A CONCEPTUAL SCHEME FOR SUSTAINABLE DEVELOPMENT OF CONSTUCITON LABOR MARKET IN CHINA

An Tingyu and Watanabe Tsunemi
Kochi University of Technology

ABSTRACT: Expansion of construction industry has been a leading contributor to the rapid development of Chinese economy these years; however, the foundations of construction labor market are being deteriorated fast. This could be seen from both the worsening of construction enterprises' business environment and the severe construction labor conditions in recent years. This research attempts to explore some promising approaches for current Chinese construction to get out of this dilemma from a sustainable development view.

Current scheme that strictly prohibits 'illegal' labor contractors and pushes corporatization among them in order to regulate construction labor market in China has been proved to be a failure. It could be judged by the extremely difficult implementation on most construction sites by general contractors (GCs) and subcontractors (SCs), particularly the latter. One of the root causes is found to lie in the current existing subcontracting systems, which neglect the potential development of subcontractors and fail to provide them with incentives for good performance as expected. Hence, new strategies and practical scheme ought to take the better ongoing development of subcontractors into consideration.

A new conceptual scheme for GC and SCs involving construction subcontracting business is proposed in this paper, mainly including the enlargement of subcontracting business scope and the introduction of cooperation into the existing competition mechanism. Then tentative analyses are conducted to validate that the new scheme could provide economic incentives for involved parties (particularly subcontractors) in today's business environment with many uncertainties (e.g. workflow unreliability) threatening their better ongoing development. It then concludes that the new scheme could help contributing a mutually beneficial subcontracting business environment for both GC's and SCs' development for current Chinese construction industry. Furthermore, it could lead to the fundamental culture change of the existing adversarial relationship into trust and win-win relationship.

KEY WORDS: subcontracting, incentive, uncertainty

1. INTRODUCTION

The Chinese construction industry has so far enjoyed a good opportunity for development, which has already been a leading contributor to the Chinese national economy. During the period from 2006 to 2010, the building construction industry in China has recorded a consistent strong year-by-year growth. It is expected to continue to grow during the period from 2011 to 2015, particularly in residential, commercial, industrial, and institutional sectors.

However, contrary to the expansion of Chinese construction, its foundations are being deteriorated fast. This could be seen from both the worsening of construction enterprises' business environment and

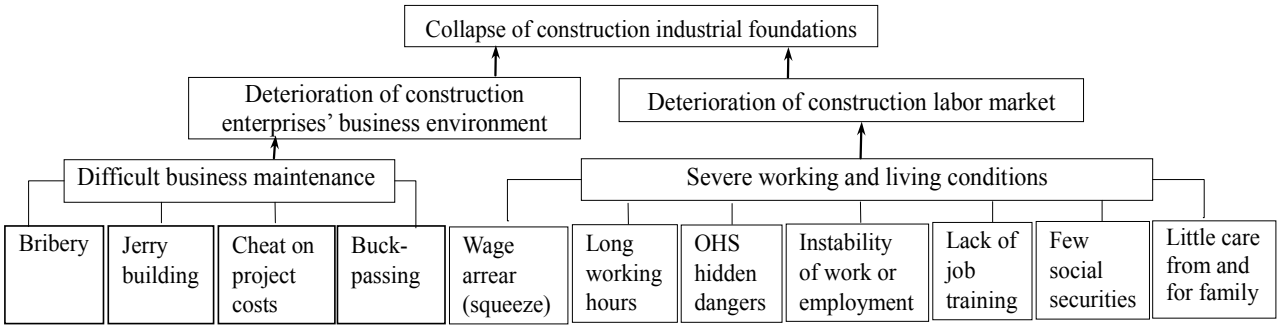

Figure 1 Deterioration of construction industrial foundations

the severe labor conditions in recent years (Figure 1). It has significantly influenced the employment growth in the Chinese construction sector. It has already been noticed that the potential of construction abilities in absorbing labor force sees a tendency to be faltered or slowed down, even with a decline in the rate of employment in some year (Hu, 2002; Qian, 2004). One of the most important reasons must lie in the universally negative image of construction industry. It greatly hinders the recruitment and retention of construction laborers in recently China, especially among the growing new generation of migrant laborers (Cai, 2009; Liang, 2010). Construction industry employers in China seem to much lag behind other industries in how they conduct their people practices. This gap must be closed; otherwise the recruitment and retention of employees will become chronic problems in the near future (Charles, 2007).

Those explanations argue that the future construction development in China calls for more labor-oriented strategies. The government should place considerable importance on maintaining a competitive and flexible construction labor market. In other words, it is urgent for Chinese construction not only to pay close attention to improve current employment situation, but to raise the issue how to foster a sustainable construction labor market as a vital element in its future development. It is certainly a complicated and systematic task to be carefully tackled, since any frequently changeable or short-sighted interventions or regulations would not only make the existing problems unresolved but in turn bring new fatal problems and even aggravate the tension between the construction industry and its labor force. Thus, it calls for a sustainable view for development (Wells, 2003).

Special attention is drawn on labor subcontracting which is the universal practice of construction employment. Its status and implications to construction industrial development should be considered carefully since many labor problems are severely blamed to be caused by 'informal' labor subcontracting behaviors. Thus, the Chinese government determined to strictly prohibit 'illegal' labor subcontractors and push corporatization among them. However, it does not work as well as expected in practice, according to the empirical observations on sites in the previous study (An, 2010a). An (2010b) argues that one of the root causes lies in the current existing subcontracting systems, which neglect the potential development of subcontractors and fails to provide them with economic incentives for good performance as expected. And thus, new adjustment or even reform of current subcontracting systems is required for improvement.

With regard to the adversarial work culture along with the construction supply chain (CSC), particularly in today's competitive environment, lessons learned from the Japanese construction industry tell a valuable approach as to promote the long term relationships between general contractor (GC) and subcontractors (SCs) regarding the subcontracting business (An, 2011). However, how to realize it concretely needs further investigations.

2. RESEARCH OBJECTIVE AND HYPOTHESES

This research attempts to explore labor-based strategies and adaptable measures in practice for the Chinese construction industry from the perspective of sustainable development.

2.1 Research objective

A tentative conceptual scheme for developing the Chinese construction labor market sustainably will be put forward in this paper. Considering that the current existing subcontracting systems provide insufficient incentives for consistent implementation in practice, efforts will be made on exploring the potential economic incentives of the proposals for those concerned parties.

2.2 Hypotheses tree

The hypotheses tree (Figure 2) summaries how this study proceeds with the tentative proposals aiming at sustainable development of construction labor market in China.

Firstly, regarding the current strict prohibitions of 'informal' labor subcontractor teams and sub-subcontracting business under the existing systems in China, it argues that the informal employment and multi-layer subcontracting systems (MLSS) must have their rationalities of existence (Assaad 1993; Aelim, 2010). Without a rational response to those schemes, any rigid interventions will finally fail to perform well in practice. To overcome some negative repercussions of those schemes, one crucial issue is to facilitate the subcontractors' development based on mutual understanding to create reciprocal business environment for both general contractor (GC) and subcontractors (SCs). It has positive meanings for both industrial structure adjustment and sustainable improvement of construction labor employment. To achieve that, current subcontracting systems should release the restriction on subcontracting business scope, and meanwhile introduce cooperative work relationship into the existing competition mechanism. It is believed to contribute to realize the efficient and effective construction production systems with just-in-time and efficient assembler (GC) and qualified suppliers (SCs) with better ongoing development in future. To be more concrete, some strategies for GC and SCs could be promoted in practice, such as enlarging subcontracting business scope, and promoting a relative stable working relationship between GC and some certain SCs.

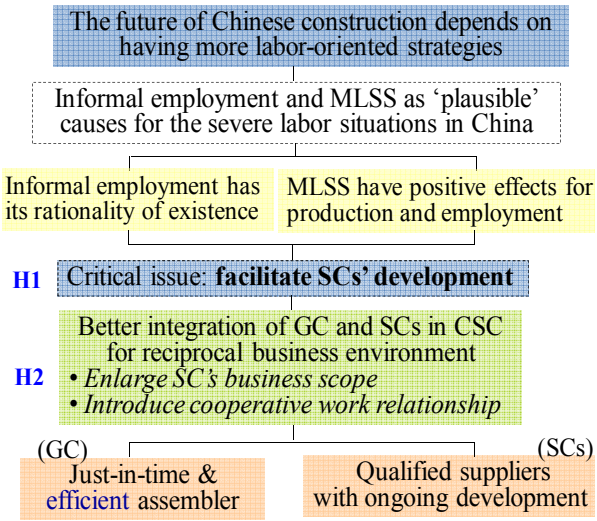

Figure 2 A conceptual scheme in the form of hypotheses tree for the sustainable development of Chinese construction labor market

3. TENTATIVE VALIDATION

Tentative analyses are conducted in this part to validate that the new scheme could provide economic incentives for those involved parties (particularly subcontractors) under today's competitive business environment with various uncertainties threatening their development.

3.1 Critical issue as to facilitate subcontractors' development

In the previous studies (An, 2010 & 2011), one of the deeper roots for construction labor problems in China has been found to be lay in the current overall subcontracting systems with excessive restriction on the scope of subcontracting business. It largely ignores the ongoing development of subcontractors, who suffer from the uncertain and futureless business environment. Situation becomes even worse in view of adversarial relationships up and down the construction supply chain. Recent practical scheme without true understanding of subcontractors is proved to be a failure in improving laborers' poor conditions. In turn it brings negative side effects, such as the current irrational industrial production structure with few developed and competent professional subcontractors. In a word, it is urgent to take subcontractors' development into consideration in order to improve construction laborers' conditions sustainably and fundamentally.

As a matter of course, we could enlarge the subcontracting business scope from previous labor-only to materials and other business, and try to convert the adversarial culture by introducing cooperation into current competitive mechanisms through long term work relationships. The key issue is how to motivate and convince those concerned parties to be better integrated in the construction supply chain to manage the uncertainties during the construction process (Table 3.1).

Table 3.1 Main sources of uncertainties during the construction process

Internal	Personal competence Integrity of the involved parties Differing economic interests of the involved parties
External	Labor Suppliers Clients Planning authorities Environmental (i.e. market) uncertainties

There are many sources for the uncertainties during the project progress, which could be mainly examined from external and internal levels (Figure 3.1). This paper will focus on the analysis of a major and universally existing internal cause as the workflow reliability. It is mainly influenced by the degree of work plan reliability by GC, and reliability in providing necessary resources by SC. It can directly result in the task uncertainty and contract uncertainty during the transaction process between GC and SC, the degree of which will become even bigger due to organizational uncertainty and natural uncertainty. SCs are generally more fragile or vulnerable to those uncertainties in construction production. They are in the downstream of construction supply chain, and their further development is greatly dependent on the fundamental accumulation on projects level.

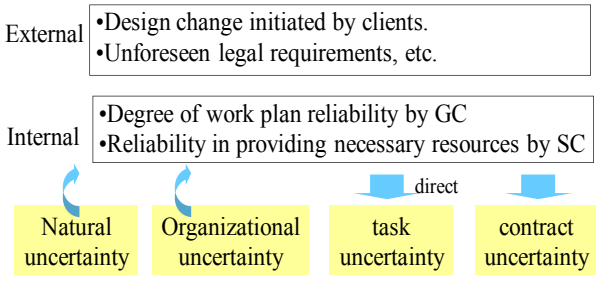

Figure 3.1 Major causes for uncertainties during the construction process

With regard to laborers, one of the induced problems by the instability of construction production is the fluctuation of labor demands during the construction process. Correspondingly, the laborers provided by subcontractors are fluctuated with a degree of uncertainty. Without a proper ability to coordinate by GC and SCs, from the project perspective, it could easily result in the waste of labor waiting or labor shortage in use, both of which have detrimental effects on the achievement of project objectives. From the labor force perspective, it is prone to the arbitrary use and exploitation of laborers by subcontractors, which is frequently taken as a major measure to cope with uncertainties inherent in the labor supply business.

Again, we would like to stress on the significant influence of those uncertainties on the development of subcontractors at a firm-level. It is obvious that those potential waste or loss brought by the instability of construction production actually could not be eliminated, but in most cases it is just simply transferred through subcontracting from the upper layer (GC) to the downer layer (SC) along with the construction supply chain. Instead of the conventional behavior of risk transfer from up to down, the authors pursue other management approaches to strive for stability amid the construction supply chain. In that way, how to deal with the uncertainties related to work plan by GC and resource allocating by SC during the production process plays a significant role in facilitating the better ongoing development of subcontractors. By that, it may provide an opportunity to improve labor force's employment conditions continuously and sustainably.

3.2 Understanding subcontractors' economic behaviors

Generally speaking, subcontractors behave to maximize their profits according to the ways in which they are measured. The basic rules are almost set in the subcontract based on a fixed unit price or lump sum contract. That should be kept in mind for better understanding of their business environment. Hence, it is necessary to examine how the proposed approaches (e.g. long term work relationship) will affect subcontractors' economic behaviors. In this section, a tentative effort is made through exploring the economic behaviors of GC and SC with regard to resource allocating along with the project process. Many negative effects caused by ineffective resource utilization have been shown on construction sites, such as longer waiting time for work assignment, labor lay-up, and so on. They could ultimately reduce the work flow reliability, which is particularly vital to SC's business.

To be specified, we focus on the dependent relationship between the degree of work plan reliability by GC and SC's reliability in providing the resources as mentioned before. Intuitively, it could be deduced that the more reliable a project work plan is, the more willing for SC to allocate resources readily and efficiently. Thus, the work flow tends to be more reliable with fewer uncertainties. Vice versa, the less reliable the work plan is, the less reliable resource allocating is likely to be. It would ultimately lead to a vicious non-trust working relationship.

Therefore, it is significant to promote working together by GC and SC. To achieve that, a better mutual understanding of their economic behaviors is required. The following model aims at helping GC understand the economic motivation of SC, and thus helping to simulate some supply chain management approaches which could contribute to the work stability amid an increasing and unavoidable practice of subcontracting.

3.2.1 Prior knowledge on subcontractor's economic behaviors

Given that the contract price between client and GC is enough reasonable so that GC does not have to worry about its payment by client, but is just concerned with how to complete project work efficiently with well coordination by SC. We have some prior knowledge in mind of subcontractor's behaviors according to empirical observations from the previous studies.

- SC's reliability of providing resources seems to be largely dependent on the reliability of work plan by GC.
- SC is liable to provide fewer resources than demanded in practice, leading to the perception of unreliable SC.
- SC prefers to subcontract more services such as materials, equipment, and so on, rather than labor-only provision.
  - Through that, SC seems to be less influenced by the uncertainties inherent in subcontracting business, meanwhile, has a higher potential to gain profit.

3.2.2 The net income of subcontractors over one planning period in one single project

The net income of SC in any particular project over one planning period could be roughly equal to the total income from work actually performed minus the total cost of the resources actually occurred. Derived from Sacks (2004), let:

- $k = R_A / R_D$, in which R_A denotes the actual resources provided by SC, and R_D is the quantity of resources demanded by GC to complete the planned work;
- $q = W_A / W_D$, in which W_A denotes the quantity of actual work made available, and W_D is the quantity of work demanded.

Then k is perceived as SC's reliability in resource providing, and q could be understood as GC's reliability of project work plan by GC. Thus, SC's net income is:

$$\begin{aligned} I &= Total\ Income - Total\ Cost \\ &\approx \min\{k, q\} W_D (U - C_M) - k W_D C_s \\ &= \begin{cases} k W_D (U - C_M - C_S) & k < q \\ q W_D (U - C_M) - k W_D C_S & k \geq q \end{cases} \end{aligned} \tag{3.1}$$

In this scenario of resource allocation, SC knows the unit price (U) for the work in the subcontract, the unit costs of materials (C_M), and the cost of the resources per unit of work planned (C_s), and the quantity of work demanded (W_D) by project manager from GC. The economic behavior for SC is to set the value of *k* that will optimize its net income.

3.2.3 Analyses of the parameters affecting subcontractor's economic behaviors

Figure 3.2 shows the relations between SC's net income, resource allocating strategy and GC's plan reliability, given that $(U - C_M - C_S)/C_S = 1/4$ for simplified calculation. It could then be inferred that:

- SC's net income is dependent on the reliability of project work plan by GC (q), resulting in SC's different behaviors when providing resource (k).

As q declines, not only the expected income (I) will be reduced, but the loss (below the vertical axis) is more easily incurred. Then it could be inferred that a rational SC must try to estimate the value of q for maximizing income, and then choose resource allocating strategy more appropriately (i.e. set $k = q$). Then it could explain that SC is liable to providing fewer resources than demanded if the work plan is less reliable.

From the perspective of SC, non-trust work relationships will lead to its behavior like not to be of honesty or integrity. It is consistent with our perception that subcontractors tend to provide less

resources demanded by project mangers, such as cheating on labor and materials (jerry building).

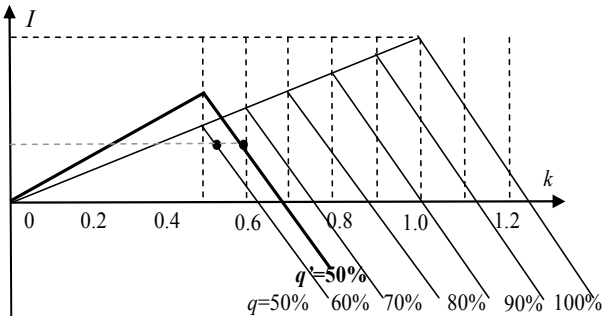

Figure 3.2 Relations between SC's net income (I), resource allocating strategy (k), and GC's work plan reliability (q)

Another interesting result is:

- The vulnerability of SC to the unreliability of work plan by GC could be influenced by its subcontracting business scope.

If SC supplies labor only in its subcontracting business (labor-only subcontractor), the slope in Figure 3.2 will become steeper. It means that SC becomes more vulnerable or sensitive to the degree of reliability of the work plan (q). On that occasion, with the same value of q, SC needs a bigger value of k to obtain the same profit (usually we consider the right half of the curve). In other words, if the subcontractor supplies a significant proportion of the materials needed for the work, its vulnerability is decreased. Here vulnerability means the extent to which changes (the reliability of work plan in this case) could affect SC's income.

3.2.4 Impacts of work plan reliability

The actual value of q occurs with uncertainty $P_r(q)$ in practice. Since the value of q varies over the multiple planning periods, if a frequency distribution can be collected, then the expected value of q is possible to be estimated. It would be much valuable for SC, but it could only happen under a long term working period. In practice, even if subcontractors can not get access to the records of the value of q for each project, they usually have a mental impression of the plan reliability in each project. As can be inferred, under a stable and long term work relationship, this kind of estimation could be more accurate and helpful for a subcontractor in its resource allocation.

3.2.5 Summary

SC is likely to allocate resources in any project according to its perception on GC's work plan reliability. Furthermore, in most cases, the capacity of resources allocated is prone to being lower than that demanded since the potential loss of supply more is greater than that of supply less. The model also indicates that in order to reduce the work flow reliability, GC and SC could cooperate regarding the work plan and execution under long term relationships. It would motivate both of them to become trustful partners.

3.3 Exploration of game relation between GC and SC

However, even the model shows the significance of working together, any exchange relationship between a buyer and supplier is likely to happen in practice. That is to say, the subcontracting in construction is in fact a series of games, in which project manager (buyers) and SCs (sellers) seek to optimize their returns.

3.3.1 Game behaviors between GC and SC

In the previous section, we explain SC's tendency of dishonest behaviors in resources allocating such as to provide fewer resources than demanded by work plan, to overbook its resources, etc. However, this tendency could also be acknowledged by project manager in practice, who generally has the

ability and responsibility to coordinate SC's work. A likely response by project management is to demand more resources than needed in order to counteract this situation. Intuitively, this would have a predictable result of damaging SC's confidence in resource allocation, which will exacerbate the problems over time. Even worse, the excessively competitive strategies will spur the situation to come to the final equilibrium at lose-lose (Figure 3.3), resulting in the non-trust work relationships. This mutual-effect behavior (game relation) between GC and SC certainly could not be neglected when pursuing for strategies to facilitate SC's development. That is to say, subcontracting in construction production in fact is a series of games, in which project manager (buyers) and SCs (sellers) seek to optimize their returns by ordering resources and allocating resources.

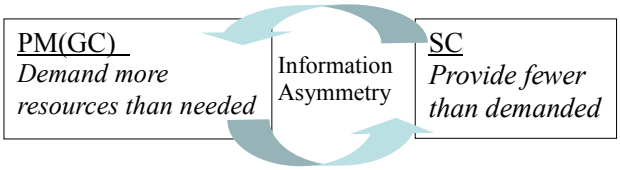

Figure 3.3 The consequence of competitive strategies with the final equilibrium at lose-lose

According to the frequency of cooperation, there can be two kinds of games:

- short term and never or rarely repeated (one-off game)
- long term and with degrees of repeatability (repeated game)

This following section is trying to explain the mechanism of non-trust working relationship, explore economic incentives to change, and put forward the strategies or efforts that could be done by GC and SC to prevent from the worst result.

3.3.2 Formulation of the one-off game scenario between GC and SC

We will exemplify the game behaviors of GC and SC through modeling the allocation resources at the start of planning period in a project. Two players are project manager from general contractor (GC) and the subcontractor (SC). The players make 'moves' (referred to as actions) one after the other through the repeated cycles of the game.

In each round of game, GC will set the work amount that is to be performed by SC in each period based on the project plan. Correspondingly, a rational SC will evaluate the demanded work amount that is likely to actually become available, and then take actions to supply the proper amount of resources.

Since the actions are taken sequentially, this process turns out to be a series of dynamic games. What is needed to stress here is that both GC and SC have imperfect knowledge about the outcome in terms of the work amount that will actually be completed until it happens.

This one-off game in each round between GC and SC is a dynamic game with incomplete information. In this game, the project manager must take an action with imperfect knowledge of the actually work amount that are made available (W_A) before the next planning period. Similarly, the subcontractor also has imperfect knowledge about whether the project manager has demanded more, exact or fewer resources than necessary. In a word, the action collections of GC and SC are supposed to be greatly influenced by the degree that they know about the actually available work amount. The work plans are not always necessarily reliable. In other words, it is often unknown with uncertainty at the beginning of each planning period. In reality, the amount of work that will actually become available at a future date can not be entirely 'known' by

either GC or SC. In turn, it is also unlikely to happen that either of them would have absolutely no knowledge of the likely value of q at all.

(1) Harsanyi transformation

To explore the impact of plan reliability on the expected behaviors of GC and SC, we will use information set with regard to the plan reliability. It will then make it possible to model the scenario in which each player either knows or does not know the variable value of 'nature' (N), in this case the value of q, which measures the amount of work that will actually become available.

This process of adding 'nature' as a player in the game is known as the Harsanyi transformation[1]. John Harsanyi won the Nobel Prize in economics for devising a method for analyzing games of incomplete information. Games in which the payoffs are not common knowledge are known as games of incomplete information. In that case, the players remain ignorant of the strategy adopted by their opponent until the play is made by the Harsanyi transformation. He proposed to consider a player who has different payoffs under different circumstances as a player of different types. It means that in this kind of game, a player must form beliefs about the strategy that an opponent will play and the player must also form some beliefs about the type of game he/she is playing. The game is then modeled as though 'nature' moves first and chooses the type of that player.

In this scenario, the incomplete game between GC and SC will then be converted into two stages of dynamic games, with an extensive form shown in Figure 3.4, where

$$q = \frac{W_{Available}}{W_{planned}}, \quad d = \frac{W_{demanded}}{W_{planned}}, \quad k = \frac{R_{provided}}{R_{demanded}}.$$

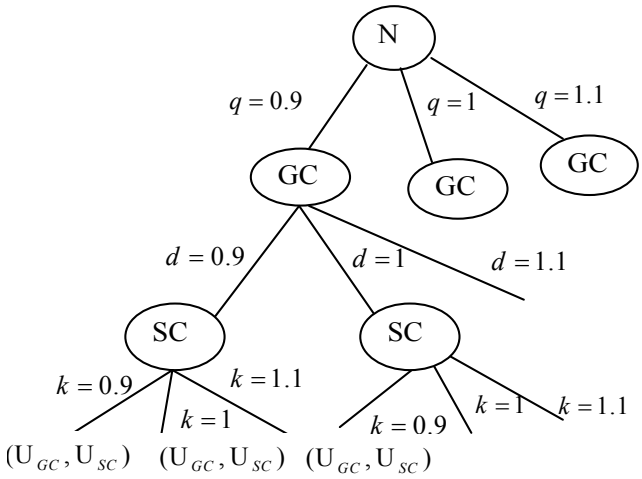

Figure 3.4 The one-off game between GC and SC by Harsanyi transformation

We state again that the values of q at the left of the tree represent the range of possible results of the ratio of the work that will actually become available (in terms of work available) to the amount of work planned. At the first stage, the nature will choose q, and then the next stage will become a static game of complete information between GC and SC.

The GC's possible actions are detailed at the second level in Figure 3.4 by d, which represents the ratio of the work demanded to the work that GC estimates will actually become available (in terms of work plan). Here, the value of d is also modeled by discrete values: demand for less work amount than estimated ($d = 0.9$), exactly the amount estimated ($d = 1$), and more than estimated ($d = 1.1$).

In response to GC's demand, SC can select the amount of resources to be allocated according to the amount required for the work demanded. Here, k represents the radio of resources supplied to those

[1]http://isc.temple.edu/economics/Econ_92/Game_Lectures/10th-IncompInfoStatic/incomplete_info_01.htm

demanded ($k=0.9$), exactly the amount required ($k=1$), or more than demanded ($k=1.1$). The latter value tells a situation in which the SC has resources available, and is willing to allocate more of them in the hope that more work amount than expected will actually become available, so they would be utilized profitably.

Then the action set of each one-off game is:

$$A_1 = \{(0.9,0.9),(0.9,1),(0.9,1.1),\\ (1,0.9),(1,1),(1,1.1),\\ (1.1,0.9),(1.1,1),(1.1,1.1)\}$$

(2) Utilities for GC and SC

The utilities or payoffs for each player are calculated at the end node of each branch of the tree. Here, we assume that the utility of GC is to be the total work amount that will be actually completed in the planning period. Thus, the expected utilities for GC and SC are:

$$\begin{cases} \mathrm{U}_{GC} = \min(q, dk) \\ E(\mathrm{U}_{GC}) = \int \min(q, dk)\,\mathrm{P_r}(q)dq \\ \qquad = \int_0^{dk} q\,\mathrm{P_r}(q)dq + \int_{dk}^{\infty} dk\,\mathrm{P_r}(q)dq \end{cases} \tag{3.2}$$

$$\begin{cases} \mathrm{U}_{SC} = \min(q, dk)(U - C_M) - kC_S \quad \text{suppose} \quad W_D = 1 \\ E(\mathrm{U}_{GC}) = \int \left[\min(q, dk)(U - C_M) - kC_S\right]\mathrm{P_r}(q)dq \\ \qquad = (U - C_M)\left(\int_0^{dk} q\,\mathrm{P_r}(q)dq + dk\int_{dk}^{\infty} \mathrm{P_r}(q)dq\right) - kC_S \end{cases} \tag{3.3}$$

Note: The labor cost is independent of the amount of work performed.

(3) An example of probability distribution of q

In practice, even the value of q could not still to be estimated, construction professionals would not estimate a continuous probability distribution, but rather use discrete values at significant intervals. Here, for simplifying the model analysis, we suppose that the probability distribution of q is given in table 3.2.

Table 3.2 An example of probability distribution of q

q	0.9	1	1.1
$\mathrm{P_r}(q)$	0.3	0.6	0.1

3.3.3 Equilibrium and discussion

Then we could have the payoff matrix (Table 3.3) of this one-off game between GC and SC under the information sets of plan reliability.

The equilibrium of this game is (1.1, 0.9), which means that GC is likely to demand more resources, and SC is prone to supply with less resources. A game theory 'equilibrium' as used here, represents a set of strategies taken by the players that result in a situation where neither player has anything more to gain by changing only his or her own strategy, so long as the other player does not change their strategy.

However, under long term work relationships

Table 3.3 Payoff matrix of the one-off game between GC and SC

GC \ SC	0.9	1.0	**1.1**
0.9	$(0.81, 0.81(U-C_M)-0.9C_S))$	$(0.9, \underline{0.9(U-C_M)-C_S)})$	$(0.963, 0.963(U-C_M)-1.1C_S)$
1.0	$(0.9, 0.9(U-C_M)-0.9C_S))$	$(0.97, 0.97(U-C_M)-C_S)$	$(\underline{0.98}, 0.98(U-C_M)-1.1C_S)$
1.1	$(\underline{0.963}, \underline{0.963(U-C_M)-0.9C_S})$	$(\underline{0.98}, 0.98(U-C_M)-C_S)$	$(\underline{0.98}, 0.98(U-C_M)-1.1C_S)$

with GC's strategy moving to $d = 1$, the equilibrium of this game would reach at (1.0, 1.0). It means that a trust work culture would be probably created between GC and SC. Moreover, as can be seen, the utilities for both GC and SC would increase to a certain extent. It is supposed to be a better equilibrium which may serve as an incentive for the involved players. It again stresses the long term relationships could be a valuable approach to motivate subcontractors.

4. RECOMMENDATIONS

(1) Make SC more reliable in the resource allocation through more cooperative production management techniques based on the mutual understanding between GC and SC.

(2) Strategies of efforts could be done by GC:

- Enlarge the subcontracting business scope, like materials and even design, not only labor resources (this is in accordance with the previous model with incentives from SC)
- Rebuild the risk management ideology with shifting part of the risks back to themselves (GCs)
  - Risk should be apportioned in accordance with the ability to control the risk
  - For example, the formula of work payment for SC adding risk shifting factor

Of course, it must be agreed by both through communication and mutual understanding of the pay-off.

- Assign more work to fewer subcontractors

(3) Strategies or efforts could be done by SC

- Develop the abilities to deal with subcontracting business, including not only labor management, but the business management, risk management, construction technology, design ability, etc. It is not only consistent with GC's strategy but could reduce the impact of task uncertainty or fluctuation of work on their income, which is essential to the sustainability and development of themselves.

REFERENCES

Aelim, Y. (2010). Regulating multi-layer subcontracting to improve labor protection. Available at: http://www.ilo.org/legacy/english/protection/travail/pdf/rdwpaper17b.pdf [Last accessed on 31 Mar, 2012]

An, T. Y., Watanabe, T. (2010a). Labor-service management of railway construction projects in China. *Internet Journal of the International Symposium on Social Management Systems*, SMS09-153, Kochi University of Technology, 4-5 March 2010, Kochi, Japan.

An, T. Y., Watanabe, T. (2010b). Research on labor-service subcontracting management in Chinese construction industry, *Journals of the Japan Society of Civil Engineers F4 (Construction and Management) Special Issue*, 66(1):329-340.

An, T. Y., Watanabe, T. (2011). Towards the Improvement of Construction Laborers' Situation in China: Inspirations from Japan. In: Proceedings of Association of Researchers in Construction Management (ARCOM). September 2011, Bristol, UK.

Assaad, R. (1993). Formal and informal institutions in the labor market, with applications to the construction sector in Egypt. *World Development*, 21(6): 925-939.

Cai, F., Du, Y. and Wang, M. Y. (2009). Migration and Labor Mobility in China. United Nations Development Programme (UNDP) Human Development Research Paper, 2009/09.

Charles, S. C. III (2007). The irony of the cranes: labour issues in the construction industry in the new China. *ChinaWorld Conference*, 19-20 March 2007, University of Durham. Asia Research Centre, CBS, Copenhagen Discussion Papers, 2007-21.

Hu, A. G. and Yang, Y. X. (2002). Creative destruction during structural change: urban unemployment and social security in China, in Hu, A. G., Cheng, Y. H. and Yang, Y. X. (eds), *Expanding Employment and Challenging unemployment*, Beijing: China Labor and Social Security Publishing House.

Liang, H. (2010). *China in Liang Zhuang*. China: Jiangsu Renmin Press. [In Chinese]

Qian X. Y., Zhao H. (2004). The Construction Sector in the People's Republic of China- Policy Analysis on Sectoral Development and Employment Challenges. Employment-Intensive Investment Branch, International Labour Office (ILO). Geneva, June, 2004.

Sacks, R., and Harel, M. (2006). An economic game theory model of subcontractor resource allocation behavior. *Construction Management & Economics*, 24(8): 869-881.

Wells, J. (2003). Social Aspects of Sustainable Construction: an ILO Perspective. United Nations Environment Programme (UNEP) Industry and Environment, 72-75.