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Exploring Coordination Effectiveness for High-Rise Buildings

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***Abstract*— The effective coordination and communication are critical factors of success in projects. Construction projects, in particular, are highly fragmented with many parties involved at different construction stages, thus leading to interference and dependence. Most contractors coordinate work through meetings. Although communication frequency increases with the level of uncertainty and dependence, meetings, characterized by high cost, cannot always eliminate uncertainty. Therefore, effective coordination is necessary for parties to interact with one another to improve effectiveness of construction project. The purpose of this study is to identify what coordination goals are adopted and to what extent coordination methods and goals for construction projects are achieved. In this project work, eight coordination methods and six goals were derived. To achieve objective of this study, a questionnaire was designed accordingly and sent to five firms for survey. Follow-up interviews were conducted with project manager and owner of the project. In this project work, it was difficult to investigate goals in this study without quantifying goal priorities. The average percentage of goal achievement of different coordination methods is also found out for identify the better coordination method for all five construction projects.**

The questionnaire also includes the replacement possibility of coordination methods with any other coordination method. And the replacement possibility is then calculated in percentage. If 5 out of 10 interviewees says the meeting is replace by another coordination method, its percentage value of goal replacement possibility is calculated as, 05/10 = 50%. That means the meeting has 50% replacement possibility. The percentage goal achievement and respective goal replacement possibility is calculate. The charts are prepared on data collected; from this best project using effective coordination method is observed.

The analysis results indicate that most coordination methods have multiple goals; written coordination methods such as plans, schedules, reports, and contract documents tend to have appropriate goals; and projects performed well by using coordination methods effectively to achieve the coordination goals. It was also observed that some firms take part in effective coordination but some of them are not take much attention in coordination. This may be due to the lack of knowledge of the coordination and effect of bad coordination on performance of project.

Keywords—High-rise Building; Methods of Coordination; Goals; Goal Achievement;Replacement Possibility; Effectiveness.

I. INTRODUCTION

This paper work is carrying out to study the coordination methods and goals for construction projects and to identify what coordination goals are adopted and to what extent goals are achieved. In the research process, eight coordination methods and six goals were derived. A questionnaire was designed accordingly for survey. Follow-up interviews were conducted with three or four managers and engineers from each contractor. The most coordination methods have multiple goals; written coordination methods such as plans, schedules, reports, and contract documents tend to have appropriate goals; and projects performed well by using coordination methods effectively to achieve the coordination goals.

Improved design coordination can minimize project uncertainty by decreasing disruption, and reducing waste in the construction processes. While the relationship between coordination and uncertainty is understood, there is little empirical evidence that quantifies the linkage.

The various team members are involved in the major construction projects such as high-rise building are as follows:

1) Architecture
2) Civil Engineer
3) Mechanical Engineer
4) Electrical Engineer
5) Plumbing Engineer (It involves sanitation, water supply and Fire Suppression sprinkler systems etc.)

The coordination between these team members is essential for the better performance of the project. Therefore it is essential to know the roles and responsibilities of these team members.

A. Necessity of Coodination for Highrise Buildings

Historically, previous coordination studies have focused on the time spent on coordination, its frequency, and its relationship with performance. However, coordination goals have received less attention, and their relationships with coordination methods and performance are not known. The necessity of this study is to search efficient coordination method. Because, "Information is Power" and effective communication is the mean in transferring the information to

all stakeholders involved in the project especially for the construction industry. Communication is critical amongst each contract parties including all the workers working in the project and is the key factor for a successful construction project. The design and built environment are changing throughout the project period and it is important to bring it clear to the whole site team on the requirements from the construction planning, latest development of the project and requirements from the management in having the team to move forward to the right direction. [1]

Proper coordination is critical factor to the success of construction projects. Relevant studies have addressed the frequency and information quality of communication, but their combination and contribution to the effectiveness of coordination methods need to be examined. This project explores two variables that affect coordination effectiveness: quantity and quality, as well as their relationships with coordination effectiveness and project performance. Eight coordination methods used on construction projects were examined and a questionnaire was designed accordingly. The analysis results indicated that coordination quality is more related to coordination effectiveness, and indirectly more related to project performance, than coordination quantity. Projects that performed well had better coordination effectiveness than projects that performed poorly. It was also found that some engineers' time used on written correspondence, plans and procedures, and reports could be saved without reducing their effectiveness. [2]

B. Scope of the Study

Construction projects, in particular, are highly fragmented with many parties involved at different construction stages, thus leading to interference and dependence. Most engineers coordinate work through meetings. Although communication frequency increases with the level of uncertainty and dependence, meetings, characterized by high cost, cannot always eliminate uncertainty. Therefore, effective coordination is necessary for parties to interact with one another to improve performance. In the construction project the coordination goals have received less attention, and their relationship with coordination methods and performance are not known.

In this paper what are the factors which affect the effective coordination and communication will be work out from the various questionnaire surveys of different projects. For this purpose questionnaire are designed accordingly and respective answers should be collect from the owner and firm through meetings. In addition, this report considers a subjective appraisal of the effectiveness of coordination and its benefits to the major construction project. After the overall study of the projects suggestion is give from the observation for improve the performance and effectiveness of the projects.

C. Objective of Study

The aim of this project is to study the coordination goals for major construction project because various team members are work together in construction industry. Coordination goals have received less attention, and their relationships with coordination methods and performance are not known. This project studies coordination methods and goals for major construction projects to identify what coordination goals are adopted and to what extent goals are achieved.

The objectives of this study are to be identified analyzed and define the proper method of coordination for High-rise building projects. The above study can have following five main objectives.

1) To study concept of coordination for High-rise building projects.
2) To investigate the coordination goals for construction project & effect of goal achievement on project performance.
3) To involve the study of coordination goals on live projects.
4) To analysis the data of above project.
5) To give the discussion and suggestion for effective coordination for construction projects.

II. SUCCESS OF COORDINATION FOR HIGH-RISE BUILDING PROJECTS

The questionnaire was used to survey the goals of the eight methods, along with the degree of goal achievement and the possibility of one method to be replaced by another. The answers of the interviewed contractor engineers about coordination goals, their achievement, and replacement possibility of different coordination methods are analyze.

Use Please read the eight coordination methods and six goals below, and choose appropriate answers about the goals and coordination methods you use on the project.

A. Eight coordination methods:

(1) Meetings,

(2) Informal discussion,

(3) Site visits,

(4) Written correspondence,

(5) Plans,

(6) Schedules,

(7) Reports, and

(8) Contract documents.

B. The six coordination goals are defined below.

1. **Instruction:** The owner gives orders or provides rules such as procedures or communication channel that the contractor is expected to follow.
2. **Clarification**: Exchange ideas and clarify issues such as arguments with residents or falling behind schedule.
3. **Facilitation:** Do things that are helpful to executing a project, such as gathering information about the contract requirements, applying good technical practices, rescheduling the sequence of site work, expediting the purchase and delivery of materials.

4. **Control:** Carry out activities to ensure that the schedule, safety or the level of quality meets the requirements.
5. **Information sharing:** Distribute information such as monthly reports or meeting minutes to other parties. The goal is to share information.
6. **Maintenance of relationships:** Contact with others for emotion liaison or enhancing understanding.

C. Based on the coordination goals the following questionnaire should be designed for finding the degree of achievement of coordination goals. For each coordination method the data is collected in following three steps:

1) Goals of coordination method? ☐ ☐ ☐
(Choose up to three from the six goals and list priority)

For example, for the weekly progress meeting with the owner and one project manager of project choose thought the top three goals in sequence were control (Goal 4), clarification (Goal 2), and instruction (Goal 1).

Then the priority is 4, 2, and 1. The score is given to each goal and the top three goals by percentage (weight) of each coordination method are observe.

The top three goals by percentage (weight) of weekly progress meetings with the owner are Control (100%), Clarification (60%), and Instruction (40%).

2) Degree of goal achievement? (5) 100% (4) 80% (3) 60% (2) 40% (1) 20%. (Other than this percentage)

The percentage degree of goal achievement is observe for each coordination method, for each project separately.

3) Can meetings be replaced by other methods?

□ Informal Discussion □ Site Visits □ Written Correspondence □ Plans □ Schedules □ Reports □ Contract documents □ cannot be replaced.

If the particular method can be replace by any other method then tick on that method. and degree of replacement possibility for that particular method is calculated in percentage.

For example, if 5 out of 10 interviewees says the particular coordination method can be replace with other method, then the replacement possibility is, 5/10 %= 50%.

The data is collected in this manner and data analysis is done by preparing the charts. The coordination effectiveness of each project is observes.

III. INVOLVE THE COORDINATION STUDY ON HIGHRISE BUILDING PROJECTS

A. Construction Project Details

The five high-rise building projects are selected for study purpose. Then the interviews are arranged with two persons on each construction projects. The data collection is done from the designed questionnaire.

After that the charts are prepare for the simplicity in observation, which project or which coordination method is most effective in construction project coordination. Which project is most effectively used the coordination methods is then observed. The table I shows the five high-rise building projects selected for the study.

TABLE I. CONSTRUCTION PROJECT DETAILS

Sr. No.	No. of Floors X No. of Wings	Cost of Project	Remark
1	72 X 1	₹440 Crores	P1
2	46 X 1	₹1200 Crores	P2
3	10 X 4	₹60 Crores	P3
4	15 X 3	₹1000 Crores	P4
5	13 X 5	₹125 Crores	P5

B. Goals of Eight Coordination Methods

The questionnaire was used to survey the goals of the eight methods, along with the degree of goal achievement and the possibility of one method to be replaced by another. The answers of the interviewed contractor engineers about coordination goals, their achievement, and replacement possibility of different coordination methods are analyzed and the results are presented as follows.

To determine the priority of the six goals of the eight coordination methods, the interviewees were asked to rank the top three goals of each method and scores were awarded based on rankings. The goal and score for the goal is as shown in Table II.

TABLE II. GOAL AND RESPECTIVE GOAL SCORE

Sr. No.	Goal	Goal Score
01	First Goal	3
02	Second Goal	2
03	Third Goal	1

The table III shows some codes (goal sequence) with respect to coordination goal for the simplicility in presentation.

TABLE III. GOALS AND RESPECTIVE GOAL SEQUENCE

Sr. No.	Goal	Goal Sequence
01	Instruction	1
02	Clarification	2
03	Facilitation	3
04	Control	4
05	Information Sharing	5
06	Maintenance of Relationship	6

C. Data Collection and Analysis

A collectivity of data, in this project is done from five different companies rather than just collecting one individual response from each project by taking their personal interviews. (i.e. project P1, P2, P3, P4, and P5).

The questionnaire was used to survey the goals of the eight methods, along with the degree of goal achievement and the possibility of one method to be replaced by another. The answers of the interviewed contractor engineers about coordination goals, their achievement, and replacement possibility of different coordination methods are analyzed and the results are presented as follows.

TABLE IV. COORDINATION GOALS OF MEETING

Project	Goal Sequence			Goal Scores					
				(1)	(2)	(3)	(4)	(5)	(6)
P1	4	2	1	1	2		3		
P2	5	3	2		1	2		3	
P3	1	4	3	3		1	2		
P4	2	1	4	2	3		1		
P5	4	2	5		2		3	1	
TOTAL				6	8	3	9	4	
PERCENTAGE				25	33	13	38	17	

For example, in Table IV of the weekly progress meeting with the owner, one project manager of project P1 thought the top three goals in sequence were control (Goal 4), clarification (Goal 2), and instruction (Goal 1). Those numbers were written down in the second column and obtained scores of 3, 2, and 1, respectively. The six goals in the weekly progress meeting of the five projects received score totals of 6, 8, 3, 9, 4, and 0, and those percentages are listed at the bottom in Table IV. The top three goals by percentage (weight) of weekly progress meetings with the owner are Control (38%), Clarification (33%), and Instruction (25%).

The table V shows top three goals (in %) for weekly progress meetings.

TABLE V. TOP THREE GOALS FOR MEETINGS

Sr. No.	Goal Sequence	Goal	Coordination Goals (%)
1	4	Control	38
2	2	Clarification	33
3	1	Instruction	25

The coordination goals for each goals is calculate in this manner for informal discussion, site visits, Written correspondence, plans, schedules, reports and contract documents.

The following table VI shows the priorities of the goals and their weights of the coordination methods were also calculated by totaling the assigned scores. The top three goals of coordination are facilitation (33%), instruction (28%), and clarification (24%) which account for 84% of the total score. A single goal with a weight less than 50% means their corresponding coordination methods have multiple goals. Moreover, the top three goals of schedules account for meeting 96% of the total (control is 42%), which implies that schedules has fewer goals. Site visits and contracts documents have the lowest score (only 75%), which indicates it can be used for more purposes.

The table VI also shows that facilitation and control are the two major goals of the eight methods for the seven projects. This may be because the construction had passed the peak for the projects under study, and the need for instruction or discussion substantially decreased. In addition, information sharing and maintenance of relationships were not major goals, as the information was mostly already known by project participants and they had been acquainted for each other for three or four years in the construction periods.

The goals of both oral and written communication methods for coordination deserve explanation. Oral communication methods, including meetings, informal discussion over the telephone or face-to-face conversation, and site visits can have multiple goals. For example, a meeting can be used to gather and share information, negotiate and solve problems, build relationships, and make plans and decisions. Oral communication, characterized by a high level of interactivity, should be used to negotiate and resolve conflicts, assert dominance, and demonstrate personal concern. These goals correspond to the goals of clarification, instruction, and maintenance of relationships. However, the study results indicate that the main goals of meetings are control (38%), clarification (33%), and instruction (25%). In site visits and written correspondence, facilitation (29% and 25%, respectively) is the main goal, followed by clarification (25%).

D. Degree of Goal Achievement

To evaluate coordination effectiveness, interviewees were asked to indicate the degree of goal achievement on a five-point scale ranged from 1 (20%, seldom achieved), to 5 (100%, completely achieved). They were also asked to assess whether a particular method could be replaced by others, then a replacement possibility was calculated. For example, if 6 of 10 interviewees thought informal discussion could be replaced by other methods, the replacement possibility is 06/10 = 60%.

TABLE VI. TOP THREE GOALS OF COORDINATION METHODS

SR No	Coordination Methods	First		Second		Third		Summary
		Goal	Weights (%)	Goal	Weights (%)	Goal	Weights (%)	
1	Meetings	4	38	2	33	1	25	96
2	Informal Discussion	4	29	1	25	2	25	79
3	Site visits	3	29	2	25	4	21	75
4	Written Correspondence	4	33	3	25	1	21	79
5	Plans	3	33	1	29	4	25	87
6	Schedules	4	42	3	29	2	25	96
7	Reports	3	33	4	29	2	25	87
8	Contract Documents	4	29	1	25	3	21	75
Average		3	33	1	28	2	24	84

TABLE VII. GOAL ACHIEVEMENT FOR DIFFERENT COORDINATION METHODS

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SR. NO.	Coordination Methods	High-rise Building Project					Avg
		P1	P2	P3	P4	P5	
1	Meetings	87	85	73	76	80	80
2	Informal Discussion	93	78	63	80	75	78
3	Site Visits	90	87	85	78	85	85
4	Written Correspondence	95	90	73	87	83	86
5	Plans	100	93	80	83	90	89
6	Schedules	85	90	78	90	85	86
7	Reports	85	80	75	70	75	78
8	Contract Documents	87	85	85	90	80	86
Average		90	86	77	82	82	83

The table VI shows goal achievement of the coordination methods. The data collected from the designed questionnaire is arranged in tabular form for simplicity analysis of the data. The various coordination methods has different goal achievement. After finding the average of all goal achievement, we decide the replacement possibility of the coordination method.

It can be seen from Table 4, the degrees of goal achievement in meetings, site visits, written correspondence, plans, schedules and contract documents are higher than 80% (the average). Informal discussion and reports achieved their goals at a level lower than the average, meaning their effectiveness needs improvement.

The coordination goals achievement is different for different companies and also for different coordination methods. Only project 1 has 100% goal achievement in plans.

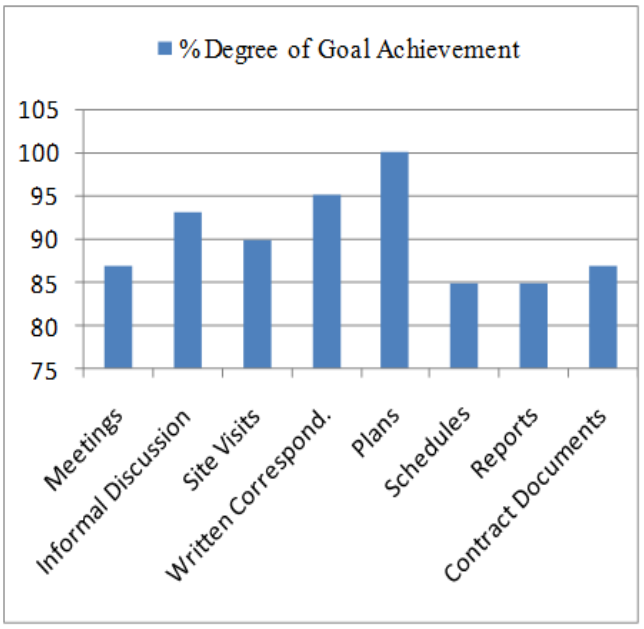
The coordination goal achievement for different coordination methods is plotted on chart for simplicity in observation and analysis. These charts are drawn for every project separately.

Above chart showing percentage degree of goal achievement by different coordination methods of P1 project. The degree of goal achievement for all coordination method is above 80%. The degree of goal achievement of plans is 100%, which is maximum. This project effectively uses the different coordination methods and becomes efficient as compare to other companies taken in this project.

On this project site, project coordinator arranges meetings when there is necessity. For informal discussion purpose, there is provision of walky-talky system which creates instant contact. The inspection of site is done by the engineer in-charge regularly. The contract documents and written correspondence on this show positive relationships with coordination effectiveness in quality and useful quantity, respectively.

Similarly comparative of all the companies are dawn on chart and project-wise comparative is made.

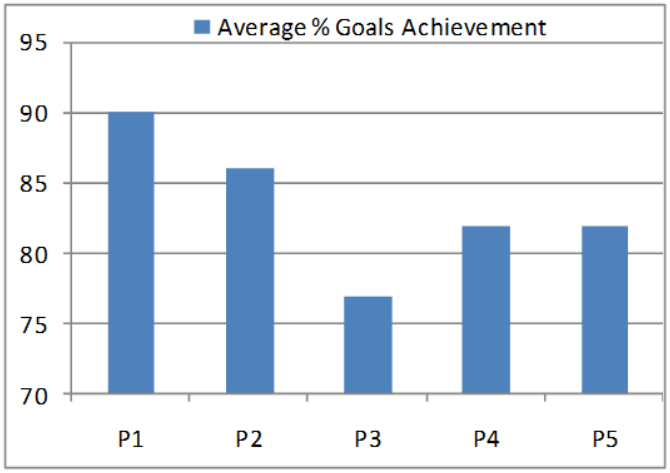
CHART I PERCENTAGE DEGREE OF GOAL ACHIEVEMENT FOR P1



The chart II shows the project wise percentage goal achievement. The Percentage goal achievement of P3 project is minimum i.e. 77%. The project L&T Construction has maximum percentage goal achievement i.e. 90 %. The coordination methods used by this project on construction project are most effective. On these project site there is one project coordinator who effectively and accurately communicate relevant project information with the employees.

On the P1 project, engineers and management team fully (90%) focus on the plans. And it achieves better coordination in between various construction processes.

CHART II. PROJECT-WISE AVERAGE % GOAL ACHIEVEMENT



E. Goal Replacement Possibility with other Coordination Methods

Total 10 interviews are taken with owner and project manager of construction site. The questionnaire includes the replacement possibility of coordination method with another method. For example if meetings has achieve 78% goal in particular project, and it is replace by other seven methods it should be noted. The respective percentage of goal replacement possibility is then calculated.

If 6 out of 10 interviewees says the meeting is replace by another coordination method (i.e. informal discussion, site visits, written correspondence, plans, schedules, and reports), its percentage value of goal replacement possibility is calculated as, 06/10 = 60%. That means the meeting has 60% replacement

TABLE VIII. REPLACEMENT POSSIBILITY FOR COORDINATION METHODS

Sr. No.	Coordination Methods	Goal Replacement Possibility with other Methods (in %)
1	Meetings	06/10 = 60%
2	Informal Discussion	05/10 = 50%
3	Site Visits	03/10 = 30%
4	Written Correspondence	06/10 = 60%
5	Plans	01/10 = 10%
6	Schedules	03/10 = 30%
7	Reports	04/10 = 40%

The table VIII shows the replacement possibility for various coordination methods.

The degrees of goal achievement and replacement possibilities of the coordination methods are plotted on chart. Above Chart III showing comparison of different coordination method related to project and respective goal achievement and replacement possibilities of coordination method. It can be seen that the degrees of goal achievement in meetings, site visits, written correspondence, plans, and contract documents are higher than 80% (the average). Informal discussion and reports achieved their goals at a level lower than the average.

Chart III also shows that written methods, including plans, schedules, reports and contract document, are important and could not be replaced by other methods. The replacement possibilities for meetings, informal discussion and written correspondence are higher than 50%, which means that these methods could be replaced by more effective methods.

F. Relationship of Coordination Goals & Performance

After analyzing and comparing the five projects with good and poor performances, the relationships between goal achievement and project performance were found.

Chart III shows the degrees of goal achievement of the coordination methods with average scores calculated. It is seen that eight methods have the average degree of goal achievement of 84%, plans (89%) exhibits the highest degree of goal achievement, in which interviewees considered 100% goal achieved. Informal discussion (78%) exhibits the lowest goal achievement. This is because the contract has the supreme power and informal discussion is not considered important. The results also show that the projects with good performance (P1, P2, P4, and P5) used coordination methods effectively. The average degree of goal achievement in these projects is higher than 80%.

In contrast, the projects with poor performance (P3) did not use the coordination methods well. Their degrees of goal achievement are lower than 80%.. The project with poor performance P3 did not use the coordination methods well. Their degrees of goal achievement are lower than 80%. The interviewees explained that the construction site of project P3 had a poor knowledge of coordination. This implies that complicated projects cannot be performed well even with good coordination.

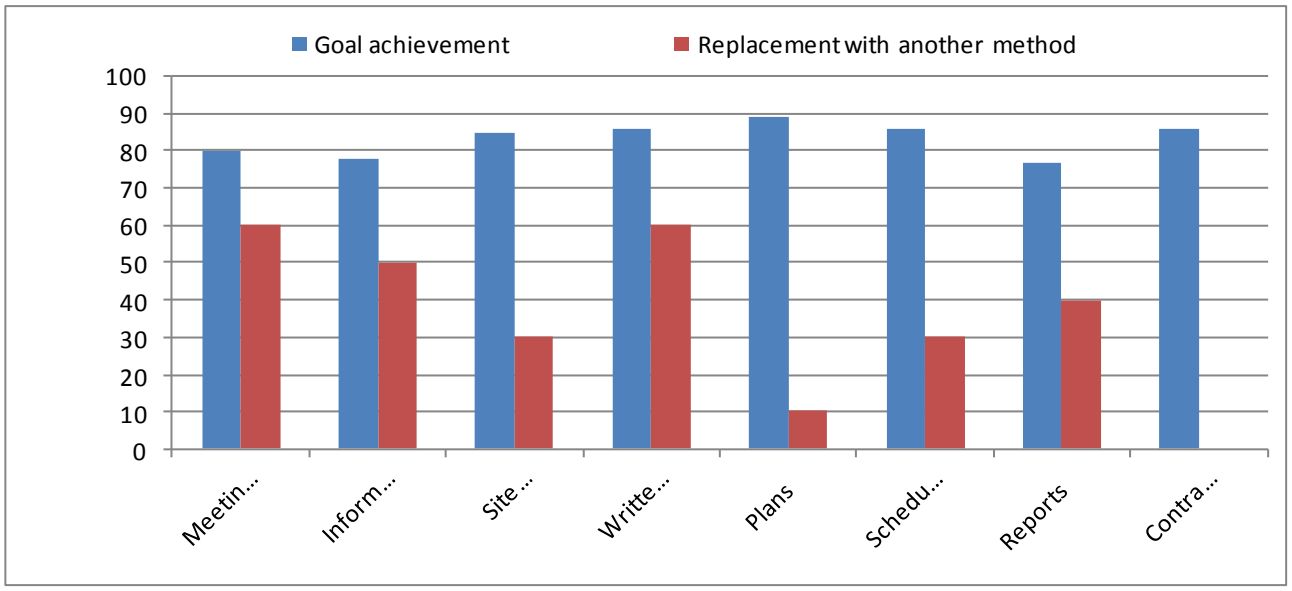


Chart III. Goal Achievements and Replacement Possibility

IV. DISCUSSIONS

This project explores coordination goals by proposing a way of evaluating goal achievement and alternate coordination methods for five construction projects. This research was exploratory because few studies have been done on this subject. Case studies are considered an appropriate methodology for developing theoretical frameworks, and so that is the approach used in this project. The number of case projects was not large. Parts of the research findings are only valid for their specific cases. Listed below are some issues that this study encountered, and suggestions for further improvement.

It would be difficult to investigate goals in this study without quantifying goal priorities. Assumptions made in quantifying the priorities of goals are examined here. The top three goals were scored 3, 2, 1, respectively. This means the first goal accounted for 50% of the purpose, and the second and the third accounted for 33 and 17%, respectively. Although the weights could be different and the primary goal of certain methods reached 70% of the purpose, the interviewees considered this weight allocation to be reasonable. Close numbers with only 1% difference were resulted by testing another set of scores with 5, 3, and 1 for the top three goals. Therefore, the 3, 2, and 1 weights used in this study were appropriate.

The project P1 & P2 has maximum percentage of goal achievement. The top management teams in these companies only focus on plans. On P1 project site, project coordinator arranges meetings when there is necessity. For informal discussion purpose, there is provision of walky-talky system which creates instant contact. The inspection of site is done by the engineer in-charge regularly.

P3 has goal achievement is minimum. For the further improvement in future I want to suggest the owner as well as engineers to follow the other methods of coordination ie informal discussion written correspondence and reports.

V. CONCLUSION AND SUGGESTIONS

Effective coordination is important on construction projects because many participants are involved; this leads to interface and dependence. Spending much time on coordination does not necessarily bring good performance. To be effective, coordination methods should be adopted on the basis of their particular characteristics.

This paper investigates coordination methods along with their goals. A questionnaire was designed based on eight different coordination methods and six coordination goals to survey and interview of engineers in five construction projects to collect the conditions of coordination. The degrees of goal achievement and replacement possibilities were analyzed and their relationships with performance were identified as well.

On the basis of this study, the conclusion was elaborated as below.

1) Now a day's on many construction projects, oral communications such as meetings are usually adopted as the major coordination method on construction projects. But the contract documents and written correspondence in this project

study show positive relationships with coordination effectiveness in quality and useful quantity, respectively. This means that written communications can play an important role in coordination and should be well used together with oral communications.

2) Most coordination methods have multiple goals. The top three goals of the eight coordination methods for the seven projects are facilitation, control, and clarification, which account for 84% of the total score. Moreover, the top three goals of meetings and schedules account for 96% of the total, which implies that meetings and schedules have fewer goals. Site visits and contract documents has the lowest score (75%), which indicates it can be used for more purposes.

3) The projects with good performance use coordination methods effectively. The degree of goal achievement in these projects is higher than average. In contrast, the projects with poor performance did not use the coordination methods well. Their degrees of goal achievement are lower.

4) Written communication such as plans, schedules, and contract documents tends to have appropriate goals, but oral communication such as meetings, informal discussion, and site visits does not. That can be because written communication is more focused and limited to a few goals and thus, can be better done. On the other hand, oral communication serves more goals and is open to interpretation and thus is more difficult to do well.

5) Contractors working on projects with good performance used coordination methods well. Coordination effectiveness, especially the coordination quality, scores of well-performed projects were higher than average. Projects with poor performance did not use the methods well. But good coordination is not enough; other means are required to overcome difficulties inherent in projects.

From the observations and analysis, I would suggest the project manager and owner of the P3 to appoint a construction coordinator for directing, organizing and controlling project activities, under the direction of project manager and project director.

So finally from the observations and analysis, I conclude that the effective coordination between top management team and employee gives the overall effectiveness and performance of construction project. For the effective coordination on construction project a project coordinator who is an integral member of the project team responsible for delivering building development projects of varying size and complexity, is needed. The project coordinator is also responsible for directing, organizing and controlling various activities, under the direction of construction project manager and project director. The project coordinator should possesses following roles and responsibilities.

a) Managing co-ordination of the partners and working groups engaged in project work.

b) Use project scheduling and control tools to monitor projects plans, work hours, budgets and expenditures.

c) Arranges meetings of top management team, whenever required.

d) Communicate ideas for improving project processes with a positive and constructive attitude, and for developing this attitude in others.

e) Effectively and accurately communicate relevant project information with the engineers.

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