

## **STUDY OF THE SUBMITTAL PROCESS USING LEAN PRODUCTION PRINCIPLES**

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### **Abstract**

*In the Architecture, Construction and Engineering (AEC) industry office activities link the information flows from project teams and the production processes on the field. Despite their importance to the overall project, office activities have been overlooked and several authors point out that they are often mismanaged, lack planning, or are buffered to account for the great amount of variability within processes developed at the office level, eventually resulting on site inefficiencies and cost overruns. This paper presents a study of the submittal process through the use of Lean Thinking. Submittals are documents exchanged between the general contractors, subcontractors, the project architect and its team of designers and consultants. Submittals carry information about products and processes used to deliver a project, and are submitted from the parties constructing the project, or supplying materials to it, to the designers so that the submitted information can be checked for conformance to project specifications. The study shows that for the project investigated the submittal process lacked transparency, had low workflow predictability, and showed low levels of reliability. The study concludes that the submittal process can be streamlined by enhancing communication and information sharing amongst stakeholders, through the understanding of the causes of variation in lead times and the understanding of participants' needs.*

**Keywords:** lean construction, lean office, submittal process

### **INTRODUCTION**

In the United States like in many other countries in the world the construction industry plays an important role in the country's economy. In the United States, in 2009 alone, the Construction Industry contributed with 4.1% of the US Gross Domestic Product (BEA 2010), and accounted for more than 7.3 million of paid employees (US-Census-Bureau 2010). However, the inefficiencies of the construction industry are well known and include: low productivity rates, poor quality of work (Koskela 1996), cost overruns, delays, constant changes, rework and claims (Gould and Joyce 2009).

Project management in construction is largely based on the traditional (conversion) model that considers that "the conversion processes can be divided into subprocesses, which also are conversion processes" (Koskela 1992, p. 12). For example, cost estimates are based on data gathered from previous projects and follow a work breakdown structure (WBS), i.e., a

hierarchical division of work in smaller parts, in which the unit cost of each major process (e.g., structure) is the sum of the cost of each subprocess (e.g., formwork, reinforcing steel, placing concrete). In these estimates, the flow aspects of the process (moving materials, inspections, waiting times) are not explicitly considered and accounted for and only the transformation tasks are tracked. As a consequence the focus of construction project management, based on the traditional model, lays in assuring that each subprocess performs as productively as possible, which does not necessarily translate in the best performance for the entire project. The sum of the local optimums in each subprocess does not equal the optimum of the entire process.

The use of Lean Production concepts, principles, and tools applied to construction production processes (e.g., activities developed on site) has proven to be possible and result in notable improvements in the performance of construction project (e.g., Kemmer et al. 2010; Schramm et al. 2009; Matt 2008; Howell and Ballard 1996). In spite of considerable success of the referenced studies, not much has been done regarding administrative processes of office-related activities in construction (Kemmer et al. 2009), notwithstanding the importance of these processes in any construction project.

Lean Thinking applied to nonproductive processes is termed Lean Office. In the office environment two main types of demand can be defined within an administrative system: value demand and failure demand. Value demand is the demand for the service that the system is set to provide, or in other words, what the client wants. Failure demand is the demand that results from “the failure to do something or to do something right to the client” in the first pass (Seddon 2008, p.32).

Office related activities support the work of construction teams working on site and without office activities production processes cannot occur because people have to be hired, paperwork has to be processed, bills have to be paid, and information has to be made available. Besides their importance to support the overall performance of the project, some office related activities are often performed by highly trained and skilled workers, such as Professional Engineers, representing a significant part of the overhead cost of the projects and therefore of the overall cost of each project (Kim and Ballard 2002).

Some of the administrative processes in construction projects are related to the constant exchange of information between the intervening teams in the project (Atkins and Simpson 2008). These teams are responsible for two major processes in construction projects identified by Koskela as the design process and the construction process (Koskela 1992). The purpose of this exchange of information is to first ensure that the designers’ intentions and requirements are implemented and second to record decisions of what happens on site in order to allow post-construction investigation (Mays and Novitski 1997).

Amongst the office activities, the submittal process deserves attention as it is one of the processes used to exchange information between the design team and the construction team. The submittals are documents that are prepared by the construction team and contain detailed dimensions, types of materials and equipment, and illustrate application conditions, allowing a determination of how interfaces with other products and systems should be dealt with during the construction phase (Atkins and Simpson 2008).

## **THE SUBMITTAL PROCESS**

During the construction phase, the general contractor (GC) and the subcontractors (Subs) work with suppliers to define and detail the products that will be used to satisfy the specifications set forth by the Architects and Engineers (A/E) of the design team. These documents containing product information (e.g., shop drawings, samples, and product data discussed later in this paper) are then sent to the architect and project consultants for review and approval. Each group of documents related to a specific item of the project (e.g., specifications for the concrete mix, product samples related to the flooring) sent by the GC is called a submittal. The process of preparing, submitting and all the intermediate steps until the approval of the submittal is called the submittal process.

The submittals may include different types of documents such as shop drawings, product data, samples, reports, manuals, and warranties. Even though some of these documents are sent to the design team only to be part of the project's record, the majority of these documents, particularly shop drawings, samples, and product data, need to be approved by the design team before installed or built in the project (Atkins and Simpson 2008; Gould and Joyce 2009). Shop drawings are the working documents, detailed and precise, that represent every component of the project, method of assembly, and materials to be used. Product data presents information about products and may be required either as supplements to shop drawings or to ensure that the products meet the required standards. Product data may include illustrations of the product, brochures, and information about the product's performance. Samples show the characteristics of a specific material and are often required to show colors and finishes (Gould and Joyce 2009; AIA 2007; EJCDC 2007).

## **RESEARCH METHOD**

This paper presents the results of a pilot case study that was part of a broader research project. The research work was carried out in two construction companies, based in San Diego/CA, and identified as Company A and Company B. Both companies independently pointed out to the submittal process when inquired about which process should be investigated as part of a study on office activities.

Case studies were used as a strategy to collect and analyze the empirical data. This research approach, as suggested by Yin (1994), concerns the study of contemporaneous events that cannot be manipulated in their environment.

According to Yin, case studies have the advantage of covering contextual conditions, relying on several types of evidence such as documents, interviews, observation, physical artifacts, and archival records (Yin 1994). The study started with two preliminary studies i.e., pilot case study 1 and pilot case study 2, followed by a case study and consequent conclusions and recommendations. This paper only addresses pilot case study 1 carried out at Company A with a brief cross-case analysis for the findings of both studies, due to space limitations.

Company A aimed at improving and standardizing its submittal processes based on the performance of one of its best teams assigned to a starting construction project. In Company A the submittal process was managed on site by the construction team, and according to a top manager of the company (information obtained during a meeting) the aforementioned team ran the process smoothly without major problems, but lacked a streamlined and standardized

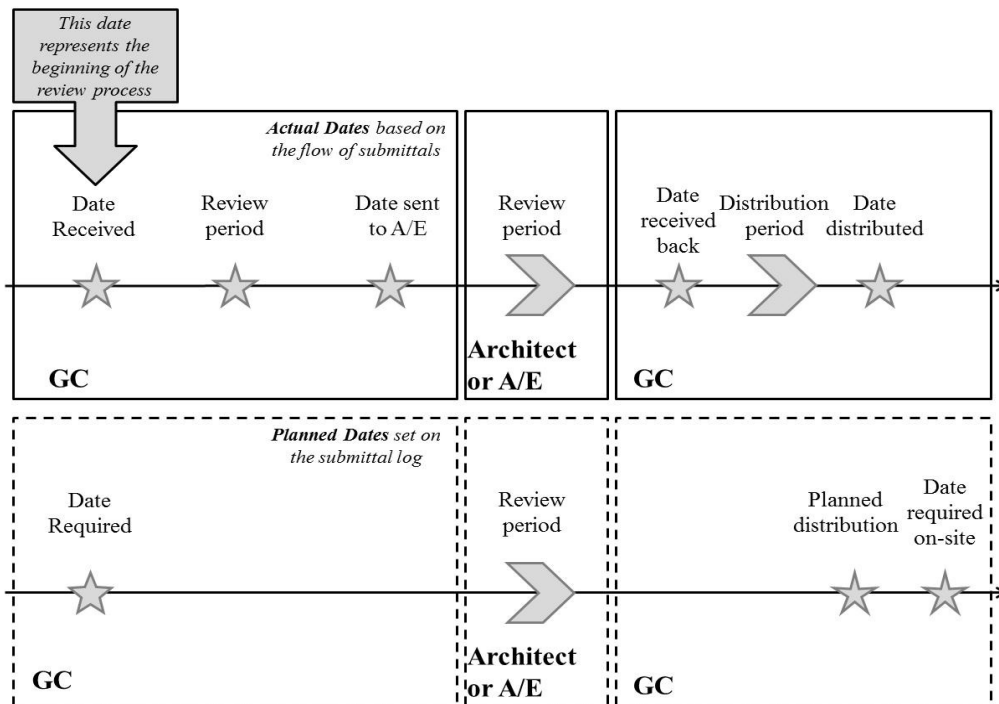
procedure to develop the submittal process. Thus it was the company’s goal to understand what was being done by this team, improve what could be improved on a new project, and standardize this process to implement it companywide.

This pilot case study was conducted on a 12-story building (cast in place concrete, post-tensional slabs, and structural steel roof). This 220,000 sq.ft mixed-use project with 136 apartment units, retail spaces and subterranean parking will support the charity work (feeding the hunger, and providing housing, healthcare, and education to those in need) of a non-profit organization in San Diego, CA. The project had already been delivered to the Owner when the Pilot Case Study started. That said, all the information obtained was related to past events.

A mixed approach (Yin 1994) was used in this research project to simultaneously collect qualitative and quantitative data throughout the research. For the pilot case study cross-sectional quantitative data was provided by the company, which had kept archival records of the submittal process in the form of spreadsheets that were used as a submittal schedule (a.k.a. submittal log). The submittal log contained the record of the process to help manage and control the submittal process. The qualitative data was collected through semi-structured interviews that were performed on a weekly basis with Company A.

**Sources of evidence**

The data collected was categorized herein as: time data (actual and planned), quality data, nominal data, and procedural data. These categories are defined below. Based on the information provided by the company, Figure 1 was drawn to represent the major milestones of the submittal process from the date the submittal was received to the time it was finally distributed to those doing the field work.



**Figure 1:** Data collected.

### *Time data*

Time data includes actual data and planned data. Actual data reflects when an event actually took place (e.g., when a submittal was delivered by a Sub to the GC; when the GC sends a submittal to the A/E). Planned data are dates that were introduced into the submittal log at the beginning of the project (e.g., when a subcontractor was required to deliver a submittal to the GC; when the submittal was planned to be distributed approved to the subcontractor) which reflect the dates when the event happened, and the planned dates that were set in the log at the beginning of the project.

### *Quality data*

The quality data reflected the approval status, i.e., Approved (A), Approved as Noted (AAN), Revise & Resubmit (RR), Rejected (R), and For Record (FR) that was determined in two different phases of the submittal process:

- 1) The GC's review period – during this phase a submittal marked as A, AAN or FR had no or minor notes and was released to the Architect for approval. A submittal marked as RR had major problems and could not be sent to the Architect before revised and resubmitted for the GC's review. A submittal marked as R was no longer needed to be submitted. A submittal marked as FR, was sent to the Architect to add to their files.
- 2) The Architect or the A/E's team review period - during this phase the Architect or the A/E marked "Approved", or AAN, or FR may had minor notes, but was returned to the GC and then to the subcontractor and was good to go. A submittal marked RR had major problems and had to be revised. In these cases the submittal was sent back to the GC and then to the subcontractor to RR, and all review cycle started again until the submittal was "Approved" or AAN. A submittal marked R was no longer needed to be submitted.

Table 1 summarizes the possible status for a submittal and the corresponding meaning for each one.

**Table 1:** *Status of the submittals*

<b>Status</b>	<b>Meaning</b>
<b>A</b>	The submittal is good to go
<b>AAN</b>	The submittal is approved with minor changes and does not need to go through a new cycle of review
<b>RR</b>	The submittal is not ready to go. It is returned to the party who submitted it for a new cycle of review. Once the party revises the submittal and addresses the comments on the submittal, a new round of review is started again. This loop may continue until all comments are addressed
<b>R</b>	The submittal is no longer required (as a result of a change order, for example)
<b>FR</b>	The submittal does not need approval, but will make part of the construction documents.

### *Nominal data*

The nominal data reflected the type of submittal delivered for approval (e.g., shop drawings, samples, or product data).

### *Procedural data*

The procedural data reflected the party responsible for the approval of the submittal, (e.g., Architect, Structural Engineer).

### **Data analysis**

The data analysis was focused on review cycle times i.e., how often a part or a product actually is completed by a process, as timed by observation (LEI 2008), approval status, and variability within those indicators. In an attempt to identify patterns, and following the indication of the Project Manager (PM) of the construction team assigned to the project, the data was first analyzed for the entire process and then analyzed separately by variables within each category: quality, nominal, and procedural.

The findings of the pilot case study were presented to the GC's construction team who provided some comments which were later addressed in the analysis of the pilot study.

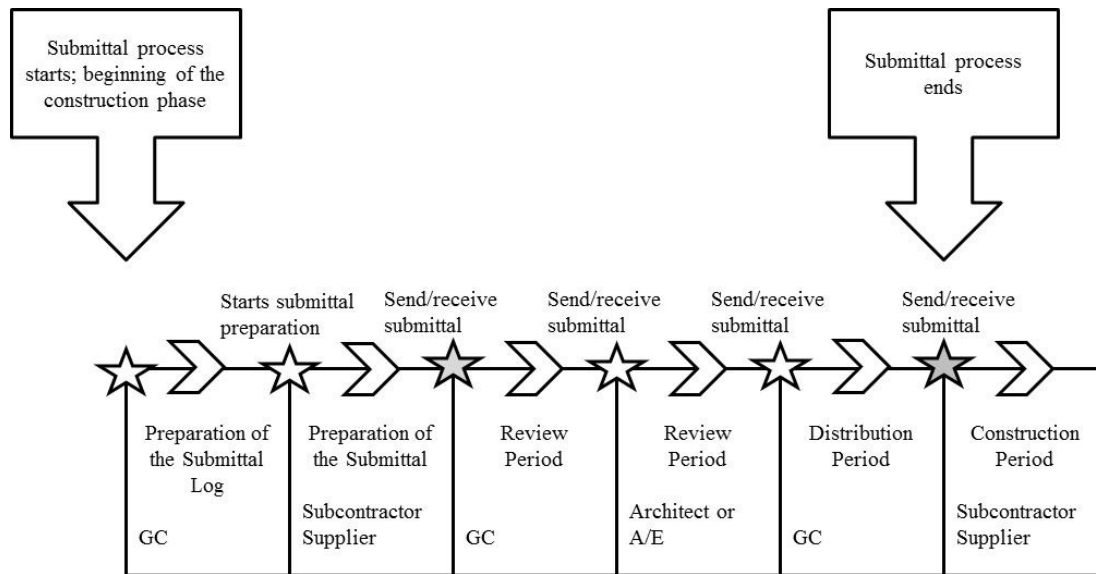
## **RESULTS**

According to the information provided by Company A's informants, the submittal process for this pilot case study started when the GC prepared the submittal schedule (or submittal log), where the specification sections, due dates, and responsible parties were represented. For this project, as in many others where there is no contractual relationship between the subcontractors (and suppliers and fabricators) and the owner, the subcontractors submitted the submittals to the GC for approval. Then, ideally, the GC reviewed each submittal, approved it, and sent it to: a) the Architect who also reviewed it, approved it, and sent it back to the GC; or b) to the A/E, then the architect received the submittal, sent it to the respective consultant for review, the consultant approved it, and sent it back to the Architect, who then reviewed it once again, approved it, and sent it back to the GC. Once the A/E reviews were completed and the submittals approved, the GC would send the submittal back to the respective contractor. Figure 2 illustrates a desirable timeline for the submittal process as described. The shaded stars correspond to the due dates that were set by the PE on the submittal log (SL) at the beginning of the construction phase.

For this case, the SL was built on an excel spreadsheet and contained different types of information. The SL listed all the submittals required that were indicated in the specification book for the project, and key information such as: Architect or A/E allowed review time; the estimated delivery lead time (estimated time to deliver a product or service once the subcontractor received the approved submittal), the due date each submittal was required to be submitted, and the date the submittal was required on site.

The submittal review process would start once a subcontractor sent a submittal to the GC for review. In an interview, the PE stated that during this period (ideally 3 to 5 days) the GC's construction team assigned to the project verified that what was submitted matched the plans and specifications. This verification was done to ensure that no time was wasted by sending an incorrect or incomplete submittal to the Architect.

During the review process, the GC's construction team would define a category for each submittal. The possible categories for this project were: 1) A; 2) AAN; 3) RR; 4) R; and 5) FR (see Table 1).



**Figure 2:** Desirable Submittal Process Timeline.

Once the submittal was sent to the Architect, a new review loop started. The review was done either exclusively by the Architect or with the help of consultants. Ideally, the Architect and/or the A/E had 14 days to review the submittal (in some cases depending on its complexity, different times were set for this review). Once the Architect or the A/E review was complete, the submittal was sent back to the GC, who in turn distributed it to the subcontractors. Ideally the GC released the submittal within 3 days.

Provided that the A/E stamped the submittal A or AAN, the subcontractors were not required to resubmit the submittal. In some odd cases even though the submittal was categorized as AAN the submittal had so many notes and corrections that the subcontractor was asked to submit a clean copy FR. In an interview, the PM's team informed the research team that the project for which the data was analyzed pertained to a project that had a smooth submittal process with no major problems. Ultimately, the submittals were delivered on site in a timely fashion, which is what the team considered important.

### **Data analysis**

The indicators for this pilot case study were categorized into two groups: 1) time indicators, which include cycle times, and lead times, i.e., the time it takes one piece to move all the way through a process, from start to finish (LEI 2008); and 2) quality indicators, which include the relative percentage of submittals set as A, AAN, RR, R, and FR. Table 2 lists and defines those indicators.

The analysis of the data presented herein followed the indications of the PM's team. In an interview, the PM informed the research team of the estimated lead times including a breakdown of the estimated lead time (ELT) by participant of the project and estimated cycle time. This information is listed in Table 3. This information includes the cycle times (CT) for the GC and A/E reviews, the GC distribution time during the review process, and lead time (LT) for the submittal process as described by the PM's team. The values listed in Table 3 were obtained solely based on the PM's team expert judgment.

**Table 2: Indicators**

CATEGORY	INDICATOR	MEANING
<b>Time</b>	GC_CT - GC's Review Cycle Time	Represents the average time a submittal spent at the GC for approval
	A/E_CT - A/E's Review Cycle Time	Represents the average time a submittal spent at the A or A/E for approval
	GCD_CT - GC's Distribution Cycle Time	Represents the average time a submittal spent at the GC to be delivered to the subcontractors
	LT - Lead Time	Represents the average time a submittal spent at the GC and at the A/E for approval and delivery (LT= GC's CT + A/E_CT + GC_DT)
	PLT - Planned Lead Time	Represents the planned total time a submittal spent at the GC and at the A/E for approval and delivery (as set at the beginning of the project on the SL)
	ELT - Estimated Lead Time	Represents the estimated time a submittal spent at the GC and at the A/E for approval and delivery (as described by the PM's team)
<b>Quality</b>	Approval Percentage	Represents the percentage of submittals that were A, AAN, RR, R and FR.

**Table 3: PM's expert judgment estimates for the cycle times and lead time of the submittal process**

	GC	A/E	GC
<b>CT</b>	Review 3 to 5 days	Review 14 days	Distribution 3 days
<b>LT</b>	20 to 22 days		

The PM's team gave the research team access to the actual SL for the pilot case project. Indicators for all submittals were organized by the research team into different types of variables. To begin with, time indicators were analyzed considering the entire project and by each type of variable: quality, nominal, and procedural. After that, the quality indicators (A, AAN and RR) were calculated. Table 4 presents a summary of the results obtained for the time indicators. This analysis was only performed for the variables that were representative of processes that had a PLT of 11 days (93% of the data).

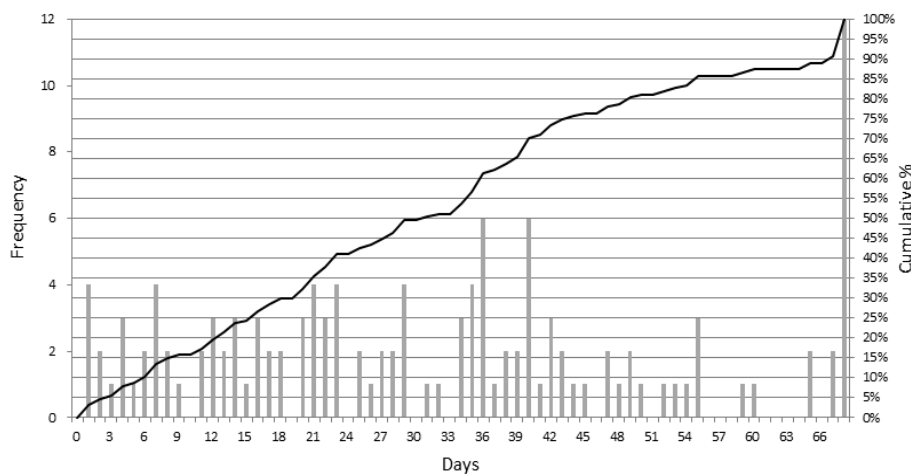
The shaded cells presented in Table 4 are discussed in more detail as they represent data that differs from what was expected by the project team. First of all, the LT (33.1 days) is about 1.5 times higher than the ELT (22 days) and more than three times the PLT (11 days). Next, the submittals spend, on average, more time to be distributed by the GC than to be reviewed by the GC (GCR-CT>GCD-CT). The GC-DT for product data (13.8 days) is about two times the GCT-CT for shop drawings (7.2 days). The submittals AAN took on average six days longer to be returned to the subcontractor than submittals A. Lastly, the LT of submittals sent to the A/E is lower than the LT of submittals sent to the Architect.



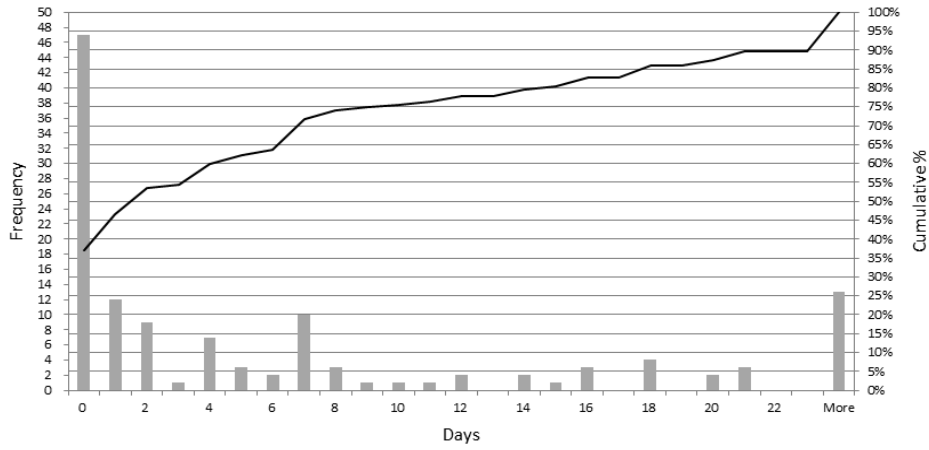
**Table 4: Submittal process: actual cycle times and lead times**

SUBMITTALS		GCR-CT (1) (DAYS)	A/ER-CT (2) (DAYS)	GCD-CT (3) (DAYS)	LT (1)+(2)+(3) (DAYS)	PLT (DAYS)	ELT (DAYS)
Project	Average	7.6	14.8	10.7	33.1	11	22
	Median	2	7	6	31	11	--
<b>Quality</b>							
A	Average	4.8	13.6	11.1	29.4	11	--
	Median	0	8	6	25	11	--
AAN	Average	9.5	15.8	10.7	36	11	--
	Median	3	11.5	6	34.5	11	--
<b>Nominal</b>							
Shop Drawing	Average	6.8	15.3	7.2	27.5	11	--
	Median	2	9	6	20	11	--
Product Data	Average	7.6	15.3	13.8	36.7	11	--
	Median	1	13	6	36	11	--
<b>Procedural</b>							
Submitted to the Architect	Average	10.5	14.8	16.9	42.2	11	--
	Median	1	9	8	36	11	--
Submitted to the A/E	Average	6.6	14.9	8.4	29.9	11	--
	Median	2	10	5.5	26	11	--

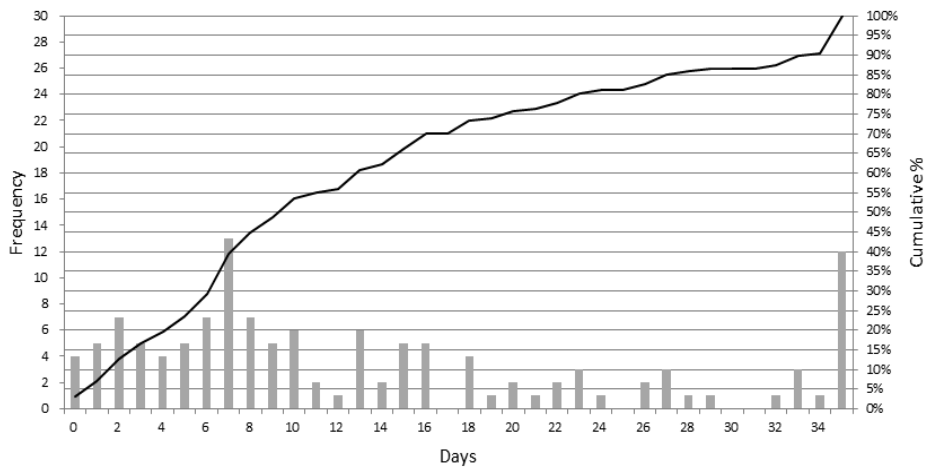
Figures 3 to 6 present charts with histograms for the LT, GCR-CT, A/ER-CT, and GCD-CT, respectively. On the same charts empirical cumulative distribution lines overlay the histograms on a secondary axis. Note that all submittals shown in Figures 3 to 6 had a PLT of 11 days as defined in the SL, corresponding to 139 observations. From the observation of Figure 3, it is clear that there is a great amount of variability in the actual lead time, and the LT numbers are very different from the PLT or even the ELT. The median value of the observed LTs is 31 days (see Table 4), which is quite different than the ELT of 20 to 22 days and only met on 38% of the cases (see Table 3).



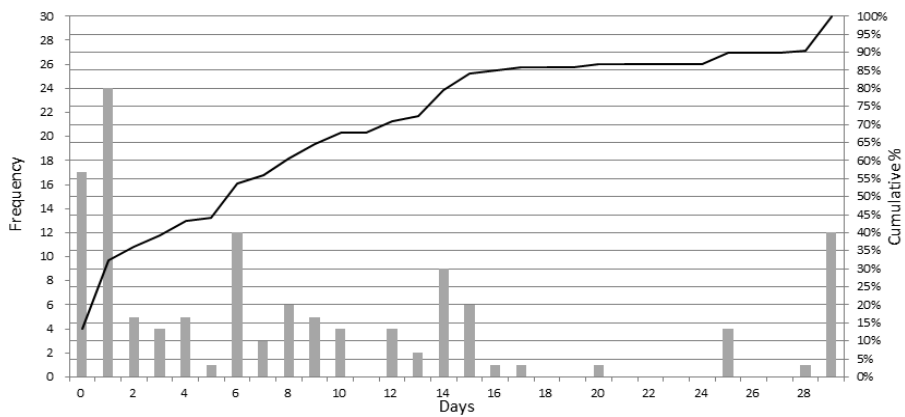
**Figure 3: Submittal process actual lead time.**



**Figure 4:** General Contractor's actual review cycle time.



**Figure 5:** A/E actual review cycle time.

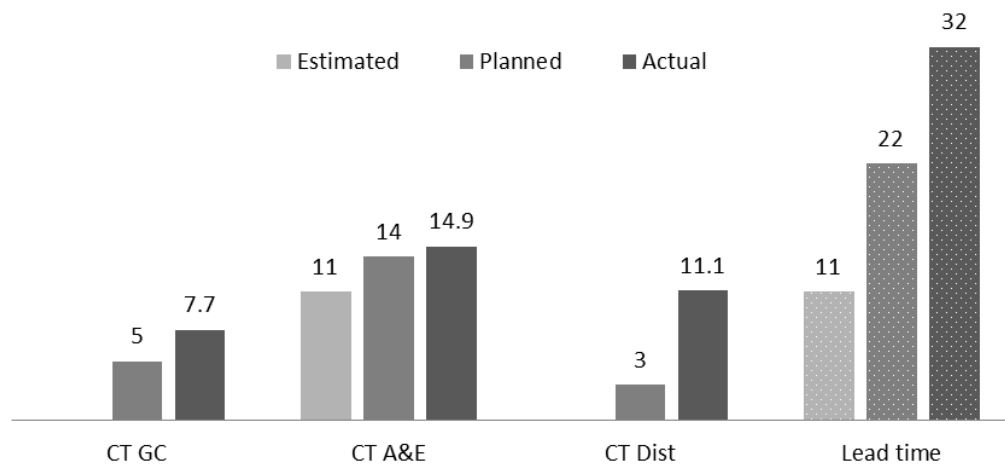


**Figure 6:** General Contractor's actual distribution cycle time.

Figure 4, which reports the GC review time, also shows great variability. However, the median value of about 1.5 days that may be observed from this figure is actually less than the estimated values of the 3 to 5 days reported in Table 4.

Figure 5 shows the A/E review cycle time. From this figure it may be observed that about 62% of the time, the A/E actually meets the estimated deadline of 14 days defined by the PM's team. Naturally, it is worth studying the reasons that lead to having the A/E team exceed the crucial value of 14 days in 38% of the submittals. Figure 6 shows the GC distribution time and it is worth analyzing the facts that lead to 62% of the submittals having a distribution time greater than the estimated distribution time (expected GCD-CT of 3 days).

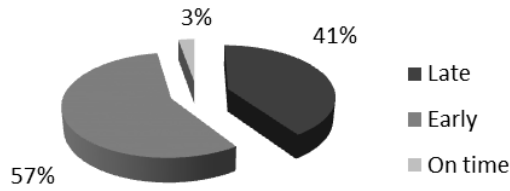
Figure 7 presents a summary of the previous figures and allows a comparison between: planned cycle times and lead times as defined in the submittal log; estimated cycle and lead times, as described by the PM's team; and the actual average of cycle and lead times that were registered on the submittal log.



**Figure 7:** Estimated, planned, and actual average cycle times and lead times.

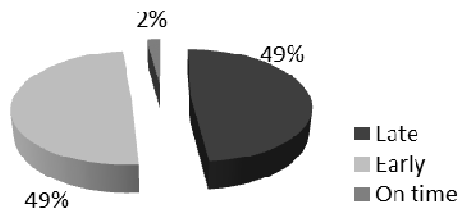
Figure 7 shows that the submittal activities took longer than planned and even longer than estimated. Also it is worth noting that the GC actually took longer to distribute the submittals than to review them. The reasons behind these findings should be analyzed. More importantly, the differences between planned and actual times should be accounted for in the future pre-construction preparation of submittal logs. A possible explanation for the deviations noted are that even though the PM's team acknowledged that they should consider their own review time, as indicated in Table 4, in the SL they did not in fact consider their own review and distribution times in the initial scheduling phase.

Figure 8 presents a chart which shows that in 57% of the time, the subcontractor delivered the submittal earlier than required to the GC, sometimes even much earlier than the due date that was scheduled by the GC. Although this number may not sound alarming, the complement is that 41% of the time the subcontractor delivered the submittals late to the GC as shown in Figure 8.



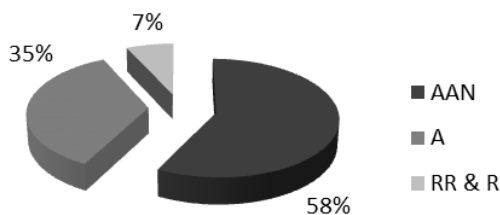
**Figure 8:** Relative portion of submittals submitted by the Subcontractors to the General Contractor on time, earlier, and later than planned in the schedule.

Another important finding was that in 49% of the cases the submittals were distributed late to the subcontractors, as shown in Figure 9.



**Figure 9:** Relative portion of submittals distributed to the Subcontractors on time, earlier, and later than planned in the schedule.

Figure 10 presents a summary of the results obtained for the quality indicator. In this case one can see that the vast majority of submittals after the A/E review were AAN (58%) followed by the submittals A (35%) and the submittals RR & R (7%). The data did not have submittals FR.



**Figure 10:** Relative proportion of submittals status.

### Analysis

In contrast to the PM team’s statements that the submittal process was smooth, the results presented in the previous section seem to indicate otherwise. The submittals were often delivered later than required on site and the lead times for the submittal process seem to be almost unpredictable. For 75% of the submittals the lead time for each submittal approval

took any time between 0 to about 45 days (see Figure 3) to be approved by the GC and the A/E.

The planned lead time did not reflect the estimated lead time, or the actual lead time, for that matter. In fact, the planned lead time was about half of the estimated lead time, and a third of the average lead time of the project. Additionally, the subcontractors pushed the submittals for approval regardless of the real needs of the project. This practice is well documented as impeding the flow of work/information and has been identified as a cause for rework and work in progress, a clear indication of wasteful practices.

The submittal process had different CT and LT for different variables within each type of variables studied. For example, submittals AAN took on average 6 more days to be returned to the subcontractors than submittals A. The submittal log did not account for those differences.

Three unexpected results were obtained. First, despite the PM's indication, the lead time for product data was, on average, 7 days longer than the corresponding lead time for shop drawings. The PM's team of the GC in Company A had indicated that shop drawings were expected to have a longer lead time than product data since they are much more complex and may detail dimensions with low tolerances.

Next, the cycle time for the Architect's review was longer than the cycle time for the A/E review, even though the review by both the A/E adds two more handoffs and a new approval loop to the process. According to the GC, when the submittal has to be sent to the consultants the Architect works on it immediately, suggesting that the Architect is more attentive to monitoring the work of the consultants than his own.

Finally, the cycle time for the GC's distribution was higher than the cycle time for the GC's review. According to the GC this should not occur. Nevertheless, the PM considered that it could be related to the fact that in some cases the Architect use submittals as a way to finish the design, leading to submittals where many notes have to be considered, and eventually leading to change orders.

The analysis of the meaning of the status for the submittals allows categorizing the each status in terms value. Only A and FR represent value added as they deliver value to GC and the Architect and ultimately to the Owner. AAN represents contributory activities as by adding notes to the submittal the GC and the A/E enable the submittals to add value to the process. RR, and R represent represents the failure to prepare the submittal right the first time in terms of what the Architect wants and it is waste. Table 5 summarizes the analyses of the submittal process for this pilot case study in terms of demand and value. The data shows that in 58% of the submittals there was value enabling demand and contributory activities, in 7% waste and failure demand were generated due to the need to rework.

*Table 5: Submittal process: actual cycle times and lead times*

STATUS	MEANING	DEMAND	VALUE
A	The submittal is good to go	Value	Value Added
AAN	The submittal is approved with minor changes and does not need to go through a new cycle of review	Value Enabling	Value Added/Contributory
RR	The submittal is not ready to go. It is returned to the party who submitted it for a new cycle of review. Once the party revises the submittal and addresses the comments on the submittal, a new round of review is started again. This loop may continue until all comments are addressed	Failure	Waste
R	The submittal is no longer required (as a result of a change order, for example)	Failure	Waste
FR	The submittal does not need approval, but will make part of the construction documents.	Value	Value Added

### **Cross Case Analysis**

The two pilot case studies were quite different from each another. The first difference is that Company A's projects are new building construction and building renovations, while Company B's projects are water and waste water infrastructures and treatment facilities. At Company A the submittal process was managed on site by the PM's team assigned to the project. In contrast, Company B managed the submittal process at the main office by an administrative department with different teams assigned to review different Divisions.

Despite the differences in the processes of the two companies, the results were similar: the unpredictability of the cycle time of the Owner introduces great variability to the process, and this variability reduces the reliability of the submittal process. In addition, failure demand is present in both submittal processes and is represented by the high number of submittals that needed to be RR or were R.

### **CONCLUSIONS**

The first conclusion that was drawn from the study is that the submittal log set at the beginning of the construction phase to manage and control the submittal process is in fact a data base used to monitor the performance of the submittal process. This log does not help to manage or plan the process. In fact, because the indicators used to build the log do not reflect the reality, the plan is completely disconnected from what really happens. Additionally, because the log does not allow a visual reading of the real indicators of the process, the submittal log does not help control the submittal process either. The log does not show the flow of information and one cannot manage what is not measured.

In addition, the unpredictability of the cycle times of participants in the process introduce great variability to the process and this variability reduces considerably the reliability of the submittal process.

Finally, through this study, two main types of waste were identified in the submittal process:

- Time waste is reflected as the time spent by the PM's team to set up an inadequate submittal log.

- Rework and failure demand is reflected by the percentage of submittals that were R or RR

As final remarks it is worth noting that:

- The project was delivered via the design-bid-build method
- The project had already been completed when the research team had access to the data
- A limited number of events were observed which do not allow for statistical generalization. Instead, the study can be generalized through the application of a similar research method to similar populations to allow for analytical generalization.

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