Optimizing Cost and Schedule Performance through Best Value Project Delivery: Application within a Design-Build Project

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Performance in the construction industry is wrought with challenges and owners often are victim to cost and schedule overruns, particularly on high profile projects that are large, complex, and risky. Alternative project delivery methods and techniques are continually being developed and implemented by buyers of construction services to address these problems. The Best Value Business Model (BVBM) has been rigorously tested and shown to improve project performance via its three-phased approach to project delivery. BVBM increases performance throughout the construction project lifecycle by utilizing value-based selection processes, pre-contract planning methodologies, and performance measurement systems. The objective of this research is to provide a detailed case study of BVBM application on a design-build project to deliver a highly complex research facility with tight schedule and budget thresholds. The implementation process is discussed in detail and project results are provided and analyzed to demonstrate the ability of BVBM to improve project performance. Special attention is paid to the ability of BVBM to optimize project cost and schedule performance through the application of a value-based selection methodology, a pre-contract preplanning period, and a weekly risk management system.

Keywords: construction, design build, planning, project delivery, risk management.

Introduction

The construction industry is often faced with low performance in the form of projects completed late or over budget (Post 1998, Shortages 2005, Georgey *et al.* 2005). Research has shown that large or complex project face difficulty in delivering quality, with cost and schedule overruns of 40 to 200 percent (Condon and Hartman 2004). Buyers of construction services have turned to various solution strategies, typically in the form of implementing alternative project delivery methods such as design-build (Gransberg *et al.* 2003). One approach, known as the Best Value Business Model (BVBM), holds the potential to overlay on top of these project delivery methods to further alleviate poor performance in construction (Santema 2011). BVBM aims to improve project performance through value-based evaluation of Proponent proposals during procurement, pre-contract planning to clarify the highest-rated Proponent's project delivery plan and risk management approaches, and a performance measurement system to regularly track cost and schedule impacts for the duration of the project.

The objective of this article is to demonstrate that the principles of BVBM can be effectively utilized in the delivery of extremely complex, risky, and high profile construction projects in the design-build arena. A detailed account of how BVBM was utilized in a representative design-build project is provided along with the resultant project performance results. One aspect of the Best Value Business Model is highlighted in particular – its unique pre-contract planning methodology – to demonstrate the significantly beneficial impact it can have in the area of risk management, minimization of cost and schedule growth, and facility optimization. A case study approach was utilized to implement BVBM in the design-build delivery of a high tech research facility, wherein the pre-contract planning methodology had a direct and drastic impact to improve project performance.

Research Context

This research presents a case study application of the Best Value Business Model (BVBM) in a design-build project to construct a highly complex and high profile research facility at the University of Alberta (UA). The context of this research is discussed in three sections. First, a summary of BVBM is given. Second, an organizational background on UA is provided as well as their involvement in BVBM application. Third, the scope of the case study Cyclotron Project is discussed.

Best Value Business Model (BVBM)

The Best Value Business Model is an approach to project delivery and management that consists of techniques to improve efficiency and value in all aspects of the lifecycle for project delivery. BVBM is divided into three major phases. The first phase is Selection, which encompasses a value-based approach to procuring goods and services and consists of unique expertise-based evaluation criteria. The second phase is a pre-contract planning process that occurs with the single highest rated Proponent from Selection. This pre-planning methodology is unique to BVBM and is called the Pre-Award Clarification Period. The third phase is Performance Measurement for the lifetime of the contract, where a formal reporting system is utilized to track cost and schedule growth while simultaneously providing a structured change management communication process.

The Best Value Business Model is not a new process; rather, it has been tested and refined by the Performance Based Studies Research Group (PBSRG) from Arizona State University (ASU) on more than 900 individual procurements of construction and design services with a total value of more than $2.7 billion (Kashiwagi *et al.* 2012a, Kashiwagi *et al.* 2012b, Sullivan *et al.* 2012a). BVBM has been implemented by more than 80 organizations, generally representing large buyers of construction and general services in the public and private sectors, including the U.S. Army Medical Command, Arizona State University, State of Oklahoma, University of Alberta, State of Idaho, University of Minnesota, General Dynamics, Harvard University, and Rochester Public Schools (Sullivan 2011). Other groups that have utilized BVBM include the Hanze University of Applied Sciences, City of Peoria, Tata Steel, and the government of the Netherlands (Bos 2012, Sullivan *et al.* 2010, van der Rijt and van den Hoogen 2012, van de Rijt & Santema 2012).

University of Alberta Application of BVBM

The University of Alberta is located in Edmonton, Alberta and is the largest postsecondary institution in the province, as well as one of the largest in Canada. UA has a student enrollment of approximately 37,000 full time students and part time student with an academic support staff of approximately 11,700. UA has a $500 million procurement budget, making it a large public organization that commands a large amount of buying power. UA partnered with PBSRG in fall of 2010 to begin implementation of BVBM within their organization, and immediately began their first pilot test on their campus-wide custodial services contract. Their second implementation of BVBM was the design-build development of the Medical Isotope and Cyclotron Facility (MICF) on campus, which began development in the summer of 2011.

Medical Isotope and Cyclotron Facility Scope

The Medical Isotope and Cyclotron Facility was planned to be a stand-alone, medium energy cyclotron facility with an integrated radiopharmacy located on the South Campus at the University of Alberta (Construction Projects 2013). The project scope consisted of the repurpose of a cold storage facility to a specialized academic teaching, research, and production facility for radiopharmaceuticals utilized in cancer treatment research. This was a technically challenging and highly complex facility that included a 24MeV cyclotron particle accelerator. This project was a partnership between University of Alberta, Alberta Health Services, Alberta Advanced Education and Technology, Alberta Health and Wellness, Natural Resources Canada, and Advanced Cyclotron Systems (MICF 2013). Both the University of Alberta and Alberta Health Services were planned to house research teams at the completed facility to conduct research and production of medical isotopes that could be used to diagnose and treat patients with cancer, cardiac, and neurological disease. The project was under intense budget and schedule pressure to be complete in time to begin the production of radioisotopes. Procurement and delivery of the project was accomplished via a value-based design-build process. The Request for Proposal included bridging documents at approximately 80 percent design to assist Proponents with their bid and costing.

Research Objective

The objective of this research was threefold:

1. Demonstrate how the implementation of value-based procurement, pre-contract planning, and a continuous performance measurement system works well in a design-build environment for highly complex projects.
2. Share a case study of the Best Value Business Model's use in a high profile, extremely complex and risky project with considerable budget and schedule constraints. The details of how BVBM was implemented in this instance are revealed.
3. Demonstrate the value of the second phase of the BVBM, known as the Pre-Award Clarification Period, which is essentially a pre-contract planning process between the selected design-builder and the owner organization and can have a significant beneficial impact towards risk management.

Research Methodology

The research background is divided into three sections to describe the three-phased project delivery method that is utilized by the Best Value Business Model. The first section describes the value-based Selection phase. The second section provides information regarding the Pre-Award Clarification Period. The third section discusses the performance measurement system used within BVBM.

Selection Phase

The BVBM selection phase consists of a value-based procurement process to deliver a wide range of goods or services. Components of the value-based procurement include (Bos 2012, Sullivan and Savicky 2010):

- Past Performance Information on key firms and individuals. Information is collected regarding from past clients that have used the Proponent firm or individual on previous projects. The past clients provide information regarding the Proponent's capabilities in management, meeting schedule deadlines, risk assessment, planning, and adhering to rules and regulations as well as their overall satisfaction with the Proponent's performance.
- Risk-based submittals that require Proponents to identify, prioritize, and minimize risks they see in the service delivery. The first submittal looks at technical risks to the project, which refers to potential risks that are directly within the Proponent's control and therefore can be minimized at the outset of the project due to the Proponent's expertise in delivering the project. The second submittal focuses exclusively on risks the Proponent does not control, such as regulatory approvals, third party interactions, or owner-provided deliverables.
- A Value Added submittal wherein Proponents may propose alternatives to the prescribed scope of services. These alternatives should be outside the owner-specified scope of services, which enables Proponents to utilize their expertise to determine the best service delivery options. All cost and schedule impacts associated with these options are also included on the Value Added submittal.
- Interviews are conducted with the operations personnel who will deliver the good or service. Each individual is interviewed independently from all other project team members. Interview questions center on how the operations personnel plan to deliver the project, risks they see to the plan, potential impacts of these risks, strategies to minimize the risks, and any support they may require from the owner organization.

Evaluations are conducted individually by each member of the Evaluation Committee on a 1 to 10 rating scale. Once complete, individual evaluations are returned to the project's contracting officer for compilation. Table 1 provides a listing of the specific components collected in the Medical Isotope Cyclotron Facility project as well as their associated evaluation weights.

Table 1

Selection criteria

No.	Criteria	Weight
1	Cost	35
2	Technical Capability	10
3	Risk Assessment	15
4	Value Added	05
5	Interviews	40
6	Past Performance Information	10
	Total Points Possible	115

Pre-Award Clarification Period

The highest rated Proponent from the Selection phase is notified of their Selection, provided that their cost is within a justifiable range. This highest rated Proponent is then moved forward into a brief, yet rigorous preplanning and risk management process known as the Pre-Award Clarification Period. This period features a highly flexible and unique approach, including traditional preplanning activities augmented with a specific focus on risk, client concerns, alignment of expectations, and the selected Proponent's service delivery plan (Sullivan *et al.* 2012a). Key deliverables of this period include:

- Thorough pre planning and proposal review by the Proponent and owner.
- Detailed project plan developed and presented by the Proponent.
- Uncontrolled risks are identified, prioritized, minimized, and documented by the Proponent.
- Project milestone schedule is developed.
- Performance system implementation is planned for Phase 3.

The specific steps within the Pre-Award Clarification Period are as follows:

- Step 1: Process Education. The owner and related consultants provide educational resources for the selected contractor regarding the philosophy of the process, expected deliverables, and agenda of the initial kickoff meeting
- Step 2: Kickoff Meeting. The contractor directs the meeting by presenting an overview of their project plan, discusses major risks and solutions, and sets the schedule of activities for the preconstruction planning period.
- Step 3: Plan & Coordinate Deliverables. All required coordination activities are conducted to determine details of the project plan. This step has the longest duration, and consists of meetings with specific owner stakeholders to provide needed information and requirements to the contractor's project team.
- Step 4: Insert Deliverables into Contract. The final functional plan is written in a formal manner and included in the contract documents. The plan includes the project scope (centered on interaction points between project participants), risk management plan, milestone schedule, financial agreement, and performance metrics.

- Step 5: Summary Meeting. This meeting serves as a formal, final check that all parties agree to the plan before signing the contract.
- Step 6: Contract Signed. Once all parties agree to the plan presented in the Summary Meeting, the contract documents are finalized, compiled, and signed.

Performance Measurement

The third phase of the Best Value Business Model is the incorporation of a performance measurement system for the lifetime of the project, which serves as a tool for the owner to analyze performance on each individual contract they procure. The main component of the Performance Measurement phase is a Weekly Risk Report (WRR) process. The WRR is an Excel spreadsheet that is submitted by the contractor prior to or at the date when Notice to Proceed is given all the way through substantial completion and project closeout. Within this spreadsheet, all risks that occur during the project are documented along with their associated cost or schedule impacts.

Submission of the Weekly Risk Report becomes a real-time performance measurement system because the WRR is submitted each week with any relevant updates. Weekly submission is typically accompanied by a risk review meeting with key stakeholders from the contractor and owner teams, which essentially becomes a formalized change management process to communicate any alterations in project approach. The information captured in the Weekly Risk Report includes:

- Contact information for key members of the owner and contractor project team.
- A brief, written description of each risk that impacted the project. This description is updated weekly with any relevant updates until the risk in question is resolved and closed out.
- Projected resolution dates for open risks.
- Cost and schedule impacts of each documented risk, as well as an associated summary of any change orders approved by the owner.
- A milestone schedule with up-to-date information on percent completion.
- An owner satisfaction rating with the contractor's actions to mitigate each risk that occurred during project delivery.

Results and Discussion

Results of BVBM implementation at the University of Alberta are separated into four sections. First, the value-based selection process and evaluation results are shown in detail. Second, the hugely beneficial impact of risk management ability in the Pre-Award Clarification Period is closely examined. Third, the performance measurement system utilizing the Weekly Risk Report is discussed. Fourth, overall project impacts and savings as a result of BVBM application are discussed.

Value-Based Selection

Four Proponents submitted proposals for the Medical Isotope and Cyclotron Facility. An Evaluation Committee of five individuals was formed, where participants had background in procurement and supply management services or facility and operations project management. The Evaluation Committee was responsible for evaluating the written portion of the Proponents' proposals, which consisted of the two risk submittals (Technical Capability and Risk Assessment) along with the Value Added options. The Evaluation Committee's scores were averaged and combined with the Proponent's Cost proposal and Past Performance Information and converted to a weighted score, as seen in Table 2. At this stage, the contracting officer performed the short list determination which ultimately removed Proponent B from moving forward in the Selection process due to their low total points. The remaining three Proponents were invited to participate in the Interviews as the final evaluation portion.

Table 2

Weighted scores for short list – prior to interviews

No.	Criteria	Weight (%)	Proponent A	Proponent B	Proponent C	Proponent D
1	Cost	35	33.2	26.3	34.8	35.0
2	Technical Capability	10	10.0	3.3	5.5	6.5
3	Risk Assessment	15	15.0	3.9	15.0	11.1
4	Value Added	05	5.0	2.2	2.8	4.3
5	Interviews	40	-	-	-	-
6	Past Performance Information	10	9.0	9.3	9.3	9.0
	Total Points	115	72.2	45.0	67.4	65.9

Individual interviews were conducted with four key members of each Proponent's design-build team: the Builder's Project Manager, the Builder's Site Superintendent, the Design Architect, and the Design Mechanical Consultant. Each of these key team members was interviewed on an individual basis and Evaluation Committee members provided their separate scores, which were then averaged to arrive at the final Selection weighting shown in Table 3. After inputting the Interview evaluations, Proponent A received 109.4 of the total 115 points possible and was the highest rated Proponent. Proponent D and Proponent C were the second and third highest rated Proponents with total evaluation scores of 90.9 points and 86.5 points, respectively. Based upon the final evaluations, Proponent A was notified of their selection and moved forward into the second phase of the BVBM.

Table 3

Weighted scores for selection – including interviews

No.	Criteria	Weight (%)	Proponent A	Proponent C	Proponent D
1	Cost	35	33.2	34.8	35.0
2	Technical Capability	10	10.0	5.5	6.5
3	Risk Assessment	15	15.0	15.0	11.1
4	Value Added	05	5.0	2.8	4.3
5	Interviews	40	37.1	18.8	25.0
6	Past Performance Information	10	9.0	9.3	9.0
	Total Points	115	109.4	86.5	90.9

Pre-Award Clarification Period

As a part of their due diligence during the Pre-Award Clarification Period that was scheduled to last three weeks, the selected design-builder conducted extensive site reviews that ultimately identified significant risks that were previously unknown and unforeseen on the project. Three major unforeseen risks were brought forward as a result of the Pre-Award process:

1. During a site review, the design builder found the existing building to be roughly 15 feet wider in the North-South direction, with added more than 1,800 square feet over the building dimensions originally shown in the bridging documents.
2. The Cyclotron Vault Design developed by the bridging consultant did not contain details regarding the acceptable wall thickness or materials, which necessitated updated calculations to be determined by the design-builder. The deep pile foundation system shown in the bridging documents made it difficult to maintain schedule.
3. A field review by the structural engineer revealed cracking on the perimeter concrete beams.

After uncovering these unforeseen risks and communicating them to UA, the design-builder requested that a 1.5 week extension of the Pre-Award be granted because they felt it was important to bring all the risks forward and be able to properly mitigate them before jumping into contract. Solutions to these three risks were developed and enacted prior to the end of the Pre-Award Clarification Period. The risk resolution strategies are summarized below:

1. The design team accommodated the extra space by incorporating additional corridors, which ultimately resulted in a more efficient facility layout. Once the new floor plan was developed and approved, the design-builder provided UA with any interior and exterior cost implications to enable budgeting.
2. The design-builder designed a raft foundation alternative which drastically reduced schedule time (by as much as five weeks). The cost of general conditions and other overages that would have been incurred over that period nearly offset the entirety of the additional cost of the newly proposed foundation design.

3. The design-builder developed a solution that would add perimeter struts during the roof deck replacement portion of the construction phase. The design-builder also recommended treating existing cracks with epoxy injection as well as a reinforcement of the deck diaphragm with permanent bracing.

These three major unforeseen risks did result in cost impacts to the project. However, the fact that these risks were identified prior to signing the contract and mobilizing for construction was beneficial because it enabled effective optimization of the facility and expedited the required regulatory approvals to accommodate the changes. This demonstrates the huge benefit gained by incorporating the Pre-Award Clarification Period as espoused by BVBM. If UA and the design-builder would have gone directly to contract after Selection, these unforeseen risks would have become changes after the fact, driven other changes, and likely delay the completion of the facility. Instead, utilization of the Pre-Award Clarification Period enabled UA and the design-builder to manage these risks – and their associated impacts – ahead of time. In this manner, the pre-contract planning methodology of BVBM does result in risk management and risk control related to the project before the award, which serves to minimize the any issues that may be encountered after the fact.

Another benefit of the Pre-Award Clarification Period was that UA was able to review the Value Added options proposed by the selected design-builder. After review and clarification, UA elected to utilize multiple Value Added options, which is an example of how BVBM enables owners to leverage industry expertise to delivery greater value on their projects. These items were identified and included directly within the design-builder's initial proposal to the University, which would not have been typical in a traditional selection process. The Value Added items proposed by the design-builder included the following:

- Replace Wood Decking – existing wood has been exposed to moisture for a considerable time and replacing it with steel decking prior to re-roofing maximize life cycle cost.
- Upsize the Emergency Generator – the originally-specified generator was smaller than the required power sizing for the building's needs. The selected design-builder identified this design error directly within their proposal and provided the associated costing required to upgrade the generator to an appropriate sizing.
- Variable Air Volume System with Reheat – the original design drawings showed a dual duct system. The design-builder proposed an alternative design that met the owner's intent while also saving $158,000 and creating interstitial space for improved maintenance access.
- Addition of Boron Carbide Additive to Vault Concrete – the radioactive shielding requirements were not specified in the owner's Request for Proposal. The design-builder included a potential solution within their proposal based upon their expertise delivering previous projects of similar scope. This solution was analyzed in the Pre-Award phased and ultimately deemed to be an appropriate solution.

- Replace Drywall and Epoxy Paint with Arcoplast – the original bridging documents showed a drywall, tape, mud, sand and paint method to be used for interior finishes, which is time consuming to install. The design-builder proposed utilizing an arcoplast product to reduce the schedule impact of the drywall trade by fifty percent. This solution also provided greater ability to maintain the high levels of cleanliness required within the building interior spaces.

Performance Measurement System

Once the contract was signed, a performance measurement system was incorporated for the duration of the project. In accordance with BVBM practices, the design-builder's construction project manager updated and distributed a Weekly Risk Report on every Thursday in preparation for a regularly scheduled Friday morning risk review meeting. All cost and schedule impacts to the project were tracked and categorized. The vast majority of cost impacts, listed in order of magnitude, stemmed from owner-driven scope additions to improve the facility, design discrepancies from the original bridging document consultant, and approved value added items to increase the facility's functionality. In this respect, cost impacts were not due to poor performance, but rather were a result of risk minimization strategies and opportunities to improve this important research and medical treatment facility for many years to come.

As a result of the WRR system's communication process, the owner project manager was enabled to "clear the path" for the design-builder, essentially eliminating bottlenecks caused by the greater owner organization of other third party groups the owner was involved with on the project. This resulted in a much more streamlined project delivery process and provided a regular forum to document and communicate risk impacts that may necessitate change management actions. As a part of the WRR system, the UA project manager from the Facilities and Operations department provided a 97 percent satisfaction rating with how the design-builder managed each risk impact throughout the project, another indicator of high performance.

Discussion of Project Savings

The Medical Isotope and Cyclotron Facility reached substantial completion on December 21, 2012, closing the eighteen month project duration with an on-schedule delivery of the operational facility. The final project cost, including all cost impacts resulting from scope additions, bridging document design discrepancies, and value added decisions by UA was $32 million. The Executive Director of Facilities and Operations at UA performed an analysis of total cost and schedule durations that would be estimated for representative projects of similar complexity to provide a benchmark performance comparison. The conclusion drawn from this analysis was that this project, if conducted via a traditional project delivery methodology, would be estimated to cost $44-48 million and have a scheduled duration of approximately 48 months. From this analysis, it was determined that UA's implementation of BVBM resulted in nearly $14 million (30 percent) in cost savings due to increased efficiency and as much as 30 months in schedule reduction (63 percent). These dominant performance results are summarized in Table 4.

Table 4

Cyclotron project BVBM results

Project	Contract Value	Cost Savings	Schedule Impacts	Satisfaction/ Performance
DB Construction (High-Tech Research Facility)	$32M	$14M (30%)	30 mo. reduction (63%)	9.7 (out of 10) satisfaction

Figures 1, 2 and 3 provide photographic representations of the substantially complete MICF on University of Alberta's South Campus. Figure 1 shows different views of the MICF's exterior appearance and envelop as well as the front entry canopy. Figure 2 provides views of the various components present within the laboratory spaces. The upper left picture shows a hallway with windows into numerous laboratory rooms while the lower left picture gives an interior view of one laboratory. The upper right picture shows some of the processing equipment available to researchers while the lower right depicts a controlled pass-through between rooms for sensitive material. Figure 3 provides views to the complex mechanical equipment array that is located above the interior roofing in the laboratory space. Pass ways were included to enable easy access points for maintenance future maintenance work.

Figure 1: Exterior views of the MICF

Figure 2: Various components of interior laboratory spaces within the MICF

Figure 3: Mechanical equipment design for radiopharmaceutical production

Conclusion

The research objective was to (1) demonstrate how the implementation of value-based procurement, pre-contract planning, and performance measurement is beneficial in a design-build environment with an extremely complex and high profile project, (2) provide detailed case study information regarding the application of the Best Value Business Model within this setting, and (3) emphasize the impact pre-contract planning can have in the construction industry to promote more effective risk management practices. These objectives were accomplished via a case study approach to document the impact of BVBM on the design and construction of the Medical Isotope and Cyclotron Facility built for the University of Alberta in Edmonton, Alberta.

Estimated total cost savings were found to be in the range of 30 percent with a 63 percent schedule reduction due to the application of the Best Value Business Model over more traditional project delivery approaches. Although all three major phased of BVBM provided a positive contribution towards these performance results, the pre-contract planning methodology of the Best Value Pre-Award Clarification Period had the largest impact on the MICF project. The design-builder utilized this process to uncover significant unforeseen risks to the project, and then extended the Pre-Award duration in order to address the risks prior to jumping into contract. The resultant benefits were numerous: it minimized changes after the fact, minimized cost and schedule impacts of the risks, allowed the owner to acquire proper budgeting for the facility, and expedited regulatory approvals.

Future research is planned to continue implementation of BVBM at the University of Alberta on contracts of all sizes and types. Different industries will be tested, including design and consulting, design-bid-build construction, construction management fast tracking, and other general services such as travel management, information technology consulting, and others. University stakeholders will be surveyed periodically to assess their perspective of the benefits gained via BVBM application. The intent also exists to apply the pre-contract planning methodology in concern with the performance measurement system on contracts that are procured via more traditional, non-value-based selection processes and track the resulting impacts to project performance across the organization.

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