Policies for Improving Design-Build Delivery System in Korea

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Abstract

Increasingly adopted by both public and private organizations, Design-build (DB) has become a favored construction project delivery system, outperforming other systems in terms of cost, schedule, and quality. However, DB has been especially criticized by the public sector for practicing subjective evaluation and for providing only limited accessibility to small and medium-sized contractors. In Korea, similar critiques have been raised, as these qualities have prevented public owners from benefiting from the potential advantages of DB. In order to address these challenging issues, the present research systematically analyzes the characteristics of the DB delivery system in Korea. Based on industry surveys and an extensive literature review, a qualitative system dynamics model is developed and used to propose and test hypothetical DB policy alternatives that are expected to enhance DB performance. Furthermore, after the appropriate customization processes, these research findings can also be applied to the industry settings of different countries.

Keywords: Delivery System; Design-Build; Turn-Key; System Dynamics

Introduction

Having become one of the preferred construction project delivery systems, Design-build (DB) has been increasingly utilized by public agencies. Accordingly, over the years, many studies have been conducted to examine its effectiveness. For instance, Konchar & Sanvido (1998) have analyzed the performance (in terms of cost, schedule, and quality) of three different project delivery systems (in 351 U.S. building projects): Design-Bid-Build, DB, and Construction Management. These case studies demonstrate that, in most cases, DB yielded excellent results. The U.S. National Institute of Standard and Technology (NIST 2002) has also reported that projects using the DB system significantly outperformed those utilizing DBB in terms of schedule, change, rework, and practice use performance. However, as reported by the U.S. Legislative Analyst’s Office (LAO 2005), the DB system has encountered criticism for being subjective in evaluation and for being limited in its accessibility to small and medium-scale contractors.

These issues have also been raised in Korea. Since DB's introduction in 1975, DB (locally called "Turn-Key") projects in Korea have steadily increased in number, accounting for 26% of public projects procured in 2005. This quantitative expansion has been attributed to Korean government construction policies such as the "Plan for Increasing DB Projects" (1996) and the "Plan for Increasing Efficiency of Public Projects" (1999). However, as these government initiatives only consider project scale and type in the selection of a delivery system (Seo 2003), they have met with considerable criticism. Additionally, only a few major contractor-led DB teams have been able to join the bidding process; this has, in fact, increased their market dominance and has subsequently raised questions about the objectivity of the bidding and evaluation processes.

In any case, public owners in Korea have not been able to benefit from the potential advantages of DB. Furthermore, although this problem has been addressed by many studies, these studies have been limited in that they examine the origin of the problem from fragmented viewpoints; this results in only short-term remedies. In contrast, the present study systematically analyzes the characteristics of the DB delivery system in Korea, and using a system dynamics modeling approach, proposes DB policy alternatives.

To achieve these objectives, this study conducts a literature review in order to identify the general characteristics of the DB system. Then, delivery trends in the Korean public sector are investigated, and the causal relationships among the DB characteristics are interrogated through questionnaire surveys. Based on the research findings, a qualitative system dynamics model is developed to further examine the research issues surrounding DB, and to analyze previously suggested policy initiatives and those proposed in this research. This study is relevant to both the construction industry and academia, as it provides a means of enhancing the performance of the DB delivery system and a quantitative basis for the systematic analysis of industrial issues.

Literature Review

DB vs. DBB

A project delivery system has been defined as the "relationship, roles, and responsibilities of project team members and the sequence of activities required" for the development of a capital project (Sanvido & Konchar 1998). DB and DBB are two of the most commonly used project delivery systems, and each system has its particular advantages. While DB is cited as being effective for large-scale or highly complex projects, DBB offers the checks and balances of a comprehensive delivery system in which risk is minimized through firm control of the design and construction processes (Thomas et al. 2002).

The evolution of DB—an industry-driven program aimed at developing a more effective project delivery system (Levy 2006)—can be traced throughout history. Indeed, it began as an outgrowth of a project delivery system dating back to pyramid construction in 1596 B.C. During the Renaissance, as project complexity increased, the need for specialization in both design and construction was required for functional purposes (Twomey 1989). Then, as statutory and case law developed in the United States in the 19th century, the separation of design and construction gradually shifted from functional to legal. Thus, the traditional DBB project delivery system emerged as the primary system (Natkin 1994).

DBB remained the standard delivery system of choice until the inflationary 1970s and litigious 1980s encouraged owner organizations to reevaluate it. In reality, the traditional DBB project often becomes a design-bid-redesign-rebid-build project. Under this system, budgets prepared by owners tend to fall short of actual construction costs; this has resulted in expensive redesign work, has made it more difficult to implement value engineering, and has delayed project deliveries (Levy 2006). Subsequently, project delivery systems such as DB, turnkey, and construction management have emerged as viable alternatives to the more conventional DBB.

DB has particularly experienced extraordinary growth (Songer et al. 1996) and has become DBB's predominant rival for winning bids to be chosen as the most appropriate delivery system. Until recently, DBB has won the majority of such bids; however, DB has posed a great challenge to its status. Indeed, although DB's winning portion has fluctuated throughout history, these two systems have been gradually becoming relatively even. Such growth suggests that more owners are selecting DB for the first time. Also, an inevitable outcome of this growth is that more contractors and architects, with little or no design-build experience, have been entering the market. Consequently, it has become necessary that owners with the appropriate technical expertise evaluate the qualifications of the DB contractors and their proposed design approaches.

An NIST report has argued that one of the potential disadvantages of the DB approach is in regards to cost containment, and the U.S LAO (agreement?) (2005) has summarized the potential risks of DB (see Table 1). As shown in Table 1, it is difficult for small and medium-sized contractors to participate in DB bidding because DB is generally used in large and complex projects that require considerable technical skill. Furthermore, as DB projects have only been evaluated on the basis of schematic design, management planning, and track records, this has raised the issue of subjective evaluation, which has met with much criticism.

Table 1. Construction Delivery Processes: Pros and Cons [LAO 2005]

Delivery Systems	Advantages	Disadvantages
DBB	Building is fully defined Competitive bidding results in lowest cost Relative ease of assuring quality control Objective contract award Good access for small contractors	Agency involvement in conflicts and disputes Builder not involved in design process May be slower Price not certain until construction bid is received
DB	Price certainty Agency may avoid conflicts and disputes Builder involved in design process Faster project delivery Agency requires less technical staff	Agency may require more technical staff Limited assurance of quality control Subjective contract award Limited access for small contractors

According to the U.S. NIST report (2002), based on a data set comprised of 326 owner projects between 1997 and 2000, the average DB project is larger than the average DBB project. This report also observes that the average cost of all DB projects was approximately four times larger than that of DBB projects ($80.5 million vs. $22.7 million). Furthermore, as construction projects have become mega-sized and increasingly complex, clients' requests have become more and more complicated. As different researchers have observed, this has subsequently resulted in a strong correlation between large projects and the tendency to select DB (Thomas et al. 2002, Kim et al 2004, Seeley 1997, Levy 2006). The NIST report has also suggested, with regard to project performance, that the utilization of DB yields performance advantages to owners. In addition, Konchar & Snavido (1998) have asserted that, on average, DB outperforms DBB in terms of cost, schedule, and quality, which reflects the main results of the University of Reading's empirical study. Ultimately, such findings reinforce the assumptions surrounding these two systems, such as the assumption that DB is an effective alternative to DBB, particularly for large-scale and complex projects.

DB Practice in Korea

In Korea, the introduction of DB into the public sector occurred in the mid 1970s and was impacted by other nations' implementation of this delivery system. For instance, in the U.S., which introduced DB into the construction industry in the early 2000s, there has recently been a significant increase in the volume of DB projects. Likewise U. S. case, there has been a striking change in volume of DB project increase recently in Korea. Based on a data set comprised of 15,934 public projects in 2005, it can be observed that the average cost of all DB projects has been larger than that of DBB projects ($84,768.3 million vs. $1,461.9 million). Moreover, in the Korean public sector in 2000, DB projects only accounted for approximately 10% of the total construction volume. Since then, DB projects executed by public agencies have been steadily increasing, and in 2005, 26% of public projects (representing $13 Billion) were delivered using DB. Hence, it can be assumed that there are similarities in the U.S. and Korea in both environmental and project specifics of DB growth and adoption that affect construction procurement.

However, despite such an increase in the Korean public sector, only a few bidders have been able to participate in the DB bidding process. Over the last 3 years, the number of DB bidders, on average, has remained below three, while the number of DBB bidders has ranged from 355 to 536 (see Table 2). As a result, the top six Korean contractors have been awarded over 67% of public DB projects. While these major contractors have enjoyed market dominance, there has not only been a consequent lack of diversity among successful DB teams, public owners have also been prevented from benefiting from the advantages of the DB system. Therefore, to address these issues, this research aims at analyzing DB characteristics and mapping out alternative and innovative DB delivery strategies.

Table 2. DB Market Dominance by Major Contractors

Year	Bid Attendant (per project on average)		% of Public DB Projects Awarded to Top 6 Contractors
	DB	DBB	
2002	-	-	79.9%
2003	-	-	81.7%
2004	2.5	355	67.3%
2005	2.5	396	67.8%
2006 (as of Oct.)	2.5	536	-

Research Methodologies

System Dynamics

System dynamics was developed in order to apply control theory to the analysis of industrial systems, and it has been used to analyze diverse industrial, economic, social, and environmental systems. One of the most powerful features of system dynamics is its capacity for providing analytic solutions for both complex and nonlinear systems (Kwak 1995, Sterman 2000). System dynamics is also useful for providing systematical explanations and policy alternatives that are often counterintuitive and discerning, and for elucidating problems and identifying feedback processes with causal loop diagrams. These loop diagrams consist of variables that are connected by arrows denoting the causal influences between variables. Each causal link is assigned a polarity, either positive (+) or negative (-), to indicate how the dependent variable is impacted when the independent variable changes.

The dynamics of all systems arise from the interaction of two types of feedback loops: positive (reinforcing) and negative (balancing) (Sterman 2000). While positive loops tend to reinforce or amplify whatever is already occurring, negative loops counteract and oppose change. Taking an example from Sterman's 2000 study, the diagram in Fig. 1 represents the behavior of engineers trying to complete a project by a certain deadline. First, the engineers compare the work remaining to be completed with the time remaining before the deadline. When schedule pressure builds up and engineers work overtime, these engineers increase the rate at which they complete their tasks, cut the backlog of work, and relieve the schedule pressure (balancing loop B1). However, if the work week is prolonged, fatigue sets in and productivity suffers. As productivity falls, the task completion rate drops; this again increases schedule pressure (reinforcing loop R1).

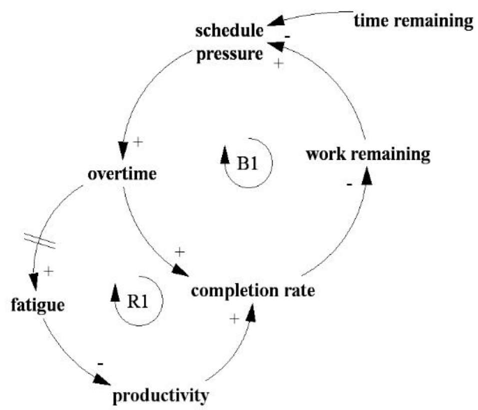

Fig. 1. Example of causal loop diagram (Sterman 2000)

Survey

To identify the underlying causes of the aforesaid problems, 41 interviews were conducted with 13 public owners and 28 contractors (including architects). The results of these surveys were used to identify the model variables and their casual relationships; these results will be discussed in the following section. On average, the public owners surveyed have had 13.31 years of experience, while the contractors have had over 15

Tabel 3. Survey Results on the Causes of DB Characteristics in Korea

Questionnaire & Answers	Owner	Contractor	Total
1. What is the advantage of DB over DBB?			
Timesaving	46.15%	32.14%	36.59%
Cost saving	0.00%	14.29%	9.76%
High quality	46.15%	46.43%	46.34%
No advantages	7.69%	7.14%	7.32%
2. What is a basis of your judgment for question #1?			
Own experience	46.15%	75.00%	65.85%
Successful case of other countries	23.08%	7.14%	12.20%
Expert opinion	30.77%	14.29%	19.51%
Other opinion	0.00%	3.57%	2.44%
3. Why do only a few organizations attend DB bidding?			
Only large architectural firms can make winning designs	53.85%	14.92%	26.83%
The high cost of responding to RFPs limits the number of construction companies that can incur such a high risk	30.77%	71.43%	58.54%
Both	15.38%	14.92%	14.63%
Other opinion	0.0%	0.0%	0.0%
4. Why is the cost of responding to DB RFPs high?			
Because of the normal burden entailed	76.92%	57.14%	63.41%
Because of illegal lobbying activities	23.08%	42.86%	36.59%
Other opinion	0.0%	0.0%	0.0%
5. Why are only a few major contractors successful in DB and poorly distributed?			
Because of the high cost of responding to RFPs combined with insufficient failure compensation	53.85%	35.71%	41.46%
A lack of diversity among successful DB contractors	15.38%	35.71%	29.27%
Large contractors offer excellence in design and construction	30.77%	28.58%	29.27%
Other opinion	0.0%	0.0%	0.0%
6. What is the influence of design specifications on design innovation?			
The more design input/prescriptive specifications, the less design innovation	84.62%	42.86%	56.10%
The more design input/prescriptive specifications, the more design innovation	15.38%	39.29%	31.70%
No influence	0.0%	17.9%	12.20%
7. What is the required design, and what are the specifications, of the current DB project?			
Will be decreased	53.85%	60.71%	58.54%
Will continue to be at the present level of detail	15.38%	21.43%	19.51%
Will be increased	30.77%	17.86%	21.95%

years. With direct regard to DB experience, public owners averaged at 3.15 projects, while contractors averaged at 8.25 projects.

Furthermore, 84.62% of the public owners have worked in construction for over 10 years, whereas 100% of the contractors possess over 15 years of experience as construction professionals. In particular, the respondents' experience, in number of DB projects, is as follows: 69.32% of the owners have had less than 3, 23.08% have had 3 to 5, 8% have had 6 to 8, and 0% have had over 9. On the other hand, 32.14% of the contractors have had less than 3 DB projects, 14.29% have had 3 to 5, 7.14% have had 6 to 8, and 46.43% have had more than 9. Among the contractors, the weighted mean number of DB projects is 8.25, while that among the public owners is 3.15. The average construction industry career length is over 16 years among the contractors and is 13.31 years among the public owners. It was also determined that public owners have had insufficient DB project experience relative not only to their career lengths, but also relative to the contractors' DB experience.

Further, 46.15% of the owner group assumes that the DB delivery system will yield advantages in terms of timesaving *and* high quality work. 23.08% and 30.77% of the respondents from the owner group answered that they base this judgment on successful cases in other countries and expert opinion, respectively. A total of 58.54% of the respondents cited the high cost of responding to RFPs as the determining factor in the reality that only a few major construction companies are able to assume the high risks entailed in bidding on a DB project. Moreover, in Korea, DB bidding requires a DB team comprised of a construction company and an architectural firm, and generally, the construction company incurs the cost of preparing the bid. Furthermore, 56.10% of the respondents asserted that high levels of design input/prescriptive specifications cause less extensive design innovation, while 58.54% of those surveyed responded that design input and specifications must be decreased (see Table 3).

SD Model Development

Based on the literature review and survey results, three major factors are extracted to analyze the specific characteristics and the phenomenon of the present DB delivery system: *number of DB projects*, *number of DB teams attending bid* (i.e., bidding competition), and *DB performance.* If *DB performance* is high, as a consequence of increasing new entry into the market (Songer et al. 1996), this will result in an increase in bidding competition (i.e., the *number of DB teams attending bid*), which will subsequently cause the *number of DB projects* to increase. Then, an increase in the *number of DB projects* will generate an influx of new bidders into the DB market. Thus, the relationship between these three factors is a reinforcing feedback.

Number of DB Projects

Drawing from the questionnaire and literature review, it can be concluded that the number of DB projects is determined by *owner's expectation of DB performance*, the *number of large-scale projects*, and *negative public opinion of DB*. The *number of large-scale projects* not only increases the *number of DB projects,* but also heightens *owner's expectation of DB performance*. Furthermore, as large-scale projects are more complex than small and medium-sized projects, owners' dependency on DB will increase as more efficient organizational collaboration is made possible by DB, thus enabling the transfer of all design and construction risks from the owner to the contractor. Moreover, it was found that both public owners and contractors believe that the DB delivery system will outperform DBB in quality (46.34% of the owner group) and time saving (36.59% of the owner group). However, *negative public opinion of DB* does cause owners to adopt fewer DB projects. In fact, in Korea, there has been a strongly negative public sentiment towards DB concerning the lack of diversity among bidders and successful DB teams.

Furthermore, in the Korean construction industry, *owner's expectation of DB performance* is considered to be the most influential factor impacting the increase in *the number of DB project*s. As seen in Fig. 4, the *owner's expectation of DB performance* is based on his/her experience with successful DB projects. However, as indicated by the survey results, owners lack sufficient experience with DB projects (3.15 DB projects over 13.31 years, on average). Additionally, there is currently no DB performance measuring system in place in Korea. As a result, the *success of DB projects* has had little impact on *owner's expectation of DB performance*. Instead, other factors, such as *expert opinion on DB superiority* and the *successful DB cases of other countries,* have taken precedence over owners' experience and *number of DB projects* (indeed, 353.85% of the owner respondents agreed with this). As illustrated in Fig. 2, with regard to the feedback effect associated with R1, once the *number of DB projects* increases, the probability that there will be more *successful DB projects* also increases. Accordingly, *owner's expectation of DB performance* increases, which can also result in amplification in the *number of DB projects* that are adopted.

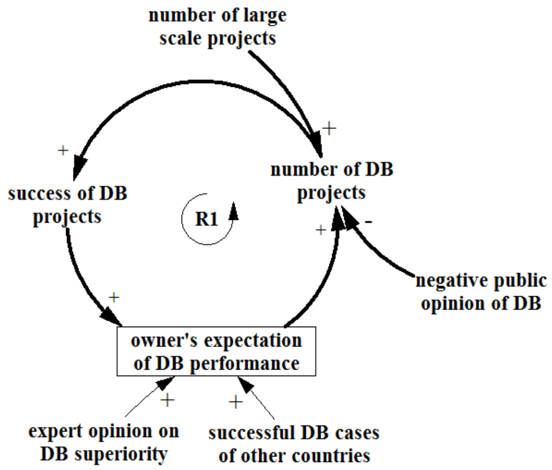

Fig. 2. Number of DB projects

Number of DB Teams Attending Bid

As summarized in Table 4, the Request For Proposal (RFP) specifications issued by Korean public owners are very detailed and prescriptive, but also less comprehensive, in comparison to those issued in Canada and the United States. As a result, preparing a bid entails prohibitive effort and expense. While Canada and the U.S. focus their evaluation criteria around planning and administrative issues, Korea's DB evaluation criteria rarely offers the flexibility necessary for the development of alternative and innovative designs.

In fact, such a high *level of prescriptive specifications* requires significant technical capability on the part of DB teams, which results in fewer companies attending DB bids (Fig. 3). A related causal factor to this is the high *cost of preparing bids*, which, in turn, increases the *risk of failing DB*; this risk is compounded by the low level of *DB failure compensation*. All of these factors reduce the *number of DB teams attending bid*.

Table 4. Comparison of Requests For Proposal (RFPs)

Countries	Program Requirements	Submittal	Evaluation
Korea	**very detailed** 114 pages of design specifications 126 pages of materials requirements	**very detailed** 52 pages of explanations concerning design submittal 70 sets of hundreds of pages of submittals requiring page limits, detailed contents of proposal report, etc.	**less comprehensive** experience, design, and proposal price are evaluated based on design results for 7 design parts
Canada	**relatively simple** 5 pages of explanations focusing on project program with guidelines	**relatively simple** 4 pages of explanations concerning management, schedule, design, O&M cost, business plan summary of 15 criteria, including QA/QC	**comprehensive** submittal is organized into all evaluation criteria so that the general business plan is evaluated comprehensively
U.S.	**relatively simple** 6 pages of explanations focusing on project program with guidelines	**relatively simple** 3 pages of explanations concerning project team organization, resumes of all on-site managers, schedule, etc., business plan of the 6 categories, 6 copies of report	**comprehensive** experience and capability of firm and on-site manager, financial capability, preliminary, acceptance of city goals etc., comprehensive evaluation of general business plan

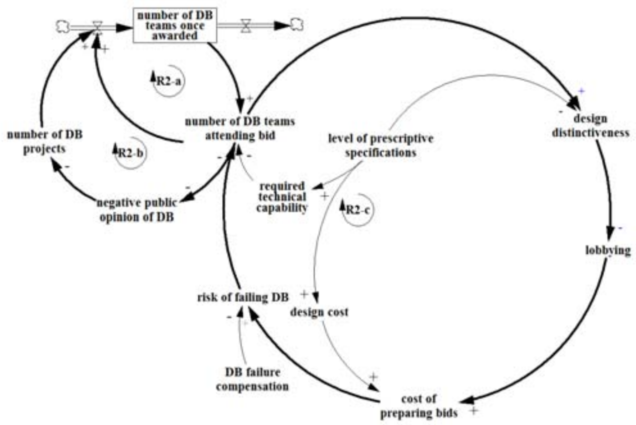

Fig. 3. Number of DB teams attending bidding

Indeed, 26.83% of the survey respondents answered that only large architect companies have the financial capability, expertise, and other necessary resources required to prepare bids, while 58.54% responded that the high *cost of preparing bids* limits the number of construction companies that can attend bidding. Meanwhile, there are two reinforcing feedbacks associated with the *number of DB teams attending bid*: R2-aand R2-b. In Korea, due to the legal stricture that construction companies cannot have an in-house design team, DB teams are normally a consortium of architect and construction companies. Thus, the limited *number of DB teams attending bid* naturally leads to a relatively small *number of DB teams once awarded*, which results in fewer DB teams possessing the track record that is necessary for Pre-Qualifications (PQ) (i.e., the prerequisite for attending the next DB bidding [R2-a]). Simultaneously, the small *number of DB teams attending bid* triggers *negative public opinion of DB*, which, in turn, makes fewer DB projects available in the market. Thisresults in a decrease in the *number of DB teams once awarded* (R2-b).

In Fig. 3, on the other hand, with regard to the R2-c loop, the high *level of prescriptive specifications* for the design renders an evaluation criteria that is extremely specific and quantitative. As a result, it becomes difficult to differentiate between teams with distinctive designs, and for this reason, 58.54% of the survey respondents argued that the *level of prescriptive specifications* must be reduced. Indeed, an American Association of State Highway Transportation Officials (AASHTO) report has also observed that a small number of bidders has a negative impact on design innovation, as bidders attempt to win bids through means such as lobbying, not by competing with better designs (Levy 2006). All of these issues contribute to increasing proposal costs and consequently, project costs. As a result, bidders incur a high *cost of preparing bids*, which increases the *risk of failing DB*, thereby reinforcing the trend toward a decreased *number of DB teams attending bid* (see R2-c in Fig. 3).

DB Performance

As already noted, *DB performance* consists of the *cost efficiency* and *quality* that is achieved when the competition for proposal price and quality is among bidders. According to auction theory—which is based on game theory—a bidder's optimal bid is dependent on the cost he/she sets and by the probability the he/she will win the contract, which is impacted by the distribution of cost of other firms and by the number of competitors. In general, most bidders attempting to secure public projects are adverse to risk and thus tend to bid aggressively; therefore, contract prices are more likely to be lower (Yu 2000). Consequently, if the *number of DB teams attending bid* is increased, the contract price will be decreased, which will result in better *cost efficiency*.

Moreover, with intensified competition, the probability of high *quality* will also be increased. However, in Korea, despite DB bidders having to compete with their designs and proposal prices, because these bidders tend to have similar track records, high *quality* and *cost efficiency* cannot be expected when there are less than three bidders attending the bid for a project. Therefore, an increase in the number *of DB teams attending bid* will have an positive effect on *DB performance*. This will subsequently reinforce the feedbacks of R3-a and R3-b, and will also generate competition with more design distinctiveness, which reinforces the feedbacks of R3-c (Fig. 4).

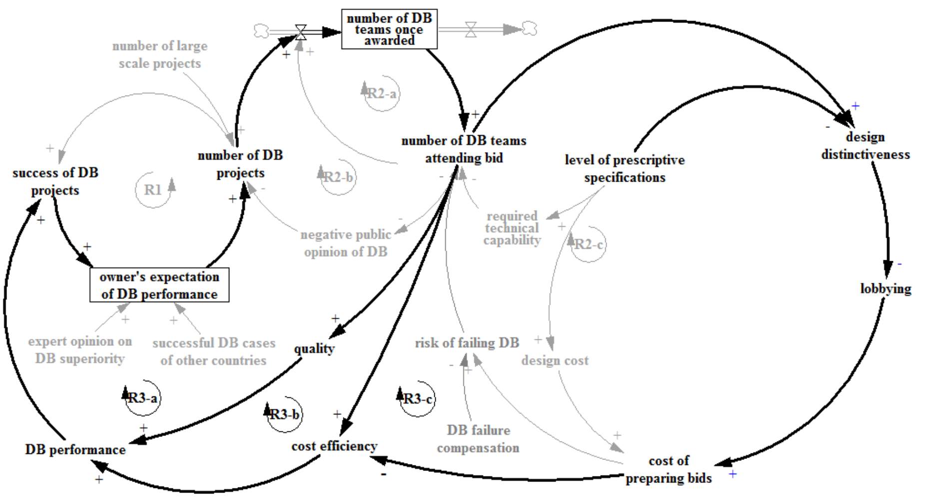

Fig. 4. DB performance

Unsuccessful Government Efforts

In regards to the problem of R2-c as shown in Fig. 5, the Korean government has attempted to improve the DB evaluation method and process. In order to prevent bidders from lobbying to the evaluation committee, the government has increased the *pool size of evaluation committee members* several times (from 250 in 1999 to 2,200 in 2003). However, this strategy has not been effective in reducing *lobbying* costs. In fact, *lobbying* costs have increased significantly, as potential bidders have been obliged to target thousands of potential evaluation committee members in advance (R3-a in Fig. 5). As well, the efforts made by the Korean government to enhance the prescriptive nature of design specifications by further quantifying and adding more details to the evaluation criteria, has exacerbated the situation with regard to R2-c (Fig. 5).

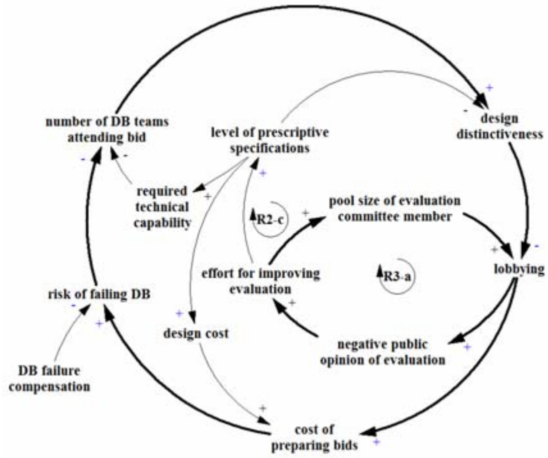

Fig. 5. Unsuccessful government efforts

Finally, Fig. 6 shows the full model structure, while Table 5 summarizes the variables extracted from the model and the basis of their causal relationships.

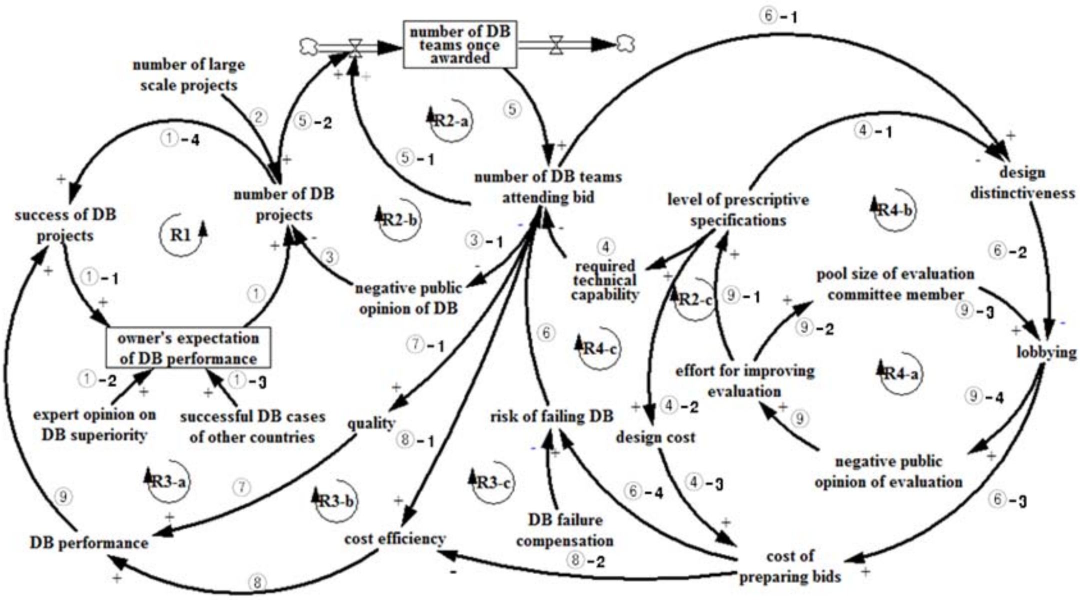

Fig. 6. Full DB model

Table 5. Model Variables and Basis of Causal Links

Variables	Link number	Basis
Number of DB projects Owner's expectation of DB performance Number of large-scale projects Negative public opinion	①, ①-1,2,3,4 ② ③, ③-1,2, ⑤, ⑤-2	Survey result, Thomas et al.(2002), Songer et al. (1996), Kim (2004), Seeley (1997), Levy (2006) Empirical data, Korean case
Number of DB teams attending bid Number of DB teams once awarded Level of prescriptive specification Cost of preparing bid	③, ③-1, ⑤, ⑤-1, 2 ④, ④-1,2,3, ⑥, ⑥-1,2,3,4, ④-2,3	Survey result, Levy (2006), LAO (2005), Comparison of RFPs, Empirical data, Korean case
DB performance Quality Cost efficiency	⑦, ⑦-1, ⑨ ⑧, ⑧-1,2, ⑨	Survey result, Konchar & Sanvido (1998), Yu (2000), Chan (2000), Lam (2008)
Unsuccessful government efforts	④-1, ⑥-2, ⑨, ⑨-1,2,3,4	Survey result, Levy (2006), Empirical data, Korean case

Policy Tests

Decreasing DB projects by increasing budget standards (Lee 2006)

To address a marketplace dominated by a few major contractors, one policy proposed by Lee is to increase budget standards (2006). This policy was implemented to reduce the volume of DB projects rather than to enhance the current DB system. However, as discussed with regard to R2-a, this measure only further accelerated the dominance of the select group of major contractors. This effect can also be verified by the fact that a similar policy triggered by negative public opinion of DB (R2-b in Fig. 6), has had a negative impact on the diversity of DB teams.

Increasing DB projects by dividing large projects into smaller projects (Lee 2006)

This measure—increasing the number of DB projects by dividing large projects into smaller ones—might, of course, encourage small and medium-sized contractors to enter into the bidding process. However, this strategy would also result in owners having to manage plenty of administrative work and an increased probability of conflict amongst various contractors. Thus, this measure cannot be considered an effective alternative, as it would be unreasonable to expect that the potential advantages of DB could be achieved.

Introducing Bridging DB (Lee 2006)

Another strategy referred to as Bridging DB (or, design-design-build), is a delivery system whereby an owner contracts with an architect to create a set of preliminary design documents to be used in soliciting bids in the market (Levy 2006). In Bridging DB, the owner invites the architect to suggest preliminary design changes, or he/she allows the submission of a value engineering proposal that will not entail a significant redesign cost. Due to its unique features, Bridging DB could be effective in enhancing the design quality of DB projects. Nevertheless, if the same design requirements are given to those bidders attending the main round of bidding, the vicious loop effects will still be activated (R2-a, R2-b, R2-c, R4-a, R4-b, and R4-c, as seen in Fig. 6), and the current problems will persist.

Decreasing the number of committee members by establishing a long-standing specialized evaluation committee (Kim 2007)

This measure could eventually have a positive long-term impact, as it eliminates the vicious loop effect of R4-a (Fig. 6) by disconnecting the causal link between efforts to improve evaluation and the size of the evaluation committee membership pool. It could also help reduce the costs of DB bid preparation. However, with the currently high level of prescriptive specifications, contractors would have to continue to resort to lobbying as a means of differentiating themselves from their competitors. In this case, corrupt and/or subjective evaluation will continue to persist, as will the critiques such methods raise.

Policy Suggestions

So far, policy insights and implications obtained throughout the development of a system dynamics model. Accordingly, this section suggests three fundamental policy initiatives that can mitigate the current DB issues, thereby allowing for the potential advantages of DB to be fully achieved (Fig. 7).

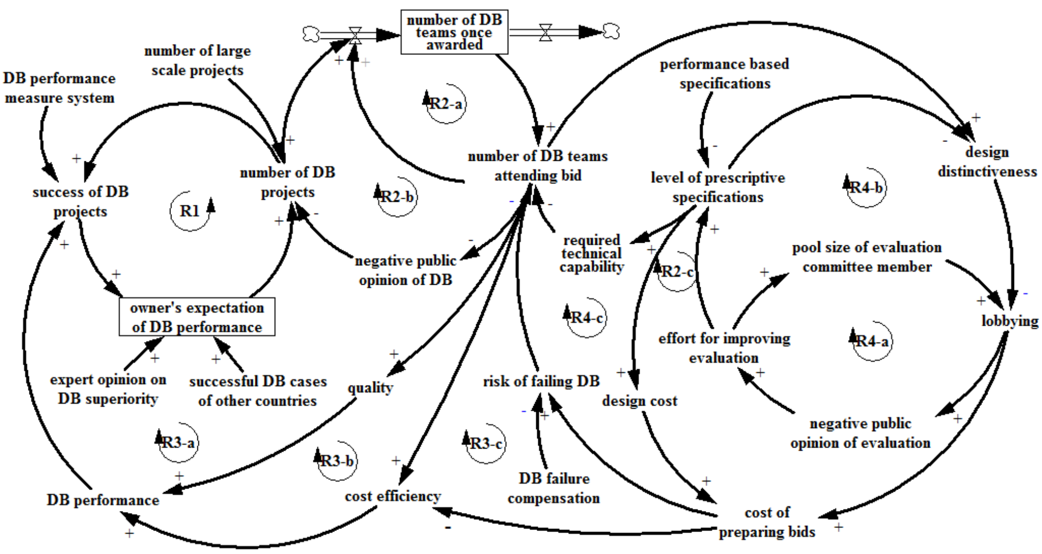

Fig. 7. Policy suggestions

Changing Prescriptive Design Specifications to Performance-Based Specifications

The research model demonstrates that as there are no market-mechanism based balancing loops to help alleviate the current DB issues, there are only reinforcing feedbacks. In particular, many reinforcing feedbacks, such as R2-c, R4-a, R4-b, and R4-c (Fig. 7), are associated with high bidding costs. With strong market governance, these reinforcing feedbacks maintain their inertia, preventing small and medium-sized contractors from entering the DB market.

Upon a closer examination of the model, the root cause of the vicious feedback effects can be identified as the high *level of prescriptive specifications*. From an owner's perspective, such detailed and strict design requirements can be viewed as advantageous in terms of simplifying project management. However, the current detailed specifications do not work as expected and have been restrictive, preventing many qualified small and medium-sized companies from entering the DB market.

To fundamentally remedy these problems, this research proposes the introduction of *performance-based specifications* into the DB bidding process, as they could lower high bidding costs (Fig. 7). That said, it should be noted that, given the associated feedbacks, it will take time to reverse the current situation. In particular, if owners persist in requiring good track records during the PQ process, the R2-a loop effect will continue to govern the market, at least for the time being (Fig. 7).

Increasing Failure Compensation

In addition to the introduction of *performance-based specificatio*ns, increasing *DB failure compensation* could fuel beneficial market changes (Fig. 7). If failure compensation is increased, more technically—although not necessarily financially—capable small and medium-sized DB teams will be able to participate in the bidding process. As this policy aims at increasing the coverage of failure compensation, not the absolute money amount (note that the current high bidding costs can also be diminished by *performance-based specifications*), it can also be executed without burdening the project budget.

Establishing a Performance Measure System

In order for the proposed *performance-based specifications* policy to be effective, a *DB performance measure sy*stem—which has already been utilized in the U.S. (Thomas et al. 2002) and the U.K. (Office of Government Commerce 2003)—must be established. This system would not only be used as a standard indicator of DB performance, but also as a tool for tracking and managing construction data.

In addition, as already discussed with regard to R1, the Korean government's expectations of DB performance have not been predominantly based on Korea's own DB successes, but on the *successful DB cases of other countries*. In such a context, once a performance measure system is established together with *performance-based specifications*, it will be possible to properly and accurately measure the performance of DB projects. This will then trigger desirable feedback processes in the DB market (i.e., R3-a, R3-b, and R3-c, as seen in Fig. 7). Then, as good *DB performance* is yielded and measured accurately with a proper measuring system, *owner's expectation of DB performance* will increase. This will result in more projects being delivered utilizing DB, and will increase the probability of more diversified DB teams, which will subsequently increase *DB performance* by enhancing either quality (R3-a) or cost efficiency (R3-b). Meanwhile, an increased *number of DB teams attending bid* can also lead to a decreased *cost of preparing bid* as well as an increased *cost efficiency* and enhanced *DB performa*nce (R3-c).

Introducing Bridging DB

Another strategy referred to as Bridging DB (or, design-design-build), is a delivery system whereby an owner contracts with an architect to create a set of preliminary design documents to be used in soliciting bids in the market (Levy 2006). In Bridging DB, the owner invites the architect to suggest preliminary design changes, or he/she allows the submission of a value engineering proposal that will not entail a significant redesign cost. Due to its unique features, Bridging DB could be effective in enhancing the design quality of DB projects. Nevertheless, if the same design requirements are given to those bidders attending the main round of bidding, the vicious loop effects will still be activated (R2-a, R2-b, R2-c, R4-a, R4-b, and R4-c, as seen in Fig. 7), and the current problems will persist.

Along with the three policy initiatives proposed in this study, two previously suggested and effective policies will also help owners achieve the advantages inherent in DB. Together, these policy initiatives are as follows:

(1) Changing Prescriptive Design Specifications to Performance-Based Specifications
(2) Increasing Failure Compensation
(3) Establishing a Performance Measure System
(4) Decreasing the Number of Committee Members by Establishing a Long-Standing Specialized Evaluation Committee
(5) Introducing Bridging DB

Conclusions

In recent years, the DB delivery system has been implemented more and more because of its advantageous features. However, this system has also been much criticized for being based on subjective evaluation and for being limited in its accessibility to small and medium-sized contractors. In Korea, since the introduction of DB in 1975, the number of DB projects has steadily increased. Nevertheless, only a select group of contractor-led DB teams has been able to participate in the bidding process and has thus increasingly dominated the DB market. Consequently, public owners in Korea have rarely benefited from the potential advantages of DB.

To address these significant issues, the present research has aimed at analyzing the characteristics of Korea’s DB delivery system, while suggesting alternative DB policy initiatives that are founded on system dynamics modeling. The delivery trends in the public sector and the causal relationships among DB characteristics were analyzed through surveys. Then, based on the research findings, a system dynamics DB model was developed to interrogate the issues raised in the surveys and a literature review. Accordingly, five policy initiatives—which are expected to alleviate current DB issues while enhancing DB performance—were suggested.

Finally, the research findings detailed in this paper also emphasize how a qualitative simulation method can effectively assist decision-makers involved in the construction-policy-making process. In addition, after the appropriate customization processes, this research could be beneficially applied to the industry settings of different countries.

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