# Bayesian Decision-Making Fundamentals: Goal-Fabric Analysis

**Thesis**

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ABSTRACT

Modern decision makers are confronted with the task of making qualitative, multi-criterion decisions under uncertainty with only highly quantitative, profit oriented models available as aids in making them. Presently, there are two sources from which the decision maker can obtain information on decision making techniques. The first is highly mathematical literature on Bayesian and statistical decision theory. The second is business and technical applications of decision theory. The first source is too technical for most decision makers; the second does not present the fundamentals. This thesis project presents Bayesian decision making fundamentals in a logical, non-technical text providing the decision maker with the basics necessary to make decisions under uncertainty using both qualitative and quantitative criteria.

The project is organized into: six concept chapters, a summary, a reference guide, and four appendices. The concept chapters utilize one main example problem which is solved using each new concept. Each solution utilizes (1) the problem solution framework, i.e., problem definition, selecting objectives, synthesis, analysis, and final alternative selection, and (2) decision diagrams. Each part of the problem solution framework is defined and discussed. Linear and non-linear preference (utility) is presented. Probability is introduced as well as the concepts of uncertainty, state of nature, and expected value. Two multi-criterion analyses are outlined. One is quantitative, weighted sums of numerical criteria estimates; the other is qualitative, a goal

fabric analysis. The project also deals with the economics of additional information utilizing conditional probabilities, Bayes' rule, and a pre-posterior analysis. The appendices are: (1) a glossary of terms used in the text, (2) a table of symbols, (3) a full discussion of decision diagrams, and (4) a detailed explanation of how to assess preferences and generate preference curves.

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Objectives, Criteria, and Units
for the Example Problem

| Objective | Criteria | Units |
|---|---|---|
| (1) Preserve forest and natural environment | slash | tons |
| | particulates in air and water | tons |
| | wildlife destroyed | percent of population |
| | water wasted | gallons per year |
| (2) Prevent erosion | earth lost | tons per year |
| (3) Maintain service between Logville and Lakeview | time open during construction | percent of time |
| (4) Involve area citizens in decision making process | number involved | percent |
| | weight in decisions | percent |
| (5) Maximize net gain | present worth over 20 years | dollars per day |

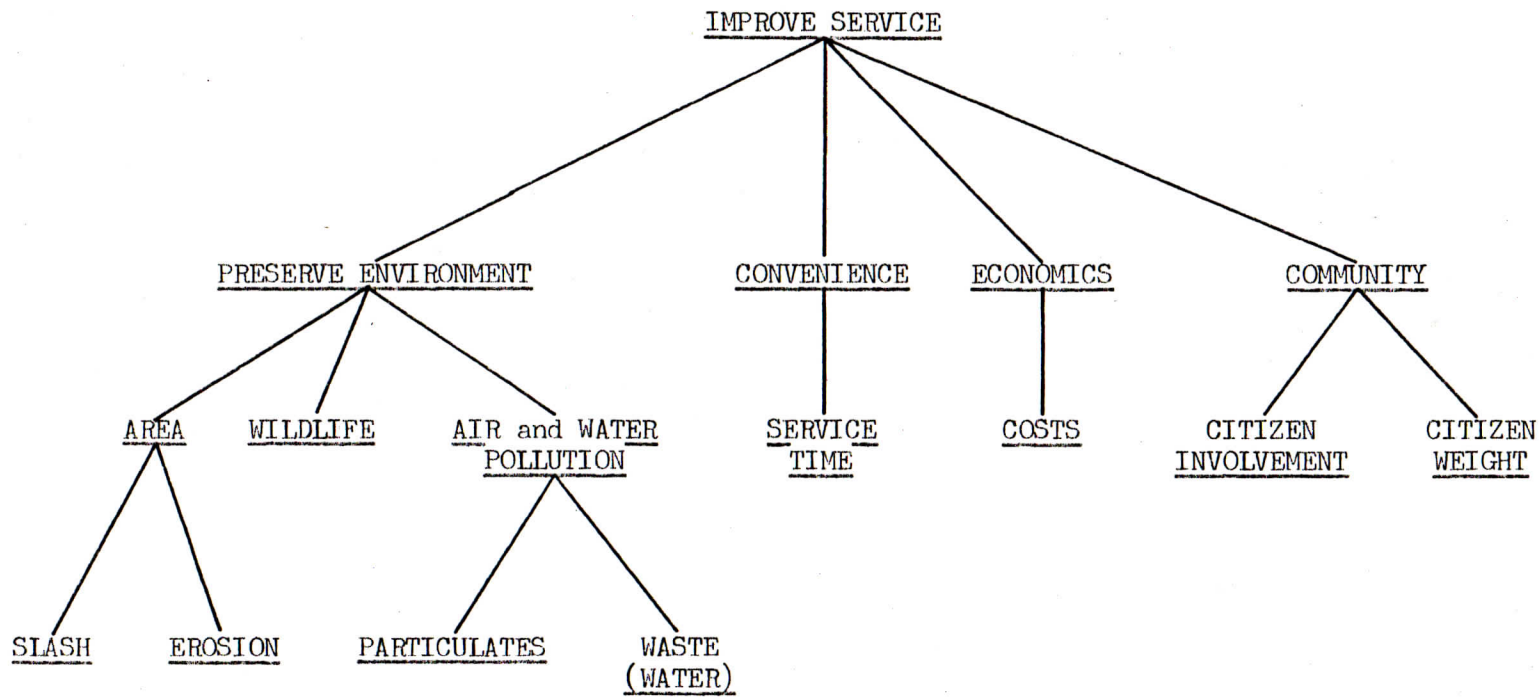


Figure 9

Goal Fabric for Example Problem

Table 11

Preferences for Transportation Alternatives

| Alternative | Criteria | | | Total |
|---|---|---|---|---|
| | Beauty | Convenience | Average Speed | |
| A | 2.5 | 1.0 | 3.0 | 21 |
| B | 4.0 | 0.5 | 3.2 | 23 |
| weights | 2 | 4 | 4 | |

Summary

The above analyses provide two possible ways to make decisions using many objectives and criteria. Similar analyses are available or in the development stage and can be found in decision making literature. However, the decision maker need not rely on specific procedures to perform his analysis. By using the principles in this chapter, he should be able to design an analysis to solve his problem. The success of his analyses will improve as the decision maker practices and experiments with the fundamentals.