The Ravenel Bridge Project: Delivering Ahead of Schedule and Under Budget[1]

A Risk Management Case Study

Susan Parente
Principal Consultant, S3 Technologies, LLC

ABSTRACT

In the construction field, being on time, on budget and within scope can sometimes occur as utopian goals. However effective risk management not only supports meeting these objectives, but it may also assist in delivery of project results ahead of schedule and under budget!

The Ravenel Bridge was a design-build project completed in 2005. This bridge replaced the John P. Grace Memorial Bridge and the Silas N. Pearman Bridge, which were built in 1929 and 1966. This bridge was designed to withstand a number of potential hazards, including: earthquakes, hurricanes and ship collisions.

The Arthur Ravenel Jr. Bridge (also known as the New Cooper River Bridge) Project is an excellent case study of how risk management supports achievement of meeting and exceeding project performance requirements. This bridge not only buoyed the transit connection of the Mount Pleasant and Charleston communities, it provided us with an excellent example of how risk management can make a profound difference in project performance and delivery of project objectives.

This paper reviews the practices used in the construction of the Arthur Ravenel Jr. Bridge, and how they relate to effective project risk management. It details how project risk management supported the completion of this large project under budget and ahead of schedule, while supporting environmentally friendly practices in construction.

We should not be under the impression that all projects are late and over budget. Instead let's manage project uncertainty (risk) to deliver our projects ahead of schedule, and under budget, while meeting customer satisfaction requirements.

[1] *This paper was originally presented at the 2nd annual University of Maryland Project Management Symposium in College Park, Maryland, USA in June 2015. It is republished here with the permission of the author and conference organizers.*

OVERVIEW

The objectives of this paper, Risk Management Case Study: Delivering Ahead of Schedule and Under Budget are to remind us of the feasibility of not only meeting project objectives of time, cost, and scope by delivering on scope, on time and within the project budget, but also the possibility of delivering project requirements ahead of schedule and under budget. This paper will engage in the topics of effective project planning and execution through the use of risk management. The goal of this paper is to provide readers with a sound example of the benefits of using project risk management for project planning and execution.

BACKGROUND

The Cooper River Bridge was a construction project of the SCDOT (South Carolina Department of Transportation). This was a bridge replacement project, in the Charleston, South Carolina area. The new bridge, the Arthur Ravenel Jr. Bridge, replaced 2 bridges which were at their end of life: The Grace Memorial and Pearman Bridges, which were along US 17 over the Cooper River. These bridges connected the cities of Charleston and Mount Pleasant, as did the bridge replacement. (USDOT, FHA, n.d.)

The main contractor for this project was Palmetto Bridge Constructors (PBC), a joint venture of Flatiron's Civil Division and Tidewater/SKANSKA. A joint venture of TY Lin International and HDR provided design review, engineering and inspection services for SCDOT. The bridge cost was approximately $675 million and was the largest contract in SCDOT's history. The project cost was 2.5 times the department's annual construction budget and used a Design-Built approach, which means development began before design was completed.

The project was initiated in July 2001, with a completion of July 2006. The project was planned for 5 years, but PBC planned to complete it in 4 years to decrease overhead costs. The project was broken down into 5 subprojects (or phases): 2 interchanges, 2 high-level approaches, and the main span. Each phase had it own budget, schedule, equipment, and management.

In addition to being schedule conscious, the project plan was also environmentally conscious. For example, the design plan included using a drilled-shaft foundation, instead of a much louder construction using pile driving. This both reduced noise for residency nearby and also caused fewer disturbances to the existing bridges in the area.

Project Team

The project team consisted of the following:

Owner/ Project Sponsor: South Carolina DOT

Designer: Parsons Brinckerhoff, New York

Design Review and Inspection: TYLI/HDR, a joint venture between T.Y. Lin International, Alexandria, Va.; and HDR, Omaha, Neb.

General Contractor: Palmetto Bridge Constructors (PBC), a joint venture of Tidewater Skanska, Virginia Beach, Va.; and Flatiron Constructors Inc., Longmont, Colo. (Constructor, 2009)

Design

The bridge design includes a 1,546 foot main span (2.5 miles long with a total length of 2.8 miles), which "hangs between the diamond-shaped support piers by 128 cables, which are made of seven-wire strands twisted together enclosed in a high-density polyethylene pipe. The bridge structure contains 300,000 yd^3 of concrete, 50,000 tons of reinforcing steel, 40,000 tons of structural steel and required 400 drilled shafts for the foundations. Each cable supports in excess of 1 million pounds." (Kable, 2015)

The following are the key data for this bridge:

- Length of bridge: 2.5 miles (total length of bridge structures: 2.8 miles)
- Number of traffic lanes: 8
- Completion date: July 2005
- Cost US $675 million
- Height above water: 186ft
- Tower height above the water: 570ft
- Longest cable-stay bridge in the Western Hemisphere)

RISK MANAGEMENT DEFINED

The Triple Constraint

The project management triple constraint (iron triangle) consists of: scope, time and cost (denoting the management of these project aspects). Often quality is shown in the middle of this triangle (as it is another key project objective) and Risk may be shown as a cloud around the triangle, or in the background, as it is shown in figure 1 below, as project risk is the uncertainty with regards to the project objectives.

Figure 1. The Triple Constraint

Fundamentally, only 2 of the 3 aspects of the triad can be selected (or detailed). The third is then determined by the aspects which are selected. This is particular critical when changes occur to the project. The project performance baseline includes the baselines for these 3 project objectives: the scope baseline, the schedule baseline and the cost baseline. If any aspect of the approved project performance baseline is modified (through a change request, or otherwise), then at least one of the other 2 baselines will be effected. For example, if the project schedule is reduced by a month, either the budget must be increased or the scope of work schedule must be adjusted or the scope of the work must be decreased to meet the project objectives.

The other project objective of quality (also known as customer satisfaction) must be met but as a best practice is never changed to accommodate a change to time, scope or cost. What a customer requires to be satisfied, is what they require and so it does not generally change due to a change in the project performance baseline. A customer will not generally agree to less than their interpretation of good project quality, even if the budget or schedule is reduced, or the project scope is increased.

Risk Defined

A Risk is an uncertain event or condition, which if it occurs, has a positive or negative effect on at least one objective. A risk is denoted using the properties of probability and impact. Probability is the likelihood of a risk occurring. It is the possibility of a project objective not being met using the current project plan. Impact is the consequence of a risk occurring. It details the penalty incurred, if the project objective, associated with the risk, is not obtained.

Expected Monetary Value (EMV) (the exposure of a risk) is calculated by multiplying a risk's probability of occurring times the impact (denoted in days or dollars).

EMV = Probability x Impact

As shown qualitatively, in figure 2 below, increased probability and/or impact increases the exposure of a risk.

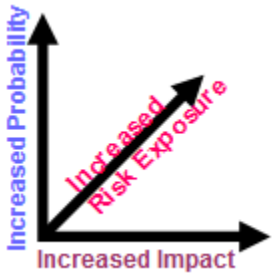

Figure 2. Probability and Impact.

It is important to understand the distinction between a risk and a problem/ issue. A Risk is an event that may occur in the future. A Problem or Issue is something which has already occurred and is being dealt with or has been resolved.

Project Risk Management Defined

Risk Management is an organized, systematic decision-making process that efficiently plans, assesses, handles, monitors, and documents risk to increase the likelihood of achieving project goals and decrease the likelihood that a risk would become a future problem

Project Risk Management has one inquire in uncertainty within their project: What are the project unknowns; what are the project's known unknowns; or what are the project's unknown unknowns? Risk Management provides a capability to quickly and effectively communicate risk information up and down the management chain.

The Risk Management Process

The risk management process includes the following: identification, assessment, response planning, execution, and planning, monitoring, documentation and communication. See figure 3 below for how these work together in a cyclical fashion.

Figure 3. The Risk Management Process.

The focus of risk identification is the discovery of potential risks to the project. In particular, in includes distinguishing any uncertain event which may positively or negatively affect the obtainment of project objectives. The process of risk assessment includes the review, analysis, and prioritization of project risks. This may include qualitative and/ or quantitative risk analysis. Qualitative risk analysis uses a subjective assessment; while quantitative risk analysis uses values for risk impacts, usually days or dollars.

After identified risks are prioritized, response planning can be developed for risks. As a best practice this is completed for higher exposure risks first. Since there are generally limited resources for risk management, it is important to focus on risks which are most urgent (could potential occur sooner) and highest (due to a high level of probability and/ or impact). Threat risk response strategies include: mitigate, avoid, transfer or accept. Opportunity risk response strategies include: enhance, exploit, share, and accept. After these response strategies have been planned, they are executed, while continuing to monitor and control these risks and identify any emergent risks (new risks which have appeared which were not initially identified). Throughout the project risk management process, planning, monitoring, documentation and communication of risks also occur. These are foundational to the risk management process and are essential to repeat iteratively throughout the project. They are also part of continuous process improvement for the project's Risk Management Plan.

PROJECT UNCERTAINTY

Design-Build Approach

The design-build approach is great for the project sponsor, as it provides them with flexibility to change requirements within the project. However, using a design-build approach puts risk (uncertainty) on the contractor, as they must begin development before the design has been fully completed. Procurement also occurs while design is still being done. This approach also increases job complexity, which yields an increase in project risk.

Challenges

Major project challenges for this project were: hurricanes, earthquakes and the ability to support the world's biggest container ships. (Extreme Engineering, 2012)

There are a number of personal risks building a bridge significantly high above the water, and in an area which commonly has hurricanes. Construction workers were often suspended for 12 hours of work each day, which required a high attention to their safety on the job. Safety rules were put in place and re-reviewed regularly. For example, workers were required to be tied off while working and if found not being tied off, they would be fired immediately. (Extreme Engineering, 2012)

Risks for the Community and Environment

The construction presented potential threat risks to the community. The Arthur Ravenel Jr. Bridge displaced residents of a low-income neighborhood. This created a potential for poor public relations. The bridge also affected the local environmental conditions, via potential noise disturbances and the displacement of wildlife.

MANAGING STAKEHOLDERS/ MANAGING RISK

Community Mitigation Plan

To address some of the risks associated with the surrounding community, a mitigation risk response plan was developed and executed. A plan "was developed with the local authorities to enhance affected local communities during construction. The plan focused on providing local employment and education opportunities, drainage and lighting improvements, the enhancement of parks and green spaces and the provision of affordable housing, which included the donation and relocation of 9 affected buildings of historic significance to the authorities." There were also plans to "redevelop the low-income communities around the bridge intersections, which [aimed] to reconnect communities that were divided by the old bridges, provide safer public spaces and affordable housing, [and constructed] connecting bicycle infrastructure and create economic opportunities." (Shanska, 2008)

Environmental Commitment

The SCDOT and the FHWA (Federal Highway Administration) were actively engaged in dialogue with various stakeholders throughout the project development and construction process. They were committed to providing a safe and efficient transportation facility which provided value within the surrounding area. This was one of many ways where potential environmental issues (risks) were included for this project to avoid or minimize risk impacts within the community environment.

The land from the old bridges was used in a socially and environmentally friendly way. In Mount Pleasant, the SCDOT partnered with the town to create an open park space by the waterfront, where the public has been able to use the space. Additionally, a public pier was built with foundations that came from the old Pearman Bridge. Also, land was redeveloped in a partnership with the city of Charleston to create inexpensive housing, parks, improvements for city drainage and economic opportunities for the city neighborhood of the East Side. After demolition was complete, the SCDOT supported the work to achieve each of these goals. ('Cooper River Bridge', n.d.)

Since the building of the Arthur Ravenel Jr. Bridge displaced residents of a low-income neighborhood, SCDOT officials included in the contract a requirement to train local residents in building trades. A 2-week course was provided by PBS to teach job-readiness skills and safety to 82 unemployed or underemployed residents, then offered on-the-job training in crafts. 62 of the people obtained journeymen's status in at least one job area. (Constructor, 2009)

Additionally, the U.S. Fish and Wildlife Service and the SC Office of Ocean and Coastal Resource Management "were involved in protecting and enhancing wetland habitats. The task force contributed toward improved cross agency communication and relationships, which may benefit future collaboration." "Reforestation was conducted immediately after construction to minimise soil erosion and only native species were used in order to maintain natural biodiversity." (Skanska, 2008)

CONCLUSIONS / LESSONS LEARNED

In conclusion, in this case study of the Arthur Ravenal Jr. Bridge Project, the most significant lesson learned is that projects can be completed ahead of schedule and under budget while achieving project scope and quality requirements. We can do this when managing risk through project design and planning, instead of incorporating risk after developing the project plan.

Stakeholder management is also an essential part of risk management and was clearly used to reduce the risk around community public relations and the effect on the local environment.

What is best about this project is that it provides an iconic example of how a project can accomplish the seemingly impossible achievement of being completed ahead of schedule and under budget, while considering both stakeholder and environmental concerns of the community by identifying and managing project risks.

REFERENCES

Extreme Engineering, (2012) "Extreme Engineering 2x05 Cooper River Bridge" Retrieved from: https://www.youtube.com/watch?v=r5WTRfsF1do

Kable, (2015) "Cooper River Bridge, United States of America" Retrieved from: http://www.roadtraffic-technology.com/projects/cooper_river/

Morrin, N. (2008) "Cooper River Bridge, USA" Skanska, Retrieved from: http://ravenelbridge.net/papers/Cooper_River_Bridge_US.pdf

PMI, (n.d.) *"PMI Risk Management Professional (PMI-RMP)*" Retrieved from: http://www.pmi.org/en/Certification/PMI-Risk-Management-Professional-PMI-RMP.aspx

Wood, D., (2009) "A Graceful Link" Retrieved from: http://constructoragc.construction.com/coverstories/archives/2005-09.asp

About the Author

Susan Parente

Connecticut, USA

Susan Parente, PMP, PMI-RMP, PMI-ACP, CISSP, ITIL, RESILIA, MS Eng. Mgmt. is a project engineer, consultant, speaker, author, and mentor who leads large complex IT software implementation projects, and the establishment of Enterprise PMOs. Ms. Parente's focuses on risk management and Agile project management. She has 17+ years' experience leading software and business development projects in the private and public sectors, including a decade of experience implementing IT projects for the DoD. Ms. Parente is also an Associate Professor at Post University in Connecticut. She has a BS in Mechanical Engineering from the University of Rochester in NY and has a MS in Engineering Management from George Washington University in DC. She is also PMP, CISSP, PMI-RMP, PMI-ACP, RESILIA and ITIL certified, and is a CMMI and ISO 9001 Practitioner.

Ms. Parente is a Principal Consultant at S3 Technologies, LLC. Her company's focuses on revitalizing projects through the use of risk management. S3 Technologies does this by teaming with clients, stakeholders and vendors and using risk management to deliver project successes. Ms. Parente trains and mentors project managers in the area of project and risk management. She is also an Agile project management generalist. Ms. Parente has developed a methodology which she uses to implement risk management programs for both small and large clients and is currently completing her manuscript for a book on implementing risk management.

Susan can be contacted at parente@s3-tec.com