Value Management Beyond Earned Value

By Ingemund Jordanger and Ole Jonny Klakegg
Faveo Project Management
Trondheim, Norway

Abstract

In project management, value concepts are normally limited to earned value related to fulfilment of project scope. This paper presents a business-by-project concept. The objective is to optimize project life-time utility. The utility function includes both monetary utility - normally Net Present Value (NPV) - and qualitative utilities. Project utility is included as a decision parameter encompassing the traditional parameters time, cost and quality. Decisions support is based on a Multi Criteria Decision Analysis (MCDA) technique. The uncertainty dimension is introduced in both quantitative and qualitative parameters. Management tools based on the concept have been applied in several projects, primarily in early phases. Examples of use are presented. To successfully implement value management in projects, active support from management and in-depth ownership among all key actors is essential. The value management concept presented, represents a general applicable concept even though it has been developed for use in construction and infrastructure projects.

Key words: Value Management; Project management; Multi Criteria Decision Analysis, Uncertainty Management

1. Introduction

The objective of the value management concept presented in this paper is to improve value creation in projects. The context of value management here is decision making in projects, especially in relation to conceptual phase evaluations. An overall value management challenge in most real world projects is to balance quantitative values (ref. “hard” paradigms) and qualitative values (ref. “soft” paradigms). The term value includes both monetary and qualitative values. Monetary value is measured by Net Present Value, while qualitative values are expressed by measurement scales and utility functions. Utility functions include decision relevant uncertainties in this value management concept. Utility value equivalents are used when combining quantitative and qualitative values.

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2. Earned Value and Life Cycle Value Management

2.1. Earned Value in Project Control

In Project Management the concept of earned value has been used for several decades. Earned value is defined as (PMI 2004):

*The value of work performed expressed in terms of the approved budget assigned to that work for a schedule activity or work breakdown structure component. Also referred to as the budgeted cost of work performed (BCWP).*

Earned value management: A management methodology for integrating scope, schedule, and resources, and for objectively measuring project performance and progress. Performance is measured by determining the budgeted cost of work performed (i.e., earned value) and comparing it to the actual cost of work performed (i.e., actual cost). Progress is measured by comparing the earned value to the planned value.

Earned value as control parameter is illustrated in figure below.

![Earned Value in Project Control](image_url)

**Figure 1 Earned value in project control**

The earned value concept relates to the completion of project outcome (object, system). This is a good starting point, but to increase value creation the value management concept must be developed further to include all relevant values in projects.

2.2. Value Management in Corporate Management

Value management in corporate management is based on building a common set of values that everyone in the company has ownership of. In this regime individual employees take greater responsibility for the overall picture and feel ownership of the company's goals, mission and vision. In value-based organization leaders deliberate release of power and control to enhance value creation, but it requires a high degree of maturity of all actors. Value based management does not mean that you do not have rules and goals, but it makes it possible to reduce the focus on rules and control.
Good economic results come because everyone has ownership of the organization's goals and how they will be achieved.

Next section deals with implementation of value management in project management.

2.3. Value Management in Project Management

The concept presented in this paper relates to value creation in the whole life cycle, including operational phase where the project result is used to produce value for the owner and other stakeholders (Jordanger 1998). From traditional project management point of view the concept of earned value of course is important. However, from the project owner’s perspective life cycle value creation is critical and most important. Based on this, project management should include life cycle value management.

![Figure 2 Total quantitative values and contextual factors](image)

In Figure 2 all cash flows are integrated in an overall quantitative objective function including all quantitative economics. Future represents uncertainties that the project has to face and manage to improve value creation. This is the first step towards life cycle value management in projects. Optimization of NPV within this realm and given external framework conditions has a huge potential of increasing value creation. One main observation is that both opportunities and risks have to be included in the evaluation of future uncertainties. The term uncertainty management is used for managing risks and opportunities. One additional important aspect with the concept illustrated in figure 2 is the integration of uncertainty management and value management. The importance of this integration is also stated by others (Green 1999).

Figure 3 illustrates how NPV can be included in project control. NPV as a control parameter does not replace earned value, but is a supplement representing the owner’s overall project objective.
This is a further step in perfecting project management. Value management in project planning and execution relates primarily to discrete decisions, which causes the steps in the NPV estimates.

The value of estimated expected NPV is normally revised at decision points in the planning and execution phases of the project. The value of expected NPV is based on deterministic calculation or preferably stochastic simulation.

The next section deals with including qualitative values in the value management concept. The main focus is value analysis and management as part of decision processes in early project phases.

3. Value Management Decision Processes

In real world projects, the value management concept must balance quantitative/"hard" and qualitative/"soft" elements. Combining quantitative and qualitative values in decision making creates new challenges. Balancing project specific qualitative values against values measured in monetary terms is complex. No general evaluation rules can be applied, since no common unit of such values exists. This allows for subjective assessment and potential conflicts between stakeholders with different interests and priorities. These challenges should not be underestimated. An open process with mutual respect between decision makers is essential.

One way of combining quantitative and qualitative values is presented next. Key words are utility functions and monetary unit equivalents.

3.1. Utility Functions implemented in the Value Management Concept

Projects at an early stage will normally include assessments of alternative solutions to satisfy specified requirements/needs. Often the situation is characterized by a high degree of complexity and uncertainty.

Multi-Criteria Decision Analysis (MCDA) is a discipline aimed at supporting decision makers who are faced with making decision among the alternatives. MCDA aims at deriving a way to come to a compromise between conflicting objectives in a transparent process. The primary focus in this paper is applied MCDA and practical
use of utility functions in real life projects. Utility functions are implicit in MCDA. MCDA uses a terminology which distinguishes between utility functions and value functions. If the analysis takes into account that the external factors may be uncertain, the functions to express preferences are called utility functions. If uncertainties are not included the functions are called value functions (Jordanger et al. 2007).

In most evaluations of alternatives it is, in addition, appropriate to include the uncertainty dimension when evaluating the decision criteria. Choosing alternatives according to the principle of expected utility is not always recommended. This additional realism caused by real life uncertainties creates additional complexity in alternative analyses. But there are available tools in the toolbox; combining MCDA, (linear) utility functions and Monte Carlo simulation.

First, the steps in the applied MCDA process (Jordanger et al. 2007):

1. Problem analysis and structuring: Definition of framework and external conditions, identification of stakeholders, establishing an evaluation group, definition of objectives, evaluation criteria and weighting of these, and finally definition of alternatives.

2. Development of evaluation model; Development of model structure, goal hierarchy, modelling of utility functions, calibration, verification and validation of model.

3. Evaluation of alternatives; Qualification of alternatives, evaluation of score for each criterion for each alternative and, finally transformation of score to utilities.

4. Evaluation of uncertainty/risk; include relevant quantitative and qualitative uncertainty.

5. Concluding evaluation; produce final ranking of alternatives based on values. This step also includes sensitivity analyses to investigate robustness of ranking, especially related to subjective, qualitative criteria. Finally, evaluation process and basis for the evaluation is documented to ensure traceability of the whole decision process.

![Figure 4 MCDA process (Jordanger et al 2007)](image-url)
The aim of the utility function method is to mathematically transform the scores on an ordinal scale to equivalent values on cardinal scale, i.e. the value is measured in utility equivalents. Utility functions may be linear or non-linear. This transformation allows for the application of a new set of methods and tools that are used on a broad basis in quantitative economic analysis, including uncertainty analysis.

4. Example of Utility Function based Method and Tools

The following example describes an analysis from a real life project. In this project, utility functions are used in social economic evaluations related to building concepts and localizations. The same methodology and tools can be used in all types business projects and decision processes in general.

Step 1  Problem analysis and structuring. Based on defined assumptions and constraints, evaluation criteria and weighting are defined, see table below.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>NPV</td>
<td>50 %</td>
</tr>
<tr>
<td>Functionality</td>
<td>20 %</td>
</tr>
<tr>
<td>Flexibility</td>
<td>15 %</td>
</tr>
<tr>
<td>Community development</td>
<td>15 %</td>
</tr>
</tbody>
</table>

Table 1 Evaluation criteria and weighting. Example

- NPV: Quantitative, weight 50 %
- Functionality: Qualitative, weight 20 %
- Flexibility: Qualitative, weight 15 %
- Community development: Qualitative, weight 15 %

One criterion is quantitative (NPV), the rest are qualitative. Evaluation criteria and weights are normally decided by the evaluation team in consultation with the decision maker.

Step 2: Model development. Determine the measuring scale to be used and assign utility function to each evaluation criterion. In this example a measurement scale 1-7 is used and all utility functions are assumed to be linear (the tools used also allows for non-linear utility functions).
For each criterion, a preliminary interpretation of each step on the measurement scale is produced.

Calibration of the evaluation model. Calibration of the model is carried out before analysis of each alternative. The purpose is to examine whether the model produces the desired response from given weights and utility functions. Calibration is normally carried out with the NPV criterion as a reference. For example, if the Community development criterion score is increased by 1, how much must the NPV be changed to get the same effect on the total score? The answer in this example is 34 MNOK.

<table>
<thead>
<tr>
<th>Sensitivity evaluation</th>
<th>Change of NPV</th>
<th>Change in score</th>
<th>Change in total score</th>
</tr>
</thead>
<tbody>
<tr>
<td>NPV</td>
<td>-34</td>
<td>0.0</td>
<td>0.15</td>
</tr>
<tr>
<td>Functionality</td>
<td>0.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flexibility</td>
<td>0.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Community development</td>
<td>1.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2 Sensitivity analysis. Example

To balance each qualitative criterion against monetary value, the term willingness to pay (WTP) is introduced. One must ask the question: Should this increase in Community development value be considered to be equivalent with the monetary value 34 MNOK (no more, no less)? If the answer is yes, keep the weights. If not, adjust the weight percentages until the desired response is achieved.

All qualitative criteria should be calibrated against the NPV. This will in practice be an iterative process. After this calibration step, the monetary equivalent values of each step on the measurement scale are defined for all criteria. And important: These equivalent values are used when, on the next step, scores are assigned to each criterion for each alternative.

Step 3 Evaluation of alternatives. Assign score for each criterion and alternative. Now, the life cycle cash flow profiles are defined. Uncertainty in all economic parameters are analysed and modelled. For investments, there is an underlying cost breakdown structure. In this example there are no revenues. Eventual revenue profiles are modelled in the same way as investment costs.

Table 3 Cash flow profiles for NPV. Example

Below the scores for each alternative are presented. These scores are the results from a group process in the evaluation team.
Table 4 Scores per. criterion and alternative. Example

The score of quantitative criteria (here NPV) is calculated since this criterion is measured on a cardinal (ratio) scale. The spread of the calculated NPV score reflects the spread on NPV values.

The alternatives are evaluated on a relative basis, not “the best in the world”. Assignment of scores is based on the calibration above and assessment of WTP. One consequence of the relative approach is that all scores should be normalised so that the average of all scores are equal to the middle value on the measurement scale (Jordanger et al 2007). One reason for normalization is also to prevent that eventual entry of systematic high / low score for one evaluation criterion undermine the weights of the criteria.

Step 4 Analysis of uncertainty. To arrive at a realistic value for the total economy is recommended that they conduct an uncertainty analysis in which all the relevant uncertainties related to the overall economy alternative is identified and quantified. In calculating the NPV, a risk-free discount rate should be used. The table below shows only the aggregated uncertainties. Min represents P10, Max represent P90 and Most likely represents P50. Other costs are modelled in a similar way.

Table 5 Uncertainties of cash flow elements. Example

Scores on qualitative criteria are also in reality uncertain. As mentioned above, these scores are the results from a group process. This process may have (at least) two alternative strategies: 1) Discuss and reach consensus or 2) Discuss, include differences of opinions (among equals) and express differences as uncertainties. Include these uncertainties in further evaluations. Strategy 2 is recommended, since the alternative strategy will suppress important information for the final decision maker.
Table 6 Uncertainty of qualitative criteria. Example

In this example, there was agreement in the group about most scores. There is however a spread in scores related to Functionality of alternative 1, 2 and 4. There is also a spread in evaluation of Flexibility of alternative 1 and 4. These spreads are modelled as stochastic variables with the same parameters as used for modelling cash flow uncertainties.

Comparison of alternatives vs. scores is shown in figure below.

A visual representation provides a richer picture of the evaluation than consideration of numbers.

Step 5 Concluding evaluations, produce final ranking. Total score is calculated as the sum of the products between criteria weights and partial benefit. See figure below.
As an important part of documentation of final recommended ranking, simulation of probability to be the best alternative is performed. In this simulation, all underlying uncertainties in cash flows and qualitative evaluations are included. The results from this simulation are presented below.

Sensitivity analysis is performed to investigate the robustness of the recommendation. One will in this process focus mainly on the recommendation with regard to sensitivity with respect to changes in the score for subjective criteria. Example of key questions that needs to be asked: a) How much must the score of each criterion be changed to make the next best alternative the best? And b) Can such a change in score be considered to be within a reasonable assessment? If the answer to last question is yes for one or more of the criteria, make a final evaluation of all potential winners. In this process more detailed information normally will be needed. If the answer is no, the evaluation is final.
5. Final remarks

In this paper, the integration of value management in project management is illustrated. An example of applied MCDA in concept evaluation phase is shown. The same method can be used in all project phases when important decisions are made. Project total value, expressed as utility value equivalents may be included as an overall control parameter. This will ensure a common management basis that unites the objectives of project management, project owner and other stakeholders.

6. References


About the Authors

Ingemäß Jordanger

Ingemund Jordanger is a Civil Engineer in Software Engineering with a PhD in Project Management (1985). He has more than 30 years of experience in project management; researcher for more than 5 years in manufacturing industry (SINTEF), 16 years in oil & gas industry (Statoil) and consultant for more than 10 years in building industry within construction and infrastructure projects (Faveo Management). Member of Faveo Management Advisory Board, with special responsibility for value management. Special interest in value-, risk- and uncertainty management, project evaluations, cost/benefit analysis, optimization of project and portfolio profitability. He has published several papers on project and portfolio management at national and international conferences. Ingemund can be contacted at Ingemund.Jordanger@faveoprosjektledelse.no.

Ole Jonny Klakegg

Ole Jonny Klakegg has 23 years of experience in research, teaching and consulting within project management. Currently he is combining two half time positions as Professor at Department of Civil and Transport Engineering, Norwegian university of Science and Technology (NTNU), and as R&D Director of Faveo Project Management, the largest project management consultancy company in Scandinavia based in Norway and Sweden.