Effect of Delivery Systems on Collaborative Negotiations for Large Scale Infrastructure Projects

by

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Submitted to the Department of Civil and Environmental Engineering
in Partial Fulfillment of the Requirements for the Degree of

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Abstract

In large-scale projects, collaboration is an essential key for the success of projects. Since different participants from different organizations try to work together in projects, competitive stresses exist in their relationships and as a result, disputes or conflicts may inevitably occur. Peña-Mora and Wang (1998) have developed a preliminary collaborative negotiation methodology for facilitating/mediating the negotiation process of conflicts. In order for that collaborative negotiation methodology to be more detailed for its implementation, it needs to account for the effect of project structure and delivery method on the negotiation processes in large-scale projects. Because contracts define the temporary formal and informal relationships among the different parties in a project and subsequently, they define the framework of the negotiations of conflicts within that project, different delivery systems may be more or less effective in terms of conflict resolution.

In this research, to study the effect of delivery system on negotiation of conflicts, first, several different project structures and delivery systems are studied in order to identify participants’ roles, responsibilities, and relationships. Second, potential conflicts in relationships among project participants are examined to show that each delivery system has typical or pattern behavior that may affect the interrelationship among groups on negotiations. These patterns or characteristics of the groups and their relationship make possible to evaluate quantitatively and qualitatively the advantage or disadvantage of each delivery system in terms of conflict avoidance or dispute resolution. Then, indexes of negotiation effectiveness for each delivery system are developed in order to quantify the advantage of implementing the collaborative negotiation methodology in a large-scale project within a particular delivery system.

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My sincere thanks also go to DaVinci group member who made our research group a stimulating, educational and fun environment. Their invaluable advice and suggestion really help shape up my research work.

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Chapter 1

Introduction

1.1 Research Motivation

In large-scale civil engineering and architectural projects, collaboration is key for the success of projects. Since different participants from different organizations try to work together in projects, competitive stresses exist in their relationships and as a result disputes or conflicts may inevitably occur. Better methodologies are needed to improve the collaborative process and create more effective, efficient and sustainable results. Intensive efforts have been made so far to develop a collaborative negotiation methodology with the use of game theory and negotiation theory (Peña-Mora and Wang 1998). With the interpretation of negotiation characteristics in A/E/C industry, the methodology has integrated the concepts of game theory and negotiation theory: the
game theory represents the quantitative aspects of the relationships; negotiation theory represents the qualitative aspect of negotiations.

1.1.1 Importance of Research

In order for that collaborative negotiation methodology to be more applicable to large-scale projects, this research focuses on the contribution or the effect of project structure and delivery method on it. The issue of the project structure and delivery system is an important driver of the collaborative negotiation methodology, because they define the temporary formal and informal relationships among the different parties in a project and subsequently they define the framework of conflict negotiations within that project. Therefore, it is expected that different delivery systems can be more or less effective in terms of dispute prevention or dispute resolution, depending on the project in which they are applied. Moreover, if this effectiveness were quantified, it would provide information about barriers or difficulty of implementing the collaborative negotiation methodology in a particular large-scale project.

1.1.2 Objective of Research

The primary objective of this research is to present how the different project delivery systems through different contract conditions influence or affect a negotiation process. It is also within the scope of this research that the advantages or disadvantages of each project delivery system are quantified in terms of negotiation effectiveness for
implementing the collaborative negotiation methodology in large scale infrastructure projects.

1.1.3 Hypothesis of Research

This research will be conducted based upon the following hypotheses.

- Each delivery system has typical or pattern behavior by the different functional groups that may affect negotiations.
- These patterns or characteristics of the groups and their relationship will make possible to evaluate quantitatively the advantage or disadvantage of each delivery system, or they will support effectively or reduce considerably negotiations in the projects.
- Negotiation data in projects contains information on characteristics of negotiations taking place in that project under a certain delivery systems.

1.1.4 Benefits of Research

Given the results through this research, participants in a project will be able to comprehend each other’s interests under a certain delivery system, and will successfully allocate likely sources of joint gain from mutual advantageous trade-off. As a result, each participant can contribute toward fostering a collaborative negotiation environment in a project. Additionally, participants, especially owners, will be able to predict and diagnose
potential conflict of a project associated with negotiation, and will be able to plan conflict mitigation schemes effectively.

1.2 Research Approach

In order to reach the goal of the collaborative negotiation methodology, the research is approached in the following steps. Given the research motivation described in Section 1.1, this research will be approached in the following four phases.

Step 1: Several different pure project structures and delivery systems are studied in order to identify participants, their roles and their relationships. Depending upon the delivery systems, each participant may have a different set of interests, positions and attitudes. Owners, designers and contractors are three primary parties to be focused on.

Step 2: It is evaluated how the delivery systems impact the negotiation through changes in participants' roles and relationships. The second step focuses on potential conflicts in those relationships, to evaluate how the delivery systems impact the conflict situation, and therefore, the negotiation process through changes in participants' relationships.

Step 3: Using the data from ongoing projects, negotiation results from change order records are examined in order to: (1) confirm the negotiation characteristics in A/E/C industry; and (2) develop the indexes of conflict avoidance or negotiation effectiveness.
Step 4: Then, based upon the findings through the steps above, it is examined how the collaborative negotiation methodology can incorporate the findings from the effect of delivery system to a negotiation.
Chapter 2

Background

2.1 Collaborative Negotiation Methodology

Peña-Mora and Wang (1998) has proposed a collaborative negotiation methodology and a computer agent named CONVINCER to facilitate/mediate the negotiation process in large scale infrastructure projects. By obtaining the interpretation of negotiation characteristics in A/E/C industry, the methodology has integrated the concepts of game theory with the concept of negotiation theory to help guide negotiations toward sustainable outcomes.
2.1.1 Negotiation Characteristics in A/E/C Industry

Peña-Mora and Wang (1998) have pointed out five major characteristics in the A/E/C industry that have to be considered in a negotiation: collaborative-competitive nature; domain dependent barrier; strategy-influenced outcome; project delivery system; and globalization trend.

During the negotiation process in the A/E/C industry, a competitive environment is formed because participants are from different organizations with different objectives. So they have to use a set of strategies to reach their maximum profit due to the fact that payoffs are not highest for all. However, the project cannot be done by only one organization, and it will only be achieved if all the organizations cooperate. Therefore, players in a negotiation process may have both cooperative and competitive characteristics. In addition, negotiations in large-scale projects are also extremely domain-dependent, as there usually exist gaps between expert professionals in both their educational background and their perspectives to the issues related to the project. Moreover, the influence of the strategy used by negotiators must be also recognized and addressed in a collaborative framework, as different negotiators use different strategies and tactics in their interactions. In addition, delivery systems have a strong influence on the interest of participants, since different contract types lead to different organizational structures and different relationships between participants. Finally, different organizational and national cultures also have a significant influence on negotiations, because participants act in negotiations based upon disciplines and value judgement.
affected by different cultures.

2.1.2 Generic Negotiation Model

Given that the design and construction domain is complex, involving multiple participants and multiple negotiation variables, it is essential to break the problem down to its basic factors. Figure 2.1 is a generalized representation of the typical parties, structures, relationships, and attributes that make up a negotiation, and can assist researchers in understanding how the developed methodology fits into the subject environment. The model consists of five basic elements: (1) the project; (2) the participants; (3) the negotiation interaction process; (4) the collaborative negotiation methodology; (5) and the outcome. Each of these elements plays a part in a generic collaboration and negotiation issue within the domain of large-scale projects. In a negotiation, each participant brings several attributes with them to the project domain. For any given issue, problem, or conflict encountered, the participant will have a negotiating position (Fisher and Ury 1981). These positions can be considered the yardstick by which the initial stance and the subsequent movements can be measured. Behind positions lie the interests of the participants, which are the basic underlying needs, preferences, concerns, or goals that need to be satisfied for a successful and sustainable results (Fisher and Ury 1981, Susskind and Cruikshank 1987). Attitudes are general descriptions of a negotiator’s style, which can typify a particular negotiator’s approach, or may be purely a situation-specific variable (Darling and Mumpower 1990).
Figure 2.1: Generic Negotiation Model (From Peña-Mora and Wang 1998)
In negotiations, the important element to be concerned about is how interests are satisfied, with less concern toward individual position changes. In order to identify the relationships that those interests have with their positions, this research effort looks at utility functions in game theory. In order to define the interests of participants, the research effort looks at negotiation theory to assist in defining which variables to use in building the utility functions, as well as how to assign weights to those variables.

2.1.3 Game Theory and Negotiation Theory

Game theory, the study of rational behavior in situations involving interdependency (McMillan 1992) is an established research field that offers valid insight into strategic bargaining in competitive situations. An important aspect of the study of game theory is the examination of the effectiveness of the theory in negotiations within large-scale engineering systems. In applying game theory, it is critical to look at the concession process and payoff functions. The payoff function of a participant represents the level of participant satisfaction with the outcome, which tend to be higher when fewer concessions are made.

While the game theory represents the quantitative aspects of the relationships, negotiation theory represents the qualitative aspect of negotiations. Negotiation theory is the study of the exchanges between parties designed to reconcile their differences and produce a settlement. Negotiation theory aims to assist during the negotiation process so that the qualitative characteristics of a negotiation are taken into consideration. The dispute
resolution continuum (Susskind 1995) in Figure 2.2 is examined to identify the suitable form for the methodology. This continuum indicates different levels of involvement of the third party and the power of controlling the settlement by the participants. The continuum is broken down into three distinct categories: unassisted, assisted, and adjudicated. The collaborative negotiation methodology is aimed to the area of assisted negotiation where participants have control over the outcome. This area contains three methods: facilitation; mediation; and non-binding arbitration.

![Figure 2.2: The Dispute Resolution Continuum (From Susskind 1995)](image)

Thus, the collaborative negotiation methodology combines game theory and negotiation theory, to assist collaborative groups in reaching and maintaining their own mutual decisions. Utilizing these two complementary aspects, the methodology also strengthens the partnership between humans and computers for supporting collaborative negotiations in terms of the qualitative and quantitative aspects of negotiations.
2.2 Effect of Delivery Systems on the Methodology

Basic scenarios for the collaborative negotiation methodology have already been examined by Peña-Mora and Wang (1998). However, works on delivery system and globalization trend in projects need to be undertaken so that the methodology can be improved for its implementation. Thus the adoption of a more descriptive and realistic project structure will greatly shape up the methodology for further application. To take account of delivery systems, project participants’ roles, responsibilities, and relationships will be used to identify their interests, positions and attitudes. Given these results, the effect of delivery systems on the negotiation model will be studied and the findings will be incorporated in the collaborative negotiation methodology. The proposed components of the research is illustrated in Figure 2.3.

![Diagram showing the proposed components of the research]

**Figure 2.3: The Proposed Components of the Research**
Chapter 3

Project Structures and Delivery Systems

3.1 Selected Delivery Systems

There may be a number of ways to classify project delivery systems. The following seven delivery systems were selected for this research so that they can effectively show clear distinctions of participants' roles, responsibilities, and relationships.

- The Traditional Design-Bid-Build (DBB)
- Pure or Agency Construction Management (PCM)
- Construction Management at Risk (CMR)
- Design-Build (D/B)
- Turn-Key (TKY)
• Design-Build-Operate (DBO)
• Build-Operate-Transfer (BOT)

DBB has been the most frequently used delivery method, often called the “traditional” approach. This contemplates that design and construction of the project proceed in sequence, awarding the construction contract after plans and specifications are completed. In construction management, a construction manager plays a distinctive role to perform as the owner’s agent or sometimes to take construction risks instead of the owner. The two types of construction management, PCM and CMR, are expected to illustrate the effect of risk shift among participants’ relationships. There are some “new” delivery systems that package more than one contractual service (see Figure 3.1), such as D/B, TKY, DBO, and BOT. D/B is a delivery system where both design and construction functions are combined under one contract. TKY can be categorized as one of the modification of D/B, which packages design, construction, and short-term financing. DBO is an extension of the TKY delivery process, but with O&M included over an extended period of time (Miller 1998). BOT is a further extension of the DBO model, including long-term financing. Those differences in scope of the contracts are also

<table>
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<th>Scope of Work</th>
<th>Design</th>
<th>Construction</th>
<th>Operation &amp; Maintenance</th>
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<tbody>
<tr>
<td>Financing</td>
<td>Short-Term Financing</td>
<td>Long-Term Financing</td>
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**Figure 3.1: Contractual Services (Adapted from Gordon 1998)**
anticipated to make distinction among each participant's relationship. The models of the project structure followed in of each delivery system are depicted in Figure 3.2 to 3.8.

3.2 Participants

General characteristics of the major participants on the project, such as the owner, the A/E, the contractor, and the CM, are overviewed here on their interests, positions and attitudes.

3.2.1 Owner

The owner is the inciting party for whom the project is developed. This party is also, in most cases, the source of the financial resources that support the project. It is important to notice the distinction between private and public owners, because the private owner's contracts operate differently from the public ones. The private owner may include individuals, partnerships, corporations, or various combinations thereof. Most private owners are the end users who have the facility built for their own uses like business, habitation, or else. Some others may sell, lease or rent the facility to others for a profit. These differences of the owner's position in the "value system" (Porter 1985) may affect his/her strategy and, therefore, his/her interests in a project. On the other hand, the public owner sector is composed of local, state, or national governmental bodies. Public projects are paid for by appropriations, bonds, tax levies, or other forms of financing and are built
Figure 3.2: The Traditional Design-Bid-Build (DBB)
Figure 3.3: Pure or Agency Construction Management (PCM)
Figure 3.4: Construction Management at Risk (CMR)
Figure 3.5: Design-Build (D/B)
Figure 3.6: Turnkey (TKY)
Figure 3.7: Design-Build-Operate (DBO)
Figure 3.8: Build-Operate-Transfer (BOT)
to meet some defined public need (Clough and Sears 1994). It is interesting that public owners’ interests are largely affected by the needs of the public they serve, who is usually not at the table when conflicts occur. Another important thing is that the public owner may be subject to restrictions on delivery methods, like state law against public owners using design-build. This may sometimes result in contractual relationships that contains unresolved problems, or potential conflicts.

3.2.2 Architect/Engineer (A/E)

The A/E is the party that designs the work and often administers the construction phase of the project on the behalf of the owner and in the absence of CM. The A/E can occupy a variety of positions with respect to the owner for whom the design is done (Clough and Sears 1994). It is quite common that the A/E acts as an independent designer under contract with the owner. In some agencies that hold their own in-house designers, the A/E occupies a functional part of the owner’s organization. Meanwhile, the A/E may be affiliated with the contractor when the owner contracts with a single party for both design and construction services. Depending upon contracts and organizations, the A/E takes various positions as they relate to both the owner and the contractor. In those cases, the A/E’s interests may differ accordingly from project to project, however, some of his/her inherent interests like aesthetics will not change.
3.2.3 Contractor

The general contractor (GC) is the entities who are charged with the responsibility of actually putting construction work in place—that is, those entities who determine the means, methods, techniques, sequence, and procedures to direct the actual construction activities (Bartholomew 1998). The subcontractors are responsible to the GC in the same way that the GC is responsible to the owner. Therefore, in the interest of clarity and simplicity, the discussions on construction forces are confined to the GC or the trade contractors. In different contracts, there are a number of ways to price and pay for contracted services of the contractors (Gilbreath 1983), which greatly influence one of their greatest interests, profit and risk allocations.

3.2.4 Construction Manager (CM)

The CM may be design firms, contractors, or professional construction managers. Construction management services range from mere coordination of contractors during construction, to broad responsibilities over project planning and design, construction scheduling, cost monitoring, and other management services. Depending upon the scope of work determined by contracts, the CM may have several interests at a time. But, most of the times, some interests such as reputation remain at the center of the CM’s interest, considering the nature of the professional services it provides.
3.3 Roles, Responsibilities, and Relationships

Based upon the characteristics of the major participants in a construction project, their roles, responsibilities, and relationships are examined here for four of the selected delivery systems (DBB, PCM, CMR and D/B). Figure 3.9 shows relationship models for those four delivery systems.

![Diagram of construction project roles and relationships]

**Figure 3.9: Project Structures of Selected Delivery Systems**
To examine their relationships, it must be noted that there exist *contractual relationships* and *communicational relationships* among the participants in projects. It is important to maintain the clear distinction between these two types of relationships when we scrutinize the project structures. There may not be a contractual link between the major participants in a project, but only a communication link. This means that, although two parties may sit at opposite ends of the negotiation table, a particular outcome may have to be expressed through contracts held by a third party (Kennedy 1997). The traditional design-bid-build system, for example, places the owner in the middle of any conflict between the designer and the contractor, who only have communicational relationship in the project. It is critical to understand the contractual relationships and communicational relationships in order to explore the negotiations that will occur as part of the administration of the contract on a particular delivery system.

### 3.3.1 The Traditional Design-Bid-Build

The owner, the A/E, and the contractor are the three major participants in this structure. The project proceeds sequentially, with design reaching full completion prior to conducting bidding and the selection of a contractor.

In this structure, the owner contracts directly and separately with the contractor and the designer. There are formal contractual relationships between the owner and the contractor as well as between the owner and the designer. The owner selects and hires the A/E to whom he/she may entrust responsibility for design and construction inspection. A lump
sum bid is commonly used in this delivery system for both public and private projects. The lump sum and general contractor approach tends to set up a build-in adversarial relationship between the owner and contractor. This typically results from the general contractor’s principal interest in delivering the project below the lump sum amount to achieve or increase profit or to encourage change orders or claims for the same reason (Potter 1995). The owner’s interest may vary depending upon projects, including quality and value of product, delivery schedule, site safety, and environmental impact. However, they are greatly influenced by the major assumption for this system that responsibility and risk are allocated easily by segmenting tasks. Also the owner has an emphasis on cost benefit that DBB pursuits through a strong market competition.

The A/E completes the design and develops the general contract documents, interpreting the owner’s needs. His/her general responsibilities beyond those are to administer the owner-contractor contract, functioning as the owner’s agent. The owner and A/E are in more of a collaborative position, because the A/E is typically selected on a qualification basis, and occupies the position of primary consultant and fiduciary to the owner. No formal contract exists between the A/E and the contractor. However, despite of no contract, informal relationship of communication exists between the A/E and the contractor. The adversarial relationship may occur between them, because the contractor has to act on orders from a contractually unauthorized source. From the nature of work and selection base, the A/E’s interests may include profit, aesthetics, relationships, quality, recognition, and otherwise.
The general contractor’s role usually starts from the bidding stage, so he/she plays very little or no part in the design phase. He/she takes total charge of the site and construction of the project. He/she coordinates and supervises works of the subcontractors who actually undertake most of the construction. He/she is responsible to the owner for the construction in accordance with plans and desires of the A/E. He/she normally assumes responsibility for all site safety issues. In general, the contractor’s interests may include profit, construction time, relationships, reputation, and otherwise. But profit seems to be almost always its priority. Construction time, or schedule, is also a key element of the project especially in a situation that time costs the contractor.

3.3.2 Pure or Agency Construction Management

The owner is responsible for selecting and hiring the CM as well as the A/E. The owner’s interests may not be different from the ones in DBB. But the choice of CM as his/her agent affects largely the owner’s interests. The owner appropriately selects pure CM system, due to its advantages of great flexibility in the schedule and for changes, as well as fiduciary relationship with the contractor both before and during construction, while still providing market competition for most of the work (Gordon 1991). The role of A/E remains much the same as in the traditional design-bid-build method. But the appearance of CM affects the A/E’s roles and facilitates his/her functions. The A/E is forced to adjust his/her communication network and his/her own responsiveness to accommodate the owner-CM situation. The CM does not hold any contracts with trade contractors, nor guarantees any sort of upset price to the owner. For these reasons, the financial risk to the
CM is small but the risk of loss of reputation is very high. Unlike other participants, the CM in this system may have greater interest on reputation and relationship at the expense of profit, since most of the time they have fixed fees. In this light, it is likely that the CM could undertake facilitator/mediator roles in negotiations of conflicts in a project.

3.3.3 Construction Management at Risk

This is often called as construction management with a guaranteed maximum price (GMP). Many owners want to reduce their risk by having the CM guarantee a total upset price for the work, GMP. With GMP, the process becomes more like the traditional design-bid-build process. This casts relationships into a status somewhere between that of the traditional design-bid-build method and the pure construction management method. In this system, the CM holds all of the trade contracts directly. The CM is responsible for completing the project for a total sum equal to or less than the GMP. Then his/her interest on profit becomes more intensive as the project cost approaches to the ceiling of GMP. That may change the CM's attitudes in negotiations during the course of the project.

3.3.4 Design-Build

The owner contracts singularly with the D/B team. The design function and construction function are within one contractual team. The responsibility for design and construction rests with one organization, and there exists only one contract to the owner. This is usually a type of general contractor firm with design function. The design function can be
another firm, and the relationship is just as another subcontractor to the prime. Contrary to DBB, the owners may have more emphasis on schedules despite less control and more uncertainty of cost. One of the disadvantages of the system is the loss of control over design and flexibility in changes. The owner must be knowledgeable enough about design and construction to establish the initial parameters, review proposals, and monitor the process, which frequently require the help of an independent consultant (Gordon 1991).

3.4 Relationships among Participants

Given the roles, responsibilities, and relationships of major participants, Table 3.1 illustrates the differences of the relationships among the major participants in the four delivery systems. Depending upon the delivery systems, participants form different relationships: the contractual, communicational, or internal relationships.

Relationships differ even between same participants of projects. For example, CM-Trade Contractor relationship changes from the communicational one to the contractual one when the owner shift his/her risks to CM. Besides, the roles and positions may differ significantly even under the same relationships participants have. For example, one of the A/E’s main interests in the DBB contract is to protect his own and the owner’s benefit, while, in the D/B contract, he/she plays the opposite role as the co-worker of the contractor with the interest of benefiting the D/B team instead of the owner. The relationships between the CM and the A/E also show the differences between two
Table 3.1 relationships among different delivery systems

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K: Contractual Relationship
C: Communicational Relationship
I: Internal Relationship
*: Contractual Relationship between the Owner and the D/B Team

construction management systems. In PCM, both the CM and the A/E serves the owners as agents and work together in a collaborative manner, while, in CMR, the CM in practice appears to be a GC and they may have adversarial relationships.

Since the roles and positions that every participant takes are regulated by the contract they agreed on prior to the beginning of the project, different contract types lead to varied positions and also varied interests in their contract. Thus, the relationships and interests of participants become extremely complex. It is quite possible that an owner has a fiduciary relationship with a designer in a DBB project, while he/she has an adversarial relationship with the very same designer in a different D/B project. Moreover, one participant may take two or more distinct roles in a single project that adopts “innovative” hybrid delivery system. An example of this is the Systems and Test Track Turnkey contract in the Tren Urbano Project in Puerto Rico, which includes design and construction of a facility, operation system supply, O&M, and coordination/management of other D/B facility contracts (Harpoth 1999; Peña-Mora and Harpoth 1999). In such
situation, conflicts due to interest inconsistency occur while they have to collaborate on the same project under the relationships defined by their contract protected by law.

Thus, information on relationships may help the project participants avoid their role and responsibility confusions. This is especially important in a large-scale project, because some participants may hold several different contracts and there are some differences of roles and responsibilities among those contracts. Research in American industry shows that there is only 35% overlap between that which top managers expect their close subordinates to do, and that which the subordinates themselves think they should do (Scott and Billing 1990), which may apply directly to an owner and contractors or contractors and subcontractors. Role confusion or misunderstanding is almost inevitable, especially under competitive stresses in the context of a large-scale project. Information on roles and relationships may also help in contract planning and formation process, especially when a hybrid type of delivery system is under consideration. The owners or project managers should check the interest inconsistency in allocating multiple responsibilities and risks for hybrid systems.
Chapter 4

Potential Conflicts

4.1 Potential Conflict Analysis

In order to compare the various relationships shown in Table 3.1 and to explore their influences on negotiations in a project, the conflict situations of each relationship are examined. The basis of most negotiations is some form of conflict – a conflict of preferences, priorities, or perspectives (Lewicki et al. 1999). Though conflict is inevitable in inter-organizational environment, it is obvious that the degree of potential conflict in relationships has a large impact upon a negotiation process. Potential conflicts come into existence through the responsibilities given and risks shifted by contracts for the project. Then, the distribution of potential conflicts of each relationship in a delivery system may lead to a pattern or typical behavior of the delivery system in terms of a negotiation.
Handy (1983) suggests five different situations in which conflicts can arise:

- Formal Objectives Overlap
- Role Definitions Overlap
- Unclear Contractual Relationship
- Simultaneous Roles
- Hidden Objectives

In consideration to those situations, this research focuses in its first stage on the conflicts that may occur during the construction phase of a project. For that, the 45 categories documented by Stephenson (1996) are used (see Table 4.1). The 45 problem areas can help to check what potential conflicts may exist in the relationships of project participants of different delivery systems. Regarding each problem, the problems are analyzed whether different delivery systems make any differences in the types of potential conflicts among the different relationships. The following is an example of such analyses that are done for this research:

Constructibility: Constructibility is the degree to which the design of a structure is to be built. It is essential for the design to be conscious of construction process. As depicted in Figure 4.1, the design function and the construction force in the D/B team could collaborate to work for design, eliminating the gap of design and construction. In PCM, conflicts could be mitigated by the role of construction manager to bridge that gap.
In DBB, the designs are passed from the A/E, who mainly works for the owner's interest, through the owner to the contractor. Then the problems of constructibility could be taken less care of than in D/B projects. There may occur conflicts due to the "role definitions overlap," when the constructibility becomes a problem. In this light, D/B would have the least potential conflict regarding constructibility.

**DBB**

```
Designer → Owner → Contractor
```

**PCM**

```
Designer → Owner → Contractor
```

**D/B**

```
Designer ↔ Contractor
```

---

Figure 4.1: Flow of Design in Different Delivery Systems

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Based on this kind of analysis, each relationship in Table 3.1 of the delivery systems under study is examined in reference to Stephenson's 45 problems (Stephenson 1996). Table 4.1 depicts how the potential conflicts in Stephenson's 45 problems are distributed among the relationships in the selected delivery system. The potential conflicts are counted relationship-wise by the sum of the dot (i.e., 2 score) and the plus mark (i.e., 1 score). Each mark means that conflicts arise quite often or sometimes, respectively, due to a specific potential conflict existing in a relationship. From this, each relationship in the delivery system can be compared quasi-quantitatively in terms of potential conflicts. Figure 4.2 is a graphical representation of the score results for each relationship.

4.2 Potential Conflicts in Relationships

In DBB, it is apparent that owner-contractor relationship has much more potential conflicts than other two relationships. As mentioned above, the owner and the A/E are in more of a collaborative position because A/E is typically selected on a qualification basis and occupies the position of primary consultant and fiduciary to the owner. The results underpin this relationship. On the other hand, A/E-contractor relationship has a relatively high score although their relationship is communicational or informal. This can account for the well-recognized problem of their adversarial relationship.

In PCM, the owner-trade contractor relationship also shows the highest score among the three relationships. The total scores of the two delivery systems, DBB and PCM, are almost same. It may be inferred that both systems are not much different in terms of
Table 4.1: Potential Conflicts in Relationships (The list of 45 problems is from Stephenson 1996)

<table>
<thead>
<tr>
<th>Delivery System</th>
<th>DBB</th>
<th>PCM</th>
<th>CMR</th>
<th>D/B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Owner-Designer</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Owner-Contractor</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Designer-Contractor</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Owner-Designer</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Owner-Contractor</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Owner-Designer</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Owner-Trade Contractor</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Owner-Designer</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Owner-Contractor</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Owner-Designer</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CM-Trade Contractor</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Owner-Designer</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Owner-Contractor</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Owner-Designer</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Owner-DB Entity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Approval processes
2. Back-charges
3. Being a good off-site neighbor
4. Being a good on-site neighbor
5. Closing out the project
6. Communicating with others
7. Constructibility
8. Construction document quality
9. Contract interpretation
10. Cost growth
11. Decision making
12. Documents and documentation
13. Equipment and material problems
14. Financial matters
15. Inspecting and testing
16. Issue, conflict, and problem resolution
17. Job management
18. Labor conditions
19. Legal matters
20. Maintaining regular project evaluations
21. Organization, authority, and responsibility
22. Paperwork and administrative work
23. Payment processing
24. Personal quality and problems
25. Planning and scheduling
26. Policies and procedures
27. Procurement of materials and equipment
28. Program conditions
29. Project cost structure
30. Quality management
31. Regulatory agency matters
32. Revision processing
33. Safety
34. Staff morale and attitudes
35. Staffing and personnel
36. Submittal processing
37. Substitutions and alternates
38. Time growth
39. Timely action
40. Training
41. User-group interaction
42. Value engineering
43. Warranty conditions
44. Weather conditions
45. Work-site condition

Scores of Each Relationship: 11 42 27 12 11 48 13 47 25 32
Scores of Each Delivery System: 80 71 85 32
Normalized Scores: 0.14 0.53 0.34 0.17 0.15 0.68 0.15 0.55 0.29 1.00
Total of Normalized Scores: 1.00 1.00 1.00 1.00

44
Figure 4.2: Comparison of Potential Conflict Scores

overall potential conflict. However, PCM shifts some of the owner’s responsibilities to the CM, while, in the DBB, the owner holds most of the responsibilities.

CMR has the most total scores among the four selected systems. It can be seen that there exist many risks in the owner-CM relationship. In most cases, the owner adopts CMR with a preference for shifts of responsibilities and risks to the CM. However, while the owner may be benefited by the risk shift in CMR, he/she has to be aware of its tradeoffs.
with more potential conflicts, due to an increase in number of potential problems between the CM and the trade contractor without a great reduction of potential problems between the owner and the CM.

On the contrary to the other three, D/B delivery system shows much less total score. Of course, only the relationship of the owner-D/B Team is examined, and the internal relationships are not assessed. Besides, it is more likely in D/B project that participants have many debates when they seek agreements for contracts inside the team. Thus, a second phase of this research is to work at how internal conflicts on contracts such as D/B may affect external relationships such as the one of the D/B team and the owner. In addition, the research also needs to focus on the problems that take place at different times of the project such as design, operations and divestment in order for all the conflict situations to be assessed during the whole life of a project.

Thus, from the results of looking at the construction stage of projects, it can be determined that each relationship in different delivery systems contains different weighting for conflicts. Additionally, it is observed that the highest conflicts occur in a relationship where the risk during construction is higher. Although the scores are relative to one another, we can learn some lessons from the results.

Referring to these results for different delivery systems, participants of project will have an understanding of their potential conflicts among the relationships they are going to form. If certain participant is involved in a project with an unfamiliar delivery system,
he/she may have some ideas on the relationships to form, by comparing with results of the other systems he/she has experienced. These results also help the owners and project managers to know which relationship they should focus on for conflict avoidance or dispute prevention when considering different delivery systems. They make it possible for the owners and project managers to plan to take some measures for conflict mitigation such as partnering and alternative dispute resolution.

The same thing is true for project managers to evaluate certain activities and processes in a particular delivery system that are related with high potential conflicts. Project managers can identify such activities that are in the different Pareto tiers (Shtub et al. 1994), where small percentage of activities accounts for large percentage of the total problems. Then, they can set forward a monitoring plan for such activities or processes to improve the project performance. For example, we can sort the activities by potential conflicts as well as project risks, and categorize them into one of the following three groups (modified from Shtub et al. 1994):

**Group A**: 10 to 20% of the top activities with high potential problems, which together account for roughly 60% or more of the total potential problems of the project with a particular delivery system

**Group B**: all activities not members of group A or C

**Group C**: large percentage of the bottom activities in terms of potential problems, which account for 10% or less of the total potential problems
The strategy using these Pareto tiers is to monitor carefully group A items, conversely to pay the least amount of attention to group C.

Moreover, the conflict information may be used by the owner as one of drivers in the selection of delivery systems, when the owner has a strong concern on conflicts in a project in addition to cost, schedule and quality issues.

Although there are several findings from potential conflicts stated above, further analysis is needed. The analysis of potential conflict presented here mainly focuses on the phase of construction in a project, because the 45 problems by Stephenson are more related to construction process. More work is being undertaken to study problems further more in the front and back-end stage of a project, that is, design and operation processes, which could highlight some other risk area. Also analyses on delivery systems like BOT will be incorporated to understand the effect of their internal conflicts to the other participants of the project.
Chapter 5

Negotiation Analysis

The examination of potential conflicts in relationships of different delivery systems offers helpful information to project participants in planning and preparing for the conflict situations that they may encounter in a project. This information may help participants focus on particular relationships or activities, or adopt some conflict mitigation methods. However, to make these recommendations more effective during the course of projects, they need to know how well these plans are working. They should assess or measure their performance on negotiating conflicts, so that the participants can evaluate and improve their negotiation process. If this is done, we will be also able to assess effectiveness of delivery system in terms of negotiations and conflict resolutions. For that purpose, this research proposes a set of negotiation indexes as measures for negotiation performances.
in projects, by using, for example, negotiation data from records of the change order process.

5.1 Use of Change Order Records as Negotiation Results

Several researches have used change order records as the indexes of project performance or success such as: the number of modification (Pocock et al. 1996); the number of conflicts and change (Gardiner and Simmons 1992); and the frequency, severity, cost, and number of dispute (Diekmann and Girard 1994). But these efforts only have been used to evaluate a project after it completes, using as references only the number of conflicts that have resulted in change of scope while there are a number of negotiations on conflict. However, some contracts allow considerable scope changes as a contracting strategy due to inherent risks and uncertainty of projects, while some contracts are made to minimize scope changes as possible. Thus, we cannot simply compare project performances by the number or amount of scope changes at the end of a project.

We need to know how conflict situations are dealt with in the midst of a project, not after its completion. Now that this research has shown the conflict situation in each relationship of a particular delivery system, it is essential to monitor how negotiations under such a situation are handled. We should monitor conflict situation in a project by how much time and cost is spent for negotiations over conflicts. Then, we should compare the potential conflict with the actual conflict. Great differences between those
may show that there may be inappropriate processes in place for negotiating, which may need to be improved.

To analyze this gap, this research effort also uses change order records for analyzing negotiation results as the project proceeds. Change order records usually include the description of issues, the starting and completion dates of a negotiation, and the proposed and negotiated amounts for the change (See Table 5.1). In some projects, we may also assess the data during the different negotiation steps, like concession steps and amounts. Those various data will be analyzed with the following two hypotheses in mind.
### Table 5.1: A Sample of Negotiation Data (From CA/T 1994)

<table>
<thead>
<tr>
<th>PCN No.</th>
<th>Description</th>
<th>Related CPN</th>
<th>NTP w/PCN</th>
<th>Draft PCN</th>
<th>MHD Concur</th>
<th>FHWA Concur</th>
<th>Report to Contr.</th>
<th>Scope Meeting</th>
<th>Proposal Received</th>
<th>Proposal Amount</th>
<th>Subnet Received</th>
</tr>
</thead>
<tbody>
<tr>
<td>052</td>
<td>Relocation of 16&quot; &amp; 30' Water-Line</td>
<td>N/A</td>
<td>Y</td>
<td>09/10/93</td>
<td>09/16/93</td>
<td>09/28/93</td>
<td>10/06/93</td>
<td>06/10/94</td>
<td>12/01/93</td>
<td>$1,143,855</td>
<td>10/19/93</td>
</tr>
<tr>
<td>078</td>
<td>Mud Mat Water-Proofing</td>
<td>046</td>
<td>Y</td>
<td>12/15/93</td>
<td>05/23/94</td>
<td>06/06/94</td>
<td>----</td>
<td>08/04/94</td>
<td>04/07/94</td>
<td>$344,335</td>
<td>04/11/94</td>
</tr>
</tbody>
</table>

### NEGOTIATION REPORT

<table>
<thead>
<tr>
<th>PCN No.</th>
<th>Description</th>
<th>Negot. Started</th>
<th>Action Items</th>
<th>Negot. Comp'd</th>
<th>Negot'd Amount</th>
<th>Compl'D Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>052</td>
<td>Relocation of 16&quot; &amp; 30' Water-Line</td>
<td>06/30/94</td>
<td>N/A</td>
<td>07/14/94</td>
<td>$987,747</td>
<td>16</td>
</tr>
<tr>
<td>078</td>
<td>Mud Mat Water-Proofing</td>
<td>08/04/94</td>
<td>09/30/94</td>
<td>10/12/94</td>
<td>$261,000</td>
<td>70</td>
</tr>
</tbody>
</table>

### MODIFICATION REPORT

<table>
<thead>
<tr>
<th>PCN No.</th>
<th>Description</th>
<th>EWO No.</th>
<th>MOD No.</th>
<th>Mod'n Amount</th>
<th>MOD Drafted</th>
<th>KPAC Sign/Certif</th>
<th>MOD w/MHD</th>
<th>MOD Approved</th>
</tr>
</thead>
<tbody>
<tr>
<td>052</td>
<td>Relocation of 16&quot; &amp; 30' Water-Line</td>
<td>46</td>
<td>26-II</td>
<td>$462,747</td>
<td>07/18/94</td>
<td>10/06/94</td>
<td>10/20/94</td>
<td>11/08/94</td>
</tr>
<tr>
<td>078</td>
<td>Mud Mat Water-Proofing</td>
<td>---</td>
<td>42-II</td>
<td>$161,000</td>
<td>10/26/94</td>
<td>11/01/94</td>
<td>---</td>
<td>---</td>
</tr>
</tbody>
</table>
5.2 Confirmation of Negotiation Characteristics

_Hypothesis 1: Negotiation data from actual projects, more or less, underpin the negotiation characteristics in A/E/C industry: collaborative-competitive nature; domain dependent barrier; and strategy-influenced outcome._

In order to efficiently implement the collaborative negotiation methodology, the negotiation characteristics by Peña-Mora and Wang (1998) should be confirmed using data from projects. The competitive characteristic may be accounted for by the concession behavior that participants show, while the cooperative characteristic is expressed by the innovativeness of the results. The domain dependent nature of the interaction may be explained by the results from negotiation issues with highly technical knowledge that may show different behavior than the other issues. The strategy influenced nature of the interaction may be accounted by comparing the results of the same type of issues within different structures and/or players.

5.3 Negotiation Indexes

_Hypothesis 2: Negotiation data from actual projects contain the information that enables the evaluation both quantitatively and qualitatively of negotiation characteristics in different delivery systems._
From the data of negotiation results, indexes of negotiation effectiveness for each delivery system could be developed.

We were able to develop indexes of negotiation avoidance or effectiveness for each delivery system, by the quantitative and qualitative indexes listed in Table 5.2. The quantitative indexes are:

- The total number of negotiations: This may be defined as the total number of change orders which require negotiation processes, or the total number of claims in projects. Obviously too many negotiations are not desirable.

- The frequency of negotiations: This can be given as project duration over the number

<table>
<thead>
<tr>
<th>Table 5.2: Proposed Indexes for Negotiations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Indexes</strong></td>
</tr>
<tr>
<td>The number of negotiations</td>
</tr>
<tr>
<td>The frequency of negotiations</td>
</tr>
<tr>
<td>The duration of negotiations in a project</td>
</tr>
<tr>
<td>The number of negotiation steps</td>
</tr>
<tr>
<td>The number of parties affected in a negotiation</td>
</tr>
<tr>
<td>The number of renegotiations on a particular issue</td>
</tr>
<tr>
<td>Satisfaction with the results</td>
</tr>
<tr>
<td>Innovativeness or uniqueness of the outcome of a negotiation</td>
</tr>
</tbody>
</table>
of negotiations. The meaning of this index is not different from the total number, but this can be compared between contracts with different duration.

- **The duration of negotiations in a project**: This index refers to the total number of days negotiations take in a project. Divided by project duration, the number of active negotiations per day is obtained to show how many negotiation sessions are held everyday in a project.

- **The number of negotiation steps**: Maximum number of negotiation steps, interactions, or meetings in a negotiation can measure the degree of a negotiator’s stakehold.

- **The total number of parties affected in a negotiation**: This index may measure how much influence a negotiation has in a project.

- **The number of renegotiations on a particular issue**: Renegotiations may happen when negotiators cling to a particular issue that is turned down before. This may reveal negotiator’s strong underlying interests. In this light, when a considerable number of renegotiations are observed in a project, negotiators’ interests are not satisfied well enough. In such a case, we can be informed by the index that contracting conditions or negotiation processes should be examined whether they are appropriate and effective in terms of conflict resolutions.

The following qualitative indexes can also evaluate each delivery system’s advantages or disadvantages.

- **The innovativeness or uniqueness of the outcome of a negotiation**: In the sense of negotiation theory (Lax and Sebenius 1986), negotiations in construction process are
mostly distributive negotiations, which refers to how negotiators divide the resources to be allocated. If negotiators can seek to expand the amount of available resources instead, negotiated outcome will be more efficient. Such an innovative outcome may account for advantages of particular delivery systems.

- *The satisfaction measure expressed by the participants on a negotiation about the outcome of a negotiation:* Qualitative evaluation like how much participants are satisfied with the negotiation process can be an index to compare between different delivery systems.

Examining those negotiation indexes for many projects with different delivery system will make it possible to know how different delivery systems have advantages or disadvantages in terms of negotiations on conflicts. Indexes are examined from different angles, because the negotiation effectiveness of a particular delivery system may be expressed by a single index or a certain combination of these indexes, depending upon delivery systems. Indexes are also analyzed and evaluated as time-dependent variables. For example, DBB may always result in the similar number, frequency, duration, or cost of negotiation, while D/B may have feedback function due to the cooperation of design and construction force, to show the convergence nature of negotiation results with time.
Chapter 6

Contract Management

These concepts of negotiation indexes together with the concepts of potential conflicts need to be incorporated into the project to manage the processes of contracting. Contract management here means that the whole contracting processes should be improved by designing and implementing operational controls over the processes, rather than focusing on postfailure analysis. The contracting processes consist of contract planning, contract formation, contract administration, and contract monitoring (Gilbreath 1983). Figure 6.1 illustrates the relationships between the contracting processes and the two proposed concepts in this research: potential conflicts and negotiation indexes.

As stated in the Chapter 4, potential conflict analyses reveal the different conflicting situations on each relationship in different delivery systems. It also shows the highest
conflicts occurring in a relationship where the risk during construction is higher. These results have several points to contribute to the contracting processes. In planning phase, the owner may refer to the results of potential conflicts as one of drivers in the selection of delivery systems. The owners and project managers may have an idea on how to plan or use conflict mitigation measures like partnering (Thompson et al 1996) and an alternative dispute resolution (ADR) (Groton 1997). Also during the contract administration phase, participants can perform their contract work, by understanding the potential conflicts among the different relationships in a contract. They also can identify in a contract certain activities that are related with high potential conflicts.

On the other hand, negotiation indexes help participants monitor how negotiations are handled during the course of the project, solving perceived conflicts that arise from potential conflicts. Since potential conflicts are regulated by the contract that participants form and agree upon, and also since negotiation indexes indicate how such conflicts are handled after they are perceived, one may use them to review both phases of contract formation and administration. For example, negotiation indexes can give feedback to contract formation processes whether potential conflicts on contracts turn out to be what it had been planned. If participants found more intensive occurrence of conflicts than they had expected in a particular relationship, the owners might revise their strategy in the following contract formation. Same thing is true for contract administration. Participants are able to evaluate conflict mitigation measures through the indexes, and also are able to improve them during the course of the project and for the following contracts.
The point is that it is possible for participants to have: 1) references on conflicts to plan and form contracts according to different delivery systems; and 2) indexes to review those processes and enable feedback for its improvement.
Figure 6.1: Contract Management
Chapter 7

Case Study

In this research effort, the Central Artery and Tunnel Project (Massachusetts), which is the largest on-going civil engineering projects in the USA, has been selected as a case study, due to its life span, availability of negotiation data, and the possibility that the information generated in the research may be able to be incorporated into the Project.

7.1 The Central Artery and Tunnel Project (CA/T)

7.1.1 Background

The CA/T project of Boston, Massachusetts is the largest ongoing construction project in the United States. The project includes: (a) replacement of the existing six-lane elevated
highway with eight-to-ten-lane underground expressway; and (b) extension of I-90 from
its current terminus south of downtown Boston through a tunnel beneath South Boston
and Boston Harbor to Logan Airport.

Boston has a world class traffic problem, an elevated six-lane highway called the Central
Artery that runs through the center of downtown. When it opened in 1959, the Central
Artery comfortably carried an average of about 75,000 vehicles a day. Today it carries
upwards of 190,000, making it one of the most congested highways in the United States.
Traffic crawls for more than 10 hours each day. Without major improvements, Boston
can expect a stop-and-go traffic jam for up to 16 hours a day by 2010. The solution to this
extraordinary traffic mess is called the Central Artery/Tunnel Project.

7.1.2 Project Structure and Delivery System

Figure 7.1 is the project organizational structure of CA/T. CA/T has used a pure or
agency construction management system (PCM). The Massachusetts Turnpike Authority
(MTA) is the official director of the project (i.e., the owner), which operates on behalf of
the state of Massachusetts. The joint venture of Bechtel and Parsons Brinckerhoff (B/PB)
is the owner’s management consultant and advisor. In the design stages, the preliminary
designs are developed by B/PB and the final designs are provided by the section design
consultants. MTA directly hold contracts between the contractors, whereas B/PB
implements contract administration and construction controls.
The designers and the contractors have risk associated with their individual segments of the project. However, MTA has assumed the overall schedule and cost risk for this project, as it has to take the financial burden incurred upon delay. Despite the risks, the owner is benefited by the fast track schedule and the flexibility in planning and design, which are dispensable conditions of using an agency construction management contract in such a complex large-scale project.

During the course of the project, responsibilities of MTA (formerly as MHD) and B/PB change. The general project responsibilities of MTA, P/PB, section design consultants,
and general contractors during the three stages of planning and design development, design, and construction are listed in Table 7.1.

Table 7.1: General Project Responsibilities (From CA/T Project, 1993)

<table>
<thead>
<tr>
<th>Organizational Group</th>
<th>Planning &amp; Design Development</th>
<th>Design</th>
<th>Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>MHD</td>
<td>Establishes Policies &amp; objectives Approve Implementation plans Project management plan Preliminary concepts Secures financing Authorizes payments Approve Quarterly assessments of Consultant progress for Conformance with the contract &amp; schedule Monitors Progress &amp; implementation of MHD directives</td>
<td>Approves &amp; executes Section design &amp; other Consultant contracts Approves Plans, budgets, schedules Bidding selection process Authorizes payments Authorizes changes Approves Quarterly assessments of Consultant progress for Conformance with the contract &amp; schedule Monitors progress &amp; Implementation of MHD Directives</td>
<td>Approves &amp; executes Construction contracts Procurement contracts Authorizes Construction Payments Accepts completed work Monitors Progress &amp; implementation of MHD directives</td>
</tr>
<tr>
<td>B/PB</td>
<td>Develop Management plans Procedures, standards &amp; criteria Section design concepts EEO/AA, Community &amp; Agency Coordination Programs Controls &amp; schedules Base contract documents SDC selection process Performs project-wide/other Preliminary design</td>
<td>Develops Final design standards Implements Control programs Coordination/participation Programs Performs Technical reviews Process/invoice reviews Cost/progress trending Projectwide/other Preliminary design</td>
<td>Implements Contract administration Construction controls Claims/change orders control Performs Quality assurance/control Invoice review Technical services Cost/progress reviews Construction control mgmt Supervise start-up &amp; testing</td>
</tr>
<tr>
<td>Section Design Consultant</td>
<td>Submit qualifications &amp; proposals</td>
<td>Provide Final design Technical bid documents Estimating &amp; reporting</td>
<td>Provide technical support as requested Review shop drawings</td>
</tr>
<tr>
<td>Construction Contractors</td>
<td>Bid on contracts</td>
<td>Perform Construction Start-up &amp; testing</td>
<td></td>
</tr>
</tbody>
</table>
7.1.3 Potential Conflict

According to the results of the previous sections, the potential conflicts in this project are foreseen to exist most in the relationship between MTA and the trade contractors (see Figure 7.2). But we must note that there is a difference between the generic PCM model and the CM system of this project. B/PB has been playing an active role to take MTA under its protection against those conflicts in contract administration, utilizing its knowledge and experience. In terms of potential conflicts with the trade contractor, the owner may be able to cut down some of the potential conflicts as if it were contracting with CM at risk while maintaining low potential conflicts with the CM due to the CM agency contract. In addition, introduction and exercise of partnering and ADR have been helping mitigation of conflicts. So conflict situation and dispute resolution in the project

![Diagram](image-url)

**Figure 7.2: Potential Conflicts of the Two CM Types and CA/T**
may be expectedly improved by those efforts.

Understanding those conditions, the potential conflict analysis is conducted for the project in the same way as shown in Table 7.2. As discussed above, the result in Table 7.2 reflects reduced potential conflicts for the owner while the CM takes over many of those conflicts in the owner's behalf. However, it must be noted that many potential conflicts regarding technical and administrative issues are shifted to the CM except for final decisions directly related with the contract between the owner and the trade contractors. From this result, we find it useful to conduct such a potential conflict analysis for this particular project because we may have a better comprehension of potential conflict situations by comparing the result with the ones for the generic models of different delivery systems shown in Figure 4.2. In the following section, it is discussed how this potential conflict condition influences the dispute resolution in the project.

7.1.4 Dispute Resolution in CA/T

Figure 7.3 illustrates a simplified dispute resolution process and the result, which is compared with the dispute resolution continuum presented in the Section 2.1.3. Together with the project participants, MTA has pursued an aggressive “Dispute Resolution” (Bonine 1994) process that is proved to be very effective in reducing the number of claims that are taken to litigation (Refer Figure 7.4). As a result of this alternate method of handling claims, MTA are, on the macro level, saving an enormous amount of money in delay avoidance.
### Table 7.2: An Example of Potential Conflict Analyses for the CA/T Project

<table>
<thead>
<tr>
<th>Conflict Area</th>
<th>Owner: Designer</th>
<th>Owner: CM</th>
<th>Owner: Trade Contractor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approval processes</td>
<td></td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Back-charges</td>
<td></td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>Being a good off-site neighbor</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Being a good on-site neighbor</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Closing out the project</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communicating with others</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constructability</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction document quality</td>
<td></td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Contract interpretation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost growth</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decision making</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Documents and documentation</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equipment and material problems</td>
<td></td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>Financial matters</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inspecting and testing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Issue, conflict, and problem resolution</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Job management</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labor conditions</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Legal matters</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maintaining regular project evaluations</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Organization, authority, and responsibility</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paperwork and administrative work</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Payment processing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Personal quality and problems</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Planning and scheduling</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Policies and procedures</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Procurement of materials and equipment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Program conditions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project cost structure</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quality management</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regulatory agency matters</td>
<td></td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Revision processing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safety</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Staff morale and attitudes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Staffing and personnel</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Submittal processing</td>
<td></td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Substitutions and alternates</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time growth</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Timely action</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Training</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>User-group interaction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Value engineering</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Warranty conditions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weather conditions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Work-site condition</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Scores of Each Relationship**

<table>
<thead>
<tr>
<th></th>
<th>9</th>
<th>11</th>
<th>31</th>
<th>(36)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Scores of Each Delivery System</strong></td>
<td></td>
<td></td>
<td></td>
<td>(87)</td>
</tr>
<tr>
<td>Normalized Scores</td>
<td>0.10</td>
<td>0.13</td>
<td>0.36</td>
<td>(0.41)</td>
</tr>
<tr>
<td>Total of Normalized Scores</td>
<td></td>
<td></td>
<td></td>
<td>(1.00)</td>
</tr>
</tbody>
</table>
Figure 7.3: Dispute Resolution in CA/T

The result of the potential conflict analysis for the project shows that many potential conflicts are shifted from the owner who contracts with the trade contractors, to the CM who has no contracts with them but has sufficient technical knowledge to address some of these conflicts before they happen. This role of CM may partly account for why issues are not going to court since the trade contractors always sit at a negotiation table mainly
<table>
<thead>
<tr>
<th>Individuals Involved</th>
<th>Stages in the Claims Process</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Problem</td>
</tr>
<tr>
<td>Litigators</td>
<td></td>
</tr>
<tr>
<td>Consultants &amp; Neutrals</td>
<td></td>
</tr>
<tr>
<td>Sponsors, Standing Advisors &amp; Standing Neutrals</td>
<td>Partnering</td>
</tr>
<tr>
<td>Project Managers</td>
<td>Routine discussion and negotiations</td>
</tr>
<tr>
<td>Level of Resolution</td>
<td>On the Project</td>
</tr>
</tbody>
</table>

**Figure 7.4: Stages in the Claims Process for CA/T (Adapted from Vorster 1993)**

with the CM instead of the owner.

Though the result of the dispute resolution shows success in reducing severe disputes, more information is needed to evaluate the effectiveness of the conflict resolution and negotiation strategies at a more detailed level. For that purpose as suggested by the
methodology developed, we looked into detailed negotiation data to assess effectiveness of the project arrangement including its delivery system.

### 7.1.5 Negotiation Indexes

The negotiation data up to 1994 has been collected for the CA/T Project. Additional updated and detailed data are to be collected and processed for the goal of the continuation of this research. However, even from the already collected data, it is possible to analyze the characteristics of conflict resolution in the project, and also to observe some interesting features for negotiations, which will give insights for further negotiation analyses.

Negotiation duration and negotiated amount are plotted in Figure 7.5. This not only illustrates variance of duration and amount but also tells that considerable number of negotiations require long duration for agreement. In terms of negotiation indexes, the maximum negotiation duration is found to be over a year (see Table 7.3). Thus, this data may motivate us to investigate further the effectiveness of the dispute resolution strategy used in the project at the macro level. Although the conflicts are not reaching litigation, they are anyhow taking long time to be resolved.

In order to find how negotiations are handled during the course of project, we need to look at the data more in details. Figure 7.6 is the relationship between cost range of issues and negotiation duration. This result shows the trend f longer negotiation periods with
Figure 7.5: Negotiation Duration vs. Negotiated Amount

Table 7.3: Examples of Negotiation Indexes for the CA/T Project
(As of 3rd October, 1994)

<table>
<thead>
<tr>
<th>Negotiation Indexes</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NUMBER OF NEGOTIATIONS</strong></td>
<td>4,402 <em>negotiation</em>/ 11,607 <em>contract/day</em></td>
</tr>
<tr>
<td><strong>FREQUENCY OF NEGOTIATIONS</strong></td>
<td>0.4 <em>negotiation</em>/ <em>contract/day</em></td>
</tr>
<tr>
<td><strong>NEGOTIATION DURATION</strong></td>
<td></td>
</tr>
<tr>
<td>Max. Duration of Negotiation</td>
<td>&gt; 365 days</td>
</tr>
<tr>
<td>Negotiation Duration for issues with less than $15K</td>
<td>≈ 60 days</td>
</tr>
<tr>
<td>Negotiation Duration for issues with more than $150K</td>
<td>≈ 120 days</td>
</tr>
</tbody>
</table>
Figure 7.6: Relationship between Cost Range and Average Negotiation Duration

with concerned parties. This again may put in question the effectiveness of negotiations at the detailed level.

This result may be interpreted as a policy that the owner seek to avoid litigation by expending more time on negotiations between the owner with the CM, and the trade contractors. In addition, it may be concluded that the conflict mitigation measures have worked only to reduce severe dispute of litigation, but that there still exist intensive
negotiations on conflicts in the project, which is foreseen from the result of potential conflicts. Then, since effectiveness of negotiations at the detailed level is not at on a par with the results from the dispute resolution process at the macro level, it is advisable for the Project to review the process of negotiations for conflict resolution. It is emphasized here again that we are able to discuss negotiation effectiveness of the project with those negotiation indexes although the dispute resolution shows some good results at the macro level. While this represents one aspect of effectiveness of the conflict resolution process of the Project, more information using negotiation indexes is needed in future research efforts for assessing the effectiveness, and consequently implications of the conflict resolution process both at the macro and detailed level.

To evaluate further the dispute resolution process and effectiveness of pure construction management (PCM) in terms of conflicts and negotiations, the number or duration of negotiation for particular issues should be focused upon, which has not been analyzed yet. We can monitor which activities take more efforts for conflict resolution, to find effectiveness of PCM in terms of conflict resolution on those activities. Renegotiating items must be also examined carefully to know whether the PCM project can afford to handle such items effectively. Further analysis may reveal that PCM has advantages and disadvantages in frequently negotiated or renegotiated issues. The number of parties affected in a negotiation is also an important index to refer because one issue may involve many parties and bring some side effects in such a complex large-scale project. Compared with data from other delivery systems, effectiveness of PCM in the project may be assessed by this index, because PCM may have large number of parties involved
or affected in conflict resolution processes. The frequency of negotiations may also tell us how often meetings or committees should be held to discuss and solve issues, and consequently how much such inter-organizational effort is required for a PCM project.

7.1.6 Contract Management

In the process of contract management in the Project, the negotiation indexes presented in the previous paragraphs can be a checklist to confirm its strategies for contracting, negotiation, and conflict resolution. Since we may identify problems in conflict resolution process by those negotiation indexes at earlier stages of the Project, it is possible to take appropriate measures for those problems in a timely manner. It may be sometimes too late to wait for approval for changes and modifications of design to come up, and then to evaluate them for improvements. In consideration to the great concern of delay in the Project, the use of negotiation indexes would be very helpful in giving timely and continuous feedback to its contract management process.

7.1.7 Negotiation Characteristics

Figure 7.7 is another result related with the confirmation of negotiation characteristics (c.f., hypothesis 1), showing the relationship between negotiation duration and negotiated amount over proposed amount. As the trend line shows, the longer the negotiation duration becomes, the less the percentages of negotiated amount over proposed amount become. This behavior may be taken as concession behavior in accordance with
Figure 7.7: Relationship between Negotiation Duration and Negotiated Amount Over Proposed Amount

negotiation steps. This is an interesting finding because what is happening in a real project supports the concepts of game theory that is incorporated in the collaborative negotiation methodology. The further study of the concession process and payoff functions will help to better depict the negotiator’s behavior for problems in a project.

Although more intensive analyses are required, possibility in application of the proposed indexes are demonstrated for this on-going large-scale project. It is expected in further research that the indexes can be appropriately selected and developed so as to monitor negotiation processes in the project and to improve them effectively. Also, it is found to be possible that negotiation data from change order records are useful to examine negotiation characteristics or performances in participants of the project. Understanding

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of those characteristics will provide helpful information for the implementation of the collaborative negotiation methodology.
Chapter 8

Conclusion

An evaluation has been described and tested for the study of conflict situations and negotiation characteristics in different delivery systems.

Through the study on roles, responsibilities, and relationships of the participants in different delivery systems, it is understood that major participants form various relationships depending upon the contract types they are bound to in the project. It is also revealed that those relationships show the quantitative difference of potential conflict existing between participants. Understanding of these situation help participants to plan and prepare for negotiations on conflicts that they may take part in. Furthermore, it is found that the results on potential conflicts are helpful for the selection of delivery methods.
The research also proposes that the analysis of change order record as negotiation results provide information on the characteristics of the negotiation process. The indexes of negotiation effectiveness are also presented, which will account for the advantages or disadvantages of different delivery systems. In addition, the indexes are found to be useful to analyze and improve negotiation process in projects. Finally, the research aims to provide contract management methods that incorporate the two concepts of potential conflicts and negotiation indexes. The method makes it possible for project participants to have references on conflicts to plan and form contracts, and indexes to review those processes and enables feedback for its improvement.

The methodology presented here forms the basis of further research to measure the effects of delivery systems on a collaborative negotiation methodology.

- Delivery systems for projects like turnkey, DBO and BOT, which involve in projects other function groups of financing firm and O&M forces, need to be also investigated in a similar manner.

- The results of potential conflicts in relationships among project participants must be confirmed and strengthened by means of interviews or questionnaires with practitioners in projects with different delivery systems. Questionnaires will be also used to find out other types of conflicts at the design and operation phase of projects.

- More detailed data like concession steps and amounts are expected to be assessed so that concession behaviors could be analyzed for the negotiating participants.
• Application of game theory is further explored so that negotiation behavior in different delivery systems can be quantitatively evaluated.

• Application of contract theory is examined especially to illustrate how different contracting conditions influence relationships of contracting parties.

• More number of case studies are needed in order to:
  
  - determine the negotiation characteristics more precisely using the proposed indexes;
  
  - compare data among various different delivery systems in terms of the indexes.

• The findings on the effect of delivery systems on the collaborative negotiation methodology need to be incorporated or reflected into the CONVINCER system (Peña-Mora and Wang 1998).
Appendix

The 45 Problems by Stephenson for Potential Conflict Analysis

[Quotations from Stephenson (1996)]

Approval process
“The official acceptance of information or submittals needed on the project from regulatory agencies, governmental bodies, the user, the owner, the design team, or any of the members of the constructions group is critical to job success. A delay in approval can seriously affect job planning, scheduling, and field progress.”

Back-charges
“Back-charges are charges for actions such as cleanup, hoisting, equipment use, damage to installed work, or similar items for which the party furnishing the item feels they are entitled to be paid. A back-charge is often deducted from a payment being made by the party providing the item to the party receiving the item. Problems arise when back-charges are deducted without prior negotiation or notification, especially when there appears to be insufficient cause for the charge.”

Being a good off-site neighbor
“Being a good off-site neighbor is project participant behavior that relates to the people, organizations, or facilities outside construction site boundaries. When on-site actions cause off-site aggravation – noise or dust from a project; or when off-site actions interfere with off-site neighbors – dirt and other debris left on roadways – it is difficult to be an effective builder. Nearly everyone must get to the site by going through the neighborhood – be friendly to the people who live there.”

Being a good on-site neighbor
“The on-site behavior of project staff determines how well they are treated by other on-site people. Poor job behavior almost always damages the informal organizational and
social relations so critical to healthy jobs. The best rule is still to treat others the way you want to be treated. It is the quickest way to learn the benefits of being a good on-site partner."

Closing out the project

"Closing out means properly finishing the project totally or in part. Factors related to close-out problems affect owners through delayed occupancy, and contractors and subcontractors by delays in completing their work. Improper close-out also adversely affects payment of retainage and often increases costs difficult to associate with any specific party to the job."

Communicating with others

"Information exchanges between or among individuals, groups, or organizations can be oral or visual and may express a new thought or a commonly understood policy. Problems caused by the inadequate exchange of thoughts, messages, or information in construction makes communication with others an important factor in the design and construction."

Constructibility

"Constructibility is the degree to which the design of a facility is found to be buildable. Often when there is a constructibility problem, the project or a component of the project cannot be built as called for by the contract documents. This may lead to serious delays, extra costs, redesign, and hard feelings on the job."

Construction document quality

"Problems are caused by poor quality control in the preparation of working drawings and specifications. Difficulties are usually caused by unclear or contradictory notes, drafting errors, poor workmanship, incomplete information, dimensional errors, or similar detractions."
Contract interpretation

"Any contract is open to interpretation. Serious problems may arise from substantial differences in those interpretations, especially in the understanding of various parties as to what their work scope is and what they are entitled to claim when they are hurt by a unilateral contract interpretations. Contracts being legally binding, this factor can quickly escalate from a simple problem into a disaster if not resolved promptly."

Cost growth

"Changes in project cost, either greater or less than expected, often affect the program or project. Growth may be positive for some participants and negative for others. Problems considered here often produce damaging impacts through unfair risk assignment."

Decision making

"Wise decisions at the proper time are much sought after. Inadequate, improper or ultimately decision making on project-related matters by those not competent or authorized is frequently a cause of trouble."

Documents and documentation

"Every construction job requires documentation from conception to occupation. Improper, inadequate, unneeded, or excessive paperwork that blocks effective management and implementation is likely to result in long-standing and difficult problems."

Equipment and material problems

"You cannot build a job without equipment and materials. Problems with procurement, storage, installation, or functioning of equipment and materials used on the project can create a nightmare."
Financial matters

"Financing is at the heart of any building project. Problems related to the methods, amount, availability, or reliability of project funding are difficult to discern early and are even more difficult to resolve before they do their damage."

Inspecting and testing

"Safety and quality are the hallmarks of good construction. Inspection and testing are designed to guarantee safety and quality. That means that someone qualified must inspect and test. Problems generated by poor or ultimately inspections and poor testing methods, personnel, management, or interpretation can have a serious impact on the project."

Issue, conflict, and problem resolution

"Problems are meant to be solved. The best course of action is to agree in advance how the parties will resolve emerging issues fairly and speedily. Prompt settlement of conflicts, contested claims, and other disruptive or destructive action between or among the project participants is essential to conserving profit. Unresolved issues cost dearly and create hard feelings."

Job management

"Good leadership and knowledge in depth of the total project or of its components constitute 80% of job management. The proper use of skills in planning and scheduling, assigning resources, and assembling and effectively utilizing resources enhance the prospect of job success. Conversely, bad management can doom a design and construction project before it begins."

Labor conditions

"Conditions, rules, laws, and obligations exist under which project participants work on any project. The term labor usually refers to tradespeople of all skills located at the job site. Problems arise when there are poorly managed union-nonunion disputes, ineffectual communications between management and tradespeople, financing problems, or any of
the multitude of conditions that adversely affect the lifeline of the project – financial health for all.”

Legal matters
“The construction practitioner operates under the rule of law but cannot afford to become preoccupied by it. Adverse legal actions expected or taken on a project can reduce or destroy potential for good project performance.”

Maintaining regular project evaluations
“Competent monitoring, analyzing, and acting on information derived from a plan of work is an integral part of managing. In partnering, evaluation is often implemented by regularly measuring actual partnering performance against standards set by the stakeholders in the charter. Problems arise when the process is ignored by the stakeholders or when subjective evaluations replace objective measurements.”

Organization, authority, and responsibility
“Organization, authority, and responsibility patterns spring from a functional need for competence and responsible leadership. The pattern may be assigned or assumed and will generally govern project and program actions on the job. Problems follow when the organization, authority, and responsibility needs are disregarded or unfilled. The results will often be a disputed project, uninformed participants, and frayed tempers.”

Paperwork and administrative work
“Documents, letters, and other communications, whatever the media, must flow quickly and accurately among, between, from, and to project participants. Paperwork frequently creates a love-hate relationship. Imposing too much communication without a corresponding value added is a distraction and annoyance. Too little communication may produce a value-subtracted situation by encouraging management by blindfold, where stakeholders run their work by guessing and assuming. There is a proper amount of paperwork for each job.”
Payment processing

"The methods, practices, and timing of payments due to or from project team members are usually spelled out in contract documents. Problems arise when one party disregards that agreement or when practices in billing and paying become sloppy. Prompt payment is a great stimulator of good work."

Personal quality and problems

"The labor pool, wages, and the press of business will determine who works on what job. Variations in personnel abilities, qualifications, desires, skills, attitudes, and honesty of the project staff working in the interests of the project can give rise to any number of conflicts and problems."

Policies and procedures

"Policies and procedures are detailed statements of expected behavior, sequences, courses of action, and principles that help determine decisions, actions, and others matters for the participants on a planning, design, and constructions program. Usually, policies and procedures are set both for the firms involved in doing the project work and for the project. Problems arise when those policies and procedures are unrealistic or when involved firms cannot or will not conform to agreed-on policies and procedures."

Procurement of materials and equipment

"Procurement is the process of detailing, approving, fabricating, and delivering materials, equipment, and other physical elements to be installed in the facility. Intelligent, experienced management and a strong interest in excellent performance is at the core of successful procurement. Procurement problems cause frustration and delays."

Program conditions

"The quality of the project program has a sizable effect on the design, construction, turnover, and use of the facility. A good program helps design and build a good facility. Poor programs hinder work and often lead to damaging project surprises."

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**Project cost structure**

"The characteristics of the project relative to how funding is determined, allocated, and disbursed to the project participants determine the project cost structure. Cost structure is usually established during early programming of a project. It can begin there as a problem or it may rear its ugly head later if there is an unwelcome change."

**Quality management**

"Quality management concerns factors in project success or failure that are related to the quality of people, workmanship, materials, equipment, or organizations being used on the project. Quality, as used here, means of a nature that meets contract requirements and procedures results that satisfy or exceed exceptions. Anything less may be a problem."

**Regulatory agency matters**

"Rules and guidelines are often set by regulatory agencies in the public or private sectors. Regulations can be maintained by voluntary compliance or by compliance dictated by law. Intelligent compliance with legitimate, well-interpreted regulations helps a job. If the rules and guidelines are misused or poorly interpreted, problems will surface. Regulatory difficulties often occur because regulators are sometimes not considered as a participant in the project. The result of this is an us–them mentality that produces potentially damaging conflicts between the regulators and the stakeholders."

**Revision processing**

"Revision processing includes steps taken to produce proper and effective project revisions from formulation to implementation of the change. As a supportive action, good revision processing is almost invisible. Continued poor performance in this critical part of a design and construction project leads to progressive deterioration of nearly all job management functions."
Safety
“Provision and maintenance of safe working conditions on the job site are crucial to job success. Safety problems usually result in damage or injury. Both harm job quality and progress.”

Staff morale and attitudes
“Individual and collective morale and attitudes of people can heavily influence and shape working conditions and outcomes on a project. Often, morale and attitude problems are matters of perception that may or may not correspond with reality. Good morale and constructive enthusiasm on design and construction projects are always welcome contributions to project health.”

Staffing and personnel
“Staffing and personnel items relate to the number of staff resources on the project and their quality, competence, and abilities. When resources are available, the job moves well; when resources are lacking, frustration and confusion result.”

Submittal processing
“Submittal processing concerns preparing, delivering, reviewing, approving, and returning shop drawings, specifications, designs, samples, cuts, and other documents or objects that must be approved as required by the contract provisions. Done well, submittal processing makes a job support system function well. Lack of competent attention to the procedure causes problems and delays.”

Substitutions and alternates
“Often, suggested or actual substitutions or alternative materials, equipment, methods, or systems are considered for use in place of those specified or shown on the contract documents. Problems arise when substitutions and alternatives degrade quality, present as false cost saving, or unfairly shift profit or loss among project participants.”
**Time growth**

"Time growth refers to a change in time either greater or less than expected that produces an impact upon the project or program. This impact, particularly when time is extended, almost always indicates a problem will or has appeared."

**Timely action**

"Timely action can mean action taken at the correct or effective time, or action taken for a correct or effective duration. Problems can be related to taking, or failing to take, timely action on any project or program-related matter."

**Training**

"Adequate training and education of the project team is a management necessity. Problems arise when training and education are inadequate."

**User-group interaction**

"To produce a successful project, project team members and stakeholders must maintain effective informational, technical, business, and professional relationships with the owner and the end user of the facility. When these relations are damaged or ignored, problems are almost certain to follow."

**Value engineering**

"Cost and other cost-related benefits are often gained on a generic construction project by improving the means, methods, materials, and sequences of architectural and engineering systems used. Without striving to improve value within the target cost restraints, a job remains a static system. Value engineering is best applied before construction contracts are awarded."

**Warranty conditions**

"Warranty conditions are those construction guarantees placed in effect subsequent to completion of the work and usually upon acceptance by the owner. Warranty problems
arise when their starting or expiration dates are unfairly assigned or unilaterally imposed for the benefit of one party and to the detriment of the other.”

Weather conditions
“Weather and construction are either fighting or are friends, but weather will have its way. Bad weather at a poorly managed job can create insurmountable obstacles to good work. Weather is one of the best documented scientific occurrences that exist. The manager is not expected to change the weather. He or she is, however, expected to know the when, how, what, and where of weather in their locality so that the people on the job can maintain work continuity and profitability irrespective of poor weather conditions.”

Work-site conditions
“Work-site conditions almost always affect a project. A poorly organized and badly maintained work site prevents people from doing their best work, even when they want to do well. A clean, safe, well-planned work site shows respect for those who earn their salaries by working there. It helps them do a good job. Poor site working conditions demotivate; good site working conditions motivate. One leads to trouble and danger; the other shows good faith and confidence.”
References


