Evaluating Projects with Conflicting Objectives

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Abstract

Decision-makers are often asked to evaluate a range of projects in order to select the alternative that, within given resource constraints, will best achieve their organization's combined objectives. When faced with this situation, it is uncommon for a single project to satisfy all of the **conflicting objectives** represented by individuals on the evaluation team. As a result, *trade-offs* between the competing objectives of the organization must be made. In practice, these trade-offs can be difficult to make and hard to justify to others, because they often require consideration of a lot of *subjective* data. This paper will discuss how Multiple Objective modelling techniques have been used to successfully facilitate transparent and auditable evaluation decisions. It introduces *Logical Decisions*® decision support software to demonstrate this approach, and includes a case study of work undertaken for *Infrastructure Auckland* to evaluate stormwater projects for funding. Multiple Objective modelling has been used widely in Europe and the U.S.A for the evaluation of projects, programmes and overall policy framework decisions. In Australasia it has been used to evaluate environmental policy and defence spending, to select training programmes and information technology vendors, and to allocate grants to strategic projects.

Introduction

In today's fast moving environment, organizations are finding that they must develop new strategies, projects and programmes to keep pace with the changing needs and heightened demands of the individuals that they serve. These demands are often the product of changes in technology, social attitudes or government legislation, and they can be conflicting in nature. For example, consumers are continually demanding costly technological improvements to products and services, at a reduced price to the end user. Members of the public are similarly demanding community projects that simultaneously promote economic, social and environmental sustainability, rather than solely promoting economic growth.

Few organizations have the resources or funds available to implement strategies or projects that achieve *all* of their objectives. Indeed, no solution may actually exist that *equitably* addresses all conflicting demands. As a result, prioritisation and *trade-offs* of objectives must be made, to determine the best courses of action from the wide range of possible alternatives. Many organizations are now finding that their traditional decision-making processes are not adequately addressing the complexity of these trade-offs. As a result, they often resort to focusing on what they already know, or they over simplify the decision by using a single objective such as "least cost." This inevitably leads to sub-optimal decisions being made.

Justifying the Decision

While decisions made on individual intuition or "gut feel" would appear to be one way to resolve complexity difficulties, this is also an increasingly unacceptable route for organizations to take. The accountability demanded by today's public and media requires decision-makers to explain and justify every step of the process that led them to their final decision. Boards, representatives and the general public are calling for more and more input into key decision-making processes. These interest groups increasingly want to *audit* the process undertaken to evaluate a project. The process undertaken must therefore be highly transparent and robust; especially with regard to the way it identifies and values the intangible benefits of the project.

Dealing with Facts & Value Judgments

For complex decisions, internal project teams and external advisors can often spend months evaluating different projects or strategies and predicting possible benefits and pay-offs. When evaluating alternate courses of action, the decision-makers must consider many conflicting *value* judgments, along with more easily quantifiable considerations such as costs, timeframes, and statistical facts. Value judgments can be wide ranging, and may include assessments of culture, sustainability, community well being, or other perceptual attributes. Value judgments are subjective and can be open to individual interpretation if they are not clearly defined, measured and agreed upon by all decision-makers. They can lead to disputes, time wastage or extreme difficulty reaching consensus and a final decision.

Why Use a Structured Evaluation Process?

The Evaluation Process presented in this paper has been developed to address the difficulties described above. Using Multiple Objective modelling (or *"multi-attribute utility theory"*) techniques, it is designed to keep decision-making on course. Used in conjunction with Logical Decisions for Windows® (LDW) software, the process has been tested and proven to offer the following benefits:

- **Provides a structured framework** that breaks the evaluation down into manageable steps. It allows decision-makers to work through the problem together, and in a logical way.

- **Records an "audit trail"** that provides people who are not directly involved in the evaluation process, with a clear insight into the steps and deliberations that were undertaken to reach the decision.

- **Creates a common scale of measurement** that allows qualitative values, along with quantifiable values (expressed in dollars, minutes, kilograms or other scales), to be compared and weighted side by side.

- **Filters large quantities of information**. In today's information age, the problem is not that organizations can't access enough information to make a decision, but that they are often overloaded with information and can't "see the wood for the trees." The Evaluation Process not only helps decision-makers to look at the data associated with their choices, but also enables them to organize it in a way that is more useful than a simple database of raw information.

- **Promotes consensus.** Complex decisions often involve many decision-makers with opposing points of view. These people could be stakeholders or experts from different fields or divisions within the organization. This approach allows each participant to contribute their objectives and to have their say about what is most important or preferred, without creating conflict. Their feedback is captured in real time with decision support software, and live on-screen analysis throughout the decision-making meeting(s).

Overview of the Evaluation Process

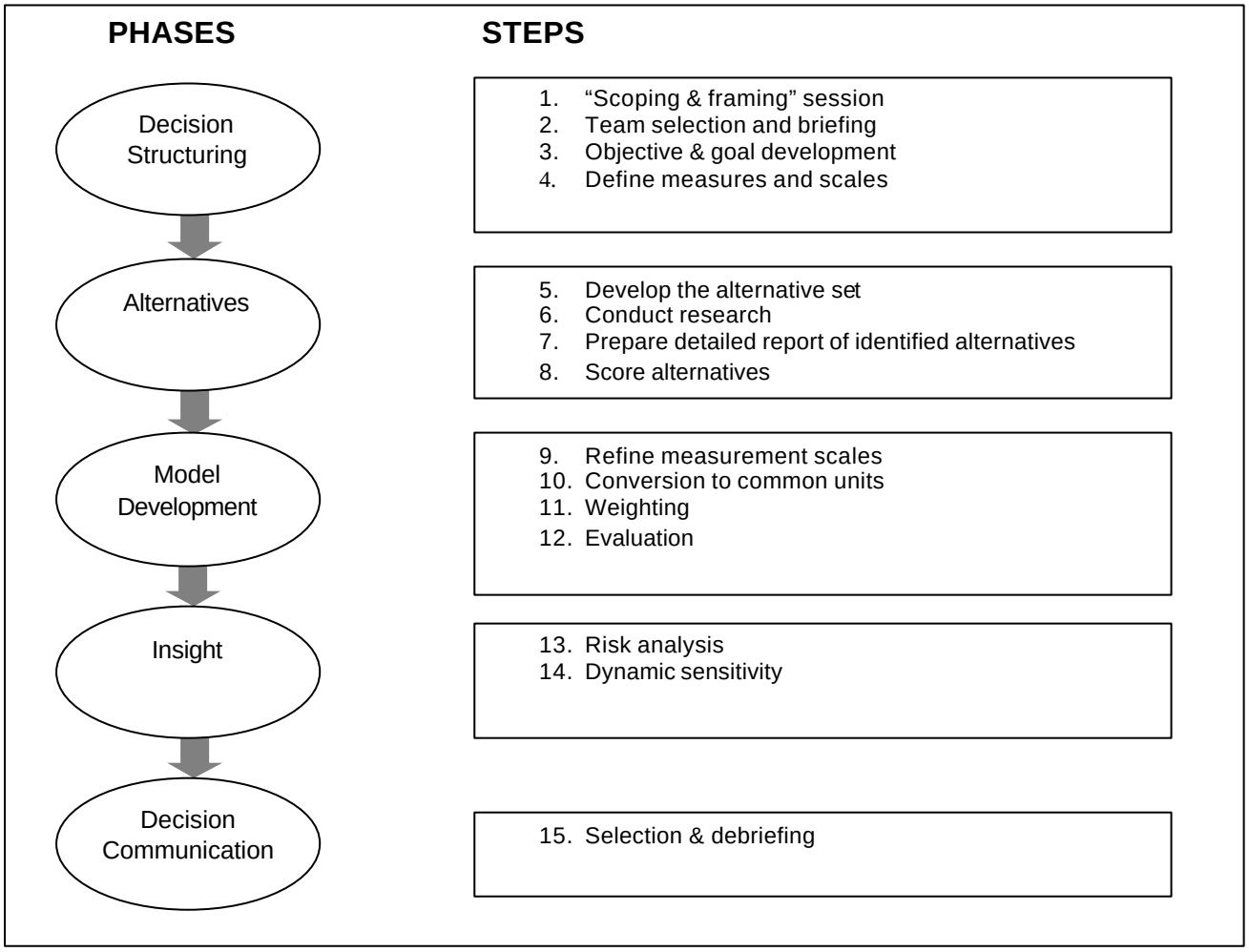
The first step in the process focuses on setting a common overall objective, then breaking this down into more detailed "goals" and weighting the importance of each. Every decision-maker then individually scores or "measures" each possible course of action against the weighted set of goals, by using a scale that has been developed and agreed by the group. At each stage of the process, the LDW software aggregates the individual judgments into a common unit or *utility score*. The software displays real-time graphs and statistics that show the combined decision-makers' prioritised goals and measures, and which of the project alternatives best correlate with these. Valuable insight is gained using LDW's graphical *dynamic sensitivity* function, which allows the group to test whether alterations to certain goal weights will affect the final decision outcome. This structured process saves valuable time by helping to quickly and accurately define a decision problem, and by then "zeroing in" on key objectives and points of contention.

To minimize personal bias and promote consensus, the process works best when every decision-maker has an equal input into the objective/goal setting and weighting, measurement setting, and final evaluation of each alternative. This is achieved with the guidance of an experienced meeting facilitator. The facilitator leads the discussion, elicits responses from the group and then inputs the results into the *single-user* version of LDW software. The LDW software, in turn, tracks and analyses this information and displays it on a screen at the front of the meeting room.

However, in situations where debate is dominated by certain individuals, or the decision is highly sensitive or controversial; a "*groups version*" of the LDW software can be employed. This version runs over a Local Area computer Network (or *LAN*). Every participant at the meeting is assigned their own computer terminal and they input their judgments and feedback directly into this. The *groups' version* of LDW then simultaneously collects and aggregates the group's information, and communicates the results to all participants over the LAN. If desired, each individual in the group can even submit their feedback on a **confidential** basis using LDW.

The diagram below outlines the process used for evaluating projects, programmes or policies/strategies when there are multiple conflicting objectives.

The Evaluation Process for Multiple Objective Decisions



Case Study – Evaluating Stormwater Projects for Funding

Introduction

One of the many applications of this process has been the development of a granting model and decision framework for *Infrastructure Auckland* (IA). IA is a public sector organisation whose principle function is to make grants towards projects in the Auckland Region for the purposes of providing:

- Land Transport
- Any passenger service
- Any passenger transport operation
- Stormwater infrastructure

IA has allocated NZ $100 million of its fund for stormwater projects, to be distributed over a five-year period. Grants are made to stormwater projects bi-annually via funding rounds. The first grants were made in November 1999. Since then there have been three subsequent funding rounds and grants to the value of $11,190,647 have been made using this process.

Goals Hierarchy

IA is governed by a Deed stipulating eleven criteria that must be considered when making any grant. It was necessary to include these as well as any other relevant criteria when evaluating stormwater projects. In order to do this, a 'goals hierarchy' was developed that set out IA's objectives with respect to stormwater projects. At the top of the hierarchy is the overall objective. Below this sits the key goals. These can broadly be described as:

- **Economic** – Contribute to the economic growth of the region.
- **Environmental** – Maintain and improve the physical and natural environment of the region.
- **Social** – Make the region a better place to live, work and play.

Goals help describe what we want to achieve but tend to be quite nebulous in nature and difficult to measure. In order to be meaningful, measures must be provided for each goal that informs the evaluator about the ***degree to which*** a particular project contributes towards the attainment of that goal. For each of the three goals, a set of measures was developed that encompassed all relevant criteria and informed the evaluation team about the impact of projects on each goal. Below is a list of the measures used in this process:

- **Economic**
  - Project Efficiency
  - Regional Economic Growth
- **Environmental**
  - Water Quality
    - Change in Effects
    - Change in Values
    - Area

        - Treatment Efficiency
    - Air Quality
    - Visual and Landscape
- Social
    - Community Identity and Belonging
    - Awareness of Conservation
    - Sense of Safety
    - Public health consequences of water-based recreation
    - Opportunities for water-based recreation
    - Opportunities for land-based recreation

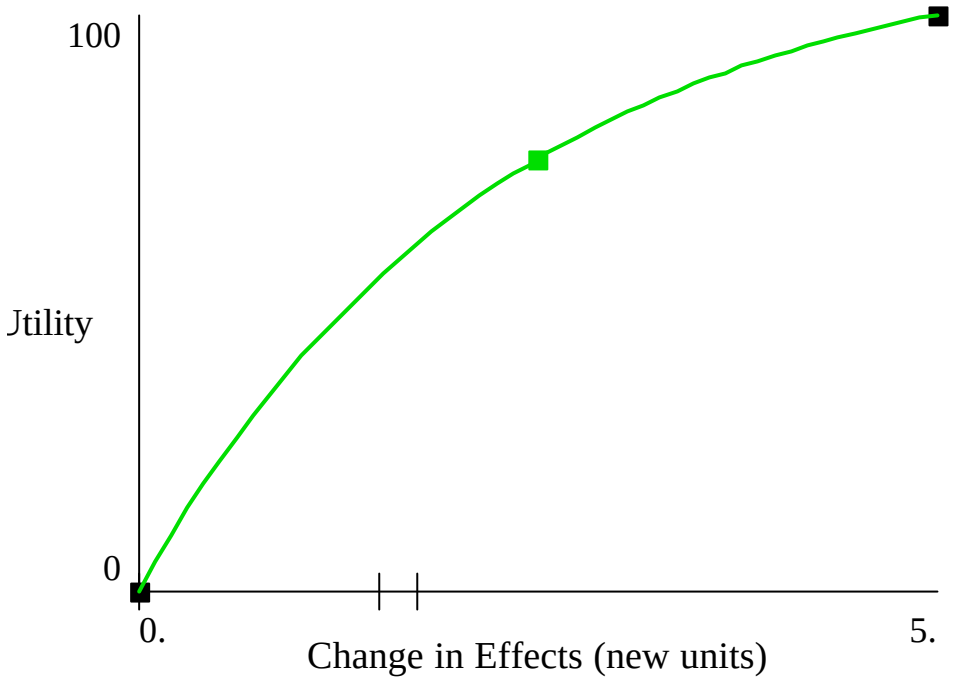
The goals hierarchy for IA's stormwater process is included as Appendix 1.

In addition to these goals and their measures, there are a number of *filters* that a project must pass before it can be evaluated. A filter is something that must be achieved and is usually expressed as a "yes" or "no" question. For example, one filter in the stormwater grants process is whether the project is not inconsistent with applicable Regional Strategies. If the project is inconsistent then it will not be evaluated. Evaluating projects that can never be funded can cause bias in the model as well as consume valuable time and resource. A filter is indicated when there is no distinct direction of preference. In our example, we are only concerned with whether a project is consistent or not with the Regional Strategies, not the degree to which it is consistent or not. As all projects evaluated are either consistent or not, this would not be a useful measure for distinguishing between the quality of each project.

Common Units

Subject matter experts from within IA, and from other specialist organizations, developed the measures for each objective. Each subject matter expert was asked to provide a set of measurements within the evaluation context, and to provide a possible range of outcomes on each measure from least preferred to most preferred. It is this range of outcomes that enables a utility function to be developed for each measure, in order to compare all measures. Each measure is provided in its own natural scale (e.g. dollars), using a constructed scale (e.g. Project Storm Water Model), or as a qualitative label (e.g. Significant Positive Impact, Medium Positive Impact, Slight Positive Impact, No Impact, Negative Impact).

The diagram below shows an example of a continuous utility function for "Change in Effects" which is a measure of Water Quality. The utility scale is shown on the vertical axis and is out of 100. (Utility measurement usually uses a 0 to 1 scale but we have scaled this to 100 as this is a more intuitive range for most people to work with). The horizontal axis represents the range of possible outcomes for the 'Change in Effects' measure. This ranges from a change of 0; the least preferred (Utility Score = 0), to a change of 5, the most preferred (Utility score = 100). The shape of the curve represents IA's preference for different changes such that the slope of the curve is steeper between 0 and 1 than it is between 4 and 5. This is because the preference for improvements becomes marginally diminished as you go higher up the scale, due to a disproportionate amount of the benefit being created by the initial change.



Weights

Once all measures have been given a utility function they can be weighted. Weights were calculated for the process using a variety of techniques. This involved several sessions with the internal Project Review Committee (PRC) as well as sessions with IA's Board of Directors (the end decision-makers). The main technique employed was 'swing weighting' using the Logical Decisions® software. This is a process where all measures are set to their least preferred point. Each person is then asked to choose which measure they would move first to its most preferred point, and to allocate that measure a swing weight of 100. The process is then repeated and the second most important measure is selected and given a swing weight that reflects the degree to which it is less important than the previous measure. For example, if the second measure were considered to be half as important as the first measure chosen, it would be given a swing weight of 50. If it were equally as important, then a swing weight of 100 would also be given to this measure. This process is repeated until all measures have been given swing weights. This is a ratio scale that creates a ranking of each measure by importance as well as the degree of difference in importance. Once all swing weights are obtained, percentage weights are inferred from the ratios.

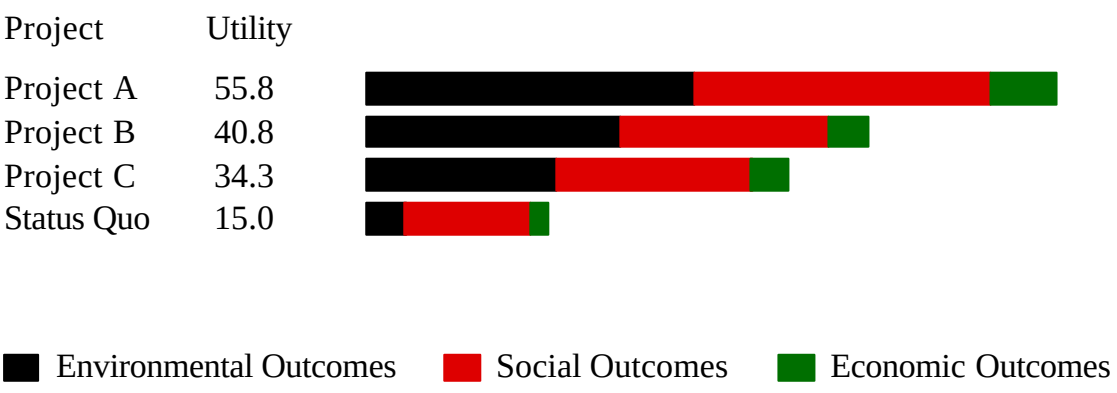
Originally, weights were allocated on a *top down* basis for this process. Using this process, weights were calculated for the three goals (Economic, Environment, Social). This created a basket of weights that was then allocated to each of the measures below it. For example, if the Economic objective received a weight of 25%, then the two measures below it are constrained by this top down allocation. This approach is often easier for people to work through as the weighting process is broken down into smaller and more manageable tasks. Originally, the process had more measures than it currently has, and this was a consideration in selecting the above approach.

Care must be taken as the *top-down* approach may result in some surprising weights on the individual measures. The structure of the 'goals hierarchy' can have an effect here, due to the number of measures that sit beneath each goal. More recently, weights have been derived from the *bottom up*, where all measures are considered at once and compared to each other. The only exception to this being Water Quality, which is a grouping of three measures.

Application

In each funding round, applications are received from various organisations responsible for the delivery of stormwater infrastructure in the Auckland region. Applicants use a manual and questionnaire provided by IA to compile their submission. The questionnaire contains each of the measures listed above. Information is taken from the applicant's questionnaire and entered into the Logical Decisions software. Each answer is evaluated by a subject area specialist and must provide adequate supporting information to verify the claim. Once all answers have been assessed and the data entered into the model, a ranking is produced and various sensitivity tests are performed which enable IA to understand which projects perform best. Funding will be on the basis of acceptable levels of benefit and on the total amount of funds available at each round.

Example of a Project Ranking Graph showing the performance on each goal.

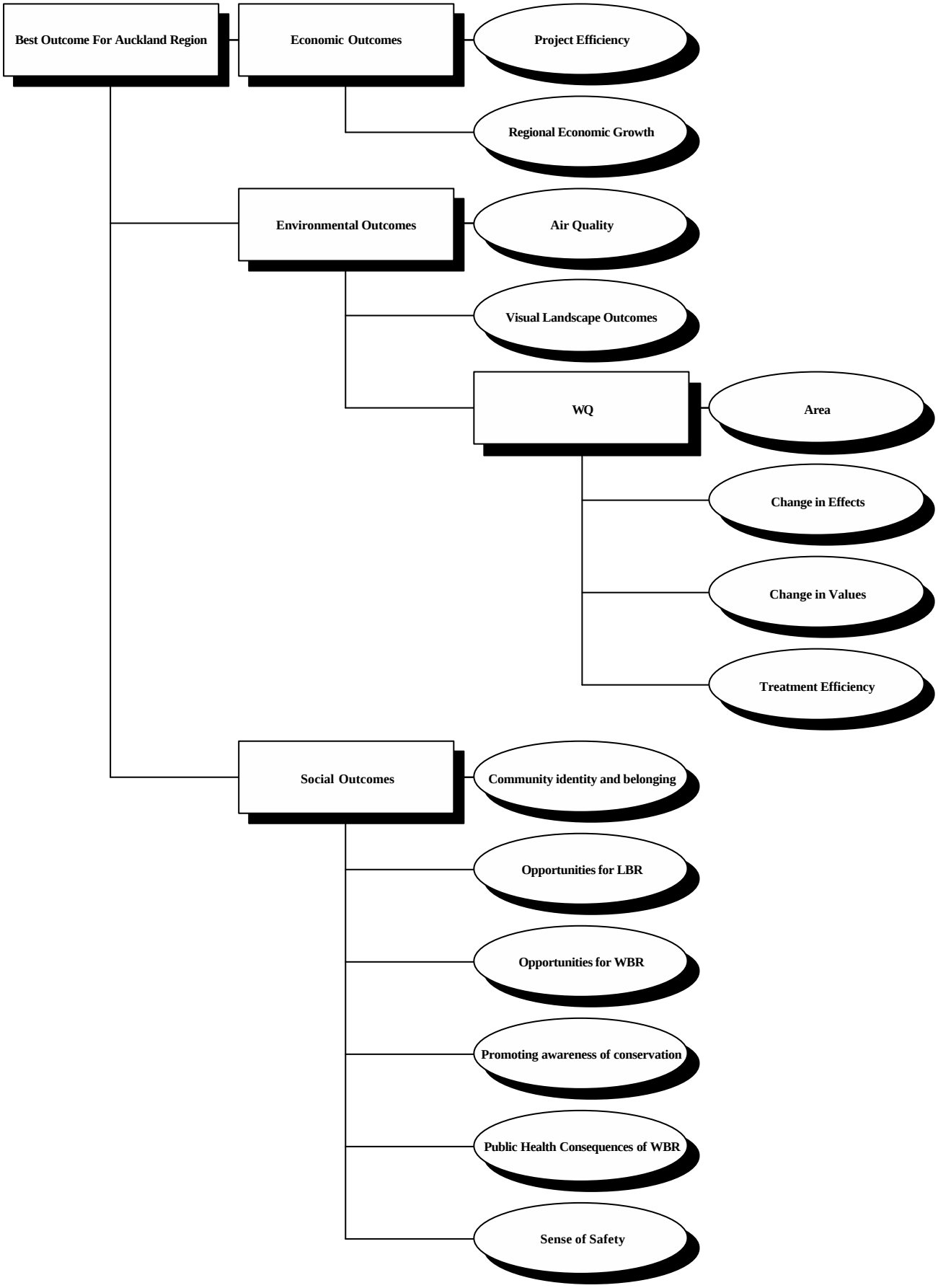


Summary

The Evaluation Process described above has been successfully employed by Infrastructure Auckland to help the organization make grants to stormwater projects. A large amount of information was collected for each project, and the Logical Decisions® software allowed this data to be organised in a meaningful way. The overall process provides a consistent decision-making framework and an audit trail that can be easily followed. Furthermore, it has enabled the important qualitative features of each project (which are unable to be adequately monetised), to be rigorously evaluated alongside more quantitative factors. This approach has enabled the evaluation team to consider all aspects of the projects presented.

The Multiple Objective modelling techniques used in the process are proven to be extremely effective when there is a large amount of both qualitative and quantitative data, multiple objectives that conflict, and a need for a consistent, transparent and auditable decision process.

Appendix 1 – Goals Hierarchy



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