Causes of Delay in Building Construction Projects in Egypt

M. E. Abd El-Razek[1]; H. A. Bassioni[2]; and A. M. Mobarak[3]

Abstract: Delay in construction projects is considered one of the most common problems causing a multitude of negative effects on the project and its participating parties. This paper aims to identify the main causes of delay in construction projects in Egypt from the point of view of contractors, consultants, and owners. A literature review was conducted to compile a list of delay causes that was purged based on appropriateness to Egypt in seven semistructured interviews. The resulting list of delay causes was subjected to a questionnaire survey for quantitative confirmation and identification of the most important causes of delay. The overall results indicated that the most important causes are: financing by contractor during construction, delays in contractor's payment by owner, design changes by owner or his agent during construction, partial payments during construction, and nonutilization of professional construction/contractual management. The contractor and owner were found to have opposing views, mostly blaming one another for delays, while the consultant was seen as having a more intermediate view. Results' analyses suggest that in order to significantly reduce delay a joint effort based on teamwork is required. Furthermore, causes of project delay were discussed based on the type and size of the project.

DOI: 10.1061/(ASCE)0733-9364(2008)134:11(831)

CE Database subject headings: Buildings; Construction management; Delay time; Egypt.

Introduction

Construction delays are for the most part costly, and completing projects on time is beneficial to all project parties. Therefore, it is essential to identify the actual causes of delay in order to minimize and avoid the delays and their corresponding expenses. The construction sector is counted as one of the most active sectors affecting the Egyptian economy to the extent that about 45% of the funds allocated for the national development plans in Egypt since 1981 were allocated to the construction sector (Ahmed 2003). With the economic development currently taking place in Egypt, building construction contributes to a large portion of the construction sector. Therefore, the objective of this paper is to determine the most important causes of delay in building construction projects in Egypt. This paper identifies the causes from the points of view of the main project parties: owner, contractor, and consultant. The results are also categorized by project type and size.

[1]Head of Construction and Building Engineering Dept., College of Engineering and Technology, Arab Academy for Science, Technology and Maritime Transport, Cairo, Egypt. E-mail: mohemam@aast.edu

[2]Assistant Professor, Construction and Building Engineering Dept., College of Engineering and Technology, Arab Academy for Science, Technology and Maritime Transport, Alexandria 21532, Egypt (corresponding author). E-mail: hbassioni@yahoo.co.uk

[3]Senior Planning Engineer, DEPA United Group, Cairo, Egypt. E-mail: ahmedmobi@gmail.com

Note. Discussion open until April 1, 2009. Separate discussions must be submitted for individual papers. The manuscript for this paper was submitted for review and possible publication on September 29, 2006; approved on May 8, 2008. This paper is part of the ***Journal of Construction Engineering and Management***, Vol. 134, No. 11, November 1, 2008. ©ASCE, ISSN 0733-9364/2008/11-831–841/$25.00.

Causes of Delay in Literature

Definition of Delay

In the study of Assaf and Al-Hejji (2006) construction delay was defined as "the time overrun either beyond completion date specified in a contract, or beyond the date that the parties agreed upon for delivery of a project." Delay was also defined as an "act or event which extends required time to perform or complete work of the contract manifests itself as additional days of work" by Zack (2003).

Egyptian Studies

Mobarak (2004) discussed the role of consultancy in minimizing the delays of large projects and showed possible categorizations of causes of delay such as internal and external, financial and nonfinancial. Construction delay problems in Egypt were discussed by Amer (1994) via studying and analyzing the causes that contribute to construction delays in order to improve the ability to implement construction projects without delays. Results of this study indicated that the major causes of delay in construction projects in Egypt are: poor contract management, unrealistic scheduling, lack of owner's financing/payment for completed work, design modifications during construction, and shortages in materials such as cement and steel. The study was conducted over 1 decade ago and the nature of the construction industry in Egypt has changed and rapidly developed ever since. Many multinational firms have expanded their operations in Egypt, in addition to a noticeable improvement in construction management practices in large projects. Due to the influence of multinational firms, the initial compilation of delay causes list depended on international studies and was further compared against the causes identified in Amer (1994) and checked for appropriateness to Egypt within the expert interviews.

International Studies

Several articles have discussed causes of delay in construction projects in numerous manners; some studies identified the main causes of delay in several countries and various project types, while other studies discussed the delay analysis methods and the proposed ways to mitigate it. Six studies were incorporated in this study to compile a list of delay causes. The study of Baldwin et al. (1971) was carried out to determine the causes of delay in the construction process in the United States. The next study was by Mansfield et al. (1992) which investigated the causes of delay and cost overruns that affect completed highway projects in Nigeria. In Saudi Arabia, Assaf et al. (1995) studied the main causes of delay in large building projects. The survey covered a random sample of contractors, consultants, and owners. As a case study regarding the Nontaburi bypass road project, Noulmanee et al. (2000) discussed the internal causes of delay in a highway construction project in Thailand. Ahmed et al. (2003) carried out a study to identify the major causes of delays in building construction in Florida, then allocated the responsibilities and types of delays for each cause. Regarding commercial construction projects, Choudhury and Phatak (2004) studied the causes that affect time overrun.

The previous studies were used to build a comprehensive list of delay causes. It was noted that the Assaf et al. (1995) study has the largest number of delay causes (56 causes), in addition to the study being within the same region as Egypt. Therefore, the causes stated in the Assaf et al. (1995) study were considered as datum, while causes in the other studies were compared against it to build a more comprehensive list of delay causes. Moreover, Assaf et al. (1995) had grouped the delay causes into nine major groups: financing, materials, contractual relationships, changes, government relations, manpower, scheduling and control, equipment, and environment. It was decided to use the same nine groups while changing the "government relations" description to be "rules and regulations" to give a wider view of the delay causes shown in other studies. The compiled list of delay causes contained a total of 87 causes and are available in the Appendix.

Expert Interviews

The main objective of these interviews was to deliver a list of delay causes which are appropriate to building construction projects in Egypt and consequently to be incorporated into a questionnaire survey. Five semistructured interviews with experts were conducted to critique the compiled list of delay causes and suggest any further causes. The sample size in qualitative research methods, such as interviews, can be identified through saturation, i.e., additional interviews do not produce new information or data (Guest et al. 2006). This was achieved by two additional interviews that confirmed the outcomes of the first five interviews and reflected saturation. A varied sample was sought that included experts from contracting, consulting, and academic backgrounds, each with a minimum experience of 15 years in construction and excellent knowledge of project management. Finally, the main causes of delay in Egypt discussed by Amer (1994), were compared to the list obtained in this research and no additional causes could be identified.

The format of the interviews was semistructured to have set questions and allow probing when necessary. The factors compiled from the literature review were subjected to two main questions: "Do you think, from your expert opinion, this cause causes delay in construction projects in Egypt?" and "Are there any further causes you might like to add?" The interviews resulted in a list of 32 causes of delay that were seen to fit the Egyptian construction industry. During the interviews, some of the causes' descriptions were slightly changed. The interview outcome concerning each cause of delay from the literature and the final list of causes resulting from interviews is shown in the Appendix. The following is a discussion of the interview outcomes for each cause, categorized by cause groups, and based on expert feedback:

1. Financing: the three causes of this group were found suitable;
2. Manpower: two causes were selected and four were deleted. "Nationality of laborers" does not apply to Egypt since mostly Egyptian labors are used. "Labor injuries" and "labor and management relations" were seen to have a minor effect in projects, and "labor disputes and strikes" are not common in Egypt;
3. Changes: five causes of this group were selected. The causes of "water table conditions on site" and "geological problems on site" were seen as already represented in "mistakes in soil investigation";
4. Contractual relationships: seven causes were selected. The cause "difficulty of coordination between various parties working on the project" could represent the causes "uncooperative owners," "insufficient communication between the owner and designer in design phase," and "legal disputes between various parties in the construction project." The cause "nonutilization of professional construction/contractual management" could represent the causes "poor contract management," "nonadherence to contract conditions," and "mistakes and discrepancies in contract documents." The cause "project delivery systems used" was deleted as most of building projects in Egypt are of the general contracting type. the causes "the jointownership of the projects" and "negotiations and obtaining of contracts" were seen to limit the effect on project duration. The cause of "the unavailability of financial incentives for contractor to finish ahead of schedule" is not common in Egypt, and was thus deleted. "Contract modifications" was seen to be represented in the changes group under the "design changes by owner." Common building projects in Egypt usually have similar scope and construction methods, and thus "completeness of project information" was not seen as a cause of project delays;
5. Environment: six of the causes were merged into a single "weather effect" cause. These causes were "hot weather," "rain effect," "flood," "hurricane," and "wind damage." "Fire" was not seen as a main determinant of project delay. The cause of "insufficient available utilities on site" was seen as not applicable, and thus deleted. The cause of "social and cultural factors" was not seen as a determinant factor of project delay;
6. Equipment: three causes were selected. The causes of "equipment failure" and "slow delivery of equipment" were seen to be represented by "shortage in equipment." The cause of "lack of high-technology equipments" was deleted because building projects in Egypt usually have regular and similar technology;
7. Rules and regulations: two causes were seen as suitable. The cause of "building permits approval process" was seen as represented in "obtaining permits from municipality." The causes of "changes in laws and regulations," "safety rules," "OSHA regulations," "building regulations in coastal regions," "coastal construction control line permit," "Florida

Table 1. Distribution of Survey Participants

Participant organization	Participant position							
	Owner/ partner	Project manager	Contract administrator	Site engineer	Architect	Coordinator	QA/QC	Total
Contractor	1	10	3	11	1	2	1	29
Consultant	5	11	2	2	2	1	—	23
Owner	5	10	3	4	—	—	—	22
Total	11	31	8	17	3	3	1	74

administrative code," "national flood insurance program," and "obtaining permits for laborers" were seen as either not applicable or having limited impact;

8. Materials: three causes were selected and the remaining two items of "damage of materials in storage" and "imported materials and plant items" were seen to have a rather low effect on project duration; and
9. Scheduling and control: four causes were selected. The "lack of database in estimating activity duration and resources" was seen as being indicative of the "judgment and experience of the people involved in estimating time and resources" and "inadequate early planning of the project." The causes of "poor subcontractor performance" and "often change of subcontractors" were seen as represented by the cause of "controlling subcontractors by general contractors in the execution of work" and the "lack of training personnel and management support to model the construction operation" was seen as being represented by "nonutilization of professional construction/contractual management" in the contractual relationships group. The two causes "preparation and approval of shop drawings" and "waiting for sample material approval" were merged to "preparation of shop drawings and material samples" and "waiting for approval of shop drawings and material samples." The causes of "preparation of scheduling networks and revisions by consultant while construction is in progress," "traffic control regulation practiced in the site of the project," and "inadequate review" were seen to have minor effects. "Staffing problems" do not commonly happen and "timeliness of project information" could be represented by the nonutilization of professional construction/ contractual management" in the contractual relationships group. "Transportation delays" can be incorporated into other causes such as "shortage of construction materials" and "shortage in equipment" in the materials and equipment groups, respectively. "Damage to structure" is quite rare and "different site conditions" and "construction methods" are not so common in Egyptian building construction. "Time spent to find appropriate subcontractors for each task" was seen as not relevant as main contractors usually have long-term relationships with subcontractors.

Questionnaire Survey

A questionnaire survey was conducted to quantitatively confirm the list of causes obtained from the interviews and identify the most important causes of delay. The questionnaire was divided into two parts: Part 1—participant's personal information (e.g., contact information, age, position, and experience); and Part 2—project information (e.g., measurement of the importance of the causes of delay). The 32 causes of delay were grouped according to responsibility (contractor, consultant, owner, and common responsibility). Two extra blank rows were provided to give the participant a chance to add any further causes, and thus confirm the list of delay causes. Each cause of delay was measured on a Likert scale using four options: very important; important; somewhat important; and not important.

Under the responsibility of the contractor there were the following causes: shortage in construction materials, slow delivery of materials, shortage in labor, poor labor productivity, shortage in equipment, unskilled operators, poor equipment productivity, financing by contractor during construction, preparation of shop drawings and material samples, errors committed due to lack of experience, accidents during construction, controlling subcontractors by main contractor in the execution of work, and lack of database in estimating activity duration and resources.

Under the responsibility of the consultant there were the following causes: changes in materials types and specifications during construction, design changes by owner or his agent during construction, design errors/incomplete made by designers, unexpected foundation conditions encountered in the field, mistakes in soil investigation, waiting for approval of shop drawings and material samples, and inspection and testing procedures used in the project.

Under the owner's responsibility, there were the following causes: delays in contractor's payment by owner, and partial payments during construction. Delays in contractor's payments resemble the contractor's whole payment and the partial payments indicate the contractor taking part of his payment on time and the remainder being delayed. Further causes were also listed under the owner's responsibility which are: obtaining permits from municipality, excessive bureaucracy in project owner operation, and slowness of the owner decision making process.

In addition, there were causes under the common responsibility which are: application of quality control based on foreign specification, the conflict in point of view between contractor and consultant, nonutilization of professional construction/contractual management, the relationship between different subcontractors' schedules, poor organization of the contractor or consultant, difficulty of coordination between various parties (contractor, subcontractor, owner, consultant) working on the project, and the weather effect.

Because of the difficulty in gathering questionnaires by post, the expectation of a very low response rate with this approach, the data were gathered in person. A snowballing technique was used to select participants; meaning potential participants were obtained from existing participants. A total of 88 questionnaires, representing 88 projects, were involved in this study, which were obtained from 74 participants. These participants were distributed as 29 contractors, 23 consultants, and 22 owners as shown in Table 1. Among the participant interviews, 30 of them preferred not to reply for a particular project but extended their reply to represent all the projects previously experienced. This provides the survey data with a wider spectrum of projects.

Table 2. Importance Index for Overall Results

Rank	Delay cause	Importance index	Responsibility
1	Financing by contractor during construction	68.33	Contractor
2	Delays in contractor's payment by owner	64	Owner
3	Design changes by owner or his agent during construction	62.67	Consultant
4	Partial payments during construction	60.67	Owner
5	Nonutilization of professional construction/contractual management	59.67	Common
6	Slow delivery of materials	59.67	Contractor
7	Difficulty of coordination between various parties (contractor, subcontractor, owner, consultant) working on the project	56.00	Common
8	Slowness of the owner decision making process	56.00	Owner
9	The relationship between different subcontractors' schedules	55.33	Common
10	Preparation of shop drawings and material samples	54.00	Contractor
11	Lack of database in estimating activity duration and resources	52.67	Contractor
12	Shortage in construction materials	51.00	Contractor
13	Poor organization of the contractor or consultant	51.00	Common
14	Controlling subcontractors by main contractor in the execution of work	50.67	Contractor
15	Changes in materials types and specifications during construction	50.33	Consultant
16	Obtaining permits from municipality	48.67	Owner
17	Waiting for approval of shop drawings and material samples	47.00	Consultant
18	Poor labor productivity	46.00	Contractor
19	Errors committed due to lack of experience	45.33	Contractor
20	Design errors/incomplete made by designers	45.00	Consultant
21	Inspection and testing procedures used in the project	45.00	Consultant
22	Unexpected foundation conditions encountered in the field	44.67	Consultant
23	Shortage in equipment	44.00	Contractor
24	Shortage in labor	43.67	Contractor
25	Excessive bureaucracy in project owner operation	41.33	Owner
26	Mistakes in soil investigation	39.67	Consultant
27	Unskilled operators	39.00	Contractor
28	The conflict in point of view between contractor and consultant	38.00	Common
29	Poor equipment productivity	37.00	Contractor
30	Application of quality control based on foreign specification	33.67	Common
31	Weather effect	30.33	Common
32	Accidents during construction	28.00	Contractor

Results Analysis

Analysis of Overall Results

To provide a degree of importance for each delay cause, an importance index was calculated, in a manner similar to that in Assaf et al. (1995), as shown in Eq. (1)

$$I = \sum_{i=1}^{4} \frac{a_i \times x_i}{3} \tag{1}$$

where I=importance index; a_i=weight of the ith response; x_i =frequency of the ith response; and i=response category index.

A response of "very important" was given a weight of response 3, "important" was given a weight of 2, "somewhat important" was given a weight of 1, and "not important" a weight of 0. For example, if 100 responses were received of which for a certain delay cause: 20 responded by "very important"; 65 responded by "important," ten responded by "somewhat important," and five responded by "not important," then the importance index for this delay cause would be calculated as shown in Eq. (2)

$$I = \frac{20*3 + 65*2 + 10*1 + 5*0}{3} = 66.67 \tag{2}$$

The importance indices were calculated for all delay causes and the delay causes were ranked accordingly. Table 2 shows the ranked delay causes, and their corresponding importance index. The most important causes identified by the survey, and based on overall results, were: financing by contractor during construction, delays in contractor's payment by owner, design changes by owner or his agent during construction, partial payments during construction, and nonutilization of professional construction/ contractual management.

In order to identify how project delay can be mitigated, it is important to identify the responsible party. Therefore, the responsibility of the delay causes is illustrated in the responsibility column of Table 2. Within the ten most important causes, three of the causes were under the contractor's responsibility, three under the owner's responsibility, three under common responsibility, and only one cause under the consultant's responsibility. It can be concluded that the most important delay causes have mixed responsibility, and no single party is responsible for delay. This

means that any attempt to prevent or mitigate delay has to be a joint attempt and based upon teamwork. A similar observation was concluded in the study of Abdul-Rahman et al. (2006) which was conducted in Malaysia.

Analysis of Results by Project Parties

In order to assess the delay causes by each party independently, the contractors', consultants', and owners' data were separated and analyzed individually. This process also facilitated determining the degree of agreement between each party's responses. The importance index was calculated for each party for all delay causes and the delay causes were ranked accordingly. The most important ten causes organized by party are shown in Table 3. The three most important causes in the overall results are indicated in boldface for better illustration.

"Financing by contractor during construction" was identified as the top cause of delay by both the owner and consultant. The view of the consultant can be considered as an intermediate result with a degree of impartiality. Furthermore, the contractor results identified this cause as the third most important, and the first within his responsibility. These results show how this cause can greatly affect a project delay and suggest the importance of using cash flow analysis, based on a realistic schedule on the project level, within the whole contractor organization to coordinate cash requirement among projects. However, the most important cause in the contractor's result was "design changes by owner or his agent during construction." It was ranked as the seventh in the consultant's result and it was not listed within the ten important causes in the owner's result. "Nonutilization of professional construction/contractual management" is ranked as the second most important cause of delay in the consultant and owner's results while it was not listed within the ten important causes in the contractor's result. However, the second important delay cause in the contractor's results was "delays in contractor's payment by owner" which had the third position in the consultant's results and the eighth position in the owner's results.

"Difficulty of coordination between various parties (contractor, subcontractor, owner, consultant) working on the project" was ranked sixth and fifth according to owner and consultant results, respectively. It has the tenth position in the contractors' results. This cause is one of three common causes among all three parties. The other two causes are "financing by contractor during construction" and "delay in contractor's payment by owner." Rather than these causes, there were no common causes between the two extremes; contractor and owner. In addition, there were three more common causes between consultant and owner; these causes are: "nonutilization of professional construction/contractual management," "preparation of shop drawings and material samples," and "controlling subcontractors by main contractor in the execution of work." There were also four common causes between consultant and contractor: "partial payments construction," design changes by owner or his agent during construction," "the relationship between different subcontractors' schedules," and "slow delivery of materials.

The agreement between parties or survey respondents has been addressed in two approaches: Pearson's correlation coefficient among values of importance indices; and Spearman rank correlation coefficient among ranks. Similar international studies used the Spearman rank correlation coefficient (Alwi and Hampson 2003; and Assaf et al. 1995) to quantitatively measure the agreement between parties. Pearson's coefficient of correlation, which is also termed the "product moment correlation coefficient" was calculated between each pair of parties and based on the importance indices of causes, as per the formula in Ayyub and McCuen (1997, p. 279). The value of Pearson's correlation coefficient ranges from +1 (perfect correlation) to 0 (no correlation) to −1 (perfect negative correlation). The results of the correlation between contractor and owner, owner and consultant, and contractor and consultant were 0.47, 0.70, and 0.71, respectively.

Spearman rank correlation coefficient was calculated according to the following formula (Assaf and Al-Hejji 2006):

$$\text{Spearman rank correlation coefficient} = 1 - \frac{6\Sigma d^2}{(n^3 - n)}$$

where d=difference between the ranks indicated by two parties, and n=number of records. The value of the Spearman rank correlation coefficient ranges from +1 (perfect correlation), to 0 (no correlation), to −1 (perfect negative correlation). The results of the correlation between contractor and owner, owner and consultant, and contractor and consultant were 0.47, 0.65, and 0.69, respectively.

Both results obtained from Pearson's correlation coefficient and Spearman rank correlation coefficient are almost the same. The degree of agreement between contractor and owner is exactly the same, 0.47 in both approaches. The Spearman rank correlation coefficient shows some sort of agreement between the consultant and the other two parties (0.65 with owner and 0.69 with contractor) while the Pearson's correlation coefficient shows very close results and high agreement (0.70 with owner and 0.71 with contractor).

Generally, these results show a low correlation between the owner and contractor, which resembles the conflicting views, and thus opposing views between these parties. However, there was a good correlation between the consultant and the other two parties. This intermediate position of the consultant shows this party as possibly having an impartial view between the differences among the contractor and the owner. Within the construction of projects, the position of the consultant might be seen as more favorable to the owner, because of the contractual relationship between them, but in this research, and through the survey conducted the consultant has no interest in taking either the contractor or owner's side, and thus reinforces his intermediate position in the results.

Analysis of Overall Results by Delay Causes Groups

The groups of delay causes were analyzed based on the overall results. The group importance index was calculated as the average of the importance indices for the delay factors in the group. For example, in the "financing group," the group importance index is the average of the importance indices of its constituting causes as follows: financing by contractor during construction (68.33); delays in contractor's progress payment by owner (64); and partial payments during construction (60.67), resulting in an average of 64.33, which is its group importance index. The ranked groups of delay causes and their corresponding importance index are shown in Table 4.

The results of the financial group show the greatest cause in project delay. This result is consistent with the outcome of the individual causes as financial reasons in the overall analysis and were ranked first, second, and fourth. The material group was in second place, and the delay factor "slow delivery of materials" was the first factor in this group in the overall result ranking of sixth. The contractual relationships group was ranked third, with "nonutilization of professional construction/

Table 3. Ten Most Important Causes by Project Party

Rank	Overall results	Owner	Consultant	Contractor
1	**Financing by contractor during construction**	**Financing by contractor during construction**	**Financing by contractor during construction**	**Design changes by owner or his agent during construction**
2	**Delays in contractor's payment by owner**	Nonutilization of professional construction/ contractual management	Nonutilization of professional construction/ contractual management	**Delays in contractor's payment by owner**
3	**Design changes by owner or his agent during construction**	Obtaining permits from municipality	**Delays in contractor's payment by owner**	**Financing by contractor during construction**
4	Partial payments during construction	Lack of database in estimating activity duration and resources	Preparation of shop drawings and material samples	Partial payments during construction
5	Nonutilization of professional construction/ contractual management	Preparation of shop drawings and material samples	Difficulty of coordination between various parties (contractor, subcontractor, owner, consultant) working on the project	Slow delivery of materials
6	Slow delivery of materials	Difficulty of coordination between various parties (contractor, subcontractor, owner, consultant) working on the project	Partial payments during construction	Slowness of the owner decision making process
7	Difficulty of coordination between various parties (contractor, subcontractor, owner, consultant) working on the project	Excessive bureaucracy in project owner operation	**Design changes by owner or his agent during construction**	Changes in materials types and specifications during construction
8	Slowness of the owner decision making process	**Delays in contractor's payment by owner**	Controlling subcontractors by main contractor in the execution of work	Shortage in construction materials
9	The relationship between different subcontractors' schedules	Unexpected foundation conditions encountered in the field	The relationship between different subcontractors' schedules	The relationship between different subcontractors' schedules
10	Preparation of shop drawings and material samples	Controlling subcontractors by main contractor in the execution of work	Slow delivery of materials	Difficulty of coordination between various parties (contractor, subcontractor, owner, consultant) working on the project

Table 4. Groups Importance Index for Overall Results

Rank	Group of delay causes	Group importance index
1	Financing	64.33
2	Materials	53.67
3	Contractual relationships	52.38
4	Changes	47.47
5	Rules & regulations	45.00
6	Manpower	44.83
7	Scheduling & control	43.39
8	Equipment	40.00
9	Environment	30.33

contractual management" from this group ranked fifth in the overall results. The changes group was ranked fourth, although the third most important individual cause in the overall results was "design changes by owner or his agent during construction."

Analysis of Results by Project Sector

To analyze the data from a project type point of view, the results were categorized by project sector. The number of project types identified in the survey responses were 54, distributed as follows: 11 housing; 31 tourism; eight industrial; 17 educational/research; and three commercial. The ten most important causes by project sector are shown in Table 5. The most important three factors in the housing sector, in order of importance were: "financing by contractor during construction," "design changes by owner or his agent during construction," and "delay in contractor's payment by owner." The tourism sector had similar causes except for "partial payments during construction" being ranked third. The educational/research sector was not very different with the most three important causes of delay, in their order of importance, being: "financing by contractor during construction," "delay in contractor's payment by owner," and "partial payments during construction."

These results show great similarity in the causes of project delay in the housing, tourism, and educational/research sectors, which can be attributed to the similar methods of construction used in many of the buildings in these three sectors in Egypt. The industrial and commercial sectors can have more differences between projects in the work items, construction methods, and designs. This might explain the reason for having design error, design changes, and the need for professional construction management as the three major causes of project delay.

Analysis of Results by Project Size

The data were also analyzed from a project size perspective. The number of respondents to the project size question in the survey was 45. The sample was divided into three equal groups of project sizes: the first interval is of projects less than 5,000,000 Egyptian pounds (EGP) and is termed size A; the second interval is of projects greater than or equal to 5,000,000 EGP and less than or equal to 24,000,000 EGP and is termed size B; and

Table 5. Ten Most Important Delay Causes by Project Sector

Rank	Housing	Tourism	Industrial	Commercial	Educational/Research
1	Financing by contractor during construction	Financing by contractor during construction	Slowness of the owner decision making process	Design errors made by designers	Financing by contractor during construction
2	Design changes by owner or his agent during construction	Design changes by owner or his agent during construction	Financing by contractor during construction	Design changes by owner or his agent during construction	Delays in contractor's payment by owner
3	Delays in contractor's payment by owner	Partial payments during construction	Nonutilization of professional construction/ contractual management	Slow delivery of materials	Partial payments during construction
4	Partial payments during construction	Slow delivery of materials	Lack of database in estimating activity duration and resources	Changes in materials types and specifications during construction	Slow delivery of materials
5	Obtaining permits from municipality	Delays in contractor's payment by owner	Difficulty of coordination between various parties working on the project	Lack of database in estimating activity duration and resources	Controlling subcontractors by main contractor in the execution of work
6	Changes in materials types and specifications during construction	Slowness of the owner decision making process	The relationship between different subcontractors' schedules	Obtaining permits from municipality	Slowness of the owner decision making process
7	The relationship between different subcontractors' schedules	Nonutilization of professional construction/ contractual management	Preparation of shop drawings and material samples	Difficulty of coordination between various parties working on the project	Shortage in construction materials
8	Unexpected foundation conditions encountered in the field	Difficulty of coordination between various parties working on the project	Poor organization of the contractor or consultant	Shortage in construction materials	Poor organization of the contractor or consultant
9	Nonutilization of professional construction/ contractual management	Lack of database in estimating activity duration and resources	Delays in contractor's payment by owner	Excessive bureaucracy in project owner operation	Poor labor productivity
10	Slow delivery of materials	Design errors made by designers	Poor labor productivity	Nonutilization of professional construction/ contractual management	Nonutilization of professional construction/ contractual management

Table 6. Ten Most Important Causes by Project Size

Rank	A <5,000,000 EGP	B 5,000,000–24,000,000 EGP	C >24,000,000 EGP
1	Design changes by owner or his agent during construction	Financing by contractor during construction	Partial payments during construction
2	Financing by contractor during construction	Slowness of the owner decision making process	Design changes by owner or his agent during construction
3	Unexpected foundation conditions encountered in the field	Difficulty of coordination between various parties (contractor, subcontractor, owner, consultant) working on the project	Delays in contractor's payment by owner
4	Obtaining permits from municipality	Controlling subcontractors by main contractor in the execution of work	Slow delivery of materials
5	Delays in contractor's payment by owner	Delays in contractor's payment by owner	Financing by contractor during construction
6	Inspection and testing procedures used in the project	Partial payments during construction	Lack of database in estimating activity duration and resources
7	Slowness of the owner decision making process	Nonutilization of professional construction/ contractual management	Nonutilization of professional construction/ contractual management
8	Excessive bureaucracy in project owner operation	Slow delivery of materials	Slowness of the owner decision making process
9	Nonutilization of professional construction/ contractual management	Shortage in construction materials	Changes in materials types and specifications during construction
10	Errors committed due to lack of experience	Design changes by owner or his agent during construction	Poor organization of the contractor or consultant

the third interval is of projects more than 24,000,000 EGP and is termed size C. This categorization is reasonable in terms of Egyptian building construction. The ten most important causes by project size are shown in Table 6. The most important causes in size A projects in order were "design changes by owner or his agent during construction," "financing by contractor during construction," and "unexpected foundation conditions encountered in the field." The most important causes in size B projects in order were "financing by contractor during construction," "slowness of the owner decision making process," and "difficulty of coordination various parties." The most important causes in size C projects in order were "partial payments during construction," "design changes by owner or his agent during construction," and "delays in contractor's payment by owner." Several points can be observed from the previous results. Unexpected foundation conditions are more common as a cause of delay in size A projects, probably due to the existence of small contractors and owners not conducting field investigations effectively. In size B projects middle size owners, contractors, and consultants are involved who do not have the agility of small companies or established processes of large companies, which can explain the presence of slowness in the owner decision making process and difficulty of coordination between various parties as important causes of delay. Partial payments are more common as a cause of delay in size C projects, probably as a result of many projects being constructed by state owned contractors.

Conclusion

The objective of this research was to identify the main causes of delay that affect building projects in Egypt. A literature review was conducted to identify the causes of delay stipulated in the literature. Seven semistructured expert interviews were conducted to identify the most appropriate causes of delay to Egyptian building projects. A compiled list of 32 causes was obtained and subjected to further quantitative evaluation in a questionnaire survey to confirm the causes and identify the most important causes of project delay.

The most important causes identified by the survey, and based on overall results, were: financing by contractor during construction; delays in contractor's payment by owner; design changes by owner or his agent during construction; partial payments during construction; and nonutilization of professional construction/ contractual management. The results show near agreement between project parties in "financing by contractor" being the topmost cause of delay. All other causes witnessed disagreement and in some cases what can be considered "pinpointing" of responsibility of delay on other parties. For example, the contractor ranked "delays in contractor's payment by owner" and "design changes by owner or his agent during construction" as the second and third most important causes of delay, both being the responsibility of other parties. However, the owner and consultant gave these causes a lesser ranking. Moreover, the owner and consultant ranked "nonutilization of professional construction/contractual management," which usually originates from the contractor as the second most important cause of delay, whereas the contractor did not include it in the top ten causes.

A correlation of the responses of each party showed the contractor and owner to have nonmatching opinions concerning the causes of delay, while the consultant held an intermediate position. An analysis of the responsibilities of delay causes suggests that a joint effort based on teamwork is required to mitigate delays. Further analysis of the results by project sector shows similarity in the top causes of project delay in the housing, tourism, and educational/research sectors which can be attributed to the similar methods of construction. The industrial and commercial sectors can have differences between projects in work items, construction methods, and designs and thus design error and design changes are more determinant causes of delay. Finally, the analysis of results by project size showed that differences exist in project causes of delay based on the size of the companies involved.

Further research can be conducted, as a result of this paper. For example, similar research can be conducted in different countries identifying causes for construction project delays. A comparison between previous international literature on the same topic can attempt to identify the reasons for differences in causes based on geographic, cultural, and socio-economic factors. Moreover, deeper research can be conducted into the results of this and similar research to identify root causes of delay using techniques such as the fishbone diagram.

Appendix: List of Causes of Delay from Literature

Group	Delay causes from literature	Interviews outcome	Delay causes resulting from interviews
Financing	Financing by contractor during construction	Selected	Financing by contractor during construction
	Delays in contractor's progress payment by owner	Selected	Delays in contractor's payment by owner
	Partial payments during construction	Selected	Partial payments during construction
Manpower	Shortage of labor	Selected	Shortage of labor
	Labor skill	Selected	Poor labor productivity
	Nationality of laborers	Deleted	
	Labor injuries	Deleted	
	Labor disputes and strikes	Deleted	
	Labor and management relations	Deleted	
Changes	Design changes by owner or his agent during construction	Selected	Design changes by owner or his agent during construction
	Design errors made by designers (due to unfamiliarity with local conditions and environment)	Selected	Design errors made by designers
	Foundation conditions encountered in the field	Selected	Unexpected foundation conditions encountered in the field
	Mistakes in soil investigation	Selected	Mistakes in soil investigation
	Errors committed during field construction at job site	Selected	Errors committed due to lack of experience
	Water table conditions on site	Already represented	
	Geological problems on site	Already represented	
Contractual relationships	The relationship between different subcontractors' schedules in the execution of the project	Selected	The relationship between different subcontractors' schedules
	The conflict between contractor and consultant	Selected	The conflict in point of view between contractor and consultant
	Slowness of the owner decision making process	Selected	Slowness of the owner decision making process
	Poor organization of the contractor or consultant	Selected	Poor organization of the contractor or consultant
	Difficulty of coordination between various parties (contractor, subcontractor, owner, consultant) working on the project	Selected	Difficulty of coordination between various parties (contractor, subcontractor, owner, consultant) working on the project
	Nonutilization of professional construction/contractual management	Selected	Nonutilization of professional construction/ contractual management
	Controlling subcontractors by general contractors in the execution of work	Selected	Controlling subcontractors main contractor in the execution of work
	Uncooperative owners	Already represented	
	Insufficient communication between the owner and designer in design phase	Already represented	
	Legal disputes between various parties in the construction project	Already represented	
	Poor contract management	Already represented	
	Nonadherence to contract conditions	Already represented	
	Mistakes and discrepancies in contract documents	Already represented	
	Project delivery systems used (design-build, general contracting, turnkey…etc.)	Deleted	
	The joint ownership of the projects	Deleted	
	The unavailability of financial incentives for contractor to finish ahead of schedule	Deleted	
	Negotiations and obtaining of contracts	Deleted	
	Contract modifications	Deleted	
	Completeness of project information	Deleted	

Group	Delay causes from literature	Interviews outcome	Delay causes resulting from interviews
Environment	Hot weather effect on construction activities	Merged	Weather effect
	Rain effect on construction activities	Merged	
	Flood	Merged	
	Hurricane	Merged	
	Wind damage	Merged	
	Fire	Deleted	
	Insufficient available utilities on site	Deleted	
	Social and cultural factors	Deleted	
Equipment	Shortage in equipments	Selected	Shortage in equipment
	Unskilled operators	Selected	Unskilled operators
	Equipment productivity	Selected	Poor equipment productivity
	Equipment failure	Already represented	
	Slow delivery of equipment	Already represented	
	Lack of high-technology equipment	Deleted	
Rules & regulations	Obtaining permits from municipality	Selected	Obtaining permits from municipality
	Excessive bureaucracy in project owner operation	Selected	Excessive bureaucracy in project owner operation
	Building permits approval process	Deleted	
	Changes in laws and regulations	Deleted	
	Safety rules	Deleted	
	OSHA regulations	Deleted	
	Building regulations in coastal regions	Deleted	
	Coastal construction control line permit	Deleted	
	Florida administrative code	Deleted	
	National flood insurance program	Deleted	
	Obtaining permits for laborers	Deleted	
	Building codes used in the design of the projects	Already represented	
Materials	Shortage in construction materials	Selected	Shortage in construction materials
	Materials changes in types and specifications during construction	Selected	Changes in material types and specifications during construction
	Slow delivery of materials	Selected	Slow delivery of materials
	Damage of materials in storage	Deleted	
	Imported materials and plant items	Deleted	
Scheduling & control	Lack of database in estimating activity duration and resources	Selected	Lack of database in estimating activity duration and resources
	Inspection and testing procedures used in the project	Selected	Inspection and testing procedures used in the project
	Application of quality control based on foreign specification	Selected	Application of quality control based on foreign specification
	Accidents during construction	Selected	Accidents during construction
	Lack of training personnel & management support to model the construction operation	Already represented	
	Judgment and experience of the involved people in estimating time and resources	Already represented	
	Inadequate early planning of the project	Already represented	
	Poor subcontractor performance	Already represented	
	Often change of subcontractors	Already represented	
	Preparation and approval of shop drawings	Merged	Preparation of shop drawings and material samples
	Waiting for sample material approval	Merged	Waiting for approval of shop drawings and material samples
	Preparation of scheduling networks and revisions by consultant while construction is in progress	Deleted	
	Traffic control regulation practiced in the site of the project	Deleted	
	Damage to structure	Deleted	
	Staffing problems	Deleted	

Group	Delay causes from literature	Interviews outcome	Delay causes resulting from interviews
	Transportation delays	Already represented	
	Inadequate review	Deleted	
	Different site conditions	Deleted	
	Construction methods	Deleted	
	Timeliness of project information	Already represented	
	Time spent to find appropriate subcontractors for each task	Deleted	

References

Abdul-Rahman, H., Berawi, M. A., Berawi, A. R., Mohamed, O., Othman, M., and Yahya, I. A. (2006). "Delay mitigation in the Malaysian construction industry." *J. Constr. Eng. Manage.*, 132(2), 125–133.

Ahmed, A. G. (2003). "Assessment of construction contracting companies performance in Egypt." Ph.D. thesis, Zagazig Univ., Zagazig, Egypt.

Ahmed, S. M., Azhar, S., Kappagantula, P., and Gollapudi, D. (2003). "Delays in construction: A brief study of the Florida construction industry." *ASC Proc., 39th Annual Conf.*, Clemson Univ., Clemson, S.C., 257–266.

Alwi, S., and Hampson, K. (2003). "Identifying the important causes of delays in building construction projects." *Proc., 9th East Asia-Pacific Conf. on Structural Engineering and Construction*, Bali, Indonesia, Institut Teknologi Bandung, Nusa Dua, Bali, Indonesia.

Amer, W. H. (1994). "Analysis and evaluation of delays in construction projects in Egypt." Master thesis, Zagazig Univ., Zagazig, Egypt.

Assaf, S. A., and Al-Hejji, S. (2006). "Causes of delay in large construction projects." *Int. J. Proj. Manage.*, 24(4), 349–357.

Assaf, S. A., Al-Khalil, M., and Al-Hazmi, M. (1995). "Causes of delay in large building construction projects." *J. Manage. Eng.*, 11(2), 45–50.

Ayyub, B. A., and McCuen, R. H. (1997). *Probability, statistics and reliability for engineers*, 2nd Ed., Chapman and Hall/CRC Press, Boca Raton, Fla.

Baldwin, J. R., Manthei, J. M., Rothbart, H., and Harris, R. B. (1971). "Causes of delay in the construction industry." *J. Constr. Div.* 97(2), 177–187.

Choudhury, I., and Phatak, O. (2004). "Correlates of time overrun in commercial construction." *ASC Proc., 40th Annual Conf.*, Brigham Young Univ., Provo, Utah.

Guest, G., Bunce, A., and Johnsons, L. (2006). "How many interviews are enough? An experiment with data saturation and variability." *Field Methods*, 18(1), 59–82.

Mansfield, N. R., Ugwu, O. O., and Doran, T. (1994). "Causes of delay and cost over runs in Nigerian construction projects." *Int. J. Proj. Manage.*, 12(4), 254–260.

Mobarak, M. S. (2004). "Consultations in stumble of large projects." *World Econ.*, 146, 96 (in Arabic).

Noulmanee, A., Wachirathamrojn, J., Tantichattanont, P., and Sittivijan, P. (2000). "Internal cause of delay in highway construction project in Thailand." ⟨http://www.languages.ait.ac.th/talkbasework/july99/construction.htm⟩.

Zack, J. G., (2003). "Schedule delay analysis; is there agreement?" *Proc., PMI-CPM College of Performance Spring Conf.* ⟨http://www.pmi-cpm.org/public/news_events/2003_spring_conf/index.html⟩, May 7–9, 2003, Project Management Institute—College of Performance Management, New Orleans.