PROJECT DESIGN AND CONSTRUCTION INTERFACE DISSONANCES

Faisal Manzoor Arain
Doctoral Candidate
School of Design & Environmental
National University of Singapore,
Singapore

Sadi Assaf
Professor, College of Environmental Design
King Fahd University of Petroleum and Minerals,
Saudi Arabia

ABSTRACT

This article draws upon the study undertaken with an objective to understand the causes of discrepancies at the design and construction interface in large building projects. To achieve the stated objective, a questionnaire survey was carried out by the authors to collect information on the potential causes of discrepancies.

Responses of 48 consultants and contractors were analyzed. Results of which, suggested that, lack of coordination, insufficient working drawings and details, involvement of designer as consultant, involvement of contractor as consultant and participants' wrong beliefs regarding construction and design are the most important causes of discrepancies at the project design and construction interface. On the other hand, project management as a professional service, nationality of the professional firms and involvement of the contractor in design phases were the least important causes of discrepancies at the project design and construction interface in large building projects.

Keywords: discrepancies, consultants, contractors, building projects, Saudi Arabia.

1- INTRODUCTION

A construction project traditionally involves two major professionals of the construction industry. These two professionals are the designer and the contractor. Communication and effective coordination between these two parties is the key factor to be considered for the successful completion of a project. It is postulated that, discrepancies between these two parties causes barriers in the design phase and construction process.

Mendelsohn (1997) observed that, upto 75% of the problems encountered on site were generated at the design phase. This is not to say that, contractors do not create a lot of problems of their own but that these problems were often compounded by inherent design flaws. If one were to seriously consider ways to reduce problems on site, an obvious place to begin with, is to focus on what the project design team can do to eliminate these at the design phase.

Assaf and Al-Hammad (1988) revealed that the construction industry in Saudi Arabia employed 15% of the total labor force of the country and used 19% of the total energy consumed in it. As projects were being constructed, the construction industry faced many problems such as; shortage of manpower, inadequate infrastructures and a lack of sophisticated technology. Most of the design inputs were completed abroad where the designers do not have the statistical data nor enough knowledge of the environmental, social and cultural factors which could affect building projects in Saudi Arabia. In addition, the contractors in Saudi Arabia were not familiar with the resources available and other related issues.

Focusing on interfaces, Fredrickson (1998) noted that each project, client and design-construction delivery team has unique design needs. There is no "one size fits all" way of identifying the right

design approach to a particular project. However, the guidelines adopted from previous projects can help a project delivery team to determine how the design should be handled and this can greatly improve the project's chances of success.

Wang (2000) argued that, conflicts between the parties were more frequent in projects marked by poor management. Conflicts can be reduced by carefully adhering to procedures set out in the contract. These may include; authorization requests granting approvals, reporting procedures, inspections routine and regular meetings. A mutual lack of attention to procedures by the owner, consultant and contractors can cause management problems.

Eliminating the discrepancies which can exist enables projects to be completed successfully. Discrepancies at the interface between parties can either result in; delay in project duration, compromise on quality or increase in cost. Considering these discrepancies which can ultimately affect any construction projects, there is a need to institute better and comprehensive solutions to coordinate activities at the interface. It is important to determine the potential causes of discrepancies in the project life cycle. These potential causes of discrepancies can hinder the progress of a building project substantially. The objectives of this study are therefore to:

a. Assess the interface between design and construction stages.
b. Identify the potential causes of discrepancies at the interface between design and construction stages.
c. Provide solutions and recommendations to eliminate these causes of discrepancies at the design and construction interface.

2- CAUSES OF DISCREPANCIES AT THE PROJECT DESIGN AND CONSTRUCTION INTERFACE

Professional discrepancies at the project design and construction interface were identified (Al-Hazmi, 1987; Al-Dubaisi, 2000; Assaf and Al-Hammad, 1988; Al-Yousif, 2001) and their causes categorized according to different project phases (Arain, 2002). The 45 causes identified from literature review are discussed below. These will also form the basis for the survey of consultants and contractors, described later.

2.1 Design Phase

2.1.1 Involvement of contractor in the design conceptual phase

This is the process in which the contractor contributes his professional experience, his creativity as well as practical ideas at the initiation stage of a design. Conventional practice in the Saudi Arabian construction industry does not, however, include the contractor in the design conceptualisation phase (Al-Ghamdi, 1999; Arain, 2002). Adrian (1983) and Al-Hazmi(1987) suggested that, getting the contractor involved in the design can help to lessen the interface problem between him and the designer later.

2.1.2 Involvement of contractor in the design development phase

This process involves inviting creative and practical ideas from the contractor as he is supposed to have recent market knowledge about materials and the latest techniques of construction (Al-Mansouri 1998). This may, however, also cause discrepancies at the design and construction interface, depending on the goals of each participant.

2.1.3 Lack of data

Lack of data can result in the misinterpretation of the actual requirements of a project (Al-Hazmi, 1987). Considering all the relevant data and information in the design can help participants understand the actual situation. When there is insufficient data, designers are compelled to develop designs based on their own perceptions, which may not be what the client wants.

2.1.4 Delay in preparing construction documents

Construction documents are important for timely project commencement and accomplishment. Delay in their preparation can affect procurement and scheduling activities. Delay in the preparation of construction documents is a frequent cause of project delay in the Saudi Arabian construction industry (Al-Hazmi, 1987).

2.1.5 Lack of human resources in design firms

Quality work and timely schedule would be affected adversely in the absence of adequate manpower support (Al-Mansouri, 1988). A lack of human resource can lead to discrepancies between the designer and the contractor. It causes a delay in the design process or a poorly executed design which can eventually affect a whole range of tasks in the supply chain.

2.1.6 Time limitation in the design phase

Time limitation may occasionally force the designer to wrap up the necessary design works at a lower quality (Al-Mansouri, 1988). If inadequate time is given, the design cannot be developed in a proper way. This may eventually cause misunderstandings between professionals working on the project.

2.2 Construction Phase

2.2.1 Designer's lack of knowledge of materials and equipment

Material standardization is not common in Saudi Arabia. Markets comprise of many different types of materials, making the pre-selection difficult. Lack of current knowledge about available materials and equipment can affect the project adversely (Al-Hazmi, 1987; Adrian, 1983).

2.2.2 Incomplete plans and specifications

If the specifications or plans are incomplete, or unclear, it will create interpretation problems which will affect the quality of the project. This creates discrepancies at the design and construction interface (Al-Hazmi, 1987).

2.2.3 Insufficient working drawing details

Working drawing and details are the graphical form of communication between the designer and the contractor (O'Brien, 1998). To convey a complete concept of the project design, the working drawings must be clear and concise. Insufficient working drawings and details may cause discrepancies at the design and construction interface.

2.2.4 Communication gap between the contractor and designer

Communication is vital in a multi-player activity like construction. Strong and incessant communication is necessary for optimum coordination (Al-Dubaisi, 2000). Through better communication, both the contractor and designer can overcome various problems which occur at different phases of a project (Puddicombe, 1997).

2.2.5 Lack of mutual respect between contractor and designer

Lack of mutual respect between the concerned professionals is a problem which can affect the entire project adversely (Al-Mansouri, 1988). For better coordination during the project, mutual respect plays a vital role as the participants give consideration to all decisions and opinions for the betterment of the entire project.

2.2.6 Exotic designs and technology

The use of exotic designs and technology requires detailed interpretations by the designer to make them comprehensible for all participants (Al-Mansouri, 1988). An exotic design may be experienced for the first time by the professionals. Hence, more coordination and cooperation between parties is required to reduce discrepancies.

2.2.7 Ambiguous design details

Ambiguity in designs can be misinterpreted by project participants, leading to rework, financial loss and delay in the project completion. O'Brien (1998) observed that, a clear design tends to be comprehended more readily. This can help to create a better work environment for the entire professional team with less room for conflicts.

2.2.8 Lack of a specialist construction manager

A construction manager is the professional who manages the construction phase (Clough and Sears, 1994). Construction manager carries out the construction phase in an organized way to eliminate the risks of delays and other problems. Arain (2002) observed that, most building projects in Saudi Arabia did not employ a construction

manager. Consequently, this increased interface problems between the contractor and the designer.

2.2.9 Material changes during the construction phase

Changes in material types and specifications can occur quite frequently in the construction phase which may eventually affect the project completion (O'Brien, 1998). Material changes may be based on a personal propensity to create change. Hence, the cause of such discrepancies is different from that caused by the shortage of materials (Al-Dubaisi, 2000).

2.2.10 Shortage of construction materials

Shortage of construction materials is a procurement problem that can affect the project completion (O'Brien, 1998). Occasionally, shortage of materials may change the design to accommodate the new materials used as a replacement.

2.2.11 Design errors

Design errors can affect a project adversely depending on the timing of the occurrence of the errors. It was argued that, it is impossible to create a perfectly error free design (Kostoff, 1977; Chappell and Willis, 1996). Design errors which are not rectified during the design phase, will eventually appear in the construction phase where the impact can be more severe than in the design phase (Chappell and Willis, 1996).

2.2.12 Procurement delays

Procurement delays have numerous adverse affects on other processes in the construction cycle (Fisk, 1997). Occasionally, a procurement delay may cause an entire design to change or replacement of the originally specified materials or equipment for the project. Procurement delays may, therefore, result in the project activities to be reworked.

2.2.13 Material approval

Material approval is a process in which the contractor gets an approval from the consultant before using the material (Clough and Sears, 1994; Fisk, 1997). This may cause discrepancies if the process and wait is too long and the contractor needs to interrupt the construction process to get the materials approved.

2.2.14 Lack of coordination between parties

Coordination is important in a multi-participant environment such as construction projects (Al-Hazmi, 1987; Clough and Sears, 1994). A lack of coordination between parties may cause conflicts that could eventually impact the project adversely. Errors which occur can usually be resolved early with due diligence in coordination.

2.2.15 Construction errors at job site

Errors during the construction process can occur frequently. These errors can include; human errors, errors caused by inclement weather and other unpredictable errors (Fisk, 1997). These can be a cause for potential discrepancies that may delay the entire project depending on the context and size of the errors.

2.2.16 Lack of skilled manpower

The non-availability of skilled manpower in the construction industry in Saudi Arabia compelled consultants to modify the method of construction (Al-Mansouri, 1988). This lacking is more obvious and likely to occur in complex technological projects. On the other hand, there is less need for specialized manpower in conventional projects.

2.2.17 Designer's lack of awareness about ongoing construction processes

A lack of awareness by the designer about the ongoing construction activities on site may cause project delays (Al-Hazmi, 1987). This happens if construction errors are not reported to the designer promptly and the problem may be magnified and affect the entire project at a later stage.

2.2.18 Contractor's lack of comprehension of drawing details and specifications

Drawing details and specifications are the only means for the contractor to comprehend the job requirements on site (Kostoff, 1977; Chappell and Willis, 1996). Hence, information from drawings should be made clear before the onset of

construction. Otherwise, the contractor's lack of comprehension of drawings details and specifications may cause misunderstanding in executing the job.

2.2.19 Involvement of designer as consultant

Involvement of the designer as consultant is a frequent practice in the Saudi Arabian construction industry (Arain, 2002). This practice may, however, cause discrepancies because the design consultant may attempt to put the blame of design errors on the contractor. The design consultant may attempt to evade responsibility for design matters.

2.2.20 Contractor's lack of knowledge about new technology

Contemporary knowledge about new materials and equipment is an important factor in a construction project (Clough and Sears, 1994; O'Brien, 1998). If the contractor is not aware of new technology, it would be difficult for him to carry out the project. Eventually, project delay may occur ending up with vital changes in the entire design.

2.3 Design-Construction Phase

2.3.1 Design complexity

Design complexity requires the involvement of skilled professionals (Fisk,1997). Complexity affects the flow of construction activities, whereas simple and linear construction works are relatively easy to handle. Complex design can lead to loss of productivity (Al-Hazmi, 1987; Al-Mansouri, 1988). Hence, complexity may cause discrepancies at project interfaces.

2.3.2 Buildability

Buildability is the integration of construction expertise into the planning and design of a project so that construction resources have the maximum opportunity to deliver the project to conform with the cost, quality, schedule and safety objectives of the project's stakeholders (Gambatese and McManus, 1999). Unfamiliarity of the designer with construction methods will create designs which are either difficult to execute or cannot be implemented practically.

2.3.3 Building codes

Unfamiliarity of the parties with building codes would render the project difficult to execute (Al-Dubaisi, 2000). The problem in Saudi Arabia was that there were no accepted unified building codes (Arain, 2002). In addition, the foreign designer follow accepted standards of their own countries which may differ from the local building codes of Saudi Arabia. This may cause a lack of coordination amongst construction professionals.

2.3.4 Government regulations

Local authorities may have specific codes and regulations that need to be accommodated in the design. Codes such as environmental or labor codes are revised periodically for compliance by the designer and contractor (Assaf and Al-Hammad, 1988). Unfamiliarity with government regulations could make the project difficult to execute.

2.3.5 Lack of professional experience and judgment

Professional experience and judgment is an important factor for successful completion of a building project (O'Brien, 1998; Clough and Sears, 1994). Lack of professional experience increases the risk of errors in design as well as during construction.

2.3.6 Project delivery systems

There are different project delivery systems. The selection of one of the best suited one is based on the objectives of the project and the client (Adrian, 1983; Fisk, 1997). Each delivery system has its own base rules to be implemented during the project completion and handing over stage. For instance, in the lump sum contract, the contractor may try to save as much money as he could and compromise on the quality in the process (Al-Mansouri, 1988).

2.3.7 Obstinate nature of participants

A construction project is the result of the combined

efforts of the professionals. They have to work at the various interfaces of a project (Clough and Sears, 1994; Fisk, 1997; Kostoff, 1977). If the participants are obstinate, they may not accommodate other creative and beneficial ideas. Eventually, this may affect the project adversely.

2.3.8 Participant's wrong convictions

Participant's wrong beliefs and convictions may cause construction professionals to contribute poor values to projects (Al-Hazmi, 1987, Al-Yousif, 2001). Contractors and designers, without having first hand knowledge, may make decisions based on their wrong beliefs which would adversely affect the pace of the project.

2.3.9 Economic situation

Economics and finances are the influential factors that may affect a construction project (Assaf and Al-Hammad, 1988). The economic situation of a country can affect the whole construction industry, including its participants.

2.3.10 Fast track construction

Fast track construction requires an organized system to concurrently carry out interdependent project activities (Clough and Sears, 1994; Fisk, 1997). This procurement mode may cause problems especially when the public and private sectors have large funds and want to complete projects in very short time, but complete plans and specifications may not be available for the contractor to start work (Al-Hazmi, 1987; Al-Yousif, 2001).

2.3.11 Weather conditions

Weather condition can affect outside activities in construction projects (O'Brien, 1998; Fisk, 1997). Weather conditions may vary, the contractor need to adjust the construction schedules accordingly. On the designer's part, weather also plays an important role in shaping the entire design scheme.

2.3.12 Nationalities of participants

Nationalities of participants play an important part in affecting project team communication and coordination (Al-Hazmi, 1987; Al-Dubaisi, 2000). In Saudi Arabia, most of the designs are carried out by foreign designers with different design approaches (Arain, 2002). Different nationalities may cause discrepancies based on different perceptions of the professionals.

2.3.13 Change orders

There are various reasons for change orders during the construction processes (O'Brien, 1998; Clough and Sears, 1994; Fisk, 1997). Whenever a change order occurs, it needs to add, delete or modify the original plans and specifications accordingly. Change orders may affect the project completion target.

2.3.14 Preparation and approval of shop drawings

The preparation and approval of shop drawings is one of the integral parts of the construction process in the Saudi Arabian construction industry (Al-Yousif, 2001; Al-Hazmi, 1987; Arain, 2002). The preparation and approval of shop drawings need time. Any delay may affect the project schedule.

2.3.15 Personal conflicts of professionals

Personal conflicts and disrespect between the professionals are problems which can adversely affect the project pace (Al-Mansouri, 1988). Mutual respect among participants enhances the coordination and acceptance of decisions and opinions of all concerned.

2.3.16 Unforeseen problems

Unforeseen conditions are usually faced by professionals in the construction industry (Clough and Sears, 1994; O'Brien, 1998; Adrian, 1983). If these conditions are not solved spontaneously, they may cause major conflicts between professionals leading to cause delays in the entire project schedule.

2.3.17 Design omissions

Changes in design are frequent in projects where construction starts before design is finalized (Chappell and Willis, 1996; Al-Hazmi, 1987).

Design omissions may lead to the loss of productivity and delay the project schedule (Al-Hazmi, 1987).

2.3.18 Involvement of contractor as consultant

Contractors who double up as consultants may strive to hide their construction errors would not accept these as design errors. In this case, the designer may face resistance in carrying out his professional responsibilities. Al-Hazmi (1987) and Al-Dubaisi (2000) observed that, in the Saudi Arabian construction industry, contractors are rarely appointed as consultants. In most cases, designers are appointed as consultants on large building projects.

2.3.19 Project management as individual professional service

This may require project management professionals and other participants to spend considerable time to comprehend the scope of the project before they plan the management strategies for project completion (Haplin and Woodhead, 1980). There is a less chance of causing discrepancies in the project management approach because it requires more time and involvement by participants.

3- RESEARCH METHODOLOGY

The above mentioned causes resulted in 45 cumulative discrepancies between the design and construction parties. These provided the basis for the formulation of a questionnaire.

A pilot study was carried out in Saudi Arabia to test the questionnaire. After the pilot study, the questionnaire was finalized and a survey of 41 consultants and 42 contractors was carried out. The selection of the respondents was carried out using the following parameters:

i) Restricted to respondents involved with large building projects [20 million (SR) Saudi Riyals or more].
ii) Restricted to large contractors (Grade 2 or better, as classified by the Ministry of Public Works and Housing in Saudi Arabia).
iii) Restricted to respondents involved with building projects (excluding industrial buildings, highways and other types of construction).
iv) Restricted to the Eastern Province of Saudi Arabia.

Keeping these parameters, the target population of 42 contractors and 41 consultants in the Eastern Province of Saudi Arabia were identified. The size of the sample required from each population was determined statistically (Al-Dubaisi, 2000).

$$n_0 = (p * q) / V^2 \quad \ldots\ldots (1)$$

$$n = n_0 / [1 + (n_0 / N)] \quad \ldots\ldots (2)$$

Where:

n_0 : First estimate of sample size
p : The proportion of the characteristic being measured in the target population
q : Complement of p or 1-p
V: The maximum standard error allowed
N : The population size
n : The sample size

To maximize n, p was set at 0.5. The target populations, N are 42 and 41 for the contractors and consultants respectively. To account for possible errors in the qualitative answers of the questionnaire, the maximum standard error V, was set at 10% or 0.1. Substituting the values in Equations 1 and 2, given above, the minimum required samples were calculated to be 15.67 and 15.53 for the contractors and consultants respectively. This means that, the minimum sample size for each populations is 16. A 5-point likert scale was used in the questionnaire to gauge the least important and most important causes of discrepancies at the design-construction interface.

4- ANALYSIS OF RESULTS

Twenty Four consultants and contractors each, responded to the survey. The aggregated survey results presented below are based on the responses. The list of 45 causes of discrepancies were analyzed and ranked accordingly. As shown in Table 1, the 45 causes of discrepancies were tabulated according to their means and standard deviations. Furthermore, the causes of discrepancies were categorized into the most

important ones, as shown in Table 2. The results suggest that, the lack of coordination, insufficient working drawings and details, involvement of designer as consultant, involvement of contractor as consultant and participants' wrong beliefs were considered to be the most important causes of discrepancies at the project design and construction interface.

Based on the statistical results shown in Table 1, the five least important causes of discrepancies at the design and construction interface are shown in Table3.

5- DISCUSSION

5.1 Most Important Causes of Discrepancies

The most important causes of discrepancies are discussed below.

5.1.1 Lack of coordination between parties

The lack of coordination between parties was ranked as the most important cause of discrepancies at the design and construction interface. This is because, the coordination between parties forms the backbone of any working relationship. As professionals frequently work within adverse conditions, coordination is least expected.

5.1.2 Insufficient working drawings and details

The second most important cause of discrepancies is insufficient working drawings and details. Many problems are frequently faced by the contractor because of the lack of details in working drawings. The lack of information on working drawings may lead the professionals away from the original goals of the project. Drawings are frequently not detailed enough by the designers as they are not specifically asked for, or required by the client. This is usually due to lack of knowledge or as an attempt to save cost.

5.1.3 Involvement of designers as consultants

The involvement of the designers as consultants was the third most important cause of discrepancies at the design and construction interface. Involving the designer as consultant places the contractor at risk because the consultant may shift all design discrepancies on the contractor. In this case, there may not be any check on the designer because he is also the consultant. The solution to this particular discrepancy would be a neutral third party who can act as a consultant to the project (such as a project manager).

5.1.4 Involvement of contractor as consultant:

The involvement of the contractor as consultant was the fourth most important cause of discrepancies at the design and construction interface. Involving the contractor as consultant may place the contractor at risk because the consultant may shift all construction discrepancies on the designer. In this case, there may not be any check on the contractor because he is also the consultant. Likewise, the solution to this particular discrepancy would be the availability of a neutral third party who could act as a consultant to the project.

5.1.5 Participants' wrong beliefs

Participants' wrong beliefs and contractor's lack of comprehension of drawing details and specifications were jointly perceived as the fifth most important cause of discrepancies at the design and construction interface. Comprehension of drawing details is an important part of executing the project with least errors. The participants' wrong beliefs may cause rigidity in the concerned professionals attitude which may hinder the progress of the project.

5.2 Least Important Causes of Discrepancies

The least important causes of discrepancies at the design and construction interface are discussed below.

5.2.1 Project management as individual professional service

According to the survey, the least important cause of discrepancies was the involvement of project management as individual professional service. It was not unexpected that project management as an individual professional service was welcomed by all the respondents. This is because, it provides

for a fair working relationship between all participants at the design and construction interface. This appear to be an excellent solution for eliminating risks involving the contractor or designer as consultant.

5.2.2 Involvement of contractor in design conceptual phase

The involvement of the contractor in the conceptual design phase and the nationalities of participants were jointly perceived as the second least important cause of discrepancies at the design and construction interface. This is because the more a contractor becomes involved in the design, the less interface problem would arise between the contractor and the designer (Adrian, 1983). A contractor's involvement in the conceptual design phase was welcomed by the respondents because designers do not consider it as a hindrance for their processes. As a major part of the Saudi Arabian construction industry consists of participants from various nationalities, this was a positive indication that different nationalities do not cause any severe discrepancies in the construction industry.

5.2.3 Involvement of contractor in design development phase

The involvement of the contractor in the design development phase was perceived as the third least important cause of discrepancies at the design and construction interface. Most contractors in Saudi Arabia were appointed based on fixed price contracts where complete plans and specifications had to be ready for the contractor to submit his bid and execute the work. As mentioned earlier about the involvement of the contractor in the design phase; the contractor's involvement in the design development phase was welcomed by the respondents. Although this was not a conventional practice in the construction industry.

5.2.4 Weather conditions

Adverse weather conditions is one of the least important cause of discrepancies at the design and construction interface. Project design and the selection of materials without considering the local weather conditions may create discrepancies for the contractor when executing the work. The contractor may claim the client for modifications and variations and increase the scope and cost of the project.

5.2.5 Unforeseen problems

Unforeseen problems was also one of the least important cause of discrepancies at the design and construction interface. Nevertheless, where earthworks are concerned, unforeseen situations may cause discrepancies at project interfaces.

6- CONCLUSION AND RECOMMENDATIONS

The most and least important causes of discrepancies have been concluded in the discussion above. Recommendations are now suggested below based on the findings of the research and the literature review done.

- The highest ranking causes of discrepancies were the lack of coordination and insufficient working drawings and details. The solution to these problem is the involvement of the contractor at the design conception and development phases. The respondents considered this involvement beneficial. Therefore, it is recommended that, the contractor should provide inputs during these phases. This will not only improve the design but also provide an opportunity to overcome the causes of discrepancies in the working drawing and details stage. This will also provide an opportunity for professionals to develop better coordination for a better working environment.
- The involvement of the contractor as consultant and involvement of the designer as consultant fosters professional risks. The solution to this particular problem would be to involve project management services. This helps to minimize conflicts between professionals.
- Participants would experience better coordination by involving project management professionals as an independent third party in the project.
- The involvement of the contractor during the design phase would help achieve better designs.
- The involvement of the owner during the design phase also provides a better opportunity

for all parties to understand the actual requirements and design brief.

- There is a need to reduce the causes of discrepancies between the contractor and the designer at the project interface. To reduce this gap it is recommended that there should be more frequent professional meetings during the various project phases which would help reduce discrepancies. The application of value engineering or other value analysis techniques would also be helpful in initiating better coordination between the parties■

1) g0203420@nus.edu.sg
2) assaf@kfupm.edu.sa

S. No.	Causes	Mean	Std. Dev.
1.	Involvement of contractor in the design conceptual phase	2.20	1.24
2.	Involvement of contractor in the design development phase	2.30	1.14
3.	Lack of data	3.20	0.61
4.	Delay in preparing construction documents	2.95	0.67
5.	Lack of human resources in design firm	3.30	0.67
6.	Time limitation in the design phase	3.28	0.61
7.	Lack of designer's knowledge of available materials and equipment.	3.30	0.53
8.	Incomplete plans and specifications	3.28	0.53
9.	Insufficien working drawings and deails.	3.44	0.57
10.	Communication gap between contractor and designer	3.30	0.67
11.	Lack of mutual respect between contractor and designer	3.08	0.78
12.	Exotic designs and technology	2.53	0.91
13.	Ambiguous design details	2.73	0.99
14.	Lack of a specialist construction manager	2.77	1.02
15.	Material changes during the construction phase	2.85	0.76
16.	Shortage of construction materials	2.87	0.83
17.	Design errors	3.26	0.60
18.	Procurement delays	2.89	0.79
19.	Material approval	2.89	0.79
20.	Lack of coordination between parties	3.46	0.64
21.	Construction errors at job site	2.77	0.71
22.	Lack of skilled manpower	3.10	0.62
23.	Designer's lack of awareness about ongoing const ruction processes	3.02	0.66
24.	Contractor's lack of comprehension of drawing details and specifications.	3.32	0.68
25.	Involvement of designer as consultant	3.40	0.81
26.	Contractor's lack of knowledge about new technology	2.87	0.75
27.	Design complexity	3.20	0.61
28.	Buildability	3.10	0.82
29.	Building codes	2.53	0.98
30.	Government regulations	2.53	0.93
31.	Lack of professional experience and judgment	2.57	1.00
32.	Project delivery systems	2.53	0.84
33.	Obstinate nature of participants	3.22	0.79
34.	Participant's wrong belief	3.32	0.82
35.	Economic situation	2.75	0.96
36.	Fast track construction	2.67	0.92
37.	Weather conditions	2.38	0.83
38.	Nationalities of participants	2.20	0.91
39.	Change orders	2.75	0.72

S. No.	Causes	Mean	Std. Dev.
40.	Preparation and approval of shop drawings	3.20	0.57
41.	Personal conflicts of professionals	3.22	0.91
42.	Unforeseen problems	2.40	0.81
43.	Design omissions	3.06	0.71
44.	Involvement of contractor as consultant	3.38	0.94
45.	Project management as individual professional service	2.00	1.19

Table1: Mean and Standard deviation of causes of discrepancies.

S. No.	Causes	Rank
20.	Lack of coordination between parties	1
09.	Insufficien working drawings and deails.	2
25.	Involvement of designer as consultant	3
44.	Involvement of contractor as consultant	4
34.	Participant's wrong belief	5
24.	Contractor's lack of comprehension of drawing details and specifications.	6

Table2: Most important causes of discrepancies.

S. No.	Causes	Rank
45.	Project management as individual professional service.	1
38.	Nationalities of participants.	2
01.	Involvement of contractor in the design conceptual phase.	3
02.	Involvement of contractor in the design development phase.	4
37.	Weather conditions.	5
42.	Unforeseen problems.	6

Table3: Least important causes of discrepancies.

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