linear representation of the research results. Figs. 4 and 5 revealed the cultural shift of the construction industry of Hong Kong from 2000 to 2004 and 2004–2006 respectively.

5.6. Combining of the results of the surveys of 2004 and 2006

The results shown in Figs. 4 and 5 represented the outcome of two different surveys in different time frames with different random sample respondents. It is important to note that the studies generated two sets of results for year 2004. The result of cultural shift value derived from the year 2004 survey is 22.92, while the result of cultural shift value of the year 2006 survey is 22.51. The differences are sufficiently close to each other with variance less than 1.8%. It would be safe to judge that the study outcomes obtained from both survey activities are reliable.

According to the research methodology, the former 2004 cultural shift value was the actual surveyed result of the 2004 survey, while the latter 2004 cultural shift value was the calculated result of the 2006 survey. The actual surveyed result of year 2004 is considered more appropriate to reflect the research finding. Therefore the integrated cultural shift value of 22.92 is adopted to combine the outcomes of both surveys in year 2004 and 2006. The cultural shift curve shown in Fig. 6 is a combination of the curves of Figs. 4 and 5 with the connection point at 22.92. The curve shown in Fig. 6 represents the trend of cultural shift of the construction industry of Hong Kong between the years 2000 and 2006 under the influence of sustainable development as introduced by Government.

Table 5
Results of Cronbach’s Alpha tests.

|                  | 2004   | 2006   |
|------------------|--------|--------|
|                  | No. of Cases | No. of Items | Alpha | F   | Sig. | No. of Cases | No. of Items | Alpha | F   | Sig. |
| Part I – Awareness | 446    | 7      | 0.3433 | 363.55 | 0.000 | 317    | 7      | 0.3528 | 410.38 | 0.000 |
| Part II – Concern  | 431    | 12     | 0.4933 | 96.89  | 0.000 | 317    | 12     | 0.5289 | 70.97  | 0.000 |
| Part III – Motivation | 437    | 7      | 0.8147 | 117.71 | 0.000 | 317    | 7      | 0.7678 | 13.74  | 0.000 |
| Part IV – Implementation | 434    | 7      | 0.7897 | 191.39 | 0.000 | 317    | 7      | 0.8499 | 41.88  | 0.000 |
| Part V – Shift     | 391    | 36     | 0.9166 | 87.74  | 0.000 | 317    | 36     | 0.9531 | 56.90  | 0.000 |

Table 6
Influential f(ai) of each stakeholder group.

| Stakeholder Groups | Year 2004 Survey | Year 2006 Survey |
|--------------------|------------------|------------------|
| Government         | 37.3%            | 39.5%            |
| Developer          | 28.4%            | 28.0%            |
| Consultant         | 13.1%            | 12.7%            |
| Contractor         | 12.5%            | 12.5%            |
| Individual Non-Professional Participants (NPP) | 8.7% | 7.4% |
| SUM                | 100%             | 100%             |

Table 7
Cultural shift of cultural component of each stakeholder group between 2000 and 2004.

| Groups             | Cultural Components | Shift | Cultural Score | ai | Cultural Value = (ai) x (Cultural Score) |
|--------------------|---------------------|-------|----------------|----|----------------------------------------|
|                    |                     | 2000  | 2002 | 2004 | 2000 | 2002 | 2004 | 2000 | 2002 | 2004 | 2000 | 2002 | 2004 |
| Government         | Awareness (x)       | 7.30  | 9.08 | 10.86| 14.29| 14.85| 17.76| 37.3%| 5.33 | 5.54 | 6.63 |
|                    | Concern (y)         | 7.76  | 8.92 | 9.93 | 5.61 | 5.79 | 6.45 | 37.3%| 2.09 | 2.16 | 2.40 |
|                    | Motivation (z)      | 7.43  | 8.42 | 9.56 | 18.17| 18.15| 20.60| 37.3%| 6.78 | 6.77 | 7.68 |
|                    | Implementation (w)  | 7.15  | 7.69 | 8.93 | 18.69| 17.30| 20.10| 37.3%| 6.97 | 6.45 | 7.50 |
| Developer          | Awareness (x)       | 8.50  | 9.25 | 10.75| 17.23| 16.13| 18.75| 28.4%| 4.89 | 4.58 | 5.33 |
|                    | Concern (y)         | 8.63  | 9.00 | 9.75 | 7.91 | 7.62 | 8.25 | 28.4%| 2.25 | 2.16 | 2.34 |
|                    | Motivation (z)      | 8.38  | 7.88 | 9.38 | 22.73| 17.96| 21.38| 28.4%| 6.46 | 5.10 | 6.07 |
|                    | Implementation (w)  | 6.75  | 7.88 | 8.75 | 17.36| 18.23| 20.25| 28.4%| 4.93 | 5.18 | 5.75 |
| Consultant         | Awareness (x)       | 7.60  | 9.00 | 10.10| 14.02| 14.79| 16.60| 13.1%| 1.84 | 1.94 | 2.17 |
|                    | Concern (y)         | 7.10  | 8.10 | 8.60 | 9.20 | 9.89 | 10.50| 13.1%| 1.21 | 1.30 | 1.38 |
|                    | Motivation (z)      | 5.70  | 8.00 | 8.80 | 13.32| 17.00| 18.70| 13.1%| 1.75 | 2.23 | 2.45 |
|                    | Implementation (w)  | 5.70  | 7.00 | 7.40 | 13.44| 15.61| 16.50| 13.1%| 1.76 | 2.04 | 2.16 |
| Contractor         | Awareness (x)       | 7.28  | 8.75 | 10.31| 14.08| 14.35| 16.92| 12.5%| 1.76 | 1.79 | 2.11 |
|                    | Concern (y)         | 7.79  | 8.75 | 9.46 | 7.10 | 7.37 | 7.97 | 12.5%| 0.89 | 0.92 | 1.00 |
|                    | Motivation (z)      | 7.59  | 8.38 | 9.27 | 18.32| 18.29| 20.23| 12.5%| 2.29 | 2.29 | 2.53 |
|                    | Implementation (w)  | 6.51  | 7.73 | 9.06 | 15.35| 15.57| 18.24| 12.5%| 1.92 | 1.95 | 2.28 |
| NPP                | Awareness (x)       | 6.33  | 9.00 | 11.00| 12.78| 14.86| 18.17| 8.7% | 1.11 | 1.29 | 1.58 |
|                    | Concern (y)         | 8.83  | 9.50 | 9.83 | 10.69| 11.11| 11.50| 8.7% | 0.93 | 0.97 | 1.00 |
|                    | Motivation (z)      | 6.17  | 7.83 | 9.33 | 14.96| 15.95| 19.00| 8.7% | 1.30 | 1.39 | 1.65 |
|                    | Implementation (w)  | 6.83  | 9.17 | 10.00| 14.41| 17.72| 19.33| 8.7% | 1.25 | 1.54 | 1.68 |

Note: The total score of each cultural component has no direct reference to one another.
### Table 8
Cultural shift of cultural component of each stakeholder group between 2004 and 2006.

| Groups       | Cultural Elements | Shift 2004 | Shift 2005 | Shift 2006 | Cultural Score 2004 | Cultural Score 2005 | Cultural Score 2006 | Cultural Score Shift 2004-2006 | Cultural Score Shift 2005-2006 | Cultural Value = (αi) × Cultural Score Shift 2004-2006 |
|--------------|------------------|------------|------------|------------|---------------------|---------------------|---------------------|--------------------------------|--------------------------------|--------------------------------|
| Government   | Awareness (x)    | 11.01      | 11.83      | 12.76      | 17.13               | 18.40               | 19.85               | 39.5%                          | 6.76                            | 7.27                            | 7.84                           |
|              | Concern (y)      | 9.64       | 10.47      | 10.64      | 8.79                | 9.55                | 9.70                | 39.5%                          | 3.47                            | 3.77                            | 3.83                           |
|              | Motivation (z)   | 10.16      | 10.83      | 11.36      | 21.82               | 23.27               | 24.39               | 39.5%                          | 8.62                            | 9.19                            | 9.63                           |
|              | Implementation (w) | 9.80      | 10.29      | 10.54      | 21.24               | 22.31               | 22.84               | 39.5%                          | 8.39                            | 8.81                            | 9.02                           |
| Developer    | Awareness (x)    | 10.13      | 11.74      | 12.39      | 17.82               | 20.64               | 21.77               | 28.0%                          | 4.99                            | 5.78                            | 6.10                           |
|              | Concern (y)      | 9.77       | 10.52      | 11.19      | 8.33                | 8.98                | 9.55                | 39.5%                          | 2.33                            | 2.51                            | 2.67                           |
|              | Motivation (z)   | 8.71       | 9.47       | 9.95       | 20.40               | 22.18               | 23.31               | 39.5%                          | 5.71                            | 6.21                            | 6.53                           |
|              | Implementation (w) | 7.97      | 9.01       | 10.16      | 14.96               | 16.90               | 19.05               | 39.5%                          | 4.19                            | 4.73                            | 5.33                           |
| Consultant   | Awareness (x)    | 8.64       | 10.56      | 12.90      | 13.82               | 16.89               | 20.63               | 39.5%                          | 1.76                            | 2.15                            | 2.62                           |
|              | Concern (y)      | 9.90       | 10.32      | 10.68      | 8.25                | 8.60                | 8.90                | 39.5%                          | 1.05                            | 1.09                            | 1.13                           |
|              | Motivation (z)   | 9.36       | 11.10      | 11.52      | 20.60               | 24.43               | 25.36               | 39.5%                          | 2.62                            | 3.11                            | 3.23                           |
|              | Implementation (w) | 9.36      | 10.68      | 11.52      | 17.63               | 20.11               | 21.69               | 39.5%                          | 2.24                            | 2.56                            | 2.76                           |
| Contractor   | Awareness (x)    | 9.02       | 10.27      | 11.72      | 14.23               | 16.20               | 18.49               | 39.5%                          | 1.77                            | 2.02                            | 2.30                           |
|              | Concern (y)      | 9.04       | 10.10      | 10.79      | 9.57                | 10.69               | 11.43               | 39.5%                          | 1.19                            | 1.33                            | 1.42                           |
|              | Motivation (z)   | 8.80       | 9.80       | 10.97      | 18.36               | 20.45               | 22.90               | 39.5%                          | 2.29                            | 2.55                            | 2.85                           |
|              | Implementation (w) | 8.45      | 9.64       | 10.62      | 16.18               | 18.46               | 20.34               | 39.5%                          | 2.01                            | 2.30                            | 2.53                           |
| NPP          | Awareness (x)    | 9.64       | 10.80      | 12.42      | 13.98               | 15.66               | 18.01               | 39.5%                          | 1.04                            | 1.17                            | 1.34                           |
|              | Concern (y)      | 10.26      | 11.34      | 12.03      | 9.97                | 11.02               | 11.69               | 39.5%                          | 0.74                            | 0.82                            | 0.87                           |
|              | Motivation (z)   | 10.03      | 11.26      | 12.11      | 25.77               | 28.94               | 31.12               | 39.5%                          | 1.92                            | 2.16                            | 2.32                           |
|              | Implementation (w) | 9.72      | 11.65      | 11.96      | 19.13               | 22.92               | 23.53               | 39.5%                          | 1.42                            | 1.71                            | 1.75                           |

Note: The total score of each cultural component has no direct reference to one another.

---

**Fig. 2.** Integrating Cultural Components in the Space Diagram of the T-model for Year 2004 Survey.
Fig. 3. Integrating Cultural Components in the Space Diagram of the T-model for Year 2006 Survey.

| Cultural Component | 2004 | 2005 | 2006 |
|--------------------|------|------|------|
| Awareness          | 15.32| 18.38| 20.20|
| Concern            | 8.79 | 9.53 | 9.93 |
| Motivation         | 21.15| 23.20| 24.55|
| Implementation     | 18.26| 20.10| 21.40|
| Area               | 506.69| 616.04| 700.87|

Fig. 4. Cultural Shift between 2000 and 2004.
5.7. Paired-samples t-test: identifying cultural shift on sustainability

Paired-samples $t$-tests were used to compare and determine whether the magnitude of cultural shift of various cultural components (Awareness, Concern, Motivation and Implementation) between the two selected year points is significant. A comparison by pairs of two-year points covering the entire research period would show the significance of cultural shift within the research period between years 2000 and 2006. If the test result
was significant at 0.05 level, then the null hypothesis of no significant mean difference between the two designated research years can be rejected, in order words, the shift of the cultural component in the two year points is significant.

The summary of test results shown in Table 9 reveals that the shift of cultural components in all stakeholder groups is evident in the research period between years 2000 and 2006. There are a few occasions in the analysis that had exceeded the 5% significance level and therefore the null hypothesis cannot be rejected. Among all stakeholder groups, the developer group was the least aggressive stakeholder in cultural change. Insignificant shift was found in "awareness", "motivation" and "implementation" between year points of 2000, 2002 and 2004. Similar results are obtained from the Government group in "concern" and "implementation" between years 2000 and 2002, reflecting the fact that the Government and the Developer groups in Hong Kong were not aggressive in the early years of the promotion of sustainable development in construction. In contrast, the Consultant, the Contractor and the NPP groups exhibited significant cultural shift throughout the research period. These three groups are the executors of project design and construction, their non-performance in sustainability are governed by rules and regulations with penalty system. Their readiness to comply with the sustainable requirements and adopting changes in practicing sustainable construction is understandable. As a result, these three groups pioneered cultural shift towards sustainability in practice.

Table 9
Summary of paired-sample t-tests result.

|                | Government | Developer | Consultant | Contractor | NPP |
|----------------|------------|-----------|------------|------------|-----|
|                | Mean Difference | t | Sig. | Mean Difference | t | Sig. | Mean Difference | t | Sig. | Mean Difference | t | Sig. | Mean Difference | t | Sig. |
| Awareness      |            |         |            |            |     |      |            |         |      |            |         |      |            |         |      |
| 2000 vs. 2002  | -16.21 0.000 | 0.14 | -0.49 0.629 | 0.15 | -4.16 0.000 | 0.32 | -13.10 0.000 | 0.32 | -8.57 0.000 |
| 2002 vs. 2004  | 18.82 0.000 | 0.60 | -1.72 0.099 | 0.17 | -2.32 0.030 | 0.33 | -15.13 0.000 | 0.36 | -4.59 0.000 |
| 2004 vs. 2006  | -6.47 0.000 | 0.79 | -7.54 0.000 | 0.79 | -7.98 0.000 | 0.42 | -12.58 0.000 | 0.25 | -4.26 0.001 |
| Concern        |            |         |            |            |     |      |            |         |      |            |         |      |            |         |      |
| 2000 vs. 2002  | -0.39 0.000 | 0.10 | -2.12 0.045 | 0.02 | -0.89 0.383 | 0.09 | -8.30 0.000 | 0.06 | -1.82 0.086 |
| 2002 vs. 2004  | -10.00 0.000 | 0.20 | -4.33 0.000 | 0.10 | -3.44 0.000 | 0.09 | 8.52 0.000 | 0.05 | -2.02 0.010 |
| 2004 vs. 2006  | -5.30 0.000 | 0.21 | -2.41 0.020 | 0.06 | -4.58 0.000 | 0.19 | -9.46 0.000 | 0.15 | -3.16 0.008 |
| Motivation     |            |         |            |            |     |      |            |         |      |            |         |      |            |         |      |
| 2000 vs. 2002  | -12.24 0.000 | 0.44 | 1.31 0.203 | 0.36 | -3.56 0.000 | 0.22 | -6.17 0.000 | 0.28 | -4.85 0.000 |
| 2002 vs. 2004  | -12.66 0.000 | 1.21 | -2.91 0.008 | 0.30 | -4.95 0.000 | 0.27 | -8.96 0.000 | 0.24 | -3.74 0.002 |
| 2004 vs. 2006  | -5.28 0.000 | 0.62 | -4.78 0.000 | 0.64 | -5.79 0.000 | 0.48 | -11.03 0.000 | 0.33 | -4.18 0.001 |
| Implementation |            |         |            |            |     |      |            |         |      |            |         |      |            |         |      |
| 2000 vs. 2002  | -1.73 0.085 | 0.76 | -2.53 0.016 | 0.17 | -2.57 0.017 | 0.30 | -12.03 0.000 | 0.42 | -5.86 0.000 |
| 2002 vs. 2004  | -14.07 0.000 | 0.57 | -1.77 0.093 | 0.08 | -2.09 0.048 | 0.35 | -12.72 0.000 | 0.13 | -5.45 0.000 |
| 2004 vs. 2006  | -3.48 0.001 | 1.13 | -4.98 0.000 | 0.53 | -6.07 0.000 | 0.44 | -11.86 0.000 | 0.26 | -4.80 0.000 |
| Total          |            |         |            |            |     |      |            |         |      |            |         |      |            |         |      |
| 2000 vs. 2002  | -8.31 0.000 | 0.49 | -0.73 0.475 | 0.62 | -3.81 0.000 | 1.00 | -15.92 0.000 | 1.10 | -8.02 0.000 |
| 2002 vs. 2004  | -20.53 0.000 | 2.27 | -2.49 0.020 | 0.91 | -2.92 0.007 | 1.02 | -16.00 0.000 | 0.70 | -5.60 0.000 |
| 2004 vs. 2006  | -6.50 0.000 | 2.82 | -6.95 0.000 | 1.95 | -7.74 0.000 | 1.59 | -15.63 0.000 | 1.05 | 6.24 0.000 |

* t-statistic significant at 0.05 level.
** t-statistic significant at 0.01 level.
N (2006 survey) = 161; K (2004 survey) = 66.

The influence of various stakeholder groups is a crucial factor that may change the sustainable outcome of the built assets. The magnitude of influential factor (\(a_i\)) of each group spelled out the differences in influential power of each stakeholder group that controlled the sustainable outcomes of the construction projects. Stakeholders of the construction industry should be able to make better use of their influential power to enhance the sustainability outcome of construction projects.

This study focused only on construction participants performing supervisory and managerial tasks at various levels. Construction workers who form a crucial part of construction participants were not included in the surveys. The result obtained is therefore limited to reflect the attitudes and behaviours of the supervisory and managerial level participants.
7. Conclusion

It is clear that the findings of the study illustrated a positive movement of cultural shift towards sustainability of the construction industry in Hong Kong from years 2000 to 2006. The growth of sustainable culture varied according to environmental and economical conditions. A sluggish cultural shift was experienced in the economic recession period and a significant increase was recorded shortly after the SARS outbreak in 2003 which uplifted the consensus of the public on improvement of hygienic condition and environmental protection. The economy of Hong Kong started to pick up in 2004 and a steady growth in cultural shift is reflected in the investigation between the years 2004 and 2006. Continuous investigation is recommended to examine whether the trend of cultural shift towards sustainability runs in parallel with economic conditions.

To conclude, this study has identified:

- the trend of cultural shift towards sustainability in the construction industry of Hong Kong
- the changes in sustainable culture are affected by sustainability policy, economic conditions and environmental factors
- the influential power of each stakeholder group and its implication on the sustainability outcomes of construction projects
- the extent of cultural shift of each stakeholder group, and some stakeholder groups do not follow the general trend of cultural shift

All in all, the study has successfully demonstrated that the T-model is an effective means to measure cultural shift of the construction industry. The result of the measurement provided important information in finer details including the shift of cultural components within each stakeholder group. The result of the study in two separate surveys provided important information for decision-makers of the construction industry in government and private sectors to review their policy.

Theoretically, the T-model can be applied to any other industries. When a particular industry wishes to measure the cultural shift within a certain time frame, the stakeholders of that particular industry can be grouped according to their functional discipline and a questionnaire can be designed to suit the investigation.

Acknowledgements

The authors wish to extend their gratitude to the professionals and academia who gave valuable comments and advice to the design of the questionnaire. We thank the respondents for completing and returning the questionnaire for this study. The financial support provided by The Hong Kong Polytechnic University for the research activities of this article is also acknowledged.

References

Abeysekera, V., 2002. Understanding ‘Culture’ in an International Construction Context. CIB Report, Perspectives on Culture in Construction 275, 39–51.
Allport, G., 1935. Attitudes: a Handbook of Social Psychology. Guilford, New York, pp. 117–138.
Ajzen, I., 1991. The theory of planned behavior, organizational behavior and human decision processes. Organizational Behavior and Human Decision Processes 50 (2), 179–211.
Blank, L., 1996. Changing Behaviour in Individuals, Couples, and Groups. Charles C Thomas Publisher, Springfield, Illinois, USA, ISBN 0-398-06657-4, pp. 9–10.
Cap. 354, 2005. Ordinance & Regulations (2005), Waste Disposal Ordinance (Cap. 354), Waste disposal (charge for disposal of construction waste regulation, HKSSAR.
C&P, 2008. Quarterly Report on General Household Survey, April to June 2008. Census and Statistics Department, Hong Kong Govt. Printer.
CRC Report, 2001. Construct for Excellence. HKSSAR, Report of the Construction Industry Review Committee.
Ding, G., 2008. Sustainable Construction – the Role of Environmental Assessment Tools. Journal of Environmental Management 86 (3).
Cronbach, L.J., 1951. Coefficient alpha and the internal structure of tests. Psycho-metrika 16, 207–334.
Dunlap, R.E., Van Liere, K.D., 1978. The “new environmental paradigm”: a proposed measuring instrument and preliminary result. Journal of Environment Educa-tion 9, 10–19.
Eagle, A.H., Chaiken, S., 1993. The Psychology of Attitudes. Harcourt, Brace, Java-novich, Fort Worth, TX.
ERM, 2001. Final Report of Sustainable Development in Hong Kong for the 21st Century. Environmental Resources Management, HKSSAR.
EPD, 2007. Monitoring of Solid Waste in Hong Kong – Waste Statistics for 2006. Environmental Protection Department, HKSSAR.
Epstein, M.J., Roy, M., 2001. Sustainability in action: identifying and measuring the key performance drivers. Long Range Planning 34 (5), 583–604.
Fazio, R.H., 1990. Multiple processes by which attitudes guide behaviour: the MODE model as an integrative framework. Advances in Experimental Social Psychology 23, 75–109.
Fong, S., Lam, W.H., Chan, A.S.K., 2004. Building Distinction Green Design and Construction in the Orchards. Symposium on Green Building Labelling, Hong Kong, pp. 69–77.
Fornosso, C.T., Sohelman, L., De Cesare, C., Isatto, E.L., 2002. Material waste in building industry: main causes and prevention. Journal of Construction Engi-neering and Management, 316–325. July/August.
HKCA, 2001. Best Practice Guide for Environmental Protection on Construction Sites – Partnership, Hong Kong Construction Association, Hong Kong.
Hui, T.C., Feldt, R.S., 1969. The effect of limitations on the number of criterion score values on the significance level of the F-test. American Educational Research Journal 6 (4), 515–527.
Jailon, L., Poon, C.S., Yu, A.T.W., 2004. Reducing building waste at construction sites in Hong Kong. Construction Management and Economics 22 (5), 461–470.
JPN, 2001. Joint Practice No. 1, Green and Innovative Buildings. Building Department of the HKSAR, Hong Kong.
JPN, 2002. Joint Practice No. 2, Second Package of Incentives to Promote Green and Innovative Buildings. Building Department of the HKSSAR, Hong Kong.
Kibert, C.J., 1994. Establishing principles and a model for sustainable construction. In: Proceedings of the First International Conference of CIB TC16, 6-9 November, Tempe, Ph, Arizona.
Koenig, A., Kwan, A., 2001. Building waste in Hong Kong: generation and potential reuse, structural symposium 2001 environmentally friendly structures, HKIE Structural Division and I Struct E Hong Kong Division, Hong Kong.
Li, M.K.Y., Chan E.P.W., Suen, A.M.T., 2005. Sustainable Building Hong Kong Wetland Park, 2005 Environmental Paper Award, HKIE Environmental Division, Hong Kong.
Mak, M.S.C., 2005. Rebirth of a building – the new headquarters for the Electrical & Mechanical Services Department, HKSSAR. In: Proceedings of Joint Hong Kong and Guangzhou Seminar, Sustainable Building, Guangzhou.
Norusis, M.J., 2002. SPSS 11.0 Guide to Data Analysis. Prentice Hall, New Jersey.
PCCIB, 2002. Provisional construction industry co-ordination board follow-up paper on procurement of public works, provisional construction industry co-ordination board, paper No. Paper No. PCCIB/022, Provisional CICB Secretariat, April 2002, Hong Kong.
Poon, C.S., 1997. Management and recycling of demolition waste in Hong Kong. Waste Management and Research 15, 561–572.
Poon, C.S., Xu, Y.Q., Ng, L.H., 1999. The Application of low-waste construction technologies in Hong Kong and Mainland China. In: Proceedings of the Asian Industrial Technology Congress, Hong Kong.
Poon, C.S., Yu, T.W., Ng, L.H., 2001. A Guide for Managing and Minimizing Building and Demolition Waste. The Hong Kong Polytechnic University, Hong Kong, ISBN 962-367-311-6.
Poon, C.S., Jailon, L., 2002. A Guide for Minimizing Construction and Demolition Waste at the Design Stage. The Hong Kong Polytechnic University, Hong Kong, ISBN 962-367-334-5.
Poon, C.S., Yu, A.T.W., Ng, L.H., 2003. Comparison of low-waste building technolo-gies adopted in public and private housing projects in Hong Kong, Engineering, Construction and Architectural Management 10 (2), 88–98.
C.P. Yip Robin, C.S. Poon / Journal of Environmental Management 90 (2009) 3616–3628
Uebergang, K., Galbraith, V., Tam, A., March 2004. Sustainable construction innovations in action. Civic Exchange, 42.

WCED, 1987. The World Commission on Environment and Development, Our Common Future. Oxford University Press, Oxford and New York.

World Conservation Strategy, 1991. Caring for the Earth – a Strategy for Sustainable Living. IUCN, UNEP, and WWF, Gland, Switzerland.

Wong, E.O.W., Yip, R.C.P., 2004. Promoting sustainable construction waste management in Hong Kong. Construction Management and Economics 22, 563–566.

Yeung, N.S.Y., Chan, A.P.C., Chan, D.W.M., 2005. Application of prefabrication in construction – a new research agenda for reform by CI-HK. In: Conference of Pre-cast Concrete Building Systems, Hong Kong.

Zhang, Z.H., Shen, L.Y., Love, P., Treloar, G., 2000. A framework for implementing ISO 14000. Construction Environmental Management and Health 11 (2), 139–149.

Websites

Census (2005), website of the Government of HKSAR. http://www.info.gov.hk/censtatd/eng/press/labour2/lb2_latest_index.html (Date of browse: 20 July 2006).

ETWB, 2005. website of the Government of HKSAR. http://www.etwb.gov.hk/press_releases_and_publications/publications/perf_ind/chart_1/index.aspx?langno=1&nodeID=1401 (Date of browse, 20 July 2006).

Kadoorie Biological and Science Building, University of Hong Kong. http://www.hku.hk/mech/sbe/case_study/case/hk/hku-bsb/bsb-index.html (Date of Browse 24 March 2007).

Integer (2000) http://integer.com.hk (Date of browse 24 March 2007).