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Improving the Conventional Decision Matrix

A decision matrix is a popular approach to systematically identify, analyze, and rate the performance of a list of alternatives based on a set of decision criteria. Once the alternatives and criteria are identified, users will assign weighting factors for each criterion which will be used to score each alternative. Typically a final score, normalized and weighted, will be combined with ranking of capital, O&M, and life cycle costs to make the final recommendation. The matrix is useful for assessing each decision factor's relative significance, and combining multiple analyses into one set of recommendations.

Carollo has developed an advanced approach, referred as the Dynamic Decision Matrices (DDM). Similar to a conventional decision matrix, DDM also utilizes the criteria, weighting, and scores to rank the alternatives. The difference is in a DDM the weighting factors, the scores, and the final ranking are linked and calculated based on critical variables such as water quality, treatment goals, material and resource intake, capital and O&M costs, and other specific inputs. Using this approach, users can conduct virtual scenarios of their system to capture the impacts and sensitivities of critical variables on the final recommendation.

The DDM function can be used to perform both **double bottom line analysis** (monetary or business impacts plus non-monetary or social impacts) and **triple bottom line analysis**, which also includes our environmental assessment evaluation.

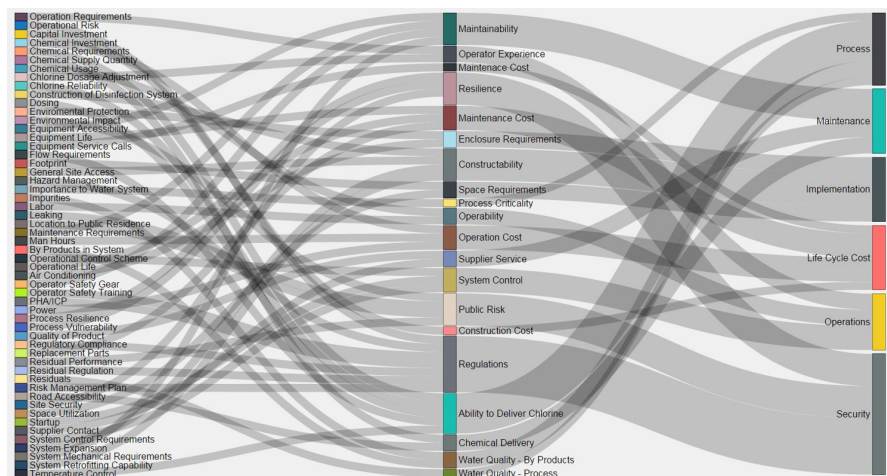
The monetary impact (capital and O&M costs) associated with each alternative can be entered or imported from a separate analysis, or linked with the detailed cost model in the Blue Plan-it® decision support system.

Social impact scores can either be entered through a conventional approach, or calculated based on inputs received through a simple online survey. The survey questions capture project-specific critical inputs from individuals in an objective manner, separating personal opinions that could skew the decision making process.

Environmental scores can be entered or imported from a full Life Cycle Environmental Impact Assessment (LCA). Scores can also be generated using a simplified LCA methodology integrated in Blue Plan-it®, which quantifies environmental impacts (global warming, acidification, eutrophication, natural resource depletion, water footprint, ozone depletion, etc.) associated with each alternative based on high level quantity

take-off of construction materials, consumables, energy, and chemicals consumed during the entire project life cycle.

For a complex decision making process with large masses of decision factors, the decision analysis often involves many interconnected, conflicting, or overlapping criteria and considerations. In conventional approaches, criteria and considerations can be missed or double counted. To better understand the relationship of these factors, a more dynamic tool with a systemic framework is required to merge these criteria and considerations into the least amount of independent parameters and ultimately an irreducible set of categories. For example, if two or more performance criteria are conflicting with each other, the multi-objective optimization capability of Blue Plan-it® would be applied. In such cases, there is not a single optimal solution and it is necessary to use decision-maker's preferences to differentiate between solutions.



Sankey diagram illustrating the criteria merging process.

Case Study: City of Phoenix Remote Facility Disinfection System Study

The City of Phoenix Water Services Department operates and maintains many remote water facilities including well sites, booster stations, pressure reducing valve stations, and water storage sites. Many of these remote facilities are equipped with disinfection systems including gaseous chlorine, sodium hypochlorite from on-site generation, chlorine tablets, or bulk delivered sodium hypochlorite that is then batched. Each system was installed over the years to meet site specific requirements or project specific goals. As a result, the City now has multiple types of systems, which increases the complexity of operation and maintenance, training, and management. To alleviate some of these challenges, a standardized set of criteria and framework for disinfection technology selection is desired.

Carollo developed a decision support tool for the City to integrate institutional knowledge, operational experience, technical expertise, and management strategies into one useful program. This tool ranks the options using a dynamic decision matrix.

"Carollo is one of the most technologically savvy water engineering firms that I have worked with. They came up with creative ways to investigate problems and collect inputs. They provided a systematic objective but also interactive tool for disinfection system selection for the City. We were very pleased with the outcome and highly recommend Carollo's Decision Support System service."

— Can Xiao, Project Manager,
City of Phoenix

Instead of conducting one site specific decision matrix, the program models the impacts of site specific conditions (e.g., distance to school and residence, length and width of emergency access, seasonal and diurnal demand patterns and intermittent uses, and criticality for maintaining chlorine residual at the site) on weighting factors, scores, costs, and ranking.

Real-time Decision Support

Connecting with Power BI, Tableau, Excel, and the Blue Plan-it® decision support system, the DDM approach can be customized to combine many analyses in one decision support dashboard. This creates a systemic and interactive decision making environment, supporting stakeholder meetings, workshops, and public outreach.

