



Methods for Comparing Design Alternatives

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Introduction

Project professionals often need to be able to compare alternatives and select a logical solution. There are many situations when a significant choice or problem arises that has multiple viable options.

Examples include:

- Design alternatives
- Equipment selection
- Vendor and subconsultant selection
- Change evaluation
- Project rescue options for unexpected issues
- Risk response planning
- Sequencing options

Key benefits to a formal alternatives comparison process include:

- Alignment with project objectives
- Stakeholder input and concurrence
- Transparency in decision-making
- Logical decision-making
- Risk management satisfied
- Encourages innovation
- Enhanced flexibility and adaptability
- Fairness and objectiveness

It is important to have an understanding of the common approaches to comparing alternatives. Some approaches are very high-level to make a quick decision. Other approaches require detailed calculations and significant mathematics.

The following are common approaches to comparing alternatives, in order from simple to complex:

- Advantages Table
- Qualitative Comparison
- Quantitative Comparison
- Multi-Criteria Scoring

This course covers each of these methods, then goes into detail on economic and sustainability comparisons.

Advantages Table

The simplest approach to comparing alternatives is with an Advantages Table or Advantages List. Each alternative is listed with perceived advantages and disadvantages. See Table 1 for comparing roof types for a new building design project.

Table 1: Example Advantages Table			
Alt. No.	Description	Advantages	Disadvantages
1	Asphalt Shingle Roof	Fast installation Low cost Color selection	Short life span
2	Clay Tile Roof	Aesthetically pleasing Long life span Storm resistant	Expensive
3	Metal Roof	Long life span Storm resistant Color selection	Expensive

With this approach, there is a lot of flexibility in choosing the criteria to include in the advantages and disadvantages columns. The project objectives and product requirements should be reviewed to help decide on the important criteria for the project.

Often, very extreme or very important differences are listed in both the advantages and disadvantages columns (like cost and life span), while less extreme or important differences are only in one column (like color, aesthetics, and storm resistance). This explains why in Table 1, Alternative 1 has an advantage of “fast installation”, but Alternatives 2 and 3 do not have “slow installation” as a disadvantage.

The person responsible for the alternatives comparison is trusted to make judgment decisions as to what criteria to include and when to list advantages/disadvantages in one or both columns. One should be humble enough to seek input from other technical experts to fully understand the impact of each alternative. Often, a project manager or client manager will review to see the table through the eyes of the client or customers.

Overall, the advantages table approach is fast and simple, but has a lot of subjectivity and may not result in choosing the best alternative.

Qualitative Comparison

An improved approach is a qualitative comparison table. An example for comparing roof types is shown in Table 2. This approach lists several criteria (also called indicators), with a comparison of the alternatives for each criterion. In this case, six criteria are presented: Installation Time, Construction Cost, Color Selection, Aesthetics, Life Span, and Storm Resistance. And the qualitative terms “Best, Average, Worst” are used to compare each alternative for each criterion. Alternatively, terms such as “Good, Fair, and Poor” may be used.

Alt. No.	Description	Installation Time	Constr. Cost	Colors Available	Aesthetics	Life Span	Storm Resistance
1	Asphalt Shingle Roof	Best	Best	Average	Worst	Worst	Worst
2	Clay Tile Roof	Worst	Worst	Worst	Best	Best	Average
3	Metal Roof	Average	Average	Best	Average	Average	Best

Note how Table 2 provides significantly more information than the previous advantages table. It also has less subjectivity since alternatives must be compared for each criterion. Often, this type of comparison table is sufficient to allow selection of an alternative.

Project Selection - Qualitative

Qualitative comparisons are also common for making project selection and prioritization. See Table 3 for an example project comparison table.

Proj. No.	Project Name	Constr. Cost	Payback Period	Return on Investment	Risks & Safety	Permit Req’s
1	Packaging Upgrade	Best	Average	Average	Average	Best
2	Storage Facility	Average	Worst	Worst	Best	Worst
3	Add Prod. Line C	Worst	Best	Best	Worst	Average

Looking at Table 3, each potential project is “best” in at least one category. Often at the business stage, the payback period and return on investment criteria hold the most weight, so Project 3 is the most likely to be chosen to proceed. However, it is possible that Project 2 is to replace an existing storage facility that

is unsafe, with a history of employee injuries, which would escalate the importance of the project. A notes column can be added for critical information for making a project selection decision.

Quantitative Comparison

The previously discussed alternatives table and qualitative comparison table are commonly used for design decisions with relatively simple and low-cost systems, or for early decisions to be confirmed later during detailed design. A quantitative approach is more common for complex, critical, high-risk, and high-cost systems. A quantitative comparison takes more effort but provides more information to make a more informed choice of alternatives.

A quantitative comparison includes numerical values for comparison, which allows seeing the magnitude of the differences. For example, dollar values are to be listed for the estimated construction cost of each alternative. See Table 4 for an example of a quantitative comparison table. The best values for each criterion are in bold to help indicate the best alternative.

Alt. No.	Description	Installation Time (days)	Constr. Cost (USD)	Colors Available (number)	Aesthetics (1 to 10 scale)	Life Span (years)	Storm Resistance (mph)
1	Asphalt Shingle Roof	3 days	\$10,000	20	4	15	110
2	Clay Tile Roof	7 days	\$60,000	10	10	50	125
3	Metal Roof	5 days	\$40,000	100	6	40	150

These types of tables are common for engineering reports with alternative comparisons. Having numerical values and seeing them in a single table is very helpful.

Project Selection – Quantitative

See Table 5 for an example project comparison table using a quantitative approach. For the last two columns, the scale of 1 to 10 is with 1 being the best and 10 being the worst. Typically, for each such criterion, the worst alternative is set to 10, and the others are set to a comparative number. A score of 5 would indicate half (50%) of the amount as the worst alternative.

Table 5: Quantitative Project Comparison for Project Selection

Proj. No.	Project Name	Constr. Cost	Payback Period	Return on Investment	Risks & Safety (1 to 10)	Permit Req's (1 to 10)
1	Packaging Upgrade	\$5M	10 yrs	50%	6	2
2	Storage Facility	\$8M	20 yrs	25%	3	10
3	Add Prod. Line C	\$20M	5 yrs	100%	10	6

Risk Scoring

Risk scoring involves comparing different systems or components. For example, in a sewer network, pipes may require replacement. A risk score is calculated based on the probability of failure values (each criterion is assigned a weight).

$$\text{Risk Score} = \text{IF} * \text{W}$$

where IF = Importance Factor

Risk ranking is covered in more detail in the next section.

Multi-Criteria Scoring

The multi-criteria scoring approach, also known as multi-criteria decision analysis (MCDA), uses numerical values for each criterion, similar to a quantitative approach, but also uses those values to calculate a total score for each alternative. The scoring approach minimizes subjectivity and provides transparency in showing how the best alternative is chosen.

See Table 6 for an example of a multi-criteria scoring table with the same six criteria as Table 4 (columns and rows are inverted). In this case, the Metal Roof gets the best score.

