

Multi-Objective, Multi-Criteria Decision-Making

Objectives are goals or outcomes. In environmental impact assessments there are always several objectives, sometimes conflicting with, other times complementing, each other. Development projects have objectives of profits or services. Considerations of impacts on the natural environment and the socioeconomic setting in which the project is located are the criteria by which the various objectives are evaluated. Since the effects of each criterion will be different on each objective, the decision-making process must involve all objectives and all criteria. A hydroelectric dam may have objectives of producing electrical power, flood control, irrigation water supply, and recreation. A gravel pit on farmland may have the objectives of both extracting aggregate and returning the land to the farmer without rocks and with optimal farming contours. A seaport may have objectives of maximizing import and export of certain commodity types, operating a ship building and repair profit center, leasing buildings and facilities for industrial and commercial operations, and running a gas-turbine, cogeneration power plant to provide electric power, heat, and process steam for all facilities. In many cases, perhaps most, the objectives have different priorities for separate groups of stakeholders. None of the objectives for the representative projects listed above included any of the components of an environmental impact assessment.

Criteria can be considered constraints that must be satisfied when an objective is reached. Criteria for a project could be included in the descriptions of objectives: maximize profit, minimize costs, constrain

environmental disturbance to the minimum acceptable level, generate more jobs. Each criterion must be satisfied regardless of which objective is accepted.

In every real world situation there are objectives and criteria along continua between extreme positions. However, without well-structured, solidly based, objective (compared with subjective) procedures for finding the most acceptable project goals and threshold of criteria satisfaction, the process may result in a zero-sum game. For one side to win, the other side must lose. While this is completely satisfactory to the winner, it leaves innocent bystanders out of the decision-making process and it creates very unhappy losers.

Among the many possible methods proposed and used in different multi-objective, multi-criteria decision-making processes, one that could be used in environmental impact assessments is based on the Analytic Hierarchy Process (AHP) developed by Thomas L. Saaty in 1970 [29]. Figure 12.1 is a visual model of a hierarchy for port development. The goal is the optimal development path, the objectives that are available to reach that goal are maritime operations, heavy or light industrial activities or commercial leases. The constraints on achieving those objectives are profits, jobs, wetlands, wildlife habitats, and fish habitats.

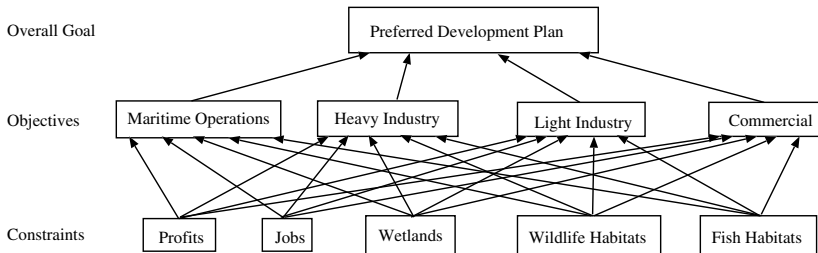


Fig. 12.1. Example of an AHP for seaport development. Four objectives and three criteria (constraints) are shown as levels in the decision-making hierarchy.

Saaty developed the AHP as both a theory and method for “modeling unstructured problems in the economic, social and management sciences” [29, page 3]. Economic theory has been developed around