THE CURRENT SITUATION OF UNIT PRICES, ETC. IN SUBCONTRACTS OF REBAR WORK: A HISTORY BASED CASE STUDY OF A REBAR COMPANY

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Abstract  
One of the major factors that make the Japanese construction production system vulnerable is the multi-layering of subcontractors. It has been pointed out frequently that business transactions in such multilayered systems often lead to pricing and scheduling difficulties due to the nature of the relationship between contractors and subcontractors. However, such circumstances have seldom been examined quantitatively. Therefore, it has been difficult to study them objectively and to improve the system.

Nonetheless, we were able to obtain a set of relevant data, which we closely studied and analyzed to examine such transactions. The company that we examined, which we call Company A, is a rather large rebar company located near Tokyo. We statistically analyzed the firm's 650 contracts over the past decade and discovered useful facts.

Keywords: specialty contractor, statistical analysis, unit price, seasonal fluctuation, duration.

1. RESEARCH OBJECTIVES AND MATERIALS

One of our research objectives is to understand the problems that are associated with the treatment of skilled construction workers in Japan. Discussions regarding this issue often lack any firm knowledge of reality. Therefore, we aim to better our understanding of such problematic treatment by examining the current situation of the construction industry from the perspective of specialized construction firms.

In the fall of 2007, we surveyed six relatively large-scale construction companies that specialize in rebar work in and around Tokyo. Although detailed descriptions of these companies are not relevant
here, it should be noted that these companies are favored subcontractors\(^1\) of influential general contractors. In other words, they are first-tier subcontractors that are powerful enough to hold executive positions in collaborative subcontractors associations\(^2\).

As part of this survey, we obtained the contract history of one rebar firm; we will refer to this firm as Company A. This contract history differs from ordinary ones in that it contains contract prices, quantities of rebar used in each project and work durations, along with the typically given data (names of the clients and projects). Moreover, this data spans over the ten-year period from 1997 to 2006, and is very detailed (except in the case of some small projects). In other words, this data is a valuable resource that shows what kinds of subcontracts this rebar company signed with prime contractors (general contractors and local construction companies). In this study, we statistically analyzed this data. Table 1 shows a profile of Company A.

| Location: | Headquarters in Tokyo; Processing plants in 2 locations |
| Foundation: | 1975 (Approximately) |
| Capital: | 50 million yen |
| Specialization: | Rebar work (Permit granted by the Governor of Tokyo) |
| Employees: | 160 (30 in processing plants, 100 on-site, 30 in other locations); 30 second-tier subcontractors (all numbers are approximate) |
| Work description: | Its principal client is one large general contractor. Its work consists primarily in building construction. |

*Table 1: Profile of Company A*

An overview of Company A's contract history is as follows:

1. Data: 650 contracts (some small jobs were omitted)
2. Duration: 1997 - 2006 (ten fiscal years)
3. Contents: As shown in Table 2. The data recorded in this contract history is the complete record of Company A's business transactions during that decade; the annual totals of the project prices recorded in this data nearly match the company's annual total sales.

<table>
<thead>
<tr>
<th>Year</th>
<th>Client</th>
<th>Project</th>
<th>Project Price</th>
<th>Quantity</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Company name</td>
<td>Building name</td>
<td>Price given in ten thousands of yen</td>
<td>tons(^3) of rebar</td>
<td>month/year - month/year</td>
</tr>
</tbody>
</table>

*Table 2: Description of the Data in Company A's Contract History*

Further description of the items in this contract history is given below.

- Project price: the actual contract prices after final adjustments (this price excludes sales tax)
- Quantity: adjusted quantities
- Duration: the length of time during which Company A actually provided rebar work services

The unit price (given as ten thousands of yen / ton) of a project is calculated from the project price and the quantity of rebar used. Although further details will be discussed later, it must be noted

\(^1\) A favored subcontractor, or meigi-nin in Japanese, is a subcontractor that has won the trust of a prime contractor as the result of their long-term working relationship. A prime contractor gives priority to its favored subcontractors when subcontracting projects.

\(^2\) A collaborative subcontractors association, or kyoryoku-kai in Japanese, is an intermediary organization consisting of first-tier subcontractors that provide services to a common general contractor.

\(^3\) Here and throughout the paper the term "ton" is used to refer to metric tons.
here that some very high unit prices should be considered as exceptions, due to the fact that they include both material and labor prices. In such material-and-labor contracts, Company A has to purchase rebar materials for the projects because either their client firms do not have sufficient credit to purchase materials themselves or because the projects are very small in scale. In transactions with large general contractors, these contractors usually provide Company A with the materials. Therefore, unit prices in such contracts only include labor.

2. TYPES OF DATA ANALYSIS

Using the data from the above-described contract history, it was possible to calculate the unit price of the rebar work and to study its fluctuations over time. This same data could also be analyzed in terms of the client firms. While most of the projects carried out by Company A were building construction, some project names suggest that they were either special or public works construction. Although the project names do not indicate the exact nature of the work involved, such projects that were suspected of being exceptional were excluded from certain analyses. The fact that this contract history provides work durations is valuable, but this data is given in terms of months and thus lacks precision. Furthermore, findings from this contract history cannot easily be generalized to the entire rebar work sector because the data comes from just one particular company. Therefore, the data used in this study has both strengths and limitations; its analyses resulted in some interesting findings, but the scope of the results of this study is somewhat limited.

We carried out the following analyses, and this paper reports the findings of some of them:

- Fluctuations in contract prices, quantities, unit prices and other factors over time;
- Fluctuations in the degree of exclusivity of Company A with a single general contractor over time;
- Frequency distributions of per-contract quantities and project prices;
- A study of whether unit prices vary between contracts with different contracting firms, and whether they fluctuate between different contracts with the same company;
- A study of whether unit prices change with the quantity contracted (for example, does an economy of scale exist?);
- An analysis of seasonality (whether the quantity of work begun and the project unit price vary from month to month);
- The relationship between the quantity (or the contract price) and the duration of the work; and
- Whether actual unit prices differ from the market unit prices, which are used to calculate the ceiling prices.\(^4\)

Price analyses (e.g. unit price analyses) over a span of approximately ten years usually require adjustments by the construction price deflator. In our case, however, the deflator varied very little, between 102.8 in 1997 and 97.4 in 2002 with 2000 as the base year. Thus, we determined that this variance was not significant enough to make special adjustments to the data.

3. STATISTICAL ANALYSIS OF COMPANY A'S REBAR WORK CONTRACTS

\(^4\) A "ceiling price" is the pre-set cost-of-construction as reasonably predicted by owner-side engineers using the provisions in the Public Accounting (Financial) Law (enacted by the Japanese government in 1889). Unlike in other countries, there is a provision in this law requiring that this pre-estimated amount should stay under a certain ceiling. This results in the rule that the successful tender price should not exceed the ceiling price.
3.1. Fluctuations in Company A's Work Performance Over Time

Figure 1 shows the fluctuations in Company A’s performance over the past decade. Company A is a relatively large rebar company. It has between 40 and 100 contracts per year, and its annual earnings fluctuate between 1.4 billion and 2.4 billion yen. The company’s quantity contracted (i.e. the weight of the rebar used) ranges between 31,000 and 48,000 tons per year.

We statistically analyzed Company A’s contract history to see if it contains any particular tendencies. We first examined Company A’s contracts by scale. While the company’s contracts vary widely in size, an overwhelmingly large number of them are small contracts (see Figure 2). Overall, the average quantity contracted is approximately 616 tons (with a median of 307 tons), and the average contract price is approximately 28 million yen (the median is approximately 14,070,000 yen). The quantities contracted and contract prices both declined slightly in recent years, perhaps because Company A signed more small contracts to maintain its business or the contracting firms are pressuring them to lower their project costs. (We will discuss unit prices later.)

Fig.1: Fluctuations in Company A’s: Annual Contract Prices, Quantities, Number of Contracts and Average Unit Prices

Fig. 2: Histograms of Company A’s Per-Contract Quantity and Price

3.2. Analysis of Company A’s Clients

Company A had contracts with 26 firms during the decade covered in the data. While most of the jobs were small-scale and sporadic, Company A had an on-going relationship with four firms, including one large general contractor (indicated as GC17 in Figures 3-1 through 3-4). Figures 3-1 through 3-4 show Company A’s relation to all of the contracting firms in terms of: number of contracts, quantities contracted, contract prices and unit prices. These graphs illustrate the nature of Company A’s relationship with each firm.

As shown in Figure 4, Company A’s degree of exclusivity (in terms of the proportion of its total income) with GC17 fluctuated between 70% and 97%. Establishing close relationships with a small number of general contractors is not unusual for first-tier rebar work subcontractors (See Reference 1). This phenomenon began after the end of World War II when rebar companies assumed the role
of specialized framework builders and were closely associated with general contractors. In fact, all of the surveyed companies in this study are so-called favored subcontractors, and they are powerful members of collaborative subcontractors associations that are each associated with a large general contractor.

Company A had only one or two contracts with some firms during the recorded period. These firms are mostly construction companies located near Company A. According to Company A, they have a policy to not neglect the demands of such neighboring firms.

3.3. Relationship Between the Quantity Contracted and the Unit Price

Generally speaking, the quantity contracted is believed to affect the unit price because of the economy of scale. We examined our data to see if this holds true in the case of Company A.

Figure 5 illustrates the relationship between these two values in the context of ordinary projects (excluding public works). A concentration of points can be observed at around 50,000 yen, but higher unit prices are recorded for jobs with low quantities contracted. Therefore, the data at first glance appears to show the economy of scale. However, Company A informed us that some of the small projects were material-and-labor contracts, implying that those unit prices included the cost of materials and labor. Furthermore, they also explained that some unit prices are unusually high because of high contract prices. These high prices were due to the fact that they either included fees from other projects done for the same firms around the same time or were for projects with materials, which were difficult to manipulate. Although such exceptional cases are not easily distinguishable in the data, they are nonetheless important factors that caused unit prices to be
skewed. Therefore, although small projects do appear to be comparatively more costly, we cannot establish that such a tendency in fact exists. For quantities of 60 tons or more, the unit price trend line becomes flat. We thus conclude that the economy of scale does not exist for unit prices in that upper range of quantities contracted.

The same relationship (quantity contracted versus unit price) for each of Company A’s main clients is shown in Figures 6-1 through 6-4. Because Company A has established contractual terms with each client, the unit price for each firm should fluctuate relatively little between contracts unless project-specific conditions cause alterations in the price. Figures 6-1 through 6-3 refer to transactions with three different nation-wide general contractors, and their unit prices only include labor. These labor-only unit prices do not vary greatly from one contractor to another. Figure 6-4, on the other hand, is of Company A’s contracts with a local general contractor. This graph’s unit prices are segmented into two groups because some include both material and labor while others include only labor. We could not classify this data into the two different
categories, as it was not possible to get this information from Company A.

3.4. Fluctuations in Unit Prices Over Time

Figure 7 shows the quarterly fluctuations in unit prices (ten thousand yen / ton) in contracts with the principal large general contractor (GC17). Until 2005, the unit price gradually declined, but then it rebounded slightly in 2006. This rise was due to a severe shortage of rodmen (see Figures 8), which was especially problematic in the Kanto region. This scarcity was comparable to that experienced during the bubble period in Japan. However, this problem has been resolved, i.e. December of 2007 recorded a negative shortage, and this factor is not expected to be the cause of increases in construction costs any longer. Rodmen scarcity is believed to have lessened in recent years because of the reduction in the number of building confirmations and inspections after the Revised Building Standards Act came into effect in June of 2007.

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**Fig. 7: Quarterly Fluctuations in Unit Prices in Contracts with GC17 (Box plot)**

**Fig. 8: Fluctuations in Rodman Shortages in the Building Sector (by National Average and Region)**

*Note:* Figures created from the monthly data in the Survey of Supply and Demand of Construction Labor compiled by the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) of JAPAN.
Interestingly, the shortage of rodmen in the building sector was the worst of all the shortages of construction workers in Japan in recent years. Other specialties, such as rodmen in public works and timbermen in building work, have also experienced shortages but were not nearly as scarce as rodmen in the building sector. Though rodmen were most scarce in the Kanto region and Hokkaido, this shortage was not as pronounced in the rest of Japan. The shortage of construction workers is an index that varies greatly, as large construction projects can cause drastic shortages of workers in their surrounding areas. Whether 2006’s shortage of rodmen (in the building sector) in the Kanto region was due to such circumstances is not known.

3.5. Seasonality of the Work Quantity

Fluctuations in quantities contracted and the quantities executed throughout the year indicate the ups and downs of a company’s business; this is also known as the “seasonality of the work quantity.” The quantity executed was estimated from the new quantity contracted in each month and the duration of each contract. More specifically, the estimated quantity executed for each month was calculated by simply dividing each quantity contracted by the duration of that project, and allocating that per-month quantity to every month during which the project took place.6 Figure 9-1 shows the quantities contracted and Figure 9-2 shows the estimated quantities executed from January through December over the decade.

9-1: Quantity Contracted in the Months that Projects were Begun (1997 - 2006)

9-2: Estimated Executed Quantity in the Months that Work was Executed (1998 - 2006)

Fig. 9: Seasonality of the Work Quantity in the Months that Projects were Begun and in the Months that Work was Executed

According to the summary of the monthly quantity of new projects (see Figure 9-1), more projects (in terms of quantity) were commissioned during the first half of the year and that number decreased

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6 According to Company A, the quantity of work fluctuates differently in each project and is therefore difficult to estimate. However, they believe that the sum of all of the estimated quantities executed for each month (calculated by a simple division as described in the text) should not deviate significantly from the actual monthly quantity of executed work. Company A’s current business objective is to install 3,500 tons of rebar every month, with an annual maximum up to 48,000 tons. (cf. Figures 9-1 and 9-2).
slightly during the second half of the year. However, this tendency is not very clear. The quantity of new work seems to fluctuate rather largely between those months with many new contracts and those with very few.

On the other hand, the summary of the monthly estimation of the quantities executed shows the opposite tendency; this quantity tends to increase during the second half of the year. The range of the variation, however, is smaller than that in Figure 9-1. In other words, the estimated quantity of executed work is rather stable from month to month. This stability is achieved by Company A’s appropriate allocations of its resources. Company A seems to adjust when and what projects it accepts in order to maintain a productivity level as close to their highest capacity as possible at all times. This ability is key for a successful specialized company.

3.6. Analysis of the Work Duration

The average duration of Company A’s projects was 8.70 months (the average for projects for GC17 was 9.35 months). However, it must be noted that the recorded durations differ slightly from (i.e. are slightly longer than) the actual durations, because the data was given in terms of months (see Figure 10). The relationships between the work duration and the quantity contracted are shown in Figure 11. These figures show that a certain level of correlation exists between the work duration and the scale of the work. However, the points are spread widely in both the vertical and the horizontal directions, and thus no strict correlation can be determined.

4. Conclusions

Because the contract history that was analyzed in this study comes from a single rebar company, our findings cannot be readily extended or generalized. Nevertheless, this study provides a glimpse of the current situation in the rebar work sector in Japan and provides information that is virtually unknown outside the construction industry. We therefore believe that our results are valuable. Below is a summary of our findings:
Most of the contracts with large general contractors include only labor (materials are provided by the general contractors), while smaller projects for medium to small-size general contractors may include both material and labor (i.e., Company A provides the materials).

The rebar used in each construction contract is estimated to range between 50 and 200 tons, according to a journal on construction related pricing information (ex. *Kensetsu-Bukka*). However, Company A averages 300 tons in their contracts. (This may be due to the fact that Company A is a favored subcontractor of a nation-wide large general contractor.)

Unit prices in big contracts (more than 100 tons) become more or less fixed, and thus no economy of scale is observed.

In the case of labor only contracts, no significant differences in unit prices are observed from one contract to another.

Starting in the latter half of the 1990’s, the unit price of rebar declined. But it rebounded following the shortage of rodmen in the Tokyo area in 2006.

An analysis of work durations revealed little change in Company A’s monthly number of finished projects (quantity of executed work), when compared with the number of projects begun (the quantity of new contracts). In other words, operational resources are being effectively utilized.

While the duration of a job tends to increase with the cost and scale of the contract, this relationship is not precisely proportional. Actual durations vary greatly from case to case.

Apart from the issues analyzed in this study, many other important factors were uncovered during the interviews. Examples of such factors include: problems related to the treatment (i.e. employment and salary) of the skilled workers who play a vital role in rebar processing plants and construction sites, and the consequent shortage of young workers acquiring such skills, the current situation with foreign trainees and apprentices, and the current atmosphere of subcontracting that necessitates that on-site construction responsibilities be multi-layered. However, we have to leave these topics for another article.

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**REFERENCES**
