EPiC Series in Built Environment
Volume 4, 2023, Pages 336–344
Proceedings of 59th Annual Associated Schools of Construction International Conference

USACE Southwestern Division: Construction Durations for Military Vertical Projects

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Delays with project completion and turnover is a global problem affecting construction and industry partners in many areas. These delays impact both planning and budgeting which are serious concerns for all stakeholders involved and difficult to resolve and overcome. The focus of this research paper is limited to only Military vertical construction projects executed by the Fort Worth District and specifically, the analysis of their associated construction durations. Construction performance data from the United States Army Corp of Engineers (USACE) SWF Primavera Project (P2) database was utilized in this study. The raw dataset covered the period of 2003 to 2021 and included a total of 4,435 projects. This dataset was reduced down to focus only on the 173 Military vertical construction projects executed by the USACE Fort Worth District and completed between the years of 2006 and 2020. The results of this research provide the USACE Project Delivery Team a better understanding of lessons learned and utilization of a more accurate method for establishing construction project durations for USACE projects.

Key Words: Construction duration, Period of Performance, Schedule, Military construction, Schedule delays

Introduction

Delays with project completion and turnover is a global problem affecting construction and industry partners in many areas. These delays impact both planning and budgeting which are serious concerns for all stakeholders involved and difficult to resolve and overcome. The competitive nature of the construction industry exerts pressure on contractors to keep project durations and costs as low as possible but the contract duration set by the client may not always be realistic and often result in delays to the project completion and added costs to the project.

Construction projects in general are full of uncertainties, including weather, labor skills, site conditions, and management quality which all have the potential to impact the construction duration of the project. Accurately estimating the period of performance or duration of a construction project represents a critical factor for both the contractor and the stakeholder as well as the feasibility of the project. Currently within the Fort Worth District, there is not an established methodology or processes for estimating and establishing the planned construction period of performance or construction duration for a construction project.

The U.S. Army Corps of Engineers (USACE), Southwestern Division's (SWD) Military Mission spans four states: Texas, Louisiana, Oklahoma and Arkansas. Nearly one-fifth of the Nation's military activities are located within the Southwestern Division, covering nearly 440,000 square miles. The Division provides engineering, construction and environmental management services for 11 Army and 11 Air Force installations. They design and manage construction of new facilities, rehabilitate older facilities, and assist with installations' engineering challenges. The mission of the USACE SWD is to ensure soldiers have the best facilities possible for readiness andy training exercises and that they and their families are afforded an enhanced quality of life while serving our country (*Southwestern Division, U.S. Army Corps of Engineers*, n.d.).

The Southwestern Division has four District Offices located in Fort Worth, Texas; Galveston, Texas; Tulsa, Oklahoma; and Little Rock, Arkansas with the Fort Worth District office having the largest Military construction program of the four. The mission of districts is to ensure successful planning, programming, design, construction, maintenance and repair, and financial management for the facilities and real property located at their associated installations.

The focus of this research paper is limited to only Military vertical construction projects executed by the Fort Worth District and specifically, the analysis of their associated construction durations. In general, construction projects are
full of uncertainties, including weather, labor skills, site conditions, and management quality that all can impact the construction duration of a project. Delays in construction projects, cost overruns and quality level issues have long been common problems in the construction and engineering sector (Larsen et al., 2016). The recent onset of the COVID pandemic that began in March 2020 and subsequent challenges with material and labor availability has added additional complexities to the art of estimating construction project durations. In the article, *Early Impacts of the COVID-19 Pandemic on the United States Construction Industry*, published in 2021 in the International Journal of Environmental Research and Public Health it was noted that "the construction industry experienced a number of adverse effects. These included material delivery delays, shortage of material, permitting delays, lower productivity rates, cash flow-related challenges, project suspension, price escalations, and potential conflicts and disputes." (Alsharef et al., 2021). Of which, many of these effects are still being realized by the construction industry in today's market conditions.

The United States Army Corps of Engineers utilizes the USACE Acquisition Instruction (UAI) manual which establishes uniform policies and procedures to ensure that business practices are consistent throughout USACE. It provides internal guidance, delegations of authority, assignments of responsibilities, procedures that are required by regulation to be established by the Head of the Contracting Activity (HCA), procedures that implement policies, and internal reporting requirements.(*Southwestern Division, U.S. Army Corps of Engineers*, n.d.). In addition to the UAI, the agency adheres to the Federal Acquisition Regulation (FAR), the Defense Federal Acquisition Regulation Supplement (DFARS), the Army Federal Acquisition Regulation Supplement (AFARS), or higher-level agency regulations in the execution of all contractual acquisitions.

A wide selection of contract types is available to the Government and contractors in order to provide needed flexibility in acquiring the large variety and volume of supplies and services required by agencies. There are many factors that the contracting officer should consider in selecting and negotiating the contract type (*FAR | Acquisition.GOV*, n.d.). Some of which include: price competition, price and cost analysis, type and complexity of the requirement, period of performance, acquisition history, availability of contracting mechanisms and contracting capacity. The contract types are grouped into two broad categories: fixed-price contracts and cost-reimbursement contracts. The typical contract type utilized by the USACE Fort Worth District for MILCON vertical construction projects is the fixed-price contract. A firm-fixed-price contract provides for a price that is not subject to any adjustment on the basis of the contractor's cost experience in performing the contract. This contract type places upon the contractor maximum risk and full responsibility for all costs and resulting profit or loss. It provides maximum incentive for the contractor to control costs and perform effectively and imposes a minimum administrative burden upon the contracting parties (*FAR | Acquisition.GOV*, n.d.). There are additional variations of this contract type that are available to the contracting officer but the basic firm-fixed-price contract type is the most utilized type by the USACE Fort Worth district for Military vertical construction projects. Within that type/category of contracts, the acquisition tools available and typically utilized by the district for MILCON construction projects include the following acquisition strategies: Design-Bid-Build, Design-Build, and Multiple Award Task Order Contract (MATOC) Task Order:

- The Design-Bid-Build acquisition strategy is a project delivery method in which the agency or owner contracts with separate entities for the design and construction of a project. The project design may be completed with in-house resources or by a separate contracting action for an Architect-Engineer to complete the design. Design-Bid-Build is considered the traditional method for project delivery.

- The Design-Build acquisition strategy employs an alternate acquisition strategy that shifts the majority of the risk to the construction contractor as they have full responsible for both the design and the construction of the project. With this acquisition strategy, the RFP includes a conceptual design (typically to ~35% design level) along with a scope of work that defines the mandatory performance requirements of the facility.

- The MATOC acquisition strategy is a combined variation of the DBB and DB acquisition strategies and is of advantage with decreased acquisition time due to the 'pre-selection' process of establishing a qualified pool of contractors for the type of project being solicitated, already being completed.

Research Objective

The accurate prediction for the period of performance or duration of a construction project represents a critical factor for both the contractor and the stakeholder as well as the feasibility of the project. This research paper studies the estimation and establishment of construction performance periods verses the actual time to complete the project for USACE Military vertical construction projects within Southwestern Division (SWD) of the U.S. Army Corps of Engineers. The focus of this research paper is limited to only Military vertical construction projects executed by the Fort Worth District and specifically, the analysis of their associated original or planned construction durations verses their actual time required to complete the projects.

One of the key mission goals of USACE is to *"Delivery What You Promise*". This sounds a lot easier than reality allows. As discussed earlier, construction projects are full of uncertainties, including weather, labor skills, site conditions, and management quality that all can impact the construction duration of a project. Delays in construction projects, cost overruns and quality level issues have long been common problems in the construction and engineering sector (Larsen et al., 2016). The goal of this research is to find applicable lessons learned from both Government and Industry partners and improve upon established processes in order to advance estimating methods for construction project durations for USACE Military vertical construction projects within Southwestern Division and more specifically for the Fort Worth District. This information would provide the Project Delivery Team a better understanding to lessons learned and utilization of a more accurate method for establishing construction project durations in order to improve project delivery and ultimately improve the organizational reputation by delivering projects as planned and promised.

Background and Literature Review

Various studies produced for the Government have highlighted poor prediction of client costs and construction duration period as key problems for the construction sector. Construction projects are widely seen as unpredictable in terms of delivery on time, within budget and to the standards of quality expected (Burrows et al., 2005). Construction projects in general are full of uncertainties, including weather, labor skills, site conditions, and management quality which all have the potential to impact the construction duration of the project.

Two critical performance indicators for any construction project are cost and duration. The construction contract cost and contract period of performance are often considered to be interconnected with impacts to one resulting with impacts to the other. Extensive research has proposed mathematical models to predict construction project durations based on regression analysis, Monte Carlo method (MCM), and the such. Yet regression analysis alone cannot capture the uncertainties within project execution and durations (Nguyen et al., 2013). Despite the close relationship between construction cost and duration, they are usually deemed as two contradictory objectives that need to be traded off in project management (Xiao et al., 2018). Various factors contribute to construction performance, including project complexity, financial considerations, political conditions, and market environments. Some are difficult to quantify because of the limited amount of data available (particularly at the early stage of construction), while other factors are difficult to incorporate due to limited knowledge of their explanatory relations, such as project communication and team hierarchical diversity. Consequently, predicting construction cost and duration is surrounded by considerable uncertainty; even the performance of projects with an identical design still differ because of these uncertainties (Xiao et al., 2018).

Contrary to cost overrun, the definition of time overrun is clearly articulated in literature. The most commonly used definition is the delay in time either beyond the agreed contract deadline or beyond the date the parties have agreed upon for the delivery of a project (O’Brien, 1976) or stated another way, a time overrun is an act or event that extends the time to perform the task beyond the agreed contract deadline. The level of success after project completion is not only based on time- and cost-based empirical criteria, but is also an individual weighing of time, cost and quality (Larsen et al., 2016) along with the level of customer satisfaction with the final product.

Walt Lipke developed a practice called earned schedule (ES) that results in time-based schedule performance metrics. These metrics are derived from standard earned value (EV) cost data. ES metrics are more intuitive in measuring schedule progress and more accurate in predicting schedule completion, than those of the limiting EV schedule metrics. A reality is that many schedules are not completely, if at all, resource/cost loaded. This creates a situation where ES or EV metrics can lead to questionable outcomes or cannot be used at all. Schedule activity duration data, however, is or should be readily available in all schedules (Crew, 2009).

In regards to contract changes and in terms of work execution, General Contractor project managers tend to keep two schedules: one for USACE to show no changes, and one for them to implement the items necessary to complete the changes and stay on schedule. This conflict creates a chance to introduce waste and error in the execution of the project. The intent for the General Contractor is to use the schedule as a management tool verses a reporting device. However, the demand to communicate compensation for unapproved work leads to a variety of schedule approaches by both the USACE and General Contractors (Gannon et al., 2012). According to Viles, et al., 2019, the main causes of construction project delays are problems that occur during execution, administrative problems and labor conflicts. The problems experienced during execution of the construction phase are typically based on unpredictable events, while administrative problems are typically rooted in communication issues and poor cash flow. A further breakdown of the issues experienced during the execution phase of a project relate to changes during construction, poor construction management, construction errors, economic/financial factors, conflict/personality clashes and lack of experience. (Viles et al., 2019).

The COVID pandemic which began in March 2020 added additional complexities to the art of estimating construction project durations due to challenges with construction materials, construction supply chain, contract administration, construction project management, changes to the working environment, health and safety management and the finances of construction organizations and individual employees of the construction industry (Ogunnusi et al., 2021).

Research Methodology

Construction performance data from the USACE SWF Primavera Project (P2) database was used in this study. The dataset covered the period of 2003 to 2021 and included a total of 4,435 projects. This dataset was reduced down to focus only the 173 Military vertical construction projects executed by the USACE Fort Worth District and completed between the years of 2006 and 2020. The detailed dataset was established as follows:

- The study is based on 173 construction projects completed within the USACE Fort Worth District Area of Responsibility (AOR) between 2006 and 2020.
- New construction and infrastructure projects were included.
- All acquisition types were considered i.e. no projects were eliminated from the dataset based on acquisition type.
- Projects for which some of the project variables were missing were excluded.
- Refurbishment, and repair and maintenance projects were excluded.
- Projects with significant changes to scope of work or uncontrollable delays were reviewed and potentially eliminated from the dataset.

Building construction duration was defined as the period of time between the date of the construction contract notice to proceed and the date of substantial completion. The original or estimated period of performance (PoP) or estimated construction duration was established as the difference between the original contract required completion (CRCD) date and the actual notice to proceed (NTP) date. [PoP = CRCD – NTP]. The actual period of performance or actual construction duration was established as the difference between the actual construction contract completion (CCD) date and the actual notice to proceed date (NTP). [Actual PoP = CCD – NTP].

The data from SWD USACE Information Systems database was analyzed and reduced down to 173 Military vertical construction projects specific to the Fort Worth District. The programmed amount of the projects ranged from ~$1M to $630M. The constructed facility types included barracks, maintenance facilities, administrative operations facilities, medical facilities, and child care facilities to name a few. Focus group discussions with personnel from Fort Worth District Programs and

Project Management Division and Construction Division were conducted to determine the existing methodology and processes being applied in estimating and establishing the original planned construction period of performance or construction duration for a planned project. The Fort Worth District Small Business Office hosted two Virtual Industry Days showcasing upcoming projects at one of the installations served by the district to engage industry partners and obtain feedback to some of the challenges of today's market and manpower conditions. The first one was on 28 June, 2022 and the second one on 28 July, 2022. The participants included over 100 industry-related partners at each venue with a follow-on Q&A session to gauge industry's input into the challenges with establishing realistic construction durations with recent economical, manpower, and supply issues. The initial feedback was more generalized and limited to typical public concerns with the problems of increased material and labor costs but no real discussion of the solution(s) or how to gauge/apply risks appropriately.

Data Analysis

Results of the focus group discussions with personnel from Fort Worth District Programs and Project Management Division and Construction Division revealed that there was no uniform methodology or processes between district offices with estimating and establishing the planned construction period of performance or construction duration for a planned project. The Project Delivery Team, lead by the project manager typically just utilized previous experience with input from the local construction office and installation personnel to establish the planned construction period of performance.

Construction performance data from the USACE SWF Primavera Project (P2) database was analyzed for 173 Military vertical construction projects completed between the years of 2006 and 2020. The programmed amount of the projects ranged from ~$1M to $630M. The constructed facility types included barracks, maintenance facilities, administrative operations facilities, medical facilities, and child care facilities to name a few. The projects that had significant scope changes and/or contractual modifications were removed from the data set to remove any outliers from the analysis. The original or estimated period of performance (PoP) or estimated construction duration was established as the difference between the original contract required completion (CRCD) date and the actual notice to proceed (NTP) date. [PoP = CRCD – NTP]. The actual period of performance or actual construction duration was established as the difference between the actual construction contract completion (CCD) date and the actual notice to proceed date (NTP). [Actual PoP = CCD – NTP].

Figure 2 displays the actual construction duration verses the predicted construction duration for the MILCON vertical construction projects analyzed from the USACE SWF P2 database. The original construction durations and actual construction durations were calculated from established contractual dates and analyzed for time growth for 173 projects. Figure 3 displays the time growth for these same projects.

The analysis of time growth for the 173 projects resulted with an average of an additional 282 days being added to the construction duration. Of the project data analyzed, ten (10) of the projects completed ahead of schedule (early), three (3) of the projects completed on time as originally scheduled (on time), and 160 projects completed behind schedule (late).

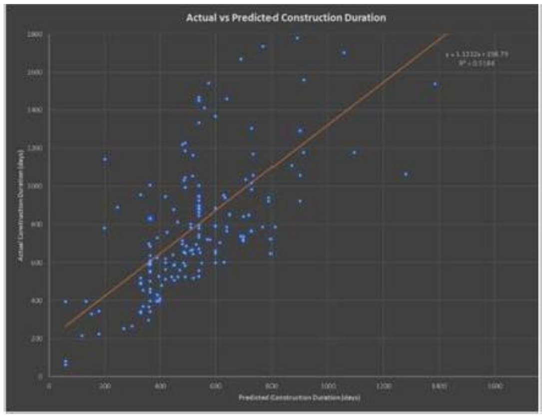

Figure 2. Actual vs Predicted Construction Duration

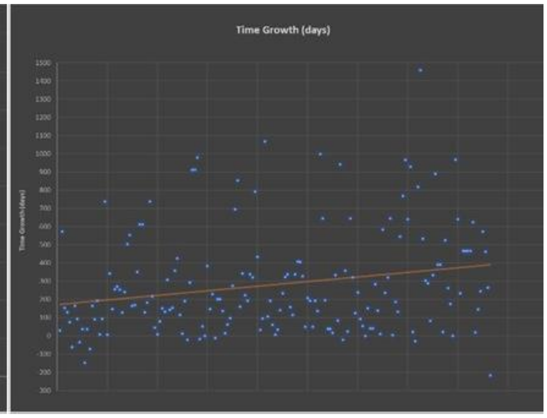

Figure 3. Construction Time Growth of MILCON Projects within Ft. Worth District

No. of Projects	Location	Avg. Time Growth (days)	% Total Projects	% Total Time Growth	PA ($M)
1	Camp Bullis	31	0.58	0.06	1.6
2	Corpus Christi Army Depot	363	1.16	1.49	25.1
2	Dyess AFB, TX	103	1.16	0.42	25.0
19	Fort Bliss	123	10.98	4.78	875.5
44	Fort Hood	260	25.43	23.49	1,834.5
17	Fort Polk	366	9.83	12.77	188.4
5	Fort Sam Houston	95	2.89	0.98	57.6
7	Goodfellow Air Force Base	298	4.05	4.28	92.9
58	Joint Base San Antonio	327	33.53	38.87	3,443.2
3	Lackland Air Force Base	146	1.73	0.90	71.7
8	Laughlin Air Force Base	542	4.62	8.90	24.6
1	Randolph Air Force Base	19	0.58	0.04	36.0
6	Red River Army Depot	246	3.47	3.03	192.3
173	**Total No. of Projects**				

The project construction durations were also analyzed based on location or Area of Responsibility (AOR). As noted above, the average time growth across the projects analyzed for the district was the addition of 282 days to the construction duration. The analysis of the individual installations revealed that five (5) of the 13 installations were above the average time growth for the district, with the top two culprits being Fort Hood and Joint Base San Antonio. Although, as would be expected due to the fact that these two installations had the majority (>50%) based on the number of projects analyzed and over 76% of total costs for all projects. Reference Appendix A and Appendix B for detail charts and analysis associated with each of the below noted areas of responsibility. For example, referencing the below table and charts in Appendix A, we see that the average time growth for the projects analyzed at Fort Hood, Joint Base San Antonio, and Fort Polk were 260 days, 327 days, and 366 days, respectfully. Also, with reference to the pie charts in Appendix B, you can see that the light blue wedge of the pie represents projects at Fort Hood, which had 44 of the total projects analyzed or 25% of the total but only had 23% of the overall total time growth. The dark grey piece on the left side of the pie charts represents Joint Base San Antonio which had 58 projects or 33% of the total projects but actually carries 39% of the total time growth. The green wedge of the two pie charts to the bottom right represents Fort Polk which had 17 of the projects analyzed or 10% of the total projects analyzed and accounted for 13% of the total time growth. The breakdown by installation or AOR was analyzed as shown in the below table.

Figure 4 contains the additional data of the programmed amount ($M) associated with each project that was reviewed but there was no real correlation or indication discovered that the cost of the project had any impact to the associated time growth of that project.

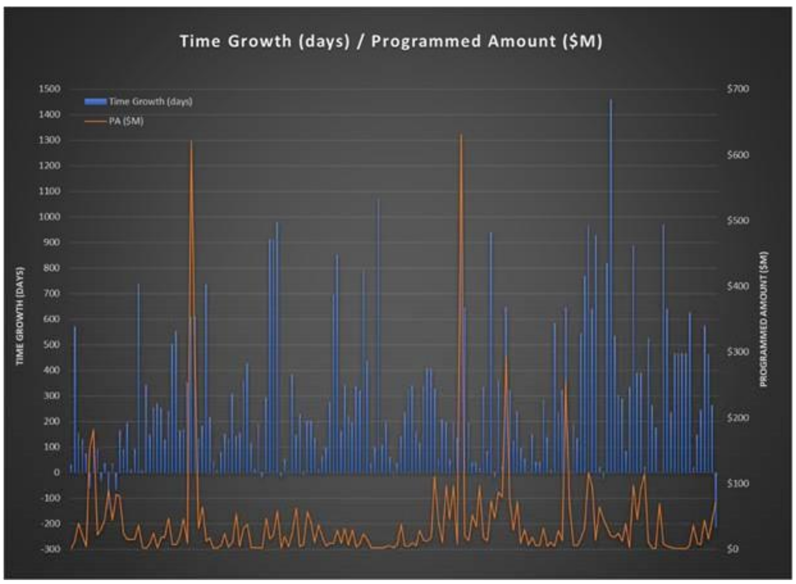

Figure 4. Construction Time Growth (days) and Programmed Amount ($M)

Conclusions and Future Research

Construction projects in general are full of uncertainties, including weather, labor skills, site conditions, and management quality which all have the potential to impact the construction duration of the project. There are many variables to this equation and there is no right or wrong answer to this question. One can only apply knowledge and experience in order to formulate an educated prediction based on conditions at the time of project solicitation / award. Based on the results of this analysis, industry input, and focus group discussions it is recommended that the Project Delivery Team apply historical lessons learned from projects with similar magnitude and complexities along with the knowledge of parameters within the area of project execution be considered and applied when establishing and estimating the construction duration for any construction project.

The impacts to the construction industry imposed by the COVID pandemic of 2020-2021 are still be realized today through labor and material shortages as well as continued supply chain delays. Of which, the impacts to project durations for MILCON vertical construction projects have not yet fully been realized. In view of the enormity of influence that the COVID pandemic had on the global construction industry, there is a need for further investigation into the impacts experienced and future implications to the construction industry. Additionally, further analysis of data related to the contract type, project location, local subcontractor/manpower availability, and geographic area may further enhance the accuracy with establishing construction project durations within a more acceptable field of error.

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