Case Study

Utilizing the Building Information Modeling Return on Investment Tool to Promote Implementation

INTRODUCTION

State Departments of Transportation (DOTs) across the Nation have an increased interest in Building Information Modeling (BIM). BIM represents an integrated full-life-cycle approach to managing information that represents the transportation system and its various assets. Utilizing BIM is a collaborative work method for structuring, managing, and using data and information about transportation assets throughout their lifecycle. It involves delivering capital projects collaboratively (through the planning, design, and construction phases) and efficiently managing services the built infrastructure is expected to provide using digital rather than traditional paper-based processes. (FHWA, 2021) BIM integrates many technologies and practices that bring together digital tools and a data-centric approach to improving lifecycle delivery and management of assets. However, despite these benefits, the approach to deploying BIM has been limited in part due to organizational constraints related to lack of understanding of the software capabilities and the expected benefits of the investments in BIM implementation. The National Cooperative Highway Research Program (NCHRP) BIM Return on Investment (ROI) Tool developed through CRP Special Release 4, is intended to help transportation agencies better understand the business case for BIM implementation.

The Federal Highway Administration's (FHWA) Advanced Digital Construction Management Systems (ADCMS) program seeks to promote the adoption of digital tools, such as BIM, to reduce risks of project delays and errors, develop more sustainable infrastructure, and deliver projects faster and more cost effectively. One way the ADCMS program does this is by promoting collaboration and partnerships between agencies across the United States who are looking for solutions to problems that are similar. This case study intends to highlight Washington DOT's (WSDOT) experience using the NCHRP BIM ROI Tool. WSDOT was chosen for this case study due to their early utilization of the BIM ROI tool. Some primary goals of this case study are to:

- Analyze how WSDOT used the NCHRP BIM ROI tool to advocate for resources, money, and staff to begin the implementation of BIM.
- Help State DOTs understand how WSDOT used the NCHRP BIM ROI tool to work towards agency support for BIM implementation.
- Provide information to States who want to use the NCHRP BIM ROI tool to assess the effectiveness of BIM implementation at their agency.

These findings aim to help States better inform decision makers on the ROI available through BIM implementation.

KEY TAKEAWAYS

- **Considerations for BIM ROI is agency specific.**
- **States may identify innovative solutions for what can be achieved with BIM implementation.**
- **Understanding the ROI tool may allow agencies to effectively advocate for BIM implementation.**
- **Key organizational relationships may help States acquire valid and verified data for input into the ROI tool.**
- **Potential BIM benefits may include improved safety, elevated asset management, lower construction bid prices due to improved organizational communication, and costs savings from avoided change orders.**

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WHAT IS BIM?

FHWA considers BIM a collaborative work method for structuring, managing, and using digital data and information about transportation assets throughout their lifecycle. BIM enables users to exchange data from one discipline to the next, indicating who is building what, when each part will be built, the materials to be used, and how it will be constructed. When applied to transportation infrastructure such as highways and bridges, BIM helps optimize the design, construction, and management of infrastructure assets throughout their lifecycles. The application of ADCMS processes result in more seamless data transfer and increases information sharing between agency business silos and among stakeholders. The use of digital technologies during construction allows projects to be completed safer, faster, and more accurately.

State agencies struggle to implement BIM as a standard practice. The complexity and perceived cost of implementing BIM remains a barrier to BIM implementation. Agencies regularly identify the difficulty of investing in agency initiatives while also maintaining their transportation infrastructure; and BIM adoption requires investment from an organization. Some of the top investment categories include training, software and professional services for systems setup, and hardware or equipment. It is important to recognize the value and need for champions to clearly develop the business case, but also clearly communicate the business case to organizational leadership and stakeholders. Thus, the likelihood of getting executive support to invest in BIM deployment can be improved with a robust business case that demonstrates its value. In many organizations there is a strong business case for adopting BIM, to support the efficient and effective delivery of projects, as well as the larger, long-term effort to use BIM in support of operations and maintenance. According to CRP Special Release 4, there is an established need for a tool that will determine an accurate and repeatable approach to calculating the ROI for adopting BIM.

NCHRP BIM RETURN ON INVESTMENT TOOL

The BIM ROI Tool was developed to help transportation agencies understand the business case for investing in BIM by quantifying the benefits and costs of BIM given an agency's specific circumstances. The BIM ROI tool is a spreadsheet developed to evaluate the costs and benefits of BIM implementation for infrastructure. Because the results vary greatly depending on the State agency context and how the agency plans to use BIM, there is no one-size-fits-all ROI result. State agencies should use the ROI tool to quantify the benefits and costs of BIM implementation given their own circumstances. Agencies can perform three functions with the ROI tool, which can be categorized as follows:

- **Default Analysis:** allows the user to perform a quick ROI analysis based on rule-of-thumb data included in the tool and some user inputs. This option incorporates only benefits and costs with the best data found through literature review, expert panel, and case studies. However, results will not be tailored to the context of a given agency.
- **Detailed Analysis:** allows the user to perform a detailed ROI analysis specific to the agency's context and includes all quantifiable benefits and costs identified by this study. This function requires the user to enter agency-specific data on several sheets. The data inputs are more detailed and take more time to enter than the simple inputs needed in the default analysis.
- **Investigate Impacts:** allows the user to review findings from the study. This function is like an automated literature review. No calculations are made, but the user can select from a drop-down list of benefits to view the benefit definition, impact metrics found through the study, and examples of case studies that experienced a given benefit.

Figure 1 shows an example of the steps for each of the functions in the BIM ROI tool.
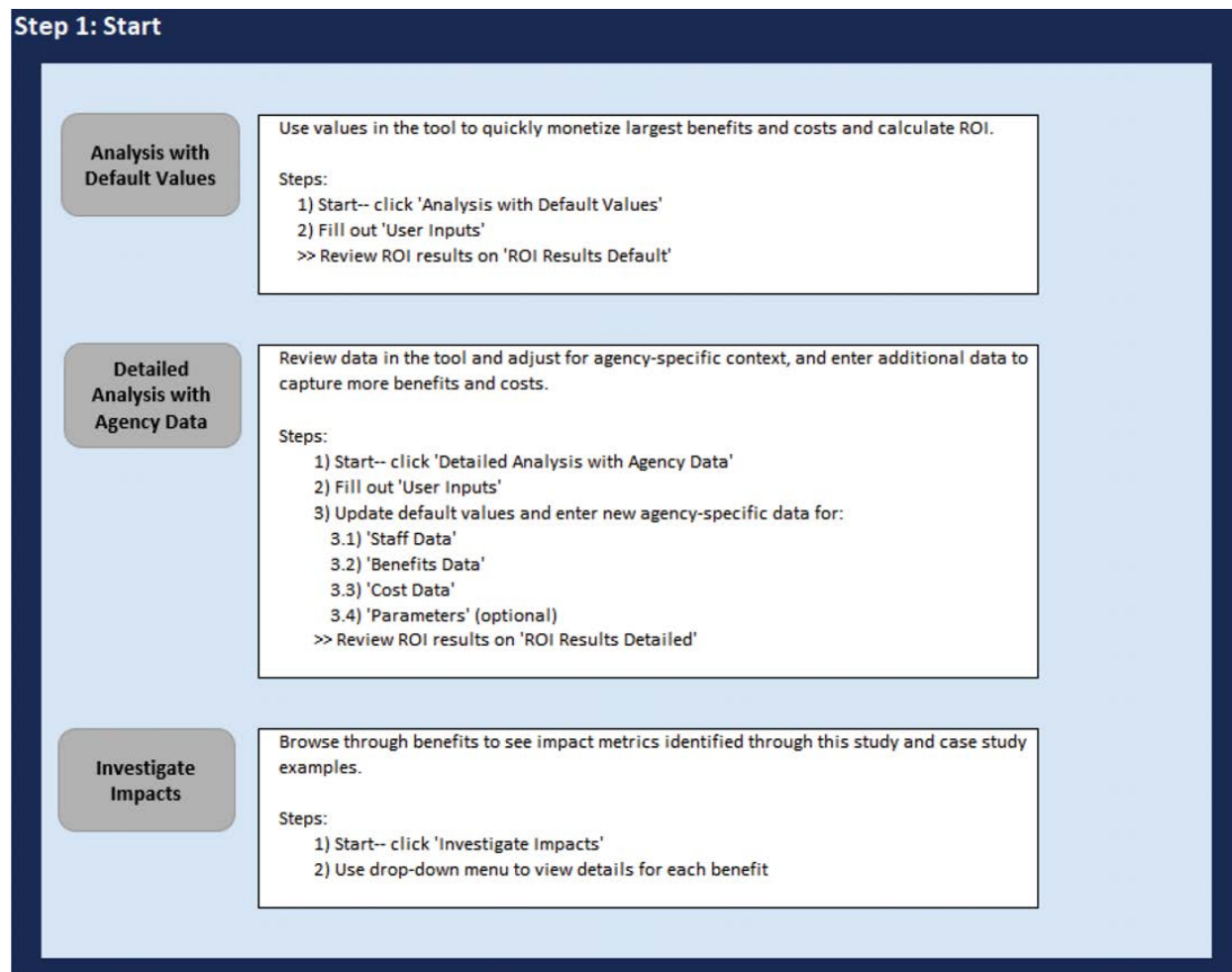
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Figure 1: ROI Start Sheet

Each of the analyses within the BIM ROI tool requires a set of data inputs. Within each analysis the data inputs are grouped into four sections. The user of the ROI tool must review and provide input in each section to receive the results of the ROI analysis:

- **Investment Case versus Base Case**: asks the user questions about the level of BIM adoption in the Base Case and the Investment Case. It also asks about the agency's typical projects. Definitions are provided to assist the user.
- **Incremental Software Costs in Investment Case:** requires the agency to estimate the additional annual spending on software due to the conversion to BIM in the Investment Case. Note this is not the total software costs, it is only the incremental cost compared to software spending in the Base Case. The user can click the hyperlink to review a table of sample BIM related software subscription costs; however, these costs vary given what software the agency is purchasing, package discounts, and other factors.
- **Use Cases of BIM in Investment Case**: asks the user yes/no questions to identify how the agency will be using BIM in the Investment Case. The user should answer "yes" only if this is a new use of BIM-related technologies.
- **Other Costs in Investment Case:** asks yes/no questions about additional costs that the agency will incur in the Investment Case, such as investment in additional hardware, IT infrastructure, and/or new BIM-related trainings.

Through these inputs the ROI analysis identifies the types of costs and benefits associated with

implementing BIM, as well as how the initial investment is linked to the eventual outcome. BIM implementation activities include efforts such as investing in software and supporting hardware, developing new standards and processes, and training employees. These activities help identify the costs associated with implementing BIM, as well as the "outputs" expected from these activities, such as trained staff being able to follow BIM procedures and use modeling software. Outputs then lead to "outcomes," which are the benefits that should be compared against costs in an ROI analysis. For example, an agency needs to purchase sufficient functionality in the modeling software to realize benefits from BIM. In fact, the type of modeling software purchased will determine which specific outcomes (benefits) the agency can realize. (NCHRP Report, 2023)

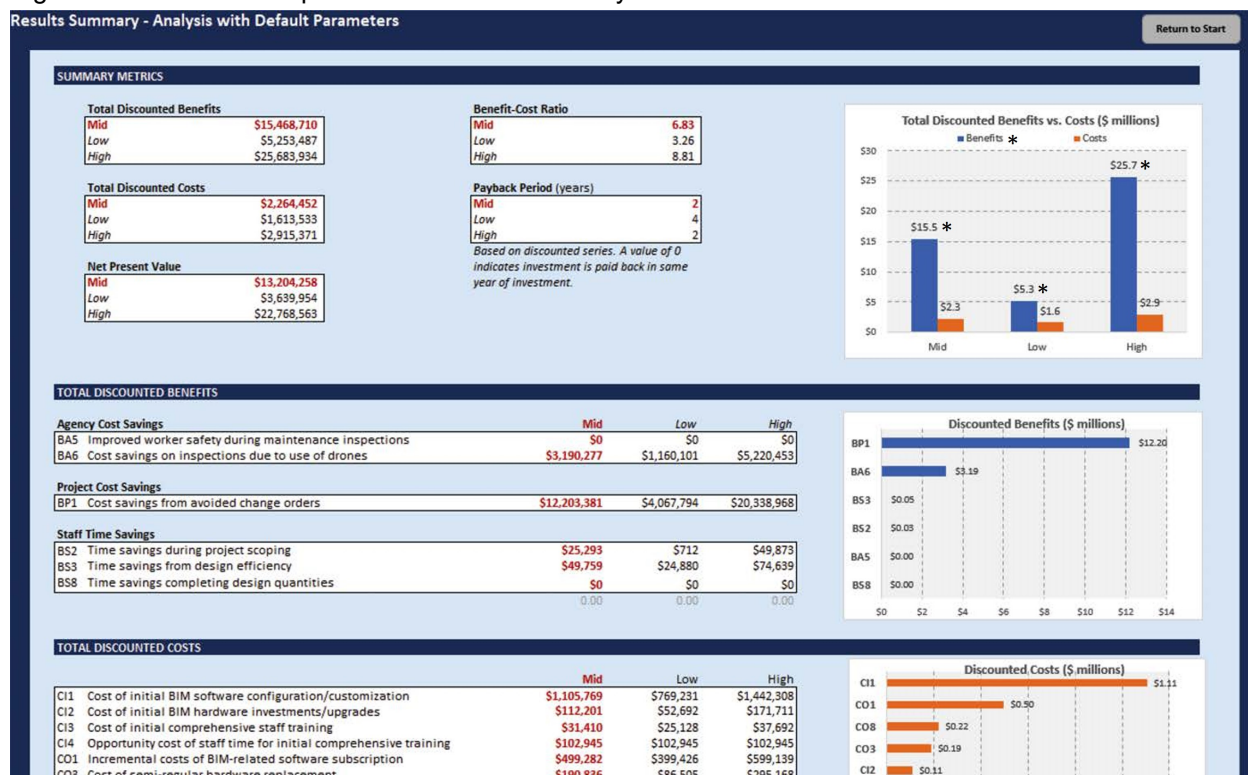Figure 2 shows an example of the Results Summary from the ROI tool.

Figure 2: ROI Results Sheet

The ROI tool allows agencies with limited information to determine a general understanding of the costs and benefits associated with implementing BIM. Conversely, those willing to develop more detailed information, such as staff size, average pay per staff member and average project size, can get agency-specific estimates pertaining to the cost of implementation.

WSDOT BIM ROI TOOL USE MOTIVATIONS

In 2021, the WSDOT Office of Multimodal Development developed a proposal for BIM implementation. In considering this proposal, the WSDOT Executive Leadership team requested a report outlining the ROI for BIM implementation. To understand the ROI of BIM implementation, WSDOT met with several States who were all in the early stages of BIM implementation. They found that each agency is applying a phased approach to BIM implementation, and each began the process by starting with a digital plan. Separately, WSDOT learned of the NCHRP BIM ROI tool and its capabilities to provide ROI data highlighting the benefits associated with BIM implementation. With this knowledge, the Office of Multimodal Development began developing a multi-divisional white paper on the business case for BIM to present to the agency's Executive Leadership team.

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WSDOT BIM ROI TOOL EXPERIENCE

After their initial research, WSDOT completed a comprehensive review of the ROI tool and worked internally to complete a default analysis by filling out the user inputs, benefits, and costs that corresponded with each section of the ROI tool. After reviewing the default analysis results, WSDOT determined that the analysis was not accurately reflecting their scenario and proceeded to conduct a detailed analysis for a more accurate ROI. By doing so, the Office of Multimodal Development worked across the organization to gather the necessary data to best reflect the organizational capabilities for BIM implementation. One area of collaboration was in trying to develop an average project cost. WSDOT determined that an average project cost does not best reflect WSDOT's situation. Therefore, WSDOT decided to create costs for multiple different project types (roadway, paving, bridge, safety, etc.) to get more accurate projections of the benefits. Additionally, while conducting the detailed analysis WSDOT recognized that the tool was not designed to conduct an analysis of a phased implementation where an agency may already have elements of BIM currently established. Therefore, throughout the input process, WSDOT made agency specific assumptions that would help provide a comprehensive ROI analysis.

After running the analyses, WSDOT was presented with the results sheet of the ROI tool which showed summary metrics from the ROI analysis, including the Benefit-Cost Ratio (BCR), total discounted benefits, total discounted costs, and the payback period. When evaluating results, a BCR greater than 1.0 indicates that the investment is "net beneficial", and the benefits of the investment are expected to outweigh the costs associated with implementation. The ROI analysis provided WSDOT with the ability to understand different considerations associated with implementing BIM and created a range of options that demonstrate how effective incorporating BIM fits within the fiscal constraints of the agency. The results of the ROI analysis proved to be Net Beneficial, with a ratio of 8.46. The ROI analysis indicated that if WSDOT were to move forward with BIM implementation the payback on the agencies initial investment would begin in 2032. Additionally, the results of the ROI analysis found that the largest and most effective agency benefits were lower construction bid prices, cost savings from avoided change orders, and improved worker safety during inspections. The results allowed WSDOT to evaluate the prospect of developing an initial "BIM Pilot Program", which would review the cost of BIM implementation over a 10-year period.

To improve the credibility of the ROI analysis, WSDOT staff got the data in the report independently verified. WSDOT hired the consultant who helped create the tool to review the inputs and results, and ensure the data presented was correct. This independent review allowed staff to receive third party validation of the data. It also allowed the agency to provide credibility to the benefits of BIM by providing an honest representation of where BIM was presently at the organization and what it looked like across the Nation. This provided the agency's executive leadership with a full understanding on a range of options that demonstrate how BIM can be implemented across the agency.

The results of the analysis were used as an input for a white paper drafted in collaboration with the Development, Construction, and Maintenance Divisions with support from IT and Executive Management. The team used the white paper to inform the Executive Leadership on BIM Implementation. The white paper also identified WSDOT's need for improvements to their digital delivery process, particularly by highlighting how the agency regularly misses the opportunity to provide complete and accurate information to contract bidders. Another result of the ROI analysis indicated that WSDOT would continue to spend multiple hours developing 2D plans of a 3D environment for construction projects, which resulted in significant time loss for the organization. These challenges enabled WSDOT the ability to identify tangible evidence about the feasibility of BIM implementation.

WSDOT Executive Leadership continues to digest the results of the ROI analysis. The agency understands the need to implement BIM in order to align with the agency's strategic objectives, and they will continue to gather input from all parts of the organization and measure the ROI of BIM in their project

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delivery. This approach will allow WSDOT to analyze and monitor BIM and inform their Executive Leadership of different opportunities that would advance their project delivery and operations.

NEXT STEPS

WSDOT continues to research ways to track and monitor progress on BIM initiatives. For example, WSDOT recently applied for grant funding to develop a BIM implementation plan. The implementation plan will provide executive leadership with a roadmap for implementation and will outline a plan to collaborate with different parts of the agency and obtain their buy-in. This process helps staff align with the goals and objectives at the beginning of the implementation process.

LESSONS LEARNED

WSDOT's internal development of ROI scenarios demonstrates how agencies can use cost in their decision-making processes to support and justify investment in change. WSDOT's example provides key lessons for other agencies to consider:

- The BIM ROI tool was effective at convincing department leadership of benefit of investing in BIM implementation;
- Deployment of BIM capabilities is best (greatest ROI) if done agency wide;
- States should be prepared to invest time understanding the full scope of the ROI tool;
- States DOTs should understand the need to communicate the limitations and methodologies of the tool to leadership;
- State DOTs should understand that the development of good input data will require some effort;
- State DOTs should be prepared to run multiple scenarios with different inputs;
- Using the NCHRP Return on Investment Tool can provide quality, quantifiable data to executive leadership to support investment in new technology and modernizing processes;
- States may achieve greater benefits from the NCHRP tool if a third-party is available to help input and verify the data;
- State DOTs could benefit from an understanding of the opportunities of the NCHRP Return on Investment tool to provide evidence that best meets their goals.

As BIM adoption expands further, State DOTs should consider using the ROI tool to better quantify the benefits of BIM implementation at their agency.

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