Constructing Sustainable Vertical Cities: Strategies to Enhance Closer Cooperation between ASEAN Contractors on Pollution Problem under the Lens of Economic Game Theories, Cost Benefit Analysis and Dynamic Markov Chain Theories

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Abstract

Global environmental problems have become one of the major concerns all over the World. Environmental issues have long been regarded as the cross border issues and externalities problem. Pollution in one country, such as nitrogen oxides produced from construction sites in China not only worsens the air of China but also the neighboring countries and cities. It is therefore, high time to consider ways to enhance a closer cooperation between ASEAN contractors. This paper examines the issues from Cost benefit analysis, game theory and dynamic Markov chain.

Keywords: Sustainable Development, Pollution, Contractors, Markov Chain Theories, Game Theories, Cost Benefit Analysis

1. A glance at the present environmental problems

Global environmental problems, e.g. the greenhouse effect, accumulate over time, making its effects a stock rather than a flow. The present environmental problems have led to an increase in dissatisfaction among city dwellers in Hong Kong (Table 1 and Table 2). From 1986 to 1989, there are only 9 out of 12 districts in Metro Area (classified by Town Planning Board) of Hong Kong with a record of more than 100 environmental complaints. Yet, there were more than half of the chosen districts with a record of more than 1000 environmental complaints in 2006. In 2006, Yau Tsim Mong alone received 1725 environmental complaints. Although Wong Tai Sin district has noted the lowest record, there were 514 complaints in 2006 which were tenfold more than that in 1986.

As a kind of public good, local environment problems can also become global issue. The effect of pollution spreads across nationwide borders (Akihiko, 2005). Moreover, environmental problems are often externalities, meaning that the solely market exchange itself cannot ensure the costs borne by individual responsible for it (Greenwood, 2007). Nobel Laureate Ronald Coase's paper "the Problem of Social Costs" had already shed light on the this issue as early as 1960 (Coase, 1960).

Taking these characteristics into account, it is indispensable to devise a series of environmental policies that manage global pollution so that the high quality of the global environment can be enjoyed over time (Akihiko, 2005). Many places include Hong Kong has monitored level of pollutants (Figure 1), implemented environmental friendly policies, such as green urban planning conditions (Li, 2009a, Lai et al., 2009, Lai et al., 2007, Li, 2009b, Li, 2008a), and/or mandatorily require developers to provide water and energy saving fittings (Li and Chau, 2010). Many developers provide green fittings to their customers, e.g. the Waterfront in Sydney provide Carbon and water metres (Payce Lifestyle Development, 2009).

While individual countries can issue their own policy agenda to combat environmental deterioration caused by human activities, cross country pollution is difficult to control. For example, the recent Copenhagen conference on climate change has once again shown the difficulty in seeking cooperation among countries. The concept "not in my backyard" remains deep in the heart of political leaders and fail to cooperate with their neighbours in developing sustainable policies. Similarly, ASEAN contractors seldom cooperate. Is there some ways to

overcome this problem? This paper sheds light on Game Theories, Cost Benefit Analysis and Dynamic Markov Chain Theories.

Insert Table 1 Here

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Insert Table 2 Here

2. Sustainable Development in our vertical cities

Solar radiation variations and dust produced by volcano in our nature were major factor of temperature change in the past. From 1950 to 2000, there is around 0.5 degree Celsius growth in global mean temperature. Yet, natural factors are not the major causes of such change. Human-induced factors, however, become the leading factor of climate change. Global greenhouse gas, such as carbon oxides, nitrogen oxides produced by human activities has risen by 70 % from 1970 to 2004, trapping heat from sunlight. Over the past century, there is a significant increase in rainfall in eastern parts of North and South America, northern and central Asia and northern Europe but a drop in parts of southern Asia and southern Africa from 1900 to 2005. In Hong Kong, there was an increase of 0.12°C per ten years from 1885 to 2006 on average and the pace of temperature rise in Hong Kong is even faster within 1989-2006 than 1947-2006 (Li, 2009d).

Insert Figure 2 Here

While we have the rights to enjoy our natural environment, we are also responsible to protect the environment where we live. A harmony of human life with nature is a difficult yet achievable target under the lens of economists and green environmentalists. Such basic fundamental thoughts build an important foundation in determining human's fate and future (Kizilaslan et al., 2007).

Sustainable development first received attention in 1972 at the UN Conference on the Human Environment. Although the term had not been referred explicitly, the international community concurred that environment and development could be managed in a mutually beneficial way, i.e. win-win situation can occur. Discussion on sustainable development continue later on in the United Nations Conference on Environment and Development (also known as "the Earth Summit") in Rio de Janeiro 1992. Partly because of global warming, the melting of ice in north and south pole, disappearance of some low rise area has drawn attention of people from all over the world, more and more research on sustainable development has been done in these few years. A variety of interpretations on the term "sustainable development" also appear. The most popularly accepted definition of sustainable development, appeared in United Nation's Brundtland Commission in 1987 (Li and Ah Pak, 2009, Li, 2009b, Li, 2008a) It stresses that development of present generation should not deprive that of the future generations (Brundtland, 1987). Discussions among participants from various sectors such as environmentalists (e.g. Barry Commoner and Lester R. Brown), divergent economic theorists (e.g. E.F. Schumaker of Britain), politicians (e.g. Willy Brandt), population analysts (e.g. Paul Ehrlich) and some of the environmental concerning groups from all parts of the world identified a number of "common challenges" facing the earth, for instance, food security, industrial development, ecosystems, population, species and human resources energy and urbanization (Li and Ah Pak, 2009).

Insert Table 3 Here

3. Why cooperation among ASEAN contractors is needed?

"For cooperation to prove stable, the future must have a sufficiently large shadow . . . the importance of the next encounter between the same two individuals must be great enough to make [noncooperation] an unprofitable strategy."(Axelrod, 1984)

We all stress the importance of cooperation nowadays. Cooperation not only exist in individual level, it also exists in country level. Generally speaking, cooperation makes participants better off if

(1) they pool their resources to increase efficiencies or

(2) they combine their complementary strengths so that they can increase the scope of activities, and/or

(3) cooperation satisfies values or beliefs or reinforces the mission (Schaeffer and Loveridge, 2002).

Although the intention to cooperate never guarantee success, however, the probability of success depends on a number of factors (Schaeffer and Loveridge, 2002).

While almost all the economic models presume people do not care about "social" goals per se, i.e. they are *exclusively* pursuing their self-interest only (Fehr and Schmidt, 1999), Xepapadeas found that non-cooperative manners lead to accumulation of pollution. Dockner and Long have revealed that, depending on the strategies

that countries use, an efficient level of pollution stock can be obtained. Zagonari has extended the Dockner-Long model, in which symmetric countries are assumed, to a pollution control game between ‘‘environmental-concerned’’ countries and ‘‘consumption-oriented’’ countries (Akihiko, 2005).

There is no doubt that contractors are profit maximizers. Maximizing gains from their business is their major target. They also need to carry social responsibilities, e.g. use jump formwork in building high-rise dwellings to reduce the use of traditional wood formwork, use standardized precast units built in factory instead of building everything on construction sites which can effectively lower wastage. While each construction companies can develop their own ways to construct buildings in sustainable ways, cooperation among contractors can pool resources together and complement deficiencies of each company.

4. Types of cooperation

Cooperation occurs when actors alter their behavior to the actual or anticipated preferences of others, through a process of policy synchronization (Milner, 1992). Cooperation can be achieved in a number of ways. It can be ***tacit*** which occur without communication. The metaphor of iterated prisoners' dilemma captures this type of situation**.** Cooperation can also be ***negotiated*** in an explicit bargaining process. Finally, cooperation can be ***imposed*** (Milner, 1992). While cooperation within the same line of production can be affected by transaction costs (Li, 2009c), cooperation between countries on environmental issues can be affected by cost and benefit and previous experiences.

5. Strategies and policies to enhance closer cooperation

5.1 Realization of absolute and relative gain by Cost and Benefit Analysis

Obedience to law cannot be taken for granted (Li and Poon, 2009b), even though environmental treaties can be signed. Cooperation cannot be guaranteed. No matter what type of cooperation it is, a central proposition in previous literature is that states cooperate in order to realize the absolute gains and act rationally to increase the net benefits (B) (Value obtained from cooperation [U] – Cost of cooperation [C]).

U(M,P,…I)

C(L,K)

Assume both F(U) and F(C) as continuous defined on a closed interval [0,T] and equally spaced subintervals by time period $t_0 \ (=0)$, t_1,…, t_n (=T). Then the time period of each time period $\Delta x = \frac{b-a}{n}$. Net benefit of cooperation is:

$$\approx \lim_{\Delta t \to 0} \sum_{i=0}^{T} f(U_i)\Delta t - \lim_{\Delta t \to 0} \sum_{i=0}^{T} f(C_i)\,\Delta t \qquad (1)$$

The above tries to illustrate the cost and benefit (CBA) for a country if they cooperate pollution reduction. Such country can gain because of savings from medical expenses (M), increases in production due to better health of citizen (P) and increase in investment (I) etc. Yet in return, they have to spend more money on labour (L) to carry out relevant policy, capital (K) in investing new technology for pollution reduction, etc.

Absolute gain is only the prerequisite for country to cooperate in environmental issues. Countries involved should enjoy similar benefit from such cooperation. Given both countries spend the same amount of resources, in case the relative gain of one country is substantially greater than the other, there will be no cooperation.

5.2 Ways to enhance new innovative information flow among construction companies in different cities

There are many methods to build a residential building. Likewise, there are tons of different ways to lower the pollution generates on sites and make the whole construction process more sustainable. Nevertheless, in positive information and transaction costs real world (Li, 2008b), information is not that easy to be obtained. Knowledge sharing barriers exist and strategies which motivate people to share their information becomes vital (Li and Poon, 2009a).

Given the absolute gain is positive, country may cooperate on environmental issue (C) or they decide not to cooperate (N) to enjoy free ride. If they both cooperate they will get the mutual benefit (M). The country which cooperate unilaterally will receive benefit (U) while the free ride country will get the benefit (F) (Snidal, 1991).

Insert Figure 3 Here

Insert Figure 4 Here

Table above illustrates that in case the relationship between countries is “harmony” or “stag hunt” then mutual cooperative is highly likely the result even it is only “tacit” form of cooperation. Nevertheless, if the case is “Hawk-Dove” or “prisoner’s dilemma”, free ride will become the dominant strategy.

Chicken (C) and prisoner’s dilemma (PD) continue to exist only if information flow does not exist (I) or high costs to receive information (F).

$$P(X: X \in I \cap X \in B) \rightarrow C \cup PD$$

Decision making on environmental issues is a long term process and based on past memories:

$$F(X_t \mid X_{(t-1)} \cap X_{(t-2)}, \ldots, \cap X_t)$$

Given information costs is low enough (to let the country have the relevant information) and the “game” can be repeated. Non-cooperation contractors will be punished, and cooperation to be rewarded in a short period of time. Information costs can be lowered by many means, mass media and internet are typical examples.

5.3 Forward planning and allows flexibility in implementation

Markov chains enjoy a wide popularity as a tool in simulation, e.g. Gibbs sampling and its extension to Markov chain Monte Carlo methods of simulation, utilizing the fact that distributions can be constructed in an invariant or limiting ways. While Markov chain theory stresses the important of previous experience on present actions, decision making is open system and dynamic process: knowledge of the time since the last input will give information to decision makers on the present or even future time (Meyn and Tweedie, 1993). It can be represented by Markov chains as the followings:

$$\mathbf{P} = \begin{bmatrix} P11 & P12 \cdots & P1N \\ \vdots & \vdots & \vdots \\ PM1 & PM2 \ldots & PMN \end{bmatrix} \qquad \mathbf{Q} = \begin{bmatrix} Q11 & Q12 \cdots & Q1N \\ \vdots & \vdots & \vdots \\ QM1 & QM2 \ldots & QMN \end{bmatrix}$$

Where Pxy denotes the xth strategy under condition y’s net value (x=1,2,3…,M; y=1,2,3,…,N). Strategy and decision making of country P and Q will change both due to the exogenous factor (e.g. relative gain of the other country) and endogenous factor (political parties’ power within country). Therefore planning for any environmental policies need to be forward looking, able to foresee possible changes.

6. Conclusions

Construction industry has always been viewed as a major regulator in our economies. Yet, construction market enhances economic development in expense of pollution generated. Even worse, pollutants in one city can spread to the neighbor cities. The above Cost Benefit Analysis, Game theories and Markov Chain theory provide insight on how to enhance the sharing of sustainable construction methods among contractors.

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Table 1. Environmental complaints in 11 districts in Hong Kong from 1996 to 2006 (Lai et al., 2009)

Districts	Tsuen Wan	Kwai Tsing	Central & Western	Wan Chai	Eastern	Southern	Kowloon City	Kwun Tong	Sham Shui Po	Wong Tai Sin	Yau Tsim Mong
1986	127	154	128	101	139	31	137	121	111	48	121
1987	215	349	209	145	247	74	238	253	136	77	241
1988	230	322	212	142	236	91	218	219	154	74	211
1989	212	467	245	276	319	121	317	310	389	89	421
1990	395	1020	416	635	527	127	574	410	550	281	845
1991	298	459	459	346	334	117	493	329	227	206	559
1992	227	258	362	285	355	133	401	308	311	120	450
1993	314	843	385	332	331	179	478	315	314	208	620
1994	285	741	540	1260	449	214	380	374	274	244	508
1995	354	1169	903	587	561	269	520	405	327	512	744
1996	475	1409	1321	655	655	290	620	621	503	213	1183
1997	508	1344	1121	520	784	298	555	531	486	231	814
1998	776	1281	1468	595	1142	395	740	1780	722	484	870
1999	930	1211	1732	833	1074	490	792	1630	1096	508	1162
2000	699	932	1120	897	974	441	1046	1579	1044	362	1180
2001	908	1086	1341	737	988	466	1047	918	1211	811	1372
2002	1041	1513	1617	837	1056	517	1089	873	728	1023	1652
2003	1337	1467	1321	841	1054	380	1261	755	804	852	1593
2004	1001	1433	1151	923	1016	386	1061	844	1036	496	1635
2005	771	1358	984	1559	1061	395	1175	802	957	415	1 619
2006	879	1627	1195	1643	1370	549	1267	909	1399	514	1725

Table 2. Environmental Complaints per person in Hong Kong Metro Area (Lai et al., 2009)

District	Environ-mental complaints in 1996	Population at 1996 census	Environ-mental Complaints per thousand people in 1996	Environ-mental complaints in 2001	Population at 2001 census	Environ-mental Complaints per thousand people in 2001	Environ-mental complaints in 2006	Population at 2006 census	Environ-mental Complaints per thousand people in 2006
Tsuen Wan	475	270801	1.75	908	275527	3.3	879	288728	3.04
Kwai Tsing	1409	470726	2.99	1086	477092	2.28	1627	523300	3.11
Central & Western	1321	259224	5.1	1341	261884	5.12	1195	250064	4.78
Wan Chai	655	171656	3.82	737	167146	4.41	1643	155196	10.59
Eastern	655	594087	1.1	988	616199	1.6	1370	587690	2.33
Southern	290	287670	1.01	466	290240	1.61	549	275162	2
Kowloon City	620	378205	1.64	1047	381352	2.75	1267	362501	3.5
Kwun Tong	621	587071	1.06	918	562427	1.63	909	587423	1.55
Sham Shui Po	503	365927	1.37	1211	353550	3.43	1399	365540	3.83
Wong Tai Sin	213	396220	0.54	811	444630	1.82	514	423521	1.21
Yau Tsim Mong	1183	260573	4.54	1372	282020	4.86	1725	280548	6.15
Metro Area Total	7945	4042160	1.965533	10885	4112067	2.647087	13077	4099673	3.189767

Table 3. Sustainable development policies in 6 cities (Li and Ah Pak, 2009)

City	Sustainable development policies
Beijing, Chengdu and Guangzhou	There are mandatory requirements on the maximum length on the space in between buildings to of closely packed building top mitigate “heat island effect”.
New York	New public buildings have to plant at least one trees on the site for approximate 1000 square metres.
Shanghai	Buildings with the length of building façade of 80 metres or more and of height equal to or less than 24 m have to be separated by a minimum of 6 m.
Singapore	Floor area of sky terrace is exempted from GFA calculation
Tokyo	Residential builders have to provide at least one-fifth of its rooftop green if the building sits on a site which is larger than 0.1ha.

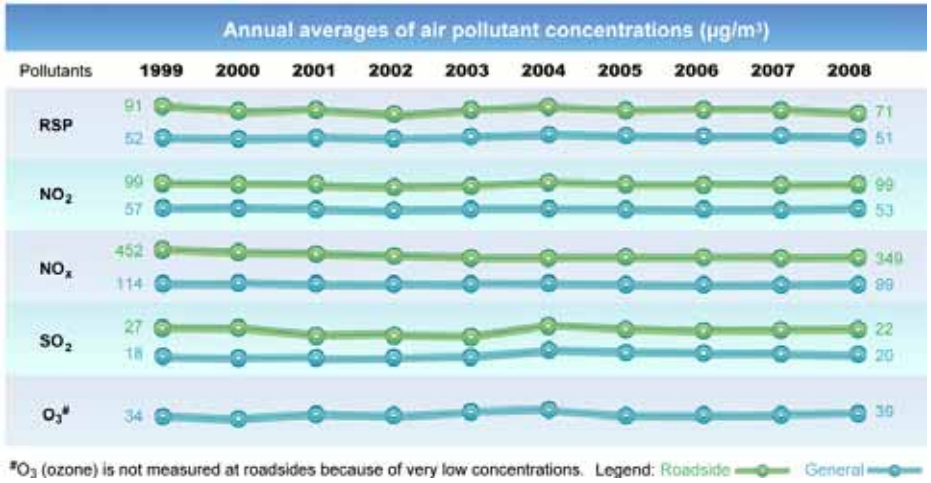

Figure 1. Air Quality Trends in Hong Kong (Hong Kong Envrionmental Protection Department, 2009)

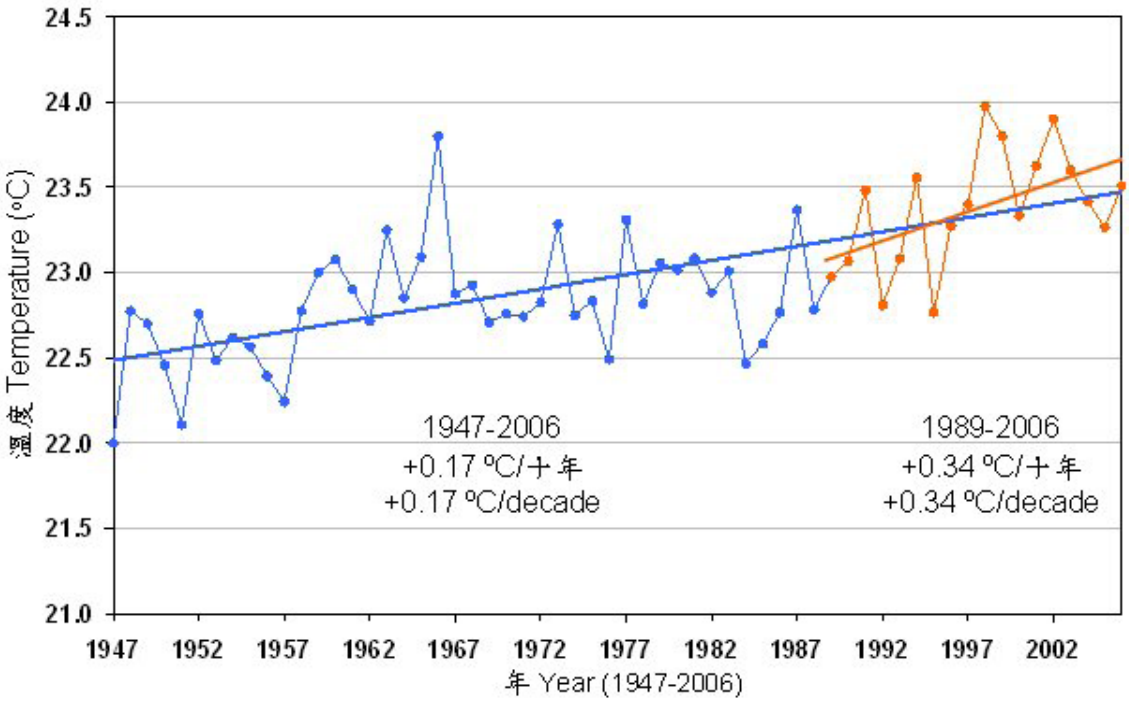

Figure 2. Trend in temperature from 1947 to 2006 and 1989 to 2006(Hong Kong Observatory, 2008)

	N	***C***
N	0,0	F,U
C	U,F	M,M

Figure 3. Results of construction companies in countries which may cooperate on environmental issues.

Name of game	Preference	Game		
			D	C
Harmony	M>F>U>0	D	1,1	3,2
		C	2,3	4,4
			D	C
Stag Hunt	M>F>0>U	D	2,2	3,1
		C	1,3	4,4
			D	C
Hawk-Dove	F>U>M>0	D	1,1	7,2
		C	2,7	6,6
			D	C
Prisoner's Dilemma	F>M>U>0	D	2,2	4,1
		C	1,4	3,3

Figure 4. The relationship between countries is “harmony” or “stag hunt” (Snidal, 1991)