

Construction Delays: A Case Study of US Army Corps of Engineers

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Abstract

The construction industry plays a pivotal role in the nations' economy and must be effectively managed in order to ensure success. Part of that management requires personnel to ensure that construction delays are identified and properly mitigated. With proper insight to the causes of the construction delay, many possible delays can be mitigated or avoided altogether. This research study explored the causes of construction delays on US Army Corps of Engineers construction projects within the Savannah District footprint in order to identify the most significant delay factors. First, the general causes of construction delays were identified by researching literature and published data. The identified delay causes were utilized to develop a survey questionnaire to solicit input from various construction professionals, both contractor and USACE employees. The information gathered was then analyzed to determine the primary factors of construction delay in USACE projects.

Keywords

Construction delays, Project management, US Army Corps of Engineers, Savannah District

1. Background

The construction industry is large, volatile and requires tremendous capital. If construction delays are not managed properly, they can lead to disputes and claims, which can further lead to lawsuits (Ahmed et al, 2002). The time that is allowed for construction performance is usually an important consideration for both the project owner and the project contractor. Yet, it is typical for construction projects to be delayed (Bubshait and Cunningham, 1998). Delayed completion of a construction project is often caused by a complex interaction of a combination of events, some of which are the contractor's risks and others are the project owner's (Ndekugri et al, 2008). Since delays are normally the result of a number of different factors, it can be difficult to identify the root cause for a delay. As a result, it can be difficult to determine the party that is responsible for the delay.

The US Army Corps of Engineers (USACE) has developed a categorization system that identifies modification types and assigns responsibility. These categories are identified within the Corps' contract administration software, which is called the Resident Management System (RMS). When the modifications are processed, these categories are included within the documentation (US Army Corps of Engineers, 2012). In the construction industry, delays are generally categorized as excusable

compensable, excusable non-compensable, and inexcusable. These delay categories are based on the determining where the responsibility for the delay lies. There have been several studies into different types of methods for determining the cause and the extent of delays. The results of these studies point to three primary accepted methods for determining the impact of delays on construction schedules. These three methods are (1) As-Planned Method, (2) As-Built Method and (3) Modified As-Built Method. Method (3) is utilized by the USACE as a basis for determining impacts from construction delays (Shi et al, 2001). Each of the methods mentioned above result in different outcomes, which makes determining the actual extent of a construction delay difficult, if not impossible to predict. One study stated that outcomes of delay analyses are not predictable, nor can one method be used universally. However, in given circumstances, one procedure may be more beneficial than another (Shi et al, 2001).

2. Research Aim, Objectives and Scope

The aim of this research is to identify the underlying causes of construction delays within the Savannah District, USACE. The objectives of this research include:

1. Solicit information on causes for construction delays from contractors and USACE employees that have recently worked on construction projects within the Savannah District.
2. Examine the results of the information solicited to determine the most significant factors for construction delays in the Savannah District.
3. Determine if there are any discrepancies or major differences between the USACE and contractor results.

The research scope is limited to construction contractors and USACE employees that have worked within the US Army Corps of Engineers, Savannah District.

3. Research Design

A questionnaire was developed to solicit information from both contractors and USACE personnel. The questionnaire utilized information obtained through literature review in order to compile a comprehensive list of factors. The literature review was conducted through various sources including books, conference proceedings, engineering journals and Internet searches. The questionnaire developed focuses on eight primary categories, which are further broken down into factors under each category. There were a total of sixty-three factors that were addressed by the questionnaire. These factors were developed by compiling information used in the literature review. This research resulted in a large number of factors that had to be reviewed and pared down. The final sixty-three factors cover a wide range of topics and are the most applicable factors for this research. The eight categories used in the questionnaire are as follows: (1) Contractor factors, (2) Design factors, (3) Equipment factors, (4) External factors, (5) Labor factors, (6) Material factors, (7) Owner factors, and (8) Project related factors. The questionnaire rated each factor from one (1) to five (5) and indicated the likelihood of encountering a delay for each factor. The following scale was used to indicate the likelihood of each factor: (1) – Unlikely; (2) – As likely as not; (3) – Likely; (4) – Almost certain; and (5) – Certain. A web-based version was utilized. The questionnaire was sent via electronic mail to all of the supervisory engineers within the Savannah District Construction Division Field Offices. In addition, the supervisors were asked to provide the questionnaire to any relevant contractor management personnel, as well as their project engineers.

4. Results

The questionnaire survey was carried out from February 7 to March 7, 2013. There were a total of sixty-three responses. Three responses were removed from the results, as they were incomplete. The

remaining sixty valid responses were analyzed for this research. The questionnaire was analyzed at three different levels: a combined analysis, contractor analysis and an analysis of USACE employees. There were thirty-three contractors and twenty-seven USACE employees that responded to the questionnaire. This equates to 55% contractors and 45% USACE employees. The data was segregated and analyzed utilizing this approach in order to determine if there were significant differences between the respondents. Table 1 shows the mean, median and standard deviation for each of the eight categories. The statistics are broken down into overall, contractor and USACE responses.

Table 1: Overall, Contractor and USACE Statistics

Category	Overall			Contractor			USACE		
	Mean	Median	S.D.	Mean	Median	S.D.	Mean	Median	S.D.
Design Factors (9)	2.99	3	1.142	2.82	3	1.155	3.20	3	1.093
Contractor Factors (10)	2.88	3	1.273	2.53	2	1.245	3.31	3	1.170
Owner Factors (11)	2.74	3	1.207	2.72	3	1.226	2.78	3	1.185
Labor Factors (7)	2.59	2.5	1.150	2.52	2	1.145	2.67	3	1.152
Material Factors (7)	2.53	2.5	1.009	2.47	2	1.054	2.61	3	0.948
External Factors (8)	2.5	2	1.136	2.50	2	1.124	2.5	2	1.153
Project Factors (5)	2.31	2	1.035	2.19	2	0.985	2.46	2	1.077
Equipment Factors (6)	2.00	2	0.962	1.85	2	0.883	2.19	2	1.023

4.1 Overall Most Significant Construction Delay Factors

Further investigation into the questionnaire results revealed the most significant factors within the eight categories. Table 2 compiles the overall most significant factors, which incorporates the responses from both the contractor and USACE personnel. The overall results indicate that the top two factors are design factors: design errors and design changes by the owner during construction. Both design errors and design changes during construction can lead to substantial delays in construction. Design errors must be resolved by the designer of record in order to ensure they are handled in the proper manner and adhere to the requirements of the original design. Additional delays can occur if the designer of record is not located in the same area as the construction site, as there could be additional time required for coordination or a site visit. Design changes during construction can also lead to changes in the project schedule, which can lead to work inefficiencies and re-sequencing of scheduled activities. These items can lead to overall construction schedule delays if they have an impact on the critical path.

Table 1: Overall Most Significant Factors

		Mean	Median	Std Dev
1	Design errors made by designers	3.483	3	0.892
2	Design changes owner/agent during const.	3.417	3	1.094
3	Slowness in decision making	3.400	3.5	1.167
4	Poor site management and supervision	3.317	3	1.359
5	Delay in approving design documents	3.317	3	1.017
6	Ineffective project planning and scheduling	3.283	3	1.354
7	Mistakes & delays in producing design docs	3.283	3	1.209
8	Change orders / modifications	3.283	3	0.885
9	Unreliable subcontractors	3.267	3	1.163

Further investigation of the top nine factors listed above reveals that there are three owner factors, three contractor factors and three designer factors. The results indicate that the primary responsibility for construction delays rest within these three categories. The results indicate that the remaining five

categories are not considered to be as likely to have an impact on construction projects within the Savannah District.

4.2: Contractor’s Most Significant Construction Delay Factors

After reviewing the overall data, the numbers were broken down into contractor and USACE categories. The contractor’s results are shown in Table 3 below. The contractor responses to the questionnaire resulted in the top three scoring factors being owner and design related. Overall, there were three owner factors, three design factors, one labor factor, one external factor and one contractor factor. This indicates that the contractors feel there is a wide range of factors that can cause delays on a construction project.

Table 2: Contractor's Most Significant Factors

		Mean	Median	Std Dev
1	Slowness in decision making	3.455	4	1.227
2	Design errors made by designers	3.364	3	0.929
3	Unqualified/inadequate exp. labor	3.182	3	1.158
4	Delay in approving design documents	3.182	3	1.074
5	Design changes owner/agent during const.	3.152	3	1.149
6	Mistakes & delays producing design docs	3.121	3	1.364
7	Change orders / modifications	3.121	3	0.893
8	Unreliable subcontractors	3.091	3	1.208
9	Unexpected subsurface & surface conditions	3.000	3	0.866

It is important to note that there were two owner factors that were in the top three factors for contractors. Those two factors were “slowness in decision making” and “delay in approving design documents”. This was a consistent theme throughout the survey. There were several open-ended comments that addressed these particular items along with item six on the contractor’s list (changes orders / modifications). As one could imagine, slow decision-making can have an immense impact on a construction schedule. In the Savannah District, the USACE personnel represent the owner. In addition, the owner normally represents the occupant of the building. So, this adds another layer to the approval process. With this type of hierarchy, sometimes it can be difficult to obtain answers from the proper personnel in a timely manner. This type of situation must be planned for and addressed appropriately in order to mitigate any possible construction delays. The contractors also included a labor factor (unqualified / inadequate experienced labor) as their number four-rated factor. This is a factor that several contractors have brought up during construction projects in the past. Contractors have expressed concern with the lack of quality tradesmen that are available in the immediate construction areas. Several contractors have resorted to bringing in labor from outside the area in order to meet the contract specifications and the construction schedule. If this issue is not properly mitigated, it can have major impacts on the contract schedule.

The only contractor related factor on the contractor’s most significant list was “unreliable subcontractors” at number eight. This item was also number nine on the overall most significant factor list. Several of the open-ended responses stated that the government restrictions and mandates that require minimum levels of small business utilization are having an impact on construction schedules. The mandates require prime contractors to contract with a certain percentage of small or disadvantaged businesses (the percentage is contract dependent). The responses to the questionnaire indicate that the utilization of these businesses is hampering the timely completion of some construction projects. In addition, there were comments about the government not recognizing the tier subcontractors that are hired by other subcontractors as part of the required percentage. This makes it mandatory for the prime contractor to contract directly with the qualified businesses and does not provide an accurate depiction of the small business utilization on a contract since the tiered subcontractors would not be included in the calculations. In addition, this could

cause a prime contractor to utilize subcontractors that they may not be familiar with, which inserts additional risk in the construction schedule.

4.3 USACE Most Significant Construction Delay Factors

As stated previously, the USACE numbers were somewhat higher than the contractor’s numbers. As a result, the mean scores of the top factors are higher than the other listings (overall and contractor). In fact, all of the eleven factors on the USACE list have a higher mean score than the average score of the top factor for the contractors. The top seven factors on the USACE list would be considered to fall under the “4 – Almost Certain” category, while none of the contractor’s list would be in that category. All of the contractor’s top factors would fall under the “3 – Likely” category, which is also where the remaining four items on the USACE list would also rank. Table 4 shows the top eleven USACE factors in the questionnaire. The USACE responses resulted in the top two factors being contractor related: ineffective project planning and scheduling; poor site management and supervision. The top eleven factors are composed of the following: five contractor factors, four design factors, and two owner factors. As with the overall factors, the top scoring factors were all contractors, owner or design related.

Table 4: USACE Most Significant Factors

		Mean	Median	Std Dev
1	Ineffective project planning and scheduling	4.148	4	0.907
2	Poor site management and supervision	3.926	4	1.035
3	Design changes owner/agent during const.	3.741	4	0.944
4	Design errors made by designers	3.630	4	0.839
5	Incompetent/inexperienced project team	3.593	4	1.083
6	Rework due to errors	3.593	3	1.118
7	Unclear and inadequate details in drawings	3.519	3	0.975
8	Unreliable subcontractors	3.481	3	1.087
9	Mistakes and delays in producing design documents	3.481	4	0.975
10	Change orders / modifications	3.481	3	0.849
11	Delay in approving design documents	3.481	4	0.935

The USACE respondents clearly indicate that a majority of construction delays on Savannah District projects are contractor or design related. It is important to note that there are five contractor factors in the top eleven factors. This amounts to 45% of the top eleven factors. Conversely, the contractor’s survey only had one contractor factor in their top nine factors (11%). This is a substantial difference in the data collected. Given the respondents, it makes sense that contractors would indicate that the fault for construction delays rested upon the owner or the designer. Similarly, USACE employees may be more likely to put the fault on contractors or designers. This position is strengthened by the results. The contractors surveyed rated 67% of the top nine factors as either owner or design related. USACE employees surveyed rated 73% of the top eleven factors as either contractor or design related.

The top factor pointed out by USACE employees was “ineffective project planning and scheduling”, followed closely by “poor site management and supervision”. These factors indicate the perception of a lack of qualified personnel on the part of the contractor. There were several open-ended responses that addressed these two issues. Specifically, respondents referred to contractors using the project schedule as a “payment tool” in lieu of properly using it to manage the construction project and manpower. In addition, there were several open ended responses that indicated that the contractors had inexperienced or unqualified personnel managing the construction process. Proper control of subcontractors was also a common factor listed on the open-ended responses. These open ended responses provide insight as to

why the contractor related factors were prevalent on the list and were also the top two factors. It also lends insight as to why “incompetent / inexperienced project team” is number six on the USACE list. Another common open-ended response addressed the quality control (QC) personnel provided by the contractor. Several respondents pointed to inexperienced personnel and failure of the QC personnel to properly inspect work. This provides insight as to the reason “rework due to errors” is listed at number five on the USACE list. It would appear that the USACE personnel surveyed feel that the contractor’s QC personnel are not adequately inspecting the work, resulting in rework and lost time and production.

The USACE personnel surveyed indicated that there were two owner factors that were considered significant. Those two factors are “changes orders / modifications” and “delay in approving design documents”. Change orders and contract modifications will always have some sort of impact to a construction schedule. It may not require additional time for the contract, but there is always an impact that must be mitigated by the project delivery team. The earlier in the construction process these items are found and addressed, the less impact there is to the construction schedule. Therefore, it is imperative for the team to be proactive and ensure that the issues are addressed in a timely manner to avoid delay. Given the manner in which USACE represents the owner, the process of getting documents approved can be a lengthy process that must be properly planned and executed. If proper planning is not utilized, it can increase the time required and possibly cause delays in getting the proper approval for design and other construction related documents.

4.4 Analysis of Open-End Questions

In addition to the questions that rated the likelihood of the various factors, respondents were also asked two open-end questions. The first question asked the respondent to provide what they considered to be the top three factors that cause construction delays on USACE projects. There were various responses, with a majority of the responses to this question being relatable to the top three categories (contractor, design and owner). The most prolific factor that was addressed in the open-ended responses was owner related. The top issue identified was “owner changes”. This can be a severe hindrance to a construction schedule. It is imperative for the end user and owner to be proactively involved in the proposal and design development. If the proper coordination does not occur, then the contract could be in danger of having additional modifications due to user preferences or requirements that were not addressed.

There were also several comments that were related to the USACE and owner’s representative personnel. Several comments indicated a lack of experience on the personnel’s part, which contributes to construction delays. Some other related comments were also mentioned several times: lack of timely resolution of issues, no sense of urgency and onerous inspections. All of these issues can contribute to construction delays. As noted earlier, there were several open-end comments that addressed the contractor factors. Specifically, it was noted that contractor’s lacked properly experienced personnel. Several comments simply stated personnel were inexperienced, while others stated that the personnel lacked experience with government contracts. Several other comments addressed poor contract supervision or field management personnel. These comments specifically included superintendents, quality control and field management. A majority of the comments that were contractor related addressed the quality of personnel provided by contractors. This indicates a perceived lack of understanding on the contractor’s part as to what the USACE personnel are expecting. It also indicates a lack of confidence in the contractors. There were several comments related to design factors, as well. A majority of these comments were related to design errors and poor construction documents. Any mistakes made during the design phase can have immense impacts on the construction schedule. Contractors have to be proactive in researching the contract documents and ensure that they are

analyzing the work well ahead of time. If contract representatives are not looking ahead in the construction schedule, they endanger themselves to construction delays that can be avoided through proper planning and execution.

There were multiple responses that indicated external factors were within the top three factors. A majority of the external factors were attributed to differing site conditions, in which the actual conditions in the field did not match those within the contract drawings and specifications. This can be a frequent occurrence on USACE contracts. The respondents surveyed dealt primarily with military construction projects that are normally built within the limits of a federal installation. As such, the facilities are normally constructed in areas that were previously built up, as opposed to a green field. So, it is very likely for contractors to encounter existing utility lines or other abandoned items below the surface that were not addressed in the contract drawings. This can lead to contract modifications and time extensions that can delay construction progress. Overall, the open-end responses supported the data collected via the questionnaire. All of the comments submitted within the open ended responses related to the factors that were identified as the most significant factors.

5. Discussion and Conclusion

This research has resulted in the identification of several key factors that lead to construction delays within the Savannah District of the US Army Corps of Engineers. These factors were broken into separate groups, which identified the key factors for: Overall group surveyed, Contractors surveyed and USACE personnel surveyed. The factors identified by the overall group contained nine factors. There were three factors from each of the following categories: design, contractor and owner. The results show that that these three categories are the primary causes for construction delays within the Savannah District. The remaining five categories (labor, material, external, project and equipment) were not perceived to have a significant impact on construction delays. The results of this research differ from the research conducted in Florida (Ahmed et al, 2002). Since the Florida study is the only recent research that was conducted within the United States cited, it was compared directly. The results of the Florida study indicated that there were two owner factors (change orders and inspections), two design factors (changes in drawings and incomplete documents) and one external factor (building permit approval). The results of that research did not indicate that contractor factors were an issue. The factors were primarily focused on owner and design factors. In that way, the two studies differed.

The study conducted in Turkey (Gunduz et al, 2012) provided results that were very similar to the current study. The Turkey study indicated that the contractor factors were the primary concern. It also indicated there were three contractor factors (inadequate contractor experience, ineffective project planning and scheduling, and poor site management and supervision) with only one design factor in the top four factors cited. Further investigation into the top factors cited in the Turkey study shows that the top four categories were: contractor related, owner related, consultant related and design related. With the exception of the consultant related factors, these results mirror the results of the current study. The study conducted in Turkey also addressed the least important factors. The results of that study indicate that there were four categories that were primarily found in the least important factors. Those categories were: external, labor, project, and material. Similarly, the current study primarily included the same factors, with the addition of the equipment category. When compared to the previously cited international studies, it is noted that the results are also comparable. The primary difference is that the international studies added the labor and material categories to their most significant factors. This is indicated by the inclusion of factors, which include: resource shortages, poor labor productivity, shortage of materials and labor shortage. These factors do not appear to be of concern within the Savannah District study. This is

logical given the availability of labor, material and resources within the Savannah District. The studies also provided comparable data with respect to the most significant factors. This is illustrated by the inclusion of the following significant factors from the international studies in each category listed, which correlate closely to the results of this study.

- Contractor Factors: ineffective project planning and scheduling, poor site management and supervision, inadequate experience, inadequate planning, and subcontractor schedules
- Owner Factors: slow decision making, client initiated changes
- Design Factors: design changes, design errors and necessary variation of works

Our results show that the contractor and USACE representatives had differing causes within their most significant factors. USACE representatives compiled a list of eleven significant factors, with five of those factors being contractor related. Conversely, the contractor personnel had only one of their top nine factors being contractor related. This indicates a disconnection associated with identifying the responsible party when it comes to analyzing a construction delay. In order for a project to be successful, all parties must work together in order to achieve a common goal. It appears that the personnel surveyed have not fully embraced this theory and are content with working on “separate sides of the fence”. Collaboration has been made easier and more convenient given the advances in construction technology. But, if the parties are not willing to work together, those advances are rendered useless.

6. Recommendations

There appears to be an “us against them” mentality on both parties’ part. But, in order to properly collaborate and ensure a successful project, all parties must work together. USACE has tried to alleviate this type of situation through the utilization of partnering sessions. The questionnaires did not address whether or not partnering had been conducted on their projects, or if it had been successful. Assuming that partnering had been done on at least a portion of the contracts that each of the respondents worked on, the questionnaire results indicate that partnering sessions alone are not enough for the parties to get together and work toward a common goal. The primary item that needs to be addressed in order to ensure construction delays are kept to a minimum is to develop a collaborative and teaming environment in which all parties work together toward achieving a common goal. This should be investigated to determine if there are strides that are being made in the private industry that can be adopted by the US Army Corps of Engineers in order to develop a strong teaming environment with their contractor partners. There is another key player that should be included in any future investigations into construction delays. This investigation sought input from contractors and USACE employees (owner), but did not solicit input from designers. Designers are a key factor when investigating construction delays. While they do not have as much control over the construction phase, it is imperative for the design to be adequate in order to mitigate construction delays. Future research should include this valuable member of the team.

7. References

- Ahmed, S.M., Azhar, S., Kappagantula, P. and Gollapudi, D. (2002). “Delays in Construction: A Brief Study of the Florida Construction Industry”. *ASC Proceedings of 39th Annual Conference*, 257-266.
- Bubshait, A. and Cunningham, M.J. (1998). “Comparison of Delay Analysis Methodologies.” *Journal of Construction Engineering and Management* 124(4), 315-322.
- Gunduz, M., Nielson, Y., and Ozdemir, M. (2012). “Quantification of Delay Factors by Using Relative Importance Index (RII) Method for Construction of Projects in Turkey”. Accepted manuscript by the American Society of Civil Engineers.
- Ndekugri, I., Braimah, N. and Gameson, R. (2008). “Delay Analysis within Construction Contracting Organizations.” *Journal of Construction Engineering and Management* 134(9), 692-700.
- Shi, J., Jingsheng, Cheung, S.O., and Arditi, D. (2001). “Construction Delay Computation Method.”

Journal of Construction Engineering and Management 127(1), 60-65.
US Army Corps of Engineers. (2012). *Contract Administration Manual for Construction Contracts*
(SADDM 1110-1-1).