

# IMPACT OF SUBCONTRACTING ON SITE PRODUCTIVITY: LESSONS LEARNED IN TAIWAN

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**ABSTRACT:** In the past decade, considerable research effort has been devoted to alleviating site productivity problems in Taiwan's construction industry. However, the results generated so far are frustrating. A school of academic debates are raised concerning the elements missing from the research framework adopted. The disregard of the crucial role played by subcontractors in the construction process is the main missing element. To gain a thorough understanding of the subcontracting practice in construction, an extensive questionnaire survey targeting more than 1,000 general contractors, selected at random, was conducted in 1995. Major findings of the survey are reported briefly in this paper. The relationship between subcontracting and site productivity was investigated. A conceptual model for analyzing productivity barriers due to subcontracting was developed and various aspects of this model were also examined. Based on the insights gained from the survey and the follow-up interviews, three promising institutional strategies for overcoming the identified productivity barriers are presented and discussed.

## INTRODUCTION

In the past decade, the construction industry in Taiwan has witnessed enduring productivity stagnation. Based on the concept and the techniques in the literature (Drewin 1982; Laufer 1985; Tavakoli 1985; Alfeld 1988; Oglesby et al. 1989; Thomas 1991), considerable research effort has been devoted in Taiwan to investigating the possible causes for productivity loss and devising means for site productivity improvement. Disappointingly, the results generated so far have been marginal and field practitioners' appreciation of productivity improvement is still sporadic. One major hypothesis in past research is that productivity stagnation on-site is caused mainly by the general deficiency of proper planning and technical ability at the site management level (Arditi 1985; Lemna et al. 1986; Maloney and McFillen 1987; Shohet and Laufer 1991). After careful examination, however, little evidence supports this. In fact, a great number of field practitioners possess admirable skill in improvising ways to solve their on-site problems on a daily basis. Certain productivity barriers may exist that are not identified in routine site observations, time cards, or cost reports. It is these productivity barriers that void the utility of the productivity improvement measures recommended by researchers.

The purpose of this paper is to provide some explanation of the effects of subcontracting on site productivity. The paper highlights the importance of subcontracting in construction and argues that subcontracting is the missing element in productivity studies conducted to date. According to the findings of an extensive survey in Taiwan's construction industry, subcontracting has become a standard practice employed by general contractors for project execution. General contractors subcontract construction work as much as possible to allow downsizing of their firms and to ensure better handling of the unstable market conditions. Coupled with the benefits yielded by subcontracting, there are institutional gaps between the contracting parties (i.e., the general contractor and the subcontractor). These gaps may be inherent or established through time with little heed, but they have the potential to divide the construction team into "islands," or self-centered decision-

making units with conflicting interests. Ignorance or mistreatment of the institutional gaps, rather than the subcontracting practice itself, impairs site productivity to a great extent.

The survey and follow-up interviews reported in this paper cover the major aspects of the subcontracting practice in Taiwan's construction industry. This paper reports some of the findings that underline the existence of institutional gaps between the general contractor and the subcontractor. To further understanding of these gaps, the connection between subcontracting and site productivity is examined and the transaction linkages between the contracting parties are investigated. A conceptual model is developed for analyzing the productivity barriers introduced by subcontracting, and several aspects of the model are explored. Then, institutional strategies for productivity improvement, which are compiled from numerous field studies in Taiwan, are presented. Based on the study findings, some concluding remarks are provided.

## SUBCONTRACTING PRACTICE IN TAIWAN'S CONSTRUCTION INDUSTRY

An extensive questionnaire survey was conducted in 1995 to provide insight into the nature and extent of subcontracting in Taiwan's construction industry. Questionnaires were sent to 1,080 general contractors, comprising one-fifth of the total population. A total of 186 companies returned the questionnaire. After the material was screened, 160 of the returned questionnaires were considered valid and used for analysis. A total of 31 general contractors were further interviewed to gain an in-depth understanding of their subcontracting practices. The questionnaire content is given in the appendix, and the associated results are compiled elsewhere (Hsieh 1996). Important findings pertaining to the scope of this paper are given here.

### Subcontracting Services

In a practical sense, subcontractors can be seen as the middleperson for the provision of various construction-related services from the market to the general contractor. They gather—and sell to the general contractor—resources and specific knowledge essential to the execution of construction. One or more of the following four types of services may be provided by a subcontractor:

1. Design input
2. Bulk material supply
3. Components prefabrication/preassembly
4. Site erection service

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## Transaction Relationship

More than 80% of general contractors confirm the need to establish a long-term working relationship with a particular subcontractor and material vendor. However, they prefer financial independence rather than any form of joint ownership. The majority of general contractors maintain a long-term relationship with an average of three subcontractors and two material vendors for a given trade. Since the long-term transaction relationship between the parties prevails, very few general contractors ever exercise open bidding to recruit new subcontractors or material vendors from the market. Even in the rare occasions of recruitment, general contractors base their decisions mainly on the recommendations of other construction firms and the candidates' quality account. Contrary to common belief, financial capability and equipment ownership rank low as criteria for selecting subcontractors.

## Contract Administration

How the subcontractor or material vendor is paid by the general contractor is the key element in the contract. Survey responses indicated that 32% of the participating general contractors provide prepayment to the subcontractor before the work begins (12.5% of the projected contract value on average) and 46% of them provide prepayment to the material vendor (13.3% of the projected contract value on average). On the other hand, more than 80% of the general contractors require a performance bond from the subcontractor and more than 50% of them require a performance bond from the material vendor. On average, a 9% progress payment is retained by the general contractor. Most general contractors make their progress payment receivable to the subcontractors every two weeks, whereas in the case of material vendors the elapsed time is usually as long as two months. Since the progress payment to subcontractors will be made only after the actual quantity of work is measured and valued, the frequency of formal quality inspection and other contract administration procedures is also every two weeks.

## Expectations from Subcontractors

Most general contractors identify quality, schedule control, and worker training as the key areas for subcontractors' productivity improvement, whereas they identify quality and business ethics as potential improvement areas for material vendors. General contractors were asked about what type of assistance they have given subcontractors and material vendors in the past. Interestingly, most have done little to rectify areas that seem to need improvement. General contractors select subcontractors and material vendors according to their quality account but nevertheless seem disappointed with their service. Because a long-term transaction relationship is valued by both contracting parties, general contractors remain alienated to the idea of educating their subcontractors.

## RELATIONSHIP BETWEEN SUBCONTRACTING AND SITE PRODUCTIVITY

In construction, the use of work sampling techniques has facilitated the collection of productivity-related data on-site. Through use of these data, along with information derived from cost reports, personnel time records, work plans, and questionnaire surveys, various problems leading to productivity loss can be investigated and understood in depth. Based on extensive experience of practicing work sampling on field operations, the author has concluded that the productivity loss items in Taiwan's construction projects are not much different from those reported in the U.S. (Oglesby et al. 1989; Thomas 1991), as shown in Table 1. Throughout interviews

with more than 30 general contractors and subcontractors, in projects of different sizes, an effort was made to assign management responsibilities for productivity losses. Although no rigor was exercised to determine the exact proportions of the shared responsibility among the involved parties, their views clearly converge. As demonstrated in Table 1, subcontractors' influence on-site productivity is critical.

To further determine the areas in which subcontractors should be involved for productivity improvement, the findings of three similar studies (Arditi 1985; Koehn and Caplan 1987; Koehn 1988) show agreement on specific areas for improvement. As Table 2 shows, subcontractors' potential to contribute to productivity improvement encompasses the general areas of management, material, labor, and equipment.

Although subcontracting significantly affects site productivity, subcontractors have not been included as a key factor in previous productivity research studies. The following reasons may help to explain why this factor has been completely ignored:

1. Most general contractors traditionally employ direct-hire workers from the union or the labor market, instead of subcontractors, for executing construction tasks. Either no construction work is subcontracted or the volume of subcontracted work is being kept to a minimum.
2. In the research framework, subcontractors are collectively fitted into the conceptual categories of the contractor (the highest decision-making level), the foreman

**TABLE 1. Productivity Loss Items Derived from Field Work Sampling**

Productivity loss category (1)	Cause (2)	Management responsibility (3)
Delays	Unorganized storage area	GC/SC/WR
	Material handling and disruption	GC/SC/WR
	Material/tool/equipment unavailability	GC/SC
	Interference with other crews/congestion	GC/SC
	Out-of-sequence work	GC/SC
	Waiting for instruction	GC
	Waiting for inspection	GC
	Interruptions due to accident	GC/SC/WR
	Adverse weather	GC
	Personal and breaks	SC/WR
	Late starts and early quits	GC/SC/WR
	Boring/repetitive task, lack of job enrichment	SC/WR
	Low morale/lack of motivation	GC/SC/WR
	Temporary installation	O/AE/GC
Ineffective work/slow work/rework	Make work	SC/WR
	Fabrication errors	SC/WR
	Poor craftsmanship	SC/WR
	Change order	O/AE/GC
	Engineering errors	AE/GC
	Incorrect technical instructions	AE/GC
Excessive travel	Lack of logistics of tools and materials	GC/SC
	Obstructed walkways	GC
	Poor housekeeping	GC
Large amount of supportive work	Unbalanced crew	GC/SC
	Unplanned work	GC/SC

Note: O = owner; AE = architect and engineering consultant; GC = general contractor; SC = subcontractor; WR = worker.

**TABLE 2. Potential for Productivity Improvement at Job Site**

Areas (1)	High potential areas for improvement (2)
Management	Labor relations,* cost control, supervision*
Material	Delivery,* prefabrication,* standardization*
Engineering	Design improvements, standard specifications
Labor	Contract agreement,* training,* quality control*
Equipment	Maintainability,* utilization*

Note: Low potential areas are not shown here.

\*Items linked to subcontractors.

(the intermediate decision-making level), the craftsman (the lowest decision-making level), or the material supplier. The existence of subcontractors in a construction project is therefore disregarded.

3. Productivity issues specifically related to subcontractors cannot be easily distinguished from those based simply on data collected from work sampling and other sources. Distinguishing these specific issues merits attention.

Because subcontracting has become a standard procedure in contemporary construction (Eccles 1981; Birrell 1985; Gray and Flanagan 1989; Hinze and Tracey 1994; Hsieh 1996; Hsieh 1997), it is highly questionable that much productivity improvement can be achieved if this vital factor continues to be either ignored or mishandled in the study framework.

The following arguments have been raised during interviews with general contractors and subcontractors on more than a dozen occasions. These arguments may serve to strengthen the argument of this paper or show what has been overlooked in past research.

### Crew Balancing

In work sampling of a number of concrete placement operations, crew-balance charts were prepared for further analysis. It was concluded that there were simply too many unneeded workers on the job. Redundant workers not only contributed very little to productivity but also presented obstructions to those who actually were contributing. Downsizing the crew was recommended to the general contractor's superintendent and the subcontractor's foreman. According to the superintendent, this recommendation was ignored by the contractor for the following reasons:

- The superintendent has little concern about the potential cost savings on labor because the task is already subcontracted out and is unit-priced by the quantity of concrete placed.
- Because the foreman of the crew is unsure of the exact number of workers turning up to work, he or she tends to call in more workers than are needed, as contingency.
- Also, the foreman is paid on a wage basis. The subcontractor, who is busy looking for new business opportunities instead of attending the work, is actually the one who pays worker's wages. The subcontractor seems to benefit more by expanding work volume than by cutting down cost.
- Firing of any worker from the crew would strongly imply that the worker is incompetent. Unless highly necessary or unavoidable, this practice is forbidden and can impair the subcontractor's ability to recruit workers in the future.

### Work Method Improvement

Detailed observation of formwork preparation revealed that carpenters spend considerable portion of their time in traveling back and forth for material and tools. The amount of material waste in cutting plywood is also too great. Some standard recommendations for work method improvement were given to the carpenter crews, including:

- The logistics of material and tools should be thought through and rearranged to reduce traveling.
- Preplanning should be exercised in order to reduce material waste.
- Several unskilled workers should be included in the crews to increase the carpenters' contribution to direct work.

The counter-arguments suggested by the crews are as follows:

- Carpenters dislike the idea of work method improvement because it implies a more rigorous or mechanical work sequence for them.
- All formwork materials are purchased directly by the procuring department of the construction firm. Crews are not awarded for waste reduction. Project superintendents will not include waste reduction as part of cost control activity. Most crews seem to complain about the logistics of material; however, superintendents would not listen due to difficulty of material management—in particular, the security problem.
- The inclusion of unskilled workers would mean outright cost increase to the subcontractor at the first glance. Although it may improve the production rate per man-hour, the subcontractor nevertheless seems reluctant, particularly because there is no alternative use of these workers in other projects. Also, the subcontractor is concerned about worker turnover.

### Mechanization of Construction Operations

Mechanization of construction operations prioritizes the use of equipment or hand tools over labor-intensive methods. Although mechanization increases the unit production rate in theory, the practical question of economies of scale remains the key bottleneck. In a number of case studies where mechanization was recommended to the general contractors or the subcontractors, the following concerns are clear:

- Although subcontractors are well aware that mechanization can benefit them, the uncertainty as well as the fluctuation of future workload outweighs the advantages of asset ownership. Also, mechanization would change the subcontractor's organization to a great extent, due to worker training, recruiting technical workers, and equipment maintenance. Few subcontractors would face such risks.
- Although equipment rental seems to be an option that is open to both the general contractor and the subcontractor, most equipment rental companies are interested in procuring only common-purpose equipment, such as loader trucks, excavators, and cranes, due to their relatively high profitability. As a result, the possibility of mechanizing specialized construction operations is rather limited.
- The ownership of special-purpose equipment is also not welcomed by general contractors. Most of them are financially capable of purchasing such equipment; their reluctance resides in the idea of being specialized. Specialization requires long-term staffing of technical personnel for operation and maintenance. It may also limit the construction firm to a smaller construction market.

### Worker Training

Few would argue that worker training can help to alleviate productivity problems such as the lack of motivation or morale, fabrication errors, lack of workmanship, crew interference, and accidents. When this issue is brought up on-site, the views expressed are far from constructive:

- With the exception of employing direct-hire workers from foreign countries, few general contractors are willing to exert effort on worker training. First, all workers are hired by subcontractors who work in several projects. Therefore, the construction firm does not have solid control over them over time. Second, without any commitment to the project or the construction firm, workers may leave the project at any time. This contradicts the purpose of worker training.

- The subcontractor, as a middleperson or an agent between the labor market and general contractors, is more interested in approaching workers who already possess good skills and work ethics than investing in human resources. Short-term considerations outweigh the long-term ones.
- After training, most workers have the tendency to ask for higher wages. The wage increase is an additional cost, which can be seldom offset by the productivity increase in the short term.

### Job Site Housekeeping

The lack of housekeeping on-site has been one of the primary causes of delays and ineffective work. The scope of housekeeping should include: waste cleanup; organization of tools and materials; inspection of passageways, stairs, and openings; and maintenance of site utilities such as electrical power, water, gas, toilet, drainage, and lighting. Despite its importance and simplicity, site housekeeping is the most cited area for improvement among those interviewed. There are two reasons for improper site housekeeping:

- Most project superintendents insist that subcontractors should be responsible for cleaning their own waste, maintaining a good practice of using site utilities, and returning borrowed items immediately after use. According to them, these responsibilities have already been specified in the contract. Subcontractors, however, have a conflicting view, especially when they are frustrated by delayed payments or unfair contractual arrangements.
- Some subcontractors further subcontract the cleanup work to unskilled, self-employed workers due to the perception that cleaning is a trivial job for the skilled worker. Often, the channel of communication is blocked between the cleanup workers and the general contractor or other related tradespeople.

### CONNOTATION AND INFERENCE

As shown, a strong connection between subcontracting and site productivity clearly exists. To improve site productivity in a practical sense, two intertwined aspects are further investigated in this section.

### Behavioral Consideration

Given that productivity improvement requires close cooperation between the general contractor and the subcontractor, it is important to examine carefully both parties' willingness to cooperate. In Table 3, possible scenarios are enumerated and analyzed. Based on these scenarios, several important observations can be made.

- In scenario I, both parties will pursue productivity im-

**TABLE 3. Scenarios of Productivity Improvement/Loss in Subcontracting**

Scenario (1)	General contractor (2)	Subcontractor (3)	Analysis (4)
I	Gain	Gain	Highly feasible and favored by both parties
II	Gain	No gain/loss	Ignored by the subcontractor
III	Gain	Loss	Not feasible, opposed by the subcontractor
IV	No gain/loss	Gain	Ignored by the general contractor
V	No gain/loss	No gain/loss	No action, indifferent by both parties
VI	No gain/loss	Loss	Not feasible
VII	Loss	Gain	Ignored by the general contractor
VIII	Loss	No gain/loss	Not feasible
IX	Loss	Loss	No action, avoided by both parties

provement without any particular third-party assistance, since both are motivated by foreseeable gains to improve productivity through collaborative effort.

- Site productivity loss occurs when the general contractor perceives no advantage to improving productivity because the cost of action is higher than the potential savings (scenarios IV to IX), or when the subcontractor perceives no advantage to cooperating with the general contractor (scenarios II and III).
- By employing compensation schemes, it is possible to motivate the other party to cooperate (scenarios II, III, IV, and VII).
- In scenarios II and IV, it is possible to motivate the other party to cooperate without immediate compensation if some speculated gain for future projects is promised. Because the general contractor usually has stronger bargaining power, this possibility is more likely to be realized in scenario II.
- Unless the action cost for productivity improvement has consumed all potential gains, scenarios, V, VI, VIII, and IX are unlikely to happen.

### Contractual Consideration

Since construction work is subcontracted by the general contractor to another party, productivity improvement measures must also be implemented under the contractual framework. Two perspectives need to be distinguished here:

- The ex ante perspective: During the initiation of a subcontract, specific terms and agreements may be designed and included in the contract, so that field practices congenial to productivity improvement are valued by both the general contractor and the subcontractor, and so that both parties have the potential to benefit from such contractual arrangements. The difficulties reside in the cost of preparing a comprehensive contract and the parties' ability to plan far ahead for future events.
- The ex post perspective: When construction is in progress, the general contractor may devise certain motivational schemes, so that the subcontractor becomes willing to cooperate with the general contractor by taking part in the productivity improvement program. This gets complicated when there is a need to modify the original agreements in the contract in terms of price, quantity, quality standards, or contractual procedures.

As shown, site productivity will not be improved simply because the contracting parties realize that productivity loss is detrimental to the project. Even though there exists evidence of an attainable gain, how this gain is divided between the contracting parties is a complex issue with practical significance. In this context, therefore, the extent to which site productivity can be improved is greatly dependent on how the parties interact with each other. Within the scope of a contract, the more friction that exists between the parties, the lesser is the chance of success. As a result, a thorough understanding of the productivity barriers introduced by subcontracting is essential. The following section explores this issue.

### CONCEPTUAL MODEL OF PRODUCTIVITY BARRIERS DUE TO SUBCONTRACTING

Productivity barriers may be rooted to project-related context—such as the parties involved in construction, site characteristics, the complexity of the project, and the organization of the project team—or to external factors such as weather, regulations, and market conditions. Since these factors are interrelated, there may not exist any simple definition

to categorize productivity barriers that are specifically attributable to subcontracting. To further explore this issue, a conceptual model of productivity barriers is developed to facilitate effective analysis from various perspectives. This model is shown in Fig. 1.

In a construction project, the general contractor can be seen as the producer whose main responsibility is to transform and convert input (i.e., construction resources) into output (the built facility). On the other hand, subcontractors, who provide labor, material, capital, and technical ability, are regarded as construction resources. General contractors demand construction resources from the resource market and subcontractors supply the needed resources to the producer market. Each market has its own set of demand-side/supply-side economic objectives, developed under the ultimate goal of profit maximization.

As indicated earlier, four main types of service are supplied by the resource market: design input, bulk material supply, components prefabrication/preassembly, and site erection service. Within the context of a project, productivity issues are limited to the interactions between the general contractor identity and the subcontractor identity (see Fig. 1). Within the subcontractor identity, there are five distinct groups: the system specialist, the specialty contractor, the trade subcontractor, the labor-only subcontractor, and the material vendor. In a typical construction project, the general contractor identity is straightforward. This, however, may get complicated when several members represent the same identity, as in the case of a joint venture project. Both identities are connected at two levels: (1) the contractual linkage; and (2) the behavioral linkage. Finally, the market force affects the subcontractor identity and the general contractor identity within the project context.

It should be noted that the model does not include the producer market characteristics—such as the general contractor's services to the client, and the institutional relationship with designers—and external factors beyond the two markets, such as weather and regulation. These are key issues to productivity but are beyond the scope of this paper. Also, there may exist on-site interactions among various subcontractors. Although these interactions may affect site productivity, this aspect is simplified on the assumption that the general contractor can streamline these interactions through direct communication with the subcontractors involved.

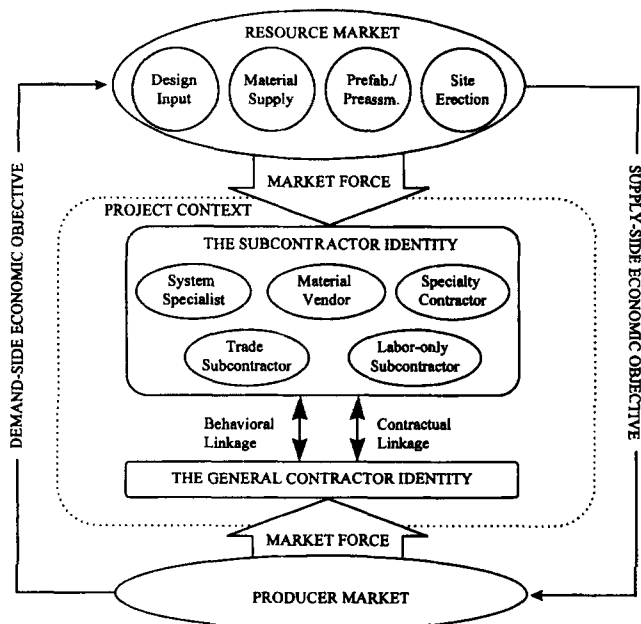


FIG. 1. Conceptual Model for Productivity Barriers Introduced by Subcontracting

Based on this model, the productivity barriers related to subcontracting can be analyzed from three perspectives: (1) the market forces; (2) the interfirm transaction linkages; and (3) the intrafirm economic objectives.

### Market Forces

The market forces come from both the producer market and the resource market. The producer market force is driven primarily by the degree of competition among counterpart contractors and has great influence on a general contractor's subcontracting practice. When the competition is intense, general contractors tend to lower the mark-up in the bid for a higher chance of winning. This practice not only puts great pressure on project cost control but also may increase the degree of various construction risks. Consequently, general contractors pass these risks to subcontractors by contractual arrangements and exercising strict cost control procedures upon subcontractors.

When risks are passed to subcontractors, the following two types for productivity barriers can evolve: (1) when the risk is unbearable, the subcontractor will be wary of seeking self-protection measures and escaping from responsibilities rather than cooperating with the general contractor; and (2) construction risks may be unfairly or unreasonably distributed among the related trades, thus magnifying on-site conflicts that already exist.

Cost control measures exercised by general contractors can be numerous. The most commonly seen are bid-hopping, the pay-when-paid policy, delayed progress payment, and stringent progress valuation. These measures aim at reducing the financial cost accrued to the general contractor and therefore at increasing the general contractor's profit. Subsequently, subcontractors are left with a lower profit margin and greater financial burden. The adversarial relationship between the contracting parties often originates here.

For subcontractors, the resource market force is driven more by locality factors and public relationships than by pure competition. Since construction projects are in different locations, subcontractors must be capable of acquiring labor and material in different localities in a responsive fashion. As a result, they are reluctant to allocate the majority of their time for site work. Meeting potential clients and gathering business information are much higher priorities for business survival. On the other hand, the ease of entry into the subcontracting market permits a large number of newcomers to enter into price competition. Occasionally, general contractors discontinue long-term relationships with particular subcontractors due to the low price offered by newcomers. Wise subcontractors learn to be more reserved when entering into price negotiation and adverse contractual treatment. Without economic parity, subcontractors would not value work ethics, investment in human resources, upgrading managerial ability, and skills and technology advancement.

### Interfirm Transaction Linkage

Within the project context, the transaction linkage between the general contractor and the subcontractor is both contractual and behavioral. Due to various uncertainties in construction, the original contract agreements concerning the pricing, quantity, quality standards, and delivery schedule may need to be adjusted. However, limited by both parties' ability to plan ahead by incorporating contingency claims for every possible event, the contract is considered incomplete. Disputes may then arise and worsen the "team spirit" of the project.

Further, the stability of the contract is affected by the characteristics of different subcontractor groups. For example, defining the content of service of a labor-only contract is more

**TABLE 4. Scenario Preference for Productivity Improvement**

Party (1)	Ranking of Scenario Preference High preference ↔ Low preference (2)						
	I	II and III IV and VII	II* and III* IV* and VIII*	IV* II*	VII* III*	IV, V and VI II, V and VIII	VII, VIII and IX III, VI and IX
General contractor	I	II and III IV and VII	II* and III* IV* and VIII*	IV* II*	VII* III*	IV, V and VI II, V and VIII	VII, VIII and IX III, VI and IX
Subcontractor	I	II and III IV and VII	II* and III* IV* and VIII*	IV* II*	VII* III*	IV, V and VI II, V and VIII	VII, VIII and IX III, VI and IX

\*Implies compensation to the other party.

difficult than defining the content of standard material procurement. Analogously, the procurement of highly specialized, customized items would abet the sense of moral hazard and opportunistic acts between a general contractor and a system specialist. However, the same concern is little in bulk material procurement.

Since mutual gain between the contracting parties are the precondition for productivity improvement, productivity barriers are developed when one party refuses to compensate the other party even though there is an identifiable gain due to productivity improvement. The differences of behavioral trends between the parties also imply conflicting views of how site productivity should be improved.

Concerning the behavioral linkage, the nine scenarios covered in Table 3 are shown in Table 4 in an attempt to examine the likely behavioral trends concerning productivity improvement. For example, scenario II is regarded highly by the general contractor, but indifferently by the subcontractor. Clearly, potential conflicts exist. Without persuasive leadership from the general contractor, there is remote chance of resolving such differences.

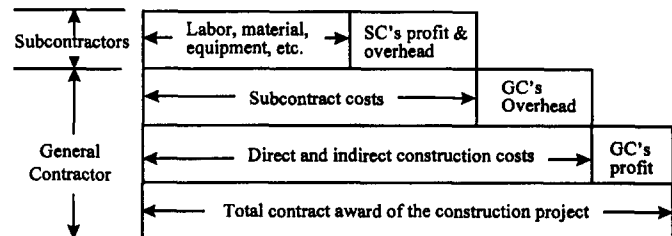
#### Intrafirm Economic Objective

Under the subcontracting framework, site operations are carried out mainly by subcontractors, whereas the general contractor is concerned with the management of site activities. Due to this difference of emphasis, construction costs can be conceptualized as those controlled by the general contractors versus those by the subcontractors, as illustrated in Fig. 2.

To maximize profit, the general contractor can exert effort in two directions: (1) controlling the subcontract costs; and (2) economizing the internal overhead. Since the purpose of controlling subcontract costs is to reduce the amount of money payable to the subcontractors without quantity or quality adjustments, subcontractors would react passively to general contractor's site management if this measure were exercised. For labor-related services, in particular, controlling subcontract cost would further worsen the situation, since supervising quality and verifying quantity are costly.

Economizing site overhead would also affect productivity. Site overhead costs normally include the expenditures of gathering and updating market price information, contract preparation, contract negotiation, contract administration, and site supervision. Downsizing site management and the use of standardized contract documents are common means of economizing the overhead costs. Together they create tremendous frustration and a sense of distrust between the subcontractors and the general contractor. Without perfect price information, the general contractor may produce erroneous subcontract budgets, leading to the selection of incapable subcontractors. Standardized contracts may eliminate the need to draft contractual terms but can be unwieldy for dealing with contingencies on-site. The deficiency of manpower in site management dilutes the general contractor's ability to plan for and communicate with subcontractors, and to handle their individual problems or interference.

For subcontractors, profit maximization relates mainly to economizing the production cost, since the overhead cost is relatively insignificant. Given that the quantity and quality



**FIG. 2. Project Cost Structures for General Contractor and Subcontractors**

must not be changed, economizing the production cost corresponds to efficient allocation of construction resources. Therefore, the employment of labor-intensive construction methods offers subcontractors the economic advantage of switching any proportion of labor from one project to another on a daily basis. Mechanization, in comparison, renders efficient resource allocation more difficult and costly. As a result, subcontractors are not motivated to collaborate with any particular general contractor for long-term betterment. Switching of workers by subcontractors also impedes site management's efforts to train and motivate workers.

#### INSTITUTIONAL STRATEGY FOR PRODUCTIVITY IMPROVEMENT

The benefit of subcontracting is that it not only allows the general contractor to acquire various construction services efficiently from the resource market but also is an effective means of cost control and risk management. Unfortunately, this practice may also pose tremendous barriers to site productivity. The institutional gaps between the general contractor and the subcontractors are crucial factors affecting site productivity and should not be overlooked. Based on the information gained from the questionnaire survey and the follow-up interviews, three key institutional strategies for resolving productivity barriers deserve special consideration: management of contracting uncertainty, rationalization of the transaction governance structure, and management of subcontractors as internal human resources.

#### Management of Contracting Uncertainty

When the construction work is subcontracted to other parties, the use of a formal contract is essential. Two aspects may be considered for managing the contracting uncertainties between the contracting parties: value-chain subcontracting and long-term procurement.

##### Value-Chain Subcontracting (Porter 1985)

General contractors often procure construction services simply based on what is available in the market. For example, concrete work is usually jointly completed by the formwork subcontractor, pre-mix concrete supplier, and the concrete placement subcontractor. This work is divided into three distinctive specialties because each possesses specific resources and the related knowledge. In consequence, the general contractor must manage three separate contracts, separate work



sequences, and the potential interference or conflicts. Alternatively, the entire concrete work may be collectively subcontracted to any of the three—preferably, the one with the greatest financial and operational ability. Since the work is packaged into one and the key subcontractor is solely responsible for any problem related to the final product, contracting uncertainties are actually reduced. For practicality, this may call for renewal of the pricing mechanism and the related contractual arrangements.

#### *Long-Term Procurement (Williamson 1979)*

For the provision of standardized materials and common labor, long-term procurement contracts may be more economical for both the general contractor and the subcontractor. Quantity procurement can greatly reduce transaction costs accrued to the general contractor. Reduced uncertainty concerning future workload permits the subcontractor to allocate its resources efficiently for a longer period and therefore to reduce production costs. Long-term procurement also provides additional mutual governance of each separate service. Consequently, both parties' opportunism is more restrained.

#### **Rationalization of Transaction Governance Structure**

Instead of subcontracting, the general contractor always has the option to perform construction tasks using internal capacity when this is more economical and less risky. However, internalizing construction services is sometimes more of a strategic decision than a purely economic one. Obviously, when this option is chosen, many of the productivity barriers cited in the preceding text are nonexistent, since the economic objectives between the contracting parties are more focused, interfirm linkage is effectively governed, and the market force from the resource market may be better managed. In short, internalization gives the general contractor a much stronger grip upon the entire construction process.

Between the two extremes of clear-cut subcontracting and hierarchical internalization (Krippaehne et al. 1992) exist several derived governance structures. The inside contracting system (Eccles 1981) and tapered integration between the contracting parties (Porter 1980), for example, are two useful concepts that have shown practical significance, according to field interviews. In practice, however, the actual implementation of these concepts can take many different forms. The true benefit of these concepts is that they allow both flexibility and control in governing the transaction of construction services. According to experience, these concepts are most suitable to construction services that involve high transaction-specific expenses, dedicated equipment and human resources, and specialized technical knowledge.

#### **Management of Subcontractors as Internal Human Resources**

The general contractor typically regards subcontractors as outsiders to the organization. The sense of alienation prevents the contracting parties from forming a project team, or at least a coalition, and causes various productivity barriers. It should be noted, however, that when the subcontractor is bound by a contract, the subcontractor may alternatively be seen as a site employee of the construction firm. The only differences in managing a subcontractor bound by a contract and managing site employees of the general contractor lie in the duration of employment and pay basis. For the subcontractor, duration has been spelled out in the contract and the pay basis is based on the level of service output rather than a regular salary or wage. If this concept becomes well understood, the general contractor would be expected to put more emphasis on the on-the-

job training, project safety systems, documentation and evaluation of work ethics and performance, and team building, all of which are key elements of human resource management (Langford et al. 1995). Positive feedback from subcontractors includes the provision of more skilled workers, a lower frequency of worker switching from site to site, and, most importantly, higher commitment to the project.

#### **CONCLUDING REMARKS**

The main focus of this paper is on highlighting the crucial connection between subcontracting and site productivity. According to lessons learned from an extensive survey in Taiwan's construction industry, subcontracting appears to be a necessary means employed by general contractors for project execution. Under subcontracting, the market forces derived from the construction industry, the interfirm transaction linkage, and the potentially conflicting intrafirm economic objectives between the contracting parties, alone or in combination, may generate enormous barriers to site productivity. If these productivity barriers are not clearly identified and understood, routine site productivity studies become superficial, in that seemingly plausible causes for productivity losses may be indicated and vain inferences or conclusions for productivity improvement follow.

As this paper has demonstrated, contractual and behavioral linkages between firms call not only for the realization of an attractive gain from productivity improvement but also for an agreeable benefit-sharing mechanism between firms. Traditional research related to construction productivity improvement generally has failed to appreciate the institutional aspects. The new emphasis, developed in this paper, points to a number of areas for deeper understanding and future research, including contracting theory, game behavior, and transaction costs.

It is the general contractor's recognition of the crucial role played by subcontractors in the construction process that leads the determining effort to seek institutional strategies for productivity improvement. Extensive interviews with field practitioners have revealed three encouraging institutional strategies. According to the conceptual model developed in this paper, these strategies are purposely employed for enhancing the transaction linkage and expediting the pursuit of economic objectives between the contracting parties. It is important for the general contractor to implement these strategies through both behavioral and contractual linkages in order to optimize the outcome. The absence of marked effort to better manage the market forces may be attributed to either bounded rationality or the potential difficulty involved. More work should be performed to refine the strategies identified and to investigate other strategies in major construction industries worldwide.

#### **APPENDIX I. QUESTIONNAIRE SENT TO GENERAL CONTRACTOR**

##### **Part I: Background**

1. Your firm is registered as:  
☐ Class A   ☐ Class B   ☐ Class C
2. Your firm has been in business for \_\_\_\_\_ years.
3. The registered capital of your firm is \_\_\_\_\_ dollars.
4. Number of permanent employees in your firm:  
 Technical:  
 Administrative:  
 Worker (domestic):  
 Worker (foreign):  
 Others (please specify)
5. Your firm's average annual business volume for the past three years:

Civil construction:  
Building construction:  
Others (please specify)

## Part II: Relationship with Subcontractors

1. Selection of subcontractors:
  - ☐ Complete renewal in every project
  - ☐ Based on past working experience
  - ☐ Based on some form of long-term contracts
  - ☐ Others (please specify)
2. Financial relationship with subcontractors:
  - ☐ Pure subcontracting
  - ☐ Share ownership of some subcontractor firms
  - ☐ Full ownership of some subcontractor firms
  - ☐ Others (please specify)
3. Please indicate your firm's long-term working relationship with the following trades:

Subcontractor trade	No. of qualified subcontractors	Length of working relationship	Full/partial ownership	
Earth moving		_____ years	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Rebar work		_____ years	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Concreting		_____ years	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Form work		_____ years	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Plastering		_____ years	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Interior fixture and finishes		_____ years	<input type="checkbox"/> Yes	<input type="checkbox"/> No
HVAC		_____ years	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Exterior fixture and finishes		_____ years	<input type="checkbox"/> Yes	<input type="checkbox"/> No

4. Account of length of working relationship with subcontractors:
  - Less than two years: \_\_\_\_\_%
  - Between two to five years: \_\_\_\_\_%
  - More than five years: \_\_\_\_\_%
5. Formal subcontractor evaluation as basis for future selection:
  - ☐ Procedure exists and is practiced regularly (continue to Question 6)
  - ☐ Procedure exists but is seldom practiced (continue to Question 6)
  - ☐ Procedure is nonexistent (please jump to Question 8)
  - ☐ Others (please specify)
6. The frequency of subcontractor evaluation:
  - ☐ Regular, \_\_\_\_\_ time(s) per year
  - ☐ After completion of each project
  - ☐ Others (please specify)
7. The criteria of subcontractor evaluation: (multiple choice)
  - ☐ Quality
  - ☐ Financial
  - ☐ Safety
  - ☐ Schedule
  - ☐ Labor relationship
  - ☐ Technical ability
  - ☐ Managerial ability
  - ☐ Cost control
  - ☐ Work ethics
  - ☐ Others (please specify)
8. Criteria for recruitment of newcomer-subcontractors:
  - ☐ Performance account of peers
  - ☐ In-progress projects
  - ☐ Capital assets
  - ☐ Accumulated work experience
  - ☐ Financial ability
  - ☐ Quality of human resource
  - ☐ Others (please specify)

## 9. Suggestions for subcontractor improvement:

- ☐ Expand business volume. Reason:
  - ☐ Improve financial ability. Reason:
  - ☐ Increase mechanization. Reason:
  - ☐ Methods improvement. Reason:
  - ☐ Quality assurance. Reason:
  - ☐ Schedule control. Reason:
  - ☐ Safety management. Reason:
  - ☐ Labor supply stability. Reason:
  - ☐ Improve worker skill. Reason:
10. Assistance ever given to subcontractors by your firm:
    - ☐ None
    - ☐ Managerial skills
    - ☐ Visit technical conference
    - ☐ R&D joint venture
    - ☐ General assistance on site
    - ☐ On-the-job training
    - ☐ Explore new technologies
    - ☐ Others (please specify)
  11. Attention devoted to subcontractors by site engineers: \_\_\_\_\_ man-hours/week.
  12. After signing contract with subcontractors, the amount of prepayment: \_\_\_\_\_% of the contract value.
  13. After completion of the work, the performance bond: \_\_\_\_\_% of the contract value.
  14. Nature of the relationship with subcontractors:
    - ☐ Low bids win all
    - ☐ Partial commitment to long-term relationship
    - ☐ Low bids with prequalifications
    - ☐ Partial ownership of some trades (please specify)
    - ☐ Internalization of some trades (please specify)
    - ☐ Others (please specify)

## Part III: Relationship with Material Suppliers

1. Selection of material suppliers:
  - ☐ Complete renewal in every project
  - ☐ Maintenance of long-term transactional relationship
  - ☐ Commitment to long-term relationship by formal contracts
2. Account of working relationship with material suppliers:
  - ☐ Less than two years: \_\_\_\_\_%
  - ☐ Two to five years: \_\_\_\_\_%
  - ☐ More than five years: \_\_\_\_\_%
3. Number of suppliers in consideration of material procurement in the following trades:
  - ☐ Steel reinforcement:
  - ☐ Pre-mix concrete:
  - ☐ Bagged cement:
  - ☐ Tiles:
  - ☐ Aggregates:
4. The criteria for supplier selection: (please limit to three items)
  - ☐ Material quality
  - ☐ Material price
  - ☐ Timing of delivery
  - ☐ Past working relationship
  - ☐ Supplier's general management ability
  - ☐ Supplier's professionalism
5. The financial relationship with material suppliers:
  - ☐ Spot transaction only
  - ☐ Share ownership: \_\_\_\_\_% (please specify)
  - ☐ Full ownership (please specify)
  - ☐ Others (please specify)
6. The amount of prepayment when completing material order: \_\_\_\_\_%  
The amount of cash payment after material delivery: \_\_\_\_\_%



7. The waiting period for cash payment after material delivery:
  - ☐ Less than one month
  - ☐ One to two months
  - ☐ Two to three months
  - ☐ More than three months
8. Assistance ever given to material suppliers by your firm:
  - ☐ None
  - ☐ Business expansion
  - ☐ Importation of new materials
  - ☐ General assistance in the firms
  - ☐ Exploration of new technologies
  - ☐ R&D joint venture
  - ☐ Others (please specify)
9. Nature of the relationship with material vendors:
  - ☐ Low bids win all
  - ☐ Partial commitment to long-term relationship
  - ☐ Low bids with prequalifications
  - ☐ Partial ownership of some trades (please specify)
  - ☐ Internalization of some trades (please specify)
  - ☐ Others (please specify)

## APPENDIX II. QUESTIONNAIRE SENT TO SUBCONTRACTOR

### Part I: Background

1. Your firm has been in business for \_\_\_\_\_ years.
2. The registered capital of your firm is \_\_\_\_\_ dollars.
3. The specialty of your firm:
4. Number of permanent employees:
  - Technical:
  - Administrative:
  - Worker (domestic):
  - Worker (foreign):
  - Others (please specify)
5. The annual average business volume for the past three years:

### Part II: Contractual Relationship with Contractors

1. The frequency of required bid bond:
  - ☐ Very often
  - ☐ Sometimes
  - ☐ Seldom
  - ☐ Never
2. The percentage of bid bond in the contract value: \_\_\_\_\_%
3. The frequency of required performance bond:
  - ☐ Very often
  - ☐ Sometimes
  - ☐ Seldom
  - ☐ Never
4. The percentage of performance bond in every progress payment: \_\_\_\_\_%
5. The frequency of being given prepayment:
  - ☐ Very often
  - ☐ Sometimes
  - ☐ Seldom
  - ☐ Never
6. The percentage of prepayment in the contract value: \_\_\_\_\_%
 

The purpose of the prepayment (please specify)
7. Reasons for being unable to collect full contract awards:
  - ☐ Contractor's short-term financial difficulty
  - ☐ Any form of change order
  - ☐ Interference of other trades
  - ☐ Others (please specify)
8. Specification of contractual terms is done:

- ☐ Solely by the contractor
  - ☐ By collaboration of both contracting parties
9. Frequency of contributing to construction planning and scheduling:
    - ☐ Very often
    - ☐ Sometimes
    - ☐ Seldom
    - ☐ Never
  10. Handling of interference/conflicts/disputes between your firm and other trades:
    - ☐ By contractor's leadership
    - ☐ By negotiation among subcontractors
    - ☐ According to characteristics of the project
    - ☐ Others (please specify)
  11. Frequency of being given working drawings:
    - ☐ Never
    - ☐ Self-provided when needed
    - ☐ Contractor-provided when requested
    - ☐ Contractor-provided always

### Part III: Behavioral Relationship with Contractors

1. Maintenance of long-term working relationship with contractors:
  - ☐ Formal procedure nonexistent
  - ☐ By commitment to quality service
  - ☐ By long-term contracts
2. Assistance ever given by contractors:
  - ☐ None
  - ☐ Managerial skills
  - ☐ Visit technical conference
  - ☐ Financial help
  - ☐ General assistance on site
  - ☐ On-the-job training
  - ☐ Explore new technologies
  - ☐ R&D joint venture
  - ☐ Others (please specify)
3. Assistance most needed from contractors: (please limit to three items)
  - ☐ General assistance on-site
  - ☐ On-the-job training
  - ☐ Explore new technologies
  - ☐ R&D joint venture
  - ☐ Managerial skills
  - ☐ Visit technical conference
  - ☐ Financial help
  - ☐ Others (please specify)
4. Assistance most needed from government agencies: (please limit to three items)
  - ☐ General assistance on-site
  - ☐ On-the-job training
  - ☐ Explore new technologies
  - ☐ R&D joint venture
  - ☐ Managerial skills
  - ☐ Visit technical conference
  - ☐ Financial help
  - ☐ Others (please specify)

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