Project X

Mid-Atlantic Region, USA

Thesis Proposal

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Executive Summary

Project X, located in the Mid-Atlantic Region of the United States, broke ground June 2013. The building will be utilized as commercial real estate that the owners will lease out to tenants. Project X is a 4 story, 76.5 foot high building, and covering 285,000 square feet. The function of the building has been requested to remain undisclosed due to the nature of work being performed.

As with any construction project three of the most important concerns are time, cost, and safety, but not necessarily in that order. With the functionality of this building relying heavily on electricity, one major concern of the owners was the redundancy of supply of the electrical power supplied to the building. With the need to constantly have a supply of electricity to building, the team of architects, engineers, and contractors were able to address any issues that arose during the construction process. Another important goal during the construction process was energy efficiency that was achieved through obtaining a LEED Gold certification under the LEED rating system for Core and Shell Development as well as becoming Energy Star rated.

Project X was selected to be a project for the Pennsylvania State University Architectural Engineering Thesis project. The purpose of this report is to discuss the preliminary areas of analysis regarding Project X, with initial background research, potential solutions, and expected outcomes. Also there will be one area of research regarding a critical industry issue that came from the PACE Fall Research Roundtable.

Analysis 1

The first area of analysis for Project X will be focused on prefabrication of MEP racks. This has the ability to decrease installation time while also cutting back on the budget. With a decrease in cost and schedule, this is also a safer alternative to the current manufacturing and installation process. The goal of this analysis is to be create a typical prefabricated section of an MEP rack and analyze the ability to maneuver throughout the building and their feasibility in the building.

Analysis 2

The second area of analysis for Project X will center on the mechanical system of the building. As part of the investigation an alternative system, a chilled water system instead of a refrigerant system, would be researched. Looking into the initial cost of the system, constructability of the system and the long term costs of both systems. This will result in a mechanical breadth of analysis of the energy efficiency of the alternative system. The goal of the analysis is to be able to recommend a system that is cost effective as well as time efficient when it comes to the constructability of the system.

Analysis 3

The third area of analysis will look into the redesign of the exterior façade through limiting the amount of glass used. As part of the investigation the cost and energy efficiency will be considered for redesigning the façade to include more of the metal paneling and less of the glass. This will result in a mechanical breadth of analysis looking into the energy efficiency of changing the façade to be more metal panels as compared to more glass. The goal of the analysis is to be able to recommend a system that is cost effective as well as time efficient when it comes to the constructability of the system.

Analysis 4

The forth area of analysis and research will be into the psychology of safety signs. This would look into the different types of signs available, signs that are more graphic or created by children and see if these signs are more effective in grabbing the attentions of people on site and if they are more likely to respond to this signs over others. The goal is to recommend the implementation of a sign system that will help decrease the number of incidents on the job site.

Proposal Analyses

Analysis 1: Prefabrication of MEP Racks

Opportunity Identification

With the building having a high mechanical load there are many MEP racks that run through the hallways and main areas. With the building being rectangular in shape with very little division in the main area it could be the perfect project to utilize prefabrication of MEP racks.

Background Research

The cost of labor and installation of the mechanical system was roughly $7.2 million, not included the cost of the equipment. The installation process lasted approximately 100 days, which includes delays due to weather. With prefabricated MEP racks the installation of overhead work could be completed much quicker cutting back on the overall schedule because the MEP work is located on the critical path. This would also be most cost efficient because the prefabrication would allow for the racks to be made by the same workers in the perfect working conditions, allowing for a learning curve for the workers.

Potential Solutions

With the utilization of prefabricated racks, overhead MEP work can be installed much more quickly, decreasing the length of the overall schedule and the critical path. With the site being tight to begin with it is most likely more feasible to find an off campus location for the prefabrication of the MEP racks that can then be transported to site once they are erected. This solution could result in less safety incidents on site, as well as a decrease of the critical path schedule and an increase in cost savings.

Analysis Procedure

Some of the major steps for prefabrication of MEP Racks include:

1. Research
    - Research elements integrated in prefabricated racks
    - Research companies that will prefabricate
    - Establish suitable on site or off site location for prefabrication
2. Technical Analysis
    - Create logistics plan for movement through out building and delivery
    - Estimate cost of prefabrication
    - Determine cost of current system

- Determine duration of current installation
- Estimate duration of prefabricated units

3. Recommendations
    - Perform a comparative analysis of the two systems
    - Recommend a system based on value added to project

Expected Outcomes

As a result of this in-depth analysis, it is expected that there will be a positive on Project X. In addition to potential cost reduction, it is the goal of these research to provide a safer means of support of excavation. For this change to occur other conditions must be met. The outcome of this analysis will align with the structural capacity the support of excavation requirement, and meet the owner's expectations and needs.

Analysis 2: Alternative Mechanical System

Opportunity Identification

The current mechanical system was manufactured by SMARTD and installed by JCM and Associates. With a high mechanical load for the building it is important that the most efficient system is installed while keeping in mind budget, schedule, and constructability. To improve the constructability of the mechanical system and alternative system that uses water instead of refrigerant can be installed. This will decrease the critical path schedule as well as decrease costs.

Background Research

The system that is currently installed is a refrigerant system. This particular system was installed because it is one of the most efficient systems available on the market, which was a requirement of the owner. This type of system requires the pipes to be vacuumed to ensure not leak in system. This process is very difficult and can be effected by the weather if it is raining or snowing on those days, resulting in schedule delays.

Potential Solutions

Instead of utilizing a refrigerant system, Project X could use a cooled water system. This would result in a decrease of cost, but also increase the ease of constructability. With the system that is in place there is a unique piping arrangement that was installed. The refrigerant is first piped to the roof and then transported back to the cellar then to be transferred throughout the building. With a different system in place there would not be a need to transport the coolant to the roof just so it is transported back down again. Also with a system that uses water instead of refrigerant the installation would go much easier.

Analysis Procedure

1. Research
    - Research mechanical system alternative that uses water as coolant not refrigerant
    - Discuss with MEP project manager and GC project manager their opinions on the current system and proposed alternative system
2. Technical Analysis
    - Determine cost of current system
    - Determine cost of alternative system
    - Estimate cost of alternative system
    - Estimate length of installation of alternative system

- Perform **mechanical breadth analysis** by looking at efficiency of both systems

3. Recommendations
    - Perform a comparative analysis of the two systems
    - Recommend a system based on value added to project

Expected Outcomes

It is the expectation that this analysis will result with a positive impact for Project X. It addition to a potential reduction in cost, the goal is of this research is to provide a possible alternative to the mechanical system that is more constructible allowing for the schedule to be accelerated. The change in the system is looking to increase efficiency, while decreasing the initial cost of the system. For this change to occur, the efficiency can only increase while still meeting the loading demands of the building. The outcome of this research will align with the mechanical loading of the building as well as the LEED requirements. Also the owner's needs and expectations will be satisfied.

Analysis 3: Alternative Exterior Façade

Opportunity Identification

A constructability challenge for this project has been the exterior façade of the building which consists of metal paneling as well as curtain walls. The installation has been a challenge in sequencing as well as cost. This is a possible opportunity to improve the façade design in multiple ways through rearranging the façade to include more of the metal paneling and less of the curtain wall windows, while also changing the layout of the façade.

Background Research

The storefront glass and glazing on this project cost approximately $1.5 million for the project, including material and labor. Changing the layout of the façade as well as the amount of each material used for the façade could result in value engineering the exterior façade to better align with budget and schedule goals. With metal paneling already being installed it is feasible to increase the use of the metal panels while decreasing the square footage of the glass being used.

Potential Solutions

For the exterior façade there are multiple solutions related to the redesign of the system. The main solution is to rework the layout of the façade so it contains more paneling and less glass, as well as changing the layout of the metal panels and glass. This solution could result in better thermal efficiency for the building envelope, as well as a reduction in cost and schedule. With a decrease in glass usage the schedule will be reduced because the metal paneling is easier to install and will take less time than the glass.

Analysis Procedure

Some of the major steps for the exterior façade redesign include:

1. Research
    - Research façade system, including installation methods, maintenance, and properties
    - Select and implement appropriate material
    - Discuss with project manager and subcontractors what their opinions are of current system
2. Technical Analysis
    - Determine cost of current system
    - Determine length of installation process for current system
    - Estimate cost of alternative system

- Estimate length of installation of alternative system
- Perform **mechanical breadth analysis** by looking at thermal resistance of both systems
- Perform **structural breadth analysis** by determining loads of alternative system to ensure current structure is adequate
- Address aesthetic changes and make sure it aligns with owner's expectations

3. Recommendations
    - Perform a comparative analysis of the two systems
    - Recommend a system based on value added to project

Expected Outcomes

As a result of this in-depth analysis, it is expected that there will be a positive impact for the project. In addition to potential cost reduction, it is the goal of the research to provide a possible method for schedule acceleration. The redesign of the exterior façade is anticipated to increase the thermal efficiency of the building envelope. For these changes to be effective, other requirements must be satisfied. With the change in the façade the structural capacity of the exterior wall must align with the requirements of the building. In addition, the owner's expectations for aesthetics of the building will be satisfied.

Analysis 4: Psychology of Safety Signs

Opportunity Identification

On Project X, Forrester Construction utilized the typical safety signs that read "Safety Comes First" or "Be sure to wear proper PPE while on site". If the signs are changed to either be more graphic with potential risks or more emotional for the workers this could affect the safety on the jobsite. Signs that are more emotional could include thoughts about their families, or even signs that are drawn by their children, in an effort to encourage the workers to put safety first.

Background Research

Currently there are studies being done around the psychology of signs that are used on jobsites and what the effects of certain colors have on the workers. Also compared to the United States, many of the safety signs are more graphic in detail; depicting images of what could happen if safety is taken into careful consideration. There are also some construction projects that utilizes signs that are made by worker's children or signs that include messages regarding going home and seeing your family at the end of the day. These signs are meant to target workers by reminding them of why the work and what they could potential lose if they were involved in an accident at work.

Potential Solutions

With the result of the surveys, it will be determined what the most effective safety sign on a jobsite. It will either be the current signs, signs that are more graphic, or signs that are relatable to the workers (made by their children, etc.). A recommendation will be suggested based on increased safety awareness by workers.

Analysis Procedure

Some of the major steps for the implementation of new safety signs:

1. Research
    - Research the types of signs used by different contractors
    - Research signs that are used abroad
    - Conduct a survey on workers regarding the signs that are used and what they are most likely to react to
2. Technical Analysis
    - Estimate the cost of implementing new signs
    - Estimate the cost savings of lower rates of safety incidents on site
    - Evaluate the outcome of survey
3. Recommendations

- Perform a comparative analysis on the types of signs
- Recommend types of safety signs based on added value to the project

Expected Outcomes

As a result of this in-depth analysis, it is expected that the implementation of different safety signs will have a positive impact on safety on not only Project X's site but future projects as well. With careful consideration it would be possible to implement new signs on the site, that will make workers take a second look at their safety and the overall safety of the site. With safety being the number one priority on any site, this is one area that every site can continually improve on. With additional safety on sites it is expected that production will increase as well a profit, improving the timeline for the project as well.

Appendix A

Breadth Analysis

Overview

As part of the Senior Capstone Thesis project every student is required to provide a demonstration of knowledge in the areas of Architectural Engineering. These areas of breadth are to be included in the proposed areas of analyses and can include mechanical and structural.

Mechanical Breadth

The first breadth analysis will be included in the analysis of the redesign of the exterior façade and will centered around a mechanical focus. The analysis will focus on the the thermal efficiency of the proposed system and will be compared to a similar analysis performed on the original system that was installed. This will ensure that the proposed system is either equal to or better than the original system in terms of thermal efficiency, so it adds a value to the project.

Structural Breadth

The first breadth analysis will also be included in the analysis of the redesign of the exterior façade and will centered around a structural focus. The analysis will focus on the the loads imposed on the building by the exterior façade system. A load analysis will have to be performed to determine that the substructure as the capability to support the proposed system will impose. If it is found that that the substructure is not adequate a new alternative will need to be found. The system in which the exterior façade is anchored to the building will be looked at as well to determine if it can sustain the load.