IMPACTS OF DESIGN-BUILD DELIVERY SYSTEM ON THE CONSTRUCTION INDUSTRY IN TAIWAN

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ABSTRACT : Although the design-build (DB) delivery system has been taking great strides in the world and relevant researches have also been quite abundant, few studies have dealt with its potential impacts on the construction industry as a whole. This research first identified the potential entry barrier factors, which may hinder the market access, based on the theory of industrial economics and characteristics of DB project. Then through a nation-wide questionnaire survey involving 103 construction contractors and engineering consultants, the influences of each factor on company's competitiveness and corporate strategies we

re scrutinized, and consequently, the evolution of the construction industry was examined.

It is found that as opposed to the traditional design-bid-build delivery system, the DB delivery system elevates competitive advantages of large organizations in terms of the financial capability, working experience, human resource, and administrative strength, and among them, the financial strength was concluded to be the most significant force in differentiating corporate strategies and widening the gap of competitiveness between companies. It is inferred if the government extensively adopts DB delivery system, large organizations that already possess the competitive advantage tend to obtain both design and construction abilities, and dominate the DB market. Small and medium sized companies will find little room to maneuver and be forced to become specialty sub-contractors.

Key words : construction industry, design-build, competitive advantage, strategy, entry barrier

1. INTORDUCTION

Conventionally, public construction projects are executed in the sequence of design-bid-build, as design is separated from construction. However, such delivery system could no longer to meet owner's demands. To satisfy the needs, design-build (DB) delivery system has been gaining acceptance as an innovative solution in many countries in recent decades. In Taiwan, it was not until the enactment of the Government Procurement Law (GPL) in 1999 that DB began to be adopted as one of the major delivery systems for public construction projects.

Construction market of public projects is often described in economics as Monopsony where government is the only buyer in the market and the government policies have a direct impact on the market. DB delivery system breaks up the conventional practice, in which design and construction have long been separately handled, and from the viewpoint of industrial economics, it certainly will affect the overall construction industry. Yates [15] mentioned that all participants on construction projects, the contracting strategies, labor situation, and the overall competition environment in the U.S. engineering and construction industry will be affected by the implementation of DB delivery system. However, most of previous studies on DB delivery system were confined to the project-level research. For instance, the performance evaluation of DB projects [1-7], contractor selection process and project controlling mechanisms [8-12], and investigation on critical success factors of DB projects [13-14]. So far, overall studies on the construction industry have long been neglected. This research use Taiwan construction industry as a study sample to assess the impacts of DB delivery system on the company's competitiveness and corporate strategy, and ultimately the structural changes in the construction industry.

2. CONSTRUCTION INDUSTRY IN TAIWAN

The construction industry in Taiwan can be categorized into three segments: construction contractors, design-consulting companies, and real estates investors. Participants in public construction projects usually come from construction and design-consulting companies.

Construction contractors in Taiwan are classified into A, B, and C classes in construction industry. Companies of A, B, and C classes are all entitled to participate in bidding for public projects, yet only those of class A are allowed to consolidate the projects with budgets over one hundred million Taiwan dollars. Hence, they are the powerhouse in the industry. According to the statistics of Construction

and Planning Agency Ministry of Interior, until 2003 there were more than 12,000 construction contractors in Taiwan, however, most of which were small-to-medium sized. The statistics of ENR 2002 show that among the top 225 construction contractors of the world in 2001, only two companies from Taiwan hit the roll. RSEA Engineering Corp. that was ranked as the 119th has the highest business revenue in Taiwan, and CTCI Corp. that was numbered as 208th is the second largest construction contractor in Taiwan. According to data collected from Ministry of Economic Affairs, during the five-year period between 1998 and 2002, construction market in Taiwan demonstrated a Market Concentration Ratio 8 of around 8%-11%, which is the most dispersed one compared to the five-scale categorization proposed by Bain [16].

Design-consulting companies can be divided into architect's office and engineering consultant. Most of architect's offices are personal workplace. The number of engineering consultants is around two thousand, and their size may greatly vary. Large-scaled ones can hire more than one thousand employees, while smaller ones consist of only 3 to 5 people. Statistics of the Chinese Association of Engineering Consultants shows that small-to-medium companies outnumber large ones and only fourteen members have capital of more than one hundred million Taiwan dollars, the amount required for a construction contractor to be ranked as Class A. There is no doubt that most design-consulting companies are not equipped with the financial ability to consolidate construction projects.

3. RESEARCH DESIGN

The structure-conduct-performance (SCP) paradigm was used comprehensively as one of the most important approaches in many studies in the last two decades. The SCP paradigm depicts the interaction relationship between market structure, market conduct, and market performance, and impact of government policies on structure, conduct, and performance [17]. In recent years, the "entry barriers" of market structure section and "corporate strategy" of market conduct section in SCP paradigm are the two focuses in the literature of economies [18]. This research is designed to first scrutinize the entry barriers caused by DB delivery system. Data collected from questionnaire survey are then analyzed to examine the influence of each factor on company's competitiveness and corporate strategies.

4. ENTRY BARRIERS CAUSED BY DB DELIVERY SYSTEM

"Entry barriers" are any structural and durable feature of a market that inhibits the ability of outsiders to enter and compete with established insiders [19]. To extend the sense, the entry barriers are able to act as a force that could influence the companies' competitive positions in the market. Thus, the consequence of high barriers is that the advantageous companies enjoy more chances to take a higher competitive position and gain more profits.

In competitive bidding system, cost is the only entry barrier to differentiate competitiveness of competitors. Companies with more sales may take the advantage of large quantity to obtain materials or labor at lower cost, and companies with better location may also enjoy lower transportation cost. In DB delivery system, the different mechanism of award and project execution brings about new entry berries to the market. The entry barriers caused by DB delivery system are discussed from two perspectives as follows.

4.1 Owner-Driven Entry Barriers

Best value contracting method is comprehensively used in DB projects, which the contractor selection criteria include both prices and qualifications [20]. In Taiwan, after the enactment of GPL in 1999, best value contracting method was granted and has been widely used for most DB projects.

Under best value contracting method, non-price issues, such as company's qualification and competence, weigh on competitive edge, and become important factors of winning bids. Taiwan government set general guidelines regarding the DB contractor selection criteria. In addition to technical proposal, the criteria consist of (1) experience of DB projects; (2) record of work performance; (3) financial capability and (4) qualification of key personnel. If companies are better qualified in these fields, they will be more competitive in the tender stage.

4.2 Contractor-Driven Entry Barriers

As DB delivery system combines the operations of design and construction, it demands more competent contractor than traditional delivery system. If DB delivery system will widen the gap of competitiveness between contractors, some forms of entry barriers could occur.

Economist Bain identified four elements that act as barriers to entry as: (1) economies of scale, (2) absolute cost advantages, (3) capital cost requirements, and (4) product differentiation advantages [17], aspects of which will be discussed as following:

4.2.1 Economies of Scale

Economies of scale refer to declines in unit costs of a product (or operation or function that goes into producing a product) as the absolute volume per period increases [21]. To view a construction project as a production process, the company with higher annual turnover has higher production amounts. Bid preparation becomes a potential source of economies of scale for companies with higher annual turnover to create cost advantage.

It is recognized that the bid preparation of DB project is a costly job. A company must put a tremendous amount of efforts to produce a competitive tender proposal. It is inevitable for companies to bear the risk of losing the bid if they join the bidding war. Chiang et al. [22] suggested that the larger companies have more capacity than their smaller rivals in absorbing the costs of unsuccessful tenders. In fact, the cost of bid preparation can easily be shared among projects in larger companies so that the burden is relatively

smaller then that of small to medium size companies.

4.2.2 Absolute Cost Advantage

Companies may have cost advantage not replicable by other companies no matter their size and attained economies of scale [21]. It can be achieved in cases of a company has proprietary construction technology, favorable access to raw materials, and constructive design.

In DB projects, the low design completion level at the tender time can motivate advantages of introducing innovative material and construction method and effectiveness of design-construction integration. This concept is contrary to common practice of 100% design completion prior to procuring builder services in traditional design-bid-build projects [6]. Therefore, competent companies may benefit from the flexibility of integrating design and construction to lower their cost.

4.2.3 Capital Cost Requirement

Capital cost requirement can differentiate companies when high capital investment is required for the production.

Typically, the design is only partially complete at the time the construction contract is executed in a DB project. The lack of a clear project scope makes it more difficult to establish activity quantities and labor requirement. The fluctuations are, therefore, to be expected [23]. Thus, more working capital is often needed to cover the variations in labor, equipment, and material quantities in a DB project.

Besides, the payment of DB project is mostly based on the established milestone along the project life cycle. This is different from the traditional practice in which payment is made monthly according to the quantities of works finished. Obviously, DB project requires relatively longer period of time for project financing and demands more capital.

4.2.4 Product Differentiation

Product differentiation is formed when consumers view products as imperfect substitutes for a variety of reasons, including differences in quality, in performance, or in reputation [24]. Unlike economies of scale, absolute cost advantage, and capital cost requirement, product differentiation emphasizes on the quality of a product rather than the cost.

DB delivery system requires companies to submit a certain amount of design during tender stage. Afterward, bidders will be asked to brief on how projects are planned and what construction methods and materials are chosen. Companies can also create their competitiveness with the help of product differentiation through fashionable designs, better alternative materials, construction methods, and etc., so as to raise the project functions and satisfy owners' need.

4.3 Deduced Entry Barriers

As discussed in the above section, there are eight barrier factors resulting from DB delivery system. Four factors derived from Owner-Driven Barriers are: (1) experiences of DB project, (2) record of work performance, (3) financial capability, and (4) qualification of key personnel. The other four factors derived from Contractor-Driven Barriers are: (1) economies of scale, (2) absolute cost advantage, (3) capital cost requirement, and (4) production differentiation.

5. THE QUESTIONNAIRE SURVEY

Since DB delivery system is still in the initial stage in Taiwan, only A-class construction contractors are qualified to participate in the DB projects, and engineering consultants are considered as main designer for public project. This research select three sampling populations: (1) A-class construction contractors from the list published by the Construction and Planning Agency, (2) roster of the Chinese Association of Engineering Consultants, and (3) the top 100 companies in construction industry during 2001-2003 (both construction contractors and engineering consultants are included) published by Common Wealth Magazine and Business Weekly, which are considered as large-scale companies in Taiwan. As there are several thousands of A-class construction contractors, 400 companies are chosen by random access. 39 engineering consultants and 67 of top 100 companies of construction industry are available for the survey. 103 valid responses out of 506 ones in total were returned. 70 of them came from construction contractors and 33 from engineering consultants. Questionnaire takers are supervisors or personnel in senior manager positions, such as company owners, general managers, vice president, department heads, and project managers.

6. STATISTICS ANALYSIS ON SURVEY DATA

In this section, data collected from questionnaire survey are analyzed to understand the changes of competitiveness and changes in corporate strategies for different companies. Data are analyzed by using statistic software SPSS.

6.1 Assessment on Company's competitiveness

The influences of entry barrier factors on company's competitiveness are assessed by Likert five-point Scale; 1 indicates that the factor is very unfavorable for the company, 3 indicates neutral, and 5 indicates very favorable. The results for different segments of companies are measured against each other, and the results are as follows:

6.1.1 Comparisons Between Contractors and Consultants

Firstly, comparisons are made between construction contractors and engineering consultants. In the contractors segment, the average value for the eight factors is all greater than 3. Five out of these eight factors are greater than 3.5 (see table 1). It indicates that the barrier factors created by DB delivery system are to the advantages of construction contractors who will become leading players in the DB market. As for the engineering consultants, average values of five factors are greater than 3 while the factors of "financial capability", "economies of scale", and "capital cost requirement" have average values lower than 3. This reveals engineering consultants' lack of confidence in financial area but have confidence in factors such as

qualification of key personnel, product differentiation, and absolute cost advantage created by integrating design and construction (the average values are higher than those of construction contractors). This result meets the existing situation that most engineering consultants in Taiwan are of smaller scale with limited financial capability. However, engineering consultants have served the government as agents for a long time in project designing, monitoring, and controlling, thus they are very confident in handling the tasks of plan, design and construction management.

Table 1. Comparisons between contractors and consultants

Evaluation Factors	Average score of bidding confidence		p-value of one-tail t test
	Con.	Eng.	
Experience of DB Projects	3.45	3.07	0.165
Record of Work Performance	4.10	3.28	0.003
Financial Capability	3.72	2.83	0.001
Major Engineering Staff	3.87	4.07	0.191
Economies of Scale	3.44	2.83	0.014
Absolute Cost Advantage	3.96	4.24	0.116
Capital Cost Requirement	3.37	2.72	0.011
Product Differentiation	4.03	4.14	0.300

Statistical differences between construction contractors and engineering consultants are examined by t-test. As shown in table 1, there are four factors which are significantly different. Three of the four factors come from financial area: financial capability, economies of scale, and capital cost requirement. Furthermore, contractors have long been consolidating construction projects, so record of work performance became another factor making them more competitive than engineering consultants. Although engineering consultants have confidence in the areas of qualification of key personnel, product differentiation, and absolute cost advantage, the t-test result does not show any significant difference. This phenomenon signals that construction contractors in Taiwan are more confident in handling DB projects and have more chance to take the lead in the DB market of Taiwan.

6.1.2 Comparison Between Large-Scale and Average-Scale Companies

Companies listed on the roll of Top 100 are classified as large-scale companies (construction contractors and engineering consultants included). As shown in table 2, large-scale companies always score higher in each and every factor than companies of average scale, and they are confident of competing in DB market.

In a nutshell, large-scale companies usually surpass others in terms of qualifications, financial capability and technical skills, and these advantages become even more critical in DB delivery system.

Among large-scale companies, large construction contractors are very confident in consolidating DB projects, and the average values for all the factors are greater than 3.5 (see table 2). Even though large-scaled engineering consultants also agree that DB delivery system can serve their interest (the average values for all factors are greater than 3), their confidence levels in each factor can vary greatly. For instance, for items of "qualification of key personnel" and "product differentiation", these companies are highly confident and the values score even higher than 4.5. In contrast, factors of "economies of scale" and "capital cost requirement" only scored between 3.5 and 3. This suggests that engineering consultants are still facing financial weaknesses and should enhance their financial capability in order to keep a ground in the DB market.

6.2 Assessment on Contractor's Corporate Strategies

Since only a few engineering consultants are financially capable for DB projects today, this section focuses on construction contractors to explore their corporate strategies under DB delivery system. Although the sample contractors have long relied on consolidating construction project in the traditional design-bid-build market, there are two streams of strategies available in the DB market. The first one is to play the role as a DB contractor and outsource designing and construction works if necessary, and the second one is to serve as sub-contractors, taking over construction tasks assigned by DB contractors.

Table 2. Comparison between large-scale and average-scale companies

Evaluation Factors	Contractor side (70 Data)			Consultant side (33 Data)		
	Average Score		p-value of one-tail t test	Average Score		p-value of one-tail t test
	Top 100	Average		Top 100	Average	
Experience of DB Projects	3.82	3.20	0.034	3.83	2.87	0.062
Record of Work Performance	4.54	3.80	0.001	4.00	3.09	0.077
Financial Capability	4.14	3.44	0.005	3.83	2.57	0.009
Qualification of Key Personnel	4.18	3.65	0.017	4.67	3.91	0.005
Economies of Scale	3.61	3.33	0.170	3.00	2.83	0.495
Absolute Cost Advantage	4.07	3.88	0.243	4.17	4.26	0.393
Capital Cost Requirement	3.68	3.17	0.041	3.00	2.70	0.406
Product Differentiation	4.29	3.85	0.024	4.67	4.00	0.073

According to the statistics, among seventy large construction contractors, only forty organizations (57%) opt for being DB contractors to join the bidding war, while thirty organizations (43%) tend to relinquish the opportunity, and resort to the role of sub-contractors. There is no doubt that a new pattern of contractor's corporate strategies has emerged in DB market. To further examine the turns of their strategies and the interactions among barrier factors, valid samples of the questionnaire were sorted out as two corporate strategies, "DB contractor-oriented" and "sub-contractor-oriented". Listed in table 3 are results gained through a comparison t-test on the average values of all barrier factors calculated.

Table 3. Factors analysis on corporate strategies

Evaluation Factors	Average score of bidding confidence		p-value of one-tail t test
	GC oriented	SC oriented	
Experience of DB Projects	3.68	3.21	0.101
Record of Work Performance	4.26	3.96	0.109
Financial Capability	4.00	3.36	0.013
Major Engineering Staff	3.95	3.75	0.239
Economies of Scale	3.68	3.11	0.033
Absolute Cost Advantage	4.12	3.68	0.072
Capital Cost Requirement	3.68	2.97	0.011
Product Differentiation	4.10	3.96	0.269

Comparisons reveal that the average values of barrier factors for DB contractor-oriented companies are higher than those of sub-contractor-oriented companies. This suggests that DB delivery system has a show down effect in terms of differentiating the competence of companies and ultimately force companies with lesser qualifications or competence to retreat and instead become sub-contractors. T-test results also identify three factors, financial capability, economies of scale, and capital cost requirement, which have the most dominant effects. It is clear to infer that corporate strategies hinge on financial area, which in turn can keep a tight grip on their market access.

7. RESEARCH IMPLICATIONS

7.1 New Competitive Environment

The conventional delivery system used in Taiwan separates design from construction. Most contractors did not involve in project planning or designing, and price is the sole selection criterion in the competitive bidding system. Under such conditions, it was hard to discern the competence of companies. However, the introduction of DB delivery system provides a different competing environment and contractor selection mechanism. Large-scale companies with good record of work performance stand a better chance under best value contracting method. Traits of DB delivery system elevate the companies' competitiveness that already possess the advantages of economies of scale, absolute cost advantage, capital cost requirement and product differentiation, and build up barriers to entry the market. Among these issues, financial concerns take the center stage. In Taiwan, small-to-medium sized companies are finding that it is relatively hard to go solo in conducting construction projects. Companies are forced to either develop as a DB contractor through obtaining both design and construction abilities and financial support, or act as sub-contractors for DB contractors by performing their familiar operations.

7.2 The Trend toward Market Concentration

Since DB delivery system emphasizes on the qualifications and competence of bidders, companies can score high for their past record and ability of integrating design and construction works. Under such conditions, the sooner companies enter the DB market, the more competitive they may become. The competition in the market reveals that large-scaled companies are in a favored position to preside over the DB market. Once they entered the market for quite a period of time and accumulate their experience, they will become very competitive and the thresholds of entry barriers are raised. If the competition cycle persists, competition in the DB market may be at the mercy of some companies. Economists call this phenomenon as "Natural Monopoly". Consequently, market-leading companies can grow bigger and bigger. For the construction industry in Taiwan, the bigger DB market develops, the greater the concentration becomes.

8. CONCLUSIONS

This paper explores the effects of DB delivery system on the construction industry from the viewpoint of entry barriers. It analyzes the changes of competitiveness and corporate strategies of different companies as the government adopts DB delivery system. As indicated in this research, DB delivery system does have the effects of differentiating the competitiveness of companies. It can further change companies' corporate strategies, as well as the development of the industry. As owners prefer to select contractors through best value contracting method, large companies will usually dominate the market. Since DB delivery system underpins the integration of design and construction, large companies are better equipped to demonstrate their competence in areas of economies of scale, absolute cost advantage, capital cost requirement, and product differentiation. This will certainly enhance the competitive advantage of large companies, raise the thresholds to enter the market, and indirectly make it more difficult for small-to-medium sized companies to compete for bidding. Thus, small to medium companies will be forced to forego their bidding and resort to becoming the specialty sub-contractors for DB contractors.

The results of this research help government and practitioners to have an idea about the potential structural changes of construction industry as DB delivery system became the main stream, and particularly, companies can better understand their strength and weakness in DB market so as to develop their new competitive strategies.

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