Task 3 summaries

The focus of Task 3 was to leverage existing tools and models relevant to this research project, test and validate models using data from previously completed ABC projects. As a continuation of Task 2, more resources on Analytical Hierarchy Process (AHP) from the literature were reviewed. Useful approaches and techniques were identified and recorded for deployment in the project. The result of this effort is available as a comprehensive collection of papers posted on the research website. Considering the nature of the decision problems in a typical ABC project, these reviews also confirmed the suitability of the AHP approach for this project. A comprehensive overview of the AHP literature and the details of the process are provided in the previous report set (titled as: Task 2&3 Report).

The synthesis of the AHP literature was deployed in a decision making software tool. This tool will help decision makers in early stages of the design process. In the next section of this report, an introduction of the decision software along with some of its key features are summarized.

In parallel to the software development effort, the research team collected data on a series of completed or under-construction bridge projects in Oregon. The data was collected through conducting interviews with ODOT experts. The survey form (see Figure 1 for a partial survey snapshot), presented in the previous report, was used for this task. The survey and the software both use the fundamental AHP scale. This survey scale is based on previous research and is well-developed, tested, and validated (Saaty, 1990). The survey form contains a series of pairwise comparisons between criteria located at multiple levels of a decision hierarchy.

The data collection and software development processes were conducted under the supervision of the TAC team. The researchers provided the team with detailed updates on the progress through sharing report documents and two teleconferences. In the last teleconference, held on October 18, the researchers introduced and demonstrated the decision making software tool for the first time. The team received positive feedback on the overall tool performance and its user interface. The development process is proceeding to its final steps and the research team is now testing more real-world construction projects, using the developed software tool.

The remaining of this report is structured as the following: first, a summary of the Oregon project analysis is presented. Next, an introduction to the developed software is provided. The criteria definition list comes next. At the end, next steps of the research study are summarized.

Please indicate the level of preference by choosing the most descriptive score (both value and direction) in the rubrics below.

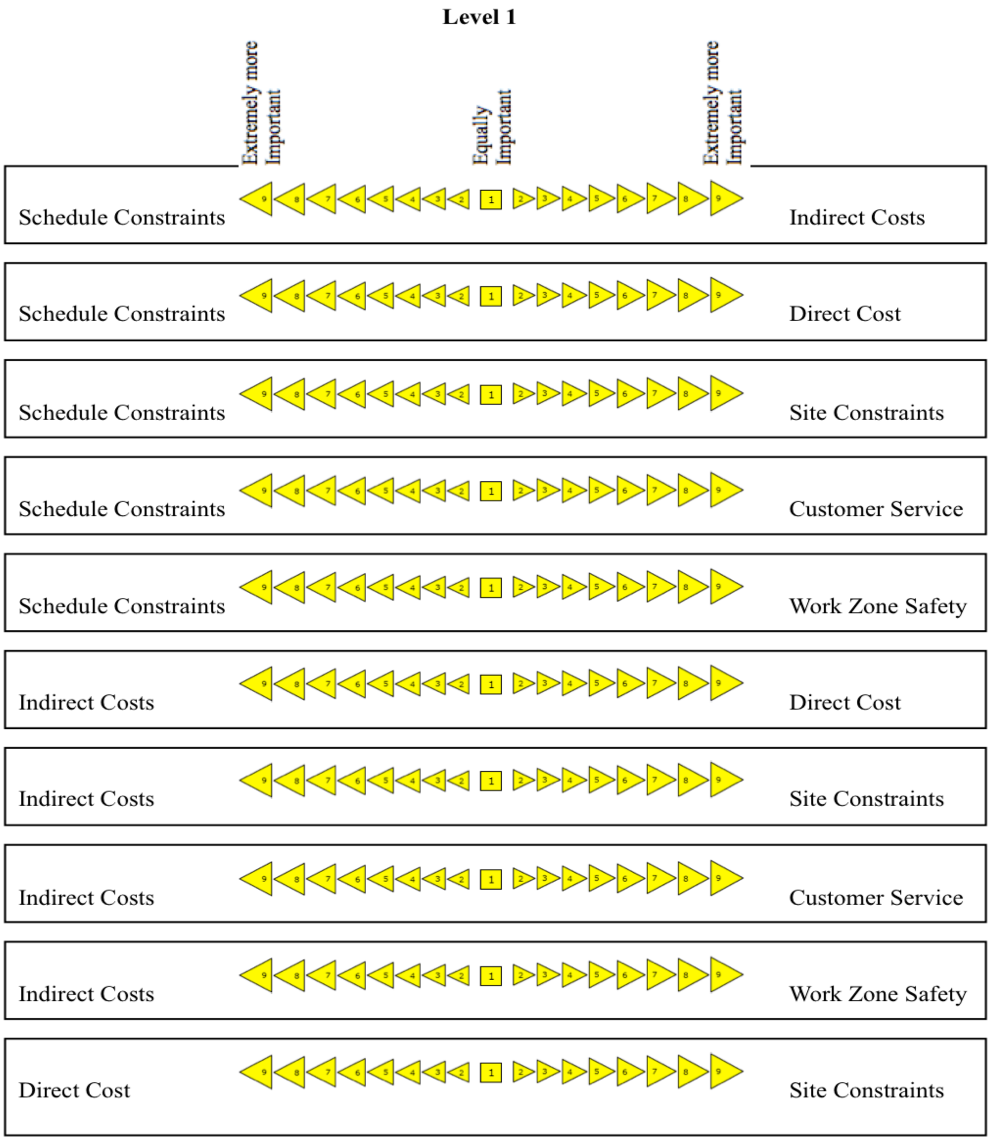

Figure 1. Survey snapshot

Review of Oregon Project AHP Analyses

During Task 3, a number of bridge construction projects were reviewed. The purpose of this study was to evaluate these project cases by considering different conventional and accelerated construction alternatives, using AHP techniques. These studies helped the research team to first validate the AHP model developed for this project and second to test the decision making software tool. In this section, a summary of the analyses conducted are presented.

1. Elk Creek Project

The Elk Creek project was completed by Oregon Department of Transportation. As a result, the research team was able to have a face-to-face meeting with an expert who worked on this project. The input data for the AHP analysis was collected through an interview session, using the developed survey. The interview session showed that the survey form works very well, when the expert has detailed knowledge of the project under the study. This initial test of the survey also highlighted some modifications to the data collection process.

The initial analysis of the data showed some inconsistency with pairwise comparisons in a number of hierarchy nodes. Inconsistency can affect the reliability of the outcomes. The research team believes that the inconsistency issue was caused by extreme evaluation of criteria (i.e. many criteria were evaluated as 9 times more preferable). The major reason for the occurrence of this inconsistency is the unfamiliarity of the interviewee with the AHP rating scale, which could be resolved by providing training or definitions of the rating scale. Figure 1 shows the overall results of the AHP analysis for the Elk Creek project. The output suggests that an ABC approach is preferable over a conventional approach. The results show that the criterion "Work Window", was the largest contributor to this result (Figure 2). This finding is also in agreement with the interviewee's overview of the Elk Creek project, which was discussed prior to completing the survey.

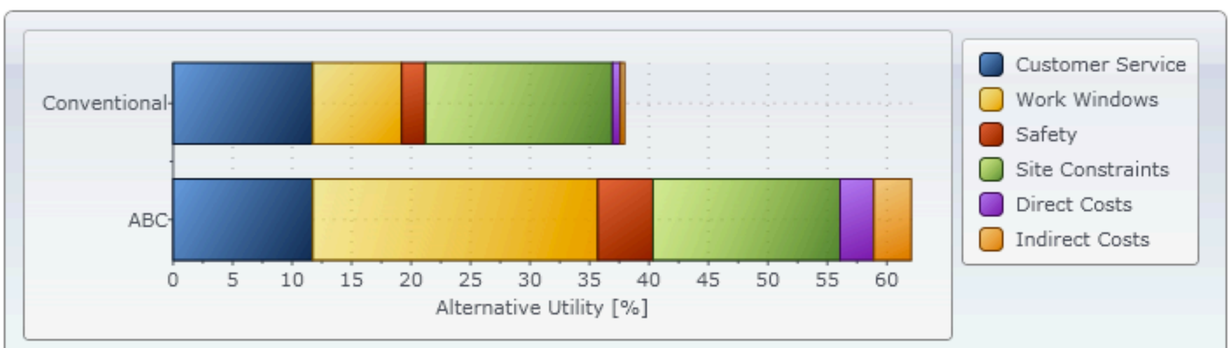

Chart Data

Alternative	Total	Customer_Service	Work_Windows	Safety	Site_Constraints	Direct_Costs	Indirect_Costs
ABC	62.050	11.730	23.970	4.640	15.730	2.830	3.150
Conventional	37.950	11.730	7.480	1.990	15.730	0.670	0.350

Figure 1. AHP analysis result for the Elk Creek project

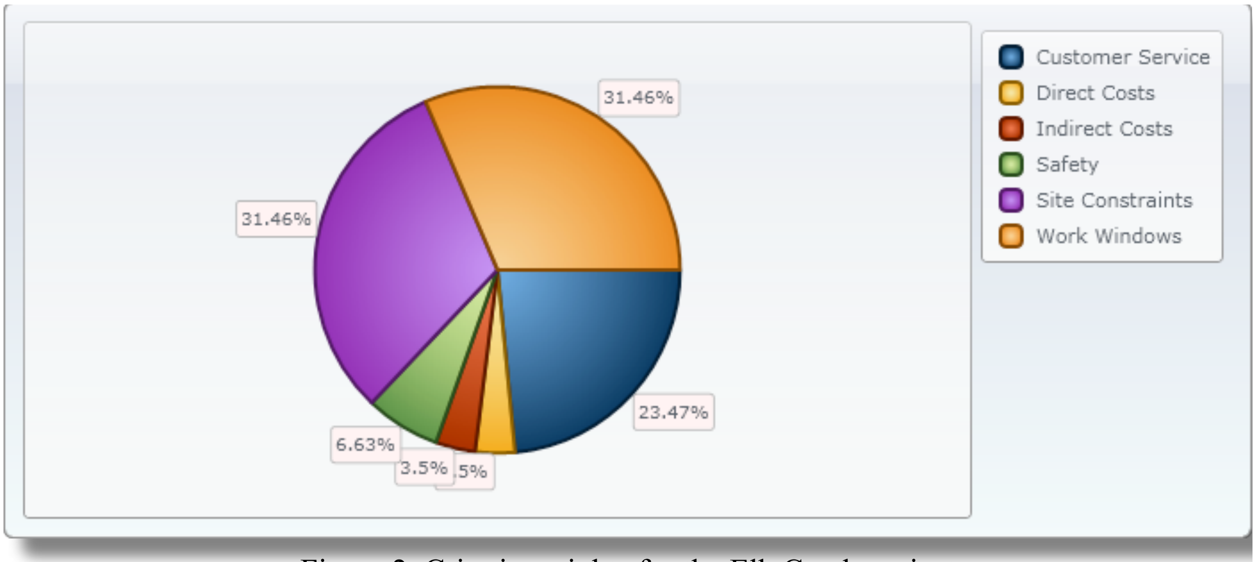

Figure 2. Criteria weights for the Elk Creek project

2. Pistol River Bridge Project

The Pistol River Bridge was constructed in 1961. At early stages of the project, decision makers planned for a rehabilitation project. However, due to the severe deterioration of the bridge, the plan was modified to a undertake a bridge replacement project. The length of the replacement bridge is 1000 ft. The project is currently in the "scoping" stage. The required data for this analysis was provided by a Senior Bridge Designer.

In this analysis, the ABC alternative was compared with two different conventional alternatives. The first alternative was a conventional bridge using a detour to maintain traffic. The second alternative consisted of a "realignment" step, which would allow a new bridge to be built beside the old bridge. The old bridge would be used for traffic during construction. The results of the analysis showed that in the first scenario, the utility values for the two alternatives are very close to each other, with only a slight (6%) preference for ABC (Figures 3 and 4). However, in the second scenario, the realignment alternative is much more preferable than the ABC alternative (Figures 5 and 6).

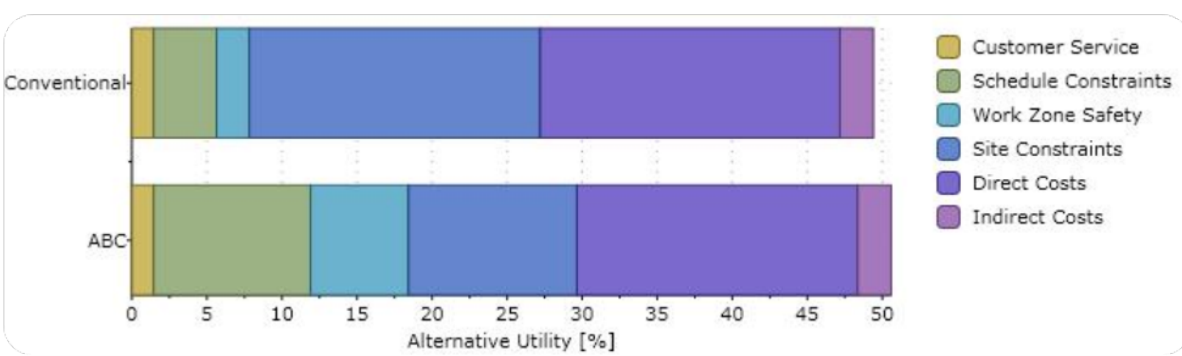

Figure 3. AHP analysis result for the Pistol River Bridge project (first scenario)

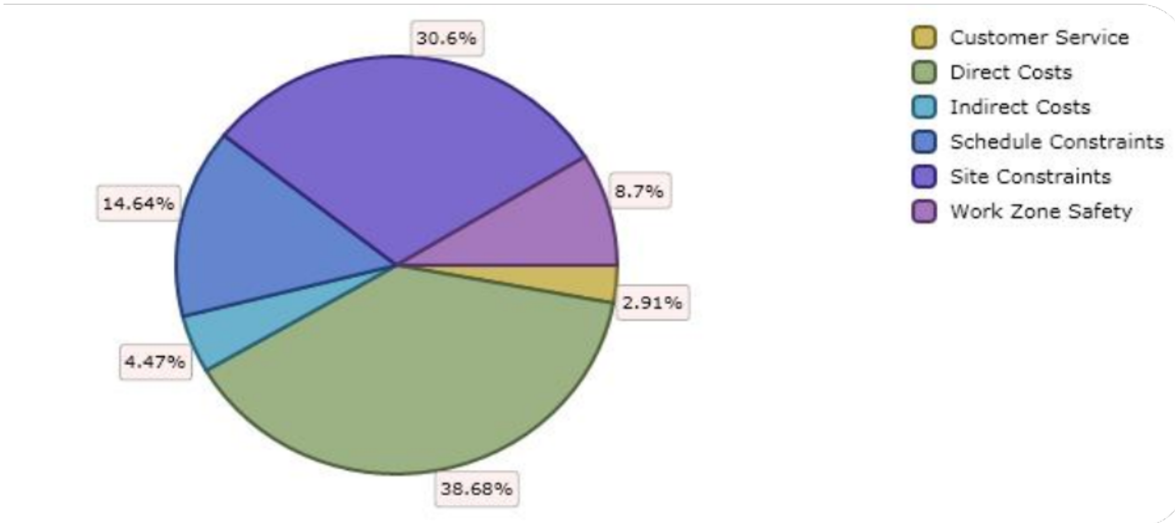

Figure 4. Criteria weights for the Pistol River Bridge project (first scenario)

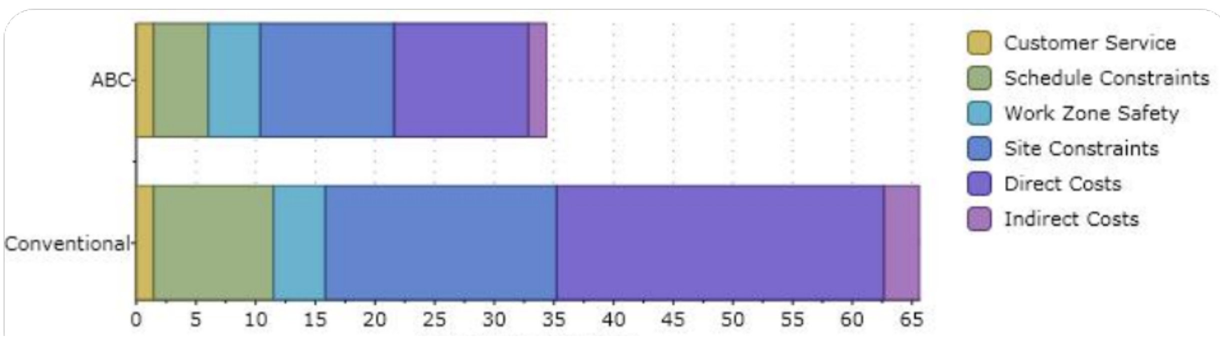

Figure 5. AHP analysis result for the Pistol River Bridge project (second scenario)

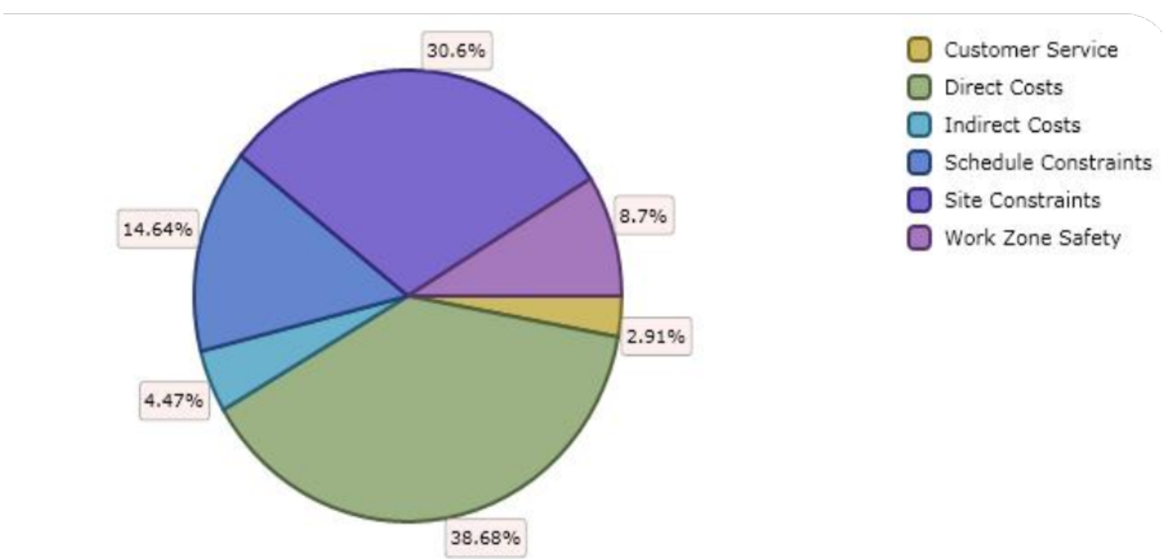

Figure 6. Criteria weights for the Pistol River Bridge project (second scenario)

3. Millport Slough Project

The required data for this analysis was provided by a project engineer and a project manager from Oregon Department of Transportation. The project was started in 2004 and the construction is not yet complete.

Based on the generated output from the interview with the project engineer, the Conventional alternative was preferred over the ABC alternative. The calculated utilities for the ABC and Conventional alternatives are 0.473 and 0.527, respectively (Figure 7).

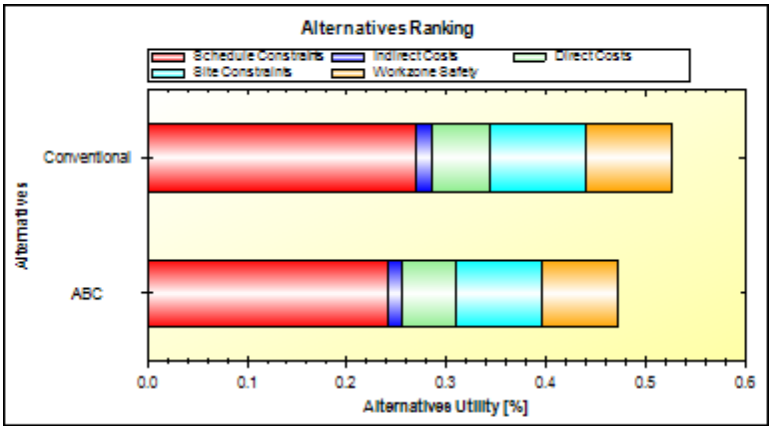

Figure 7. AHP analysis result for the Millport Slough project (first dataset)

Figure 8 presents the high-level criteria weights for the Millport Slough project. According to the results, “Schedule Constraints” and “Site Constraints” had the greatest impact on the project.

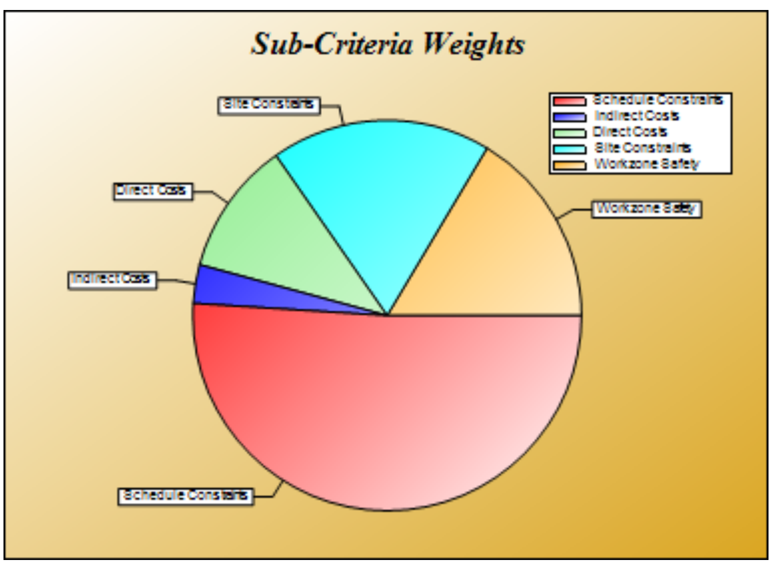

Figure 8. Criteria weights for the Millport Slough project (first dataset)

Based on the output generated from the second interview with the project manager, the Conventional alternative was preferred over the ABC alternative. The calculated utilities for the ABC and Conventional alternatives are 0.471 and 0.529, respectively (see Figure 9).

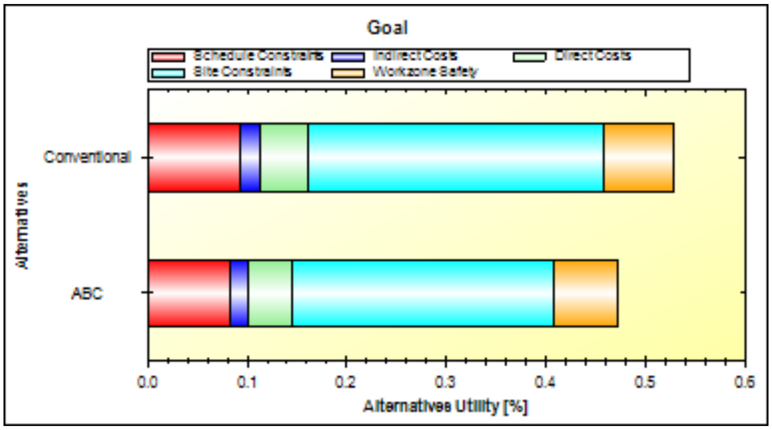

Figure 9. AHP analysis result for the Millport Slough project (second dataset)

Figure 10 presents the high-level criteria weights for the Millport Slough project. According to the results, “Site Constraints” and “Schedule Constraints” had the greatest impact on the project.

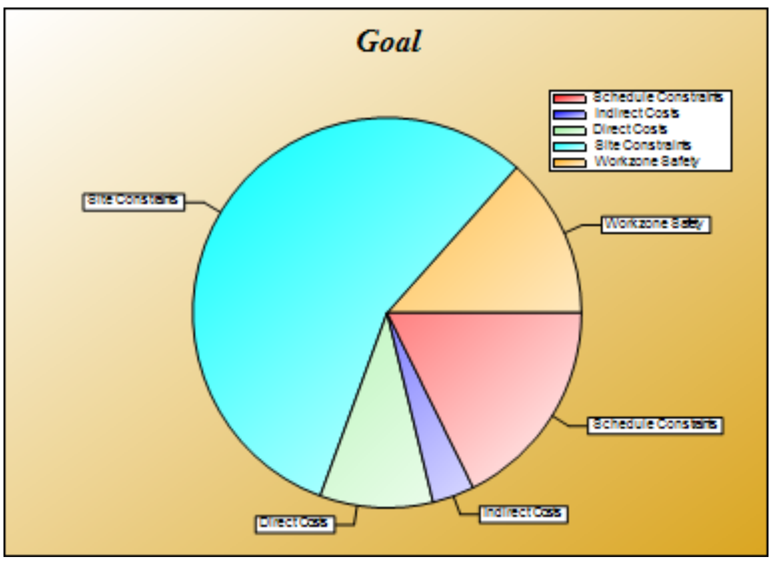

Figure 10. Criteria weights for the Millport Slough project (second dataset)

ABC Decision Making Software
In this section, a summary of the software under development is presented. The Oregon State University ABC decision making software was developed using Microsoft Visual Studio .NET as a stand-alone application. The software has been fully tested on all currently-supported Windows versions (i.e. MS Windows XP, Vista, and Seven). The software incorporates the most advanced software development concepts such as modular and object oriented design. As a result, the software has a high level of flexibility in addressing the user's needs and future expansions. Figure 11 shows a screen shot from the application's graphical user interface (GUI).

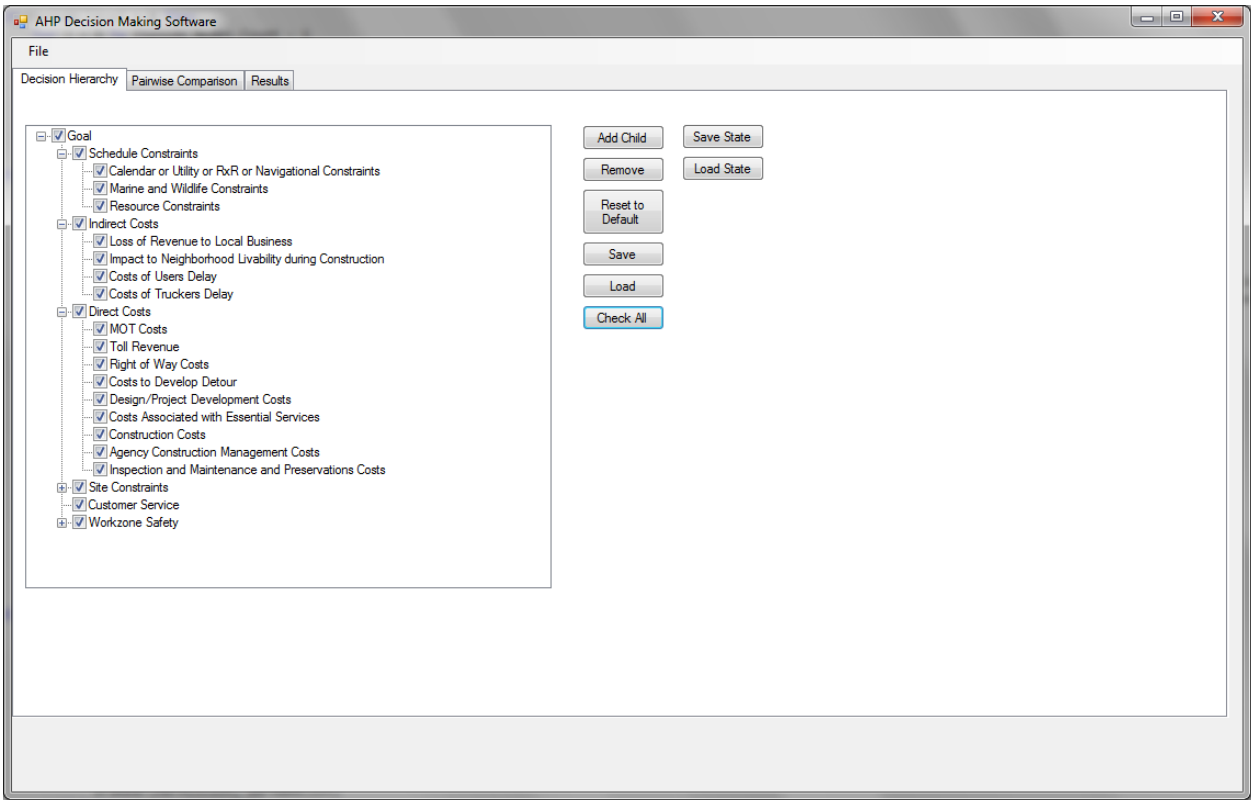

Figure 11. Decision Making Software Graphical User Interface (GUI)

The decision making software divides the overall AHP process into four steps, using a tabular design. The first tab is associated with all tasks related to constructing a decision hierarchy. In this tab, the user has access to all necessary functions to support loading, saving, and modifying a decision model. The user has an option to disable a decision category either temporarily or permanently for every model. The second tab (see Figure 12) is associated with conducting the pairwise comparison process. The user can save the state of a study at anytime and later return to that specific position, without losing any data. After finishing all the pairwise comparisons, the user can review the AHP results in the third tab (Figure 13). For each node existing in the decision model, the tool will generate a set of two plots: a bar chart indicating the utility levels of the alternatives and a pie chart showing the weights for sub-categories. The last tab provides the user with the capability to complete an additional benefit-cost analysis. This tab must be used only after all cost criteria have been eliminated from the AHP model.

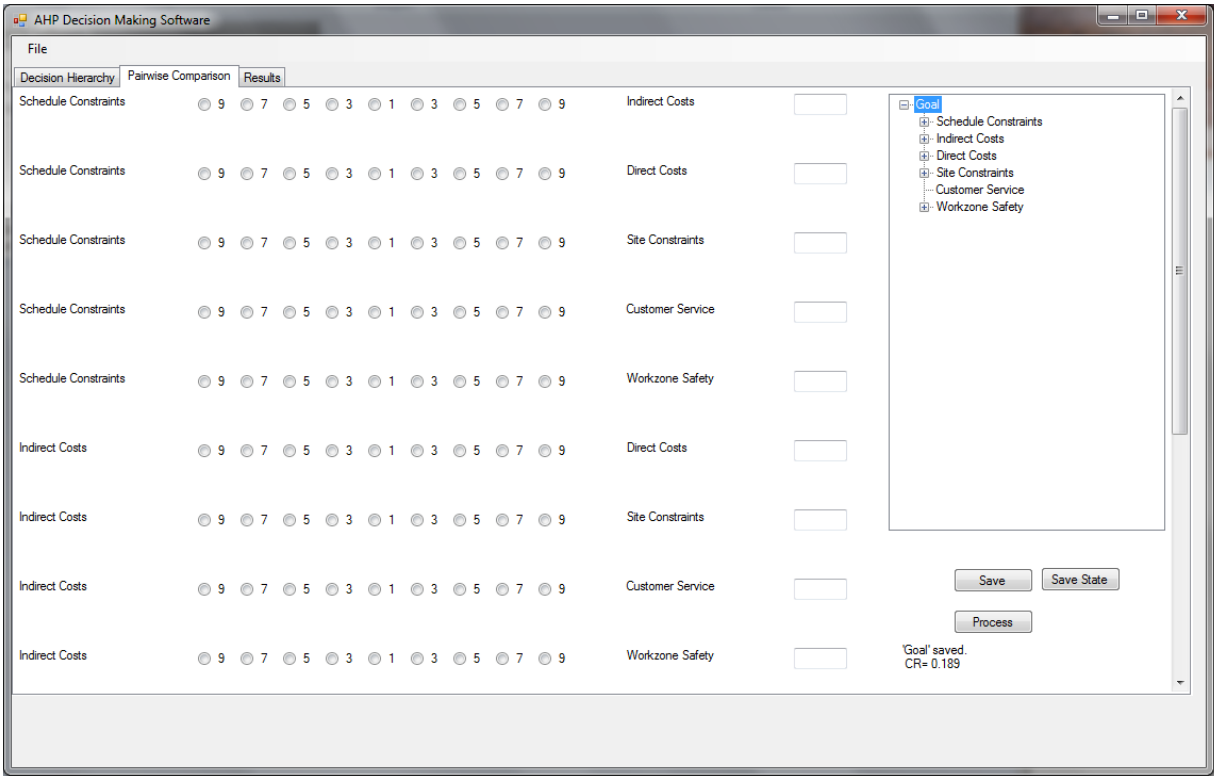

Figure 12. Pairwise Comparison Tab

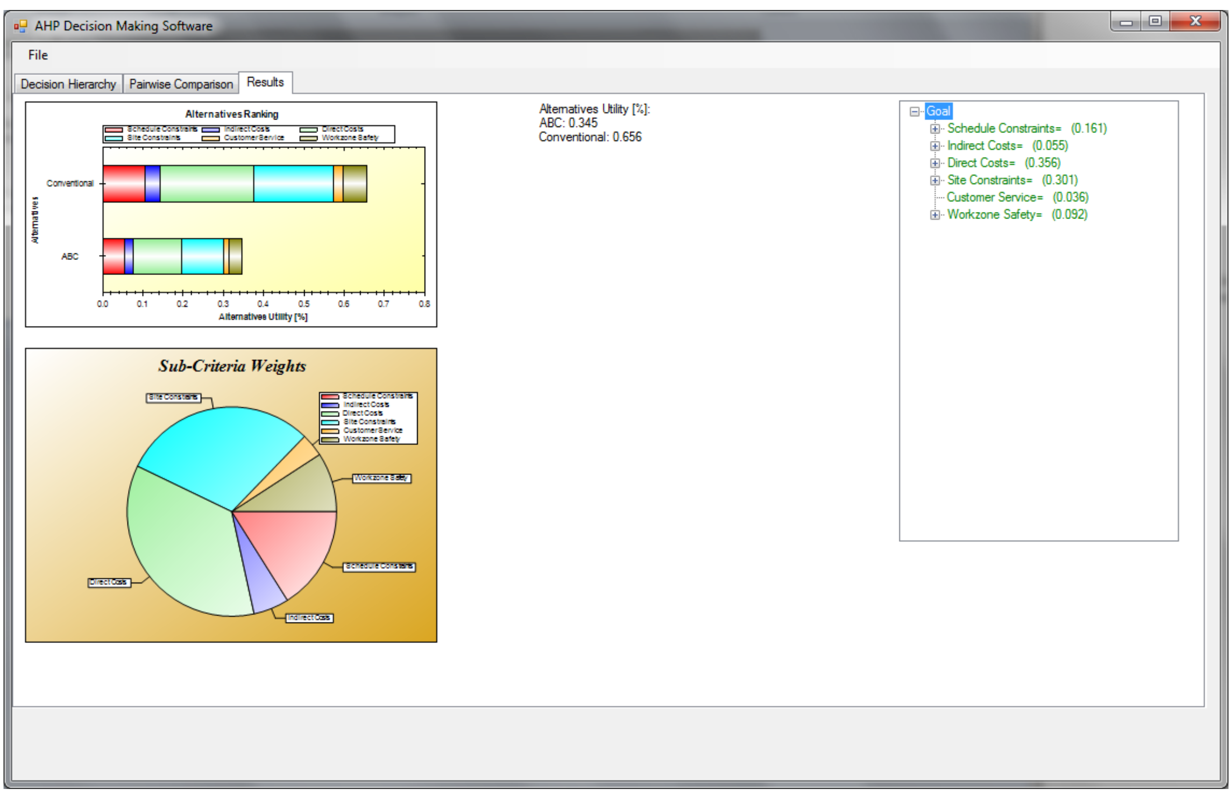

Figure 13. Results Tab

Decision Criteria Definitions

The table provided in this section contains definitions for all criteria currently incorporated into the decision model. This definition list will enable users to understand the decision hierarchy and provide consistency between users when completing the pairwise comparison process. The definitions were developed under the supervision of the TAC team and additional modifications will be incorporated over the next quarter.

Direct Costs	**Maintenance of Traffic (MOT) Costs**	This factor captures the maintenance of traffic costs at the project site. MOT costs may impact preference due to its impact on total costs. Examples of this factor include costs associated with the maintenance of detours during construction and the preparation of detours prior to construction, signage, signals, barriers, temporary overlays, crossovers.
	Toll Revenue	This factor captures the loss of revenue due to the closure of a toll facility. Toll revenue may impact preference because it directly impacts total costs.
	Right of Way (ROW) Costs	This factor captures the cost to procure ROW. This factor may impact preference due to its impact on total costs. This factor includes either permanent or temporary procurements/easements.
	Costs to Develop Detour	This factor captures the costs to meet the requirements and to construct detour bridges to accommodate traffic through the project site. This factor may impact preference due to its impact on total costs. Examples of this factor include cost to design and to construct detour bridges and roads.
	Design/Project Development Costs	This factor captures the costs associated with the design of a bridge and costs related to project development based on the construction method. This factor may impact design preference and construction methods which directly affect total costs.
	Costs associated with Essential Services	This factor captures the costs associated with the need to provide essential services that may be impacted by the construction selected. Examples of this factor include alternate routes to provide defense, evacuation, emergency access to hospitals, schools, fire station, and law enforcement, etc.
	Construction Costs	This factor captures the estimated costs associated with the construction of the project. This factor may impact preference due to its impact on total costs. This factor includes premiums associated with new technologies or construction methods. Premiums might result from factors such as contractor availability, materials availability, and contractor risk.
	Agency Construction Management Costs	This factor captures the costs associated with the agency project oversight.
	Inspection, Maintenance and Preservations costs	This factor captures the costs associated with life cycle maintenance and preservation of individual bridge elements.
Indirect Costs	**Loss of Revenue to Local Business**	This factor captures lost revenues due to limited access to local business resulting from limited or more difficult access stemming from the construction activity.
	Impact to Neighborhood Livability during construction	This factor captures the impact to the neighborhoods resulting from construction activities. Examples of this factor include noise, delays, limited access. This factor may impact preference due to a desire to accelerate construction in order to minimize a neighborhood's exposure to construction activities.
	Costs of Users delay	This factor captures costs of delay at a project site due to reduced speeds and costs associated with delays, when using off-site detour routes. As an example, cost of queue times, which are calculated using ADT, delay time, and operating costs (driver and vehicle).

	Costs of Truckers delay	This factor captures trucker costs of delay at a project site due to reduced speeds and costs associated with delays, due to the use of off-site detour routes . As an example, cost of queue times, which are calculated by ADTT, delay time, and operating costs (driver and vehicle).
Schedule Constraints	**Calendar or Utility or RxR or Navigational Constraints**	This factor captures the constraints placed on the project that might effect the timing of construction as a result of weather windows, significant or special events, railroad, or navigational channels. This factor may impact preference because certain construction methods may be more effective at accommodating these constraints.
	Marine and Wildlife Constraints	This factor captures the constraints placed on the project by resource agencies to protect marine or wildlife species. Examples of this factor include water work windows, migratory bird windows, nesting requirements, and etc.
	Resource Constraints	This factor captures resource constraints associated with the construction. A DOT may be resource-constrained in terms of staff available to design a project using a particular method or technology. This factor may impact preference since a state may be forced to go to a consultant, which may result in additional time requirements to get the consultant on board and deliver the project.
Work Zone Safety	**Safety Costs to traveling public**	This factor captures the risks associated with user exposure to the construction zone, including crash or accidents. Longer construction duration often results in higher user safety risk.
	Safety Costs to construction workers	This factor captures the risks associated with worker exposure to construction zone. Longer construction duration often results in higher worker safety risk.
Site Constraints	**Horizontal/ Vertical Obstructions**	This factor captures physical constraints that may impact construction alternatives. Examples include bridges next to fixed objects such as tunnels, ROW limitations, sharp curves or steep grades, or other urban area structures that constrain methods and/or bridge locations.
	Span Design	This factor captures criteria related to span design. The construction might require using simple spans or a continuous span. This element of the design may affect costs or owner preference.
	Archaeological Constraints	This factor captures archaeological and historical constraints existing on a construction site, which may impact a construction project. Decision makers would have a preference for construction methods that minimize the impact on the construction site environment.

Next Steps

In the remaining portion of this research study, the team will finalize the pairwise comparison survey list by conducting more data collection sessions using bridge projects from other participating states. Through this data collection, the research team will test and validate the hierarchy and software. The research team will also begin efforts to create a user's guide and to develop training materials to use in rolling out software to TAC team members and beyond.