Whitepaper ENTSCHEIDUNGSNAVI

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The ENTSCHEIDUNGSNAVI is an open-source web tool that supports a reflective decision-making process. This whitepaper provides insight into the underlying conception, refers to the theoretical background, and outlines the computational methodologies.

1. Overview

The ENTSCHEIDUNGSNAVI ...

- guides the user through a reflective decision-making process
- is not limited to certain applications
- is mainly based on Value Focused Thinking
- gives advice on how to avoid typical biases and flaws in decision-making
- calculates utilities based on the Multi-Attribute Utility Theory
- allows for imprecise information regarding preferences and data
- offers a wide range of decision-theoretic tools, e.g. sensitivity analyses, risk profiles, tornado diagrams, dominance checks, and Monte Carlo simulations
- allows for self-assessment of the achieved decision quality in different criteria
- encourages the harmony of head and gut feeling

The ENTSCHEIDUNGSNAVI is available in three variants:

ENTSCHEIDUNGSNAVI "**Starter**" – This variant is deliberately kept simple, and thus, the range of functions is greatly reduced. It is appropriate for getting a first impression of the general procedure within a short amount of time.

ENTSCHEIDUNGSNAVI "**Educational"** – This variant guides the user through the reflective decision-making process with numerous sub-steps and offers support through detailed explanations. It is particularly suitable for intensively examining all aspects of a reflective decision and improving one's own decision-making competence.

ENTSCHEIDUNGSNAVI "**Professional**" – This variant offers similar functionality as the Educational variant but without a guided process and detailed content explanations. Thus, it is suitable for those who are well acquainted with the implemented tools and methodologies and only want to solve a decision problem efficiently.

When starting a new project, it is mandatory to choose one variant. It is possible to change from the Starter variant to one of the other variants, but it is no longer possible to switch back to the Starter variant in the edited project. Switching between the Educational and Professional variants is possible at any time.

Although the ENTSCHEIDUNGSNAVI is primarily designed as a tool for individual decisions, the structured procedure also greatly promotes group decisions. To particularly support such decisions with multiple team members, additional team functionalities are available in both the Educational and Professional variants, which significantly facilitate a reflective group decision-making process with the ENTSCHEIDUNGSNAVI under the guidance of a moderator.

2. The Five Steps of a Reflective Decision-Making Process

The reflective decision-making process[1] consists of the five following steps:

1. Formulation of the decision statement
2. Development of the fundamental objectives
3. Identification of alternatives
4. Setting up a consequences table
5. Evaluation based on preference statements

This five-step breakdown results from close alignment with the **Value-Focused Thinking** (VFT) concept.[2] VFT was developed as early as the 1990s by the U.S. decision researcher Ralph Keeney. It has since established itself in countless applications as the gold standard in the analysis of decisions. VFT is based on the idea that decisions should be approached proactively, i.e. decision situations should be understood as opportunities to shape something in advance. Accordingly, the first step of a reflective decision-making process promotes a broad and open formulation of the decision question, which paves the way for a correspondingly large scope for design.

VFT pays special attention to a reflected formulation of the objectives in the decision-making situation. The focus should be less on *instrumental objectives*, which are only a means to an end. Rather, according to VFT, the decision maker should name his *fundamental objectives*, i.e., the goals that are the core of the decision. Therefore, the second step of a reflective decision-making process requires an intensive scrutiny of all collected objectives to be able to identify these fundamental objectives and to grasp them precisely.

When identifying possible alternatives, VFT calls for a high degree of creativity to find or design new attractive alternatives. In doing so, the fundamental objectives should always be kept in mind so that a high level of attractiveness can be achieved. In this respect, it is important for the third step of a reflective decision-making process that blinders are taken off and a broad spectrum of the most attractive options is developed through a high degree of creativity aligned with the fundamental objectives.

The fourth step of a reflective decision-making process is assessing the effects the identified alternatives will (presumably) have on the fundamental objectives. In setting up this impact model, there is a risk of biased assessments or biases associated with various behavioral psychological phenomena. There is sufficient evidence, often based on work by American psychology professor and Nobel Prize-winning economist Daniel Kahneman.[3] In this respect, an important component of the fourth step is to control these possible biases, i.e., to point them out and minimize them through appropriate **debiasing.**

For the evaluation of alternative actions in multi-objective contexts, various methods are proposed in decision theory, e.g., the very simple utility analysis, the broadly used Analytic Hierarchy Process (AHP), the outranking approaches widely used in francophone countries, and the scientifically based **Multi-Attribute Utility Theory**[4] (MAUT). Comparing all approaches, MAUT is best suited for a sophisticated reflective decision-making approach. It is true that the AHP, for example, enjoys great popularity in practice because it is rather simple to apply despite complex computational logic. However, the analytically derived alternative evaluations in the AHP have a black-box character and, therefore, offer only a limited ability to understand and reflect on the result and to find out reasons for a possible

[1] See von Nitzsch & Methling (2022) and similar Gregory (2012)
[2] See Keeney (1992) and Keeney (2020).
[3] See Kahneman (2012)
[4] See von Nitzsch (2021), chapters 9 and 10 and Keeney & Raiffa (1976).

discrepancy between head and gut feeling.[5] The MAUT is more difficult to apply, for example, the necessary trade-offs between the objectives require higher cognitive effort. However, this process ensures a more profound level of transparency. In this regard, the fifth step of the reflective decision process is consistently based on the demanding procedure of the MAUT. It should be noted that this only applies to the Educational and Professional variants; in the Starter variant, a simpler procedure similar to the utility analysis is deliberately implemented in order not to hinder a quick, basic familiarization with the process.

Menu Navigation of the Three Variants

The tool's menu navigation basically refers to the five steps mentioned in all variants, although there are differences between them.

The main menu navigation in both the Starter and Educational variants strictly follows this five-step process. In the **Starter variant**, only a set of carefully selected functions from the Educational variant are available.

In the **Educational variant**, the five steps explained above represent the overall structure. The five main steps are broken down into smaller sub-steps. These sub-steps should also be complemented in the specified order, but deviations are generally permitted. Thus, it is always possible to go back to processed sub-steps and to adjust entries. However, it is sufficient if the desired changes are made on the respective last page of the main step (the "result page"). Regarding the main steps, it is possible and, in a reflected decision process, quite normal and desired if it is recognized that in the already running main steps, modifications would be meaningful and are then implemented. A special feature of the Educational variant is the Navi-Assistant, which can always be reached via the question mark in the header. For each sub-step and main step, this assistant offers context-dependent and comprehensive explanations, theoretical background information, and, in some cases, links to instructional videos. At the same time, tips are given on using the functionality that has just been called up.

In the **Professional variant,** the main menu consists of two options. The first menu option, “Structure and Estimate", covers steps 1 to 4 and allows users to choose between other relevant functionalities in further submenus. The second menu option, "Evaluate and Decide", corresponds to step 5 of the reflected decision process. In the Professional variant, there is neither a predefined sequence nor additional explanations. Instead, it is up to the user to decide which instruments to use from the large range of functions of the Educational variant and to choose a preferred order.

3. Formulation of the Decision Statement

The formulation of the decision statement serves to make the decision situation clear. At the same time, a deliberately broad and open formulation should be chosen to take off possible blinders and to create room for new, creative alternatives in the subsequent steps. For this to succeed, an ideal process with the functionalities implemented in the ENTSCHEIDUNGSNAVI looks as follows:

- *Function* `Ia`**:** *"Initial Attempt at Formulating the Decision Statement and Assumptions" (available in Educational & Professional).*

  In this function, the decision statement can be formulated as it first appears in the mind. In addition, all assumptions and preliminary decisions can be noted. To better delimit the

[5] For other fundamental weaknesses of the AHP, see Dyer (1990).

decision statement, it is also possible to name decision statements that are linked to the pending question but should be regarded later.

- *Function* `Ib:` *"Reflection of Fundamental Values"* (available in Educational & Starter)
  This function removes existing blinders and consciously encourages broader thinking to counteract possibly too narrow-minded thinking. Thus, it requires a preoccupation with one's fundamental values by presenting values in a list to be prioritized relative to one another.

- *Function* `Ic:` *"Answering Impulse Questions to Encourage Proactivity"* (available in Educational).
  This function also promotes an open way of thinking about formulating the decision statement. The user is asked several questions that encourage breaking down any restricted thought patterns regarding the decision situation. With his answer notes, he is given thought impulses about which direction a broader formulation of the decision statement could take.

- *Function* `Id:` *"Reconsideration and Reformulation of the Decision Statement"* (available in Educational).
  In this sub-step, the results of functions `Ia`, `Ib`, and `Ic` are again summarized. The user's task is to formulate the decision statement more openly and broadly, with an expanded view. At the same time, assumptions and preliminary decisions can be adjusted accordingly.

Implementation in the Educational, Professional, and Starter Variant

In the **Educational variant**, this sequence is implemented exactly in the structure of the sub-steps. The user is guided successively through the functions `Ia` to `Id`. The assistant provides extensive explanations of the contents for each sub-step to contribute to a better understanding.

Users of the **Professional variant** are assumed to be able to formulate a profound decision statement. In this respect, only function `Ia` can be called up in the menu item "Structure and Estimate". Even for an experienced user, it is always useful to record all assumptions, preliminary decisions, and subsequent decisions.

In the **Starter variant**, only the formulation of the decision statement is requested. Assumptions and preliminary decisions can be noted likewise.

4. Development of Fundamental Objectives

Fundamental objectives describe the aspects that are of key importance in the decision-making situation. For a reflective decision-making process, it is necessary to ensure that all aspects relevant to evaluation are covered, i.e., that the formulated objectives system is complete. In addition, the fundamental objectives should have as little overlap with each other as possible and should be able to be evaluated largely independently of each other. In addition, the objectives should clearly describe distinctions between different alternatives.

Developing an objectives system that meets all these requirements is a challenging task that calls for support. It is suitable to start by identifying as many aspects relevant to the assessment as possible and then adding overlooked aspects using other sources. The next step is to structure the numerous collected aspects, which ideally should be implemented as an objective hierarchy. To support such a process, the ENTSCHEIDUNGSNAVI offers several suitable functions.

- *Function* `IIa`: *"Initial Brainstorming on Aspects Relevant to Assessment"* (available in Educational).

  This function allows the user to freely note all aspects relevant to the decision situation or the evaluation of the alternatives.

- *Function* `IIb`: *"Make further considerations"* (available in Educational)

  It is known from studies[6] that after an initial brainstorming session, on average, people name only about half of the relevant objectives. This is exactly what is communicated to the user in this function, combined with a request to try even more and continue brainstorming.

- *Function* `IIc`: *"Developing an Initial objective hierarchy"* (available in all variants).

  This function provides a graphical structuring aid for setting up an objective hierarchy. All aspects already noted are to be examined by the user, whether they stand in a means-ends-relationship or, if necessary, in a sub-objective-objective-relationship to each other. With successive incorporation of all aspects into the objective hierarchy, in which these relationships are considered, a first structured representation of the objective system is created. In addition, the fundamental objectives are worked out through these investigations and separated from the means objectives.

- *Function* `IId`: *"Examples and Suggestions"* (available in Educational & Professional)

  This function provides example objective hierarchies and lists with topic-related objectives to add aspects overlooked to one's hierarchy. Some objectives are provided with suitable explanatory texts and, in most cases, contain suitable sub-objectives.

- *Function* `IIe`: *"Checking the Objective Hierarchy for Required Properties" (*available in Educational).

  After this initial structuring, it is usually necessary to revise the objective hierarchy so that the conditions mentioned above are met. The resulting hierarchy ideally comprises five to seven fundamental objectives at the first level. The further hierarchical levels of the revised hierarchy contain the corresponding subordinate objectives and mean objectives, which can still be a valuable aid in subsequent steps, e.g., in the definition of measurement scales.

- *Function* `IIf`: *"Display of Fundamental Objectives as a List"* (available in Educational & Professional)

  This function displays the fundamental objectives as a list. Each objective can be explained precisely in this display. The explanation field can also be accessed at other points in the ENTSCHEIDUNGSNAVI if an orange triangle is visible at the top right corner. In addition, the boxes for the individual objectives on the right contain sections of the hierarchy that show the subordinate and means objectives.

Implementation in the Educational, Professional, and Starter Variant

In the **Educational variant**, functions `IIa` to `IIf` represent the sub-steps to be run through successively. Although an objective hierarchy is displayed by default on the results page, it is also possible to switch to the list view (function `IIf`). In addition, the assistant provides extensive explanations for each substep, including very detailed information on the requirements that a well-structured objective hierarchy must meet. In addition, instructions can be accessed via the question mark in the top left corner that help to improve the workflow, for example, through various shortcuts.

The **Professional variant** includes the objective hierarchy function `IIc`, the Example Objectives function `IId`, and the list view function `IIf`, which are usually sufficient support for experienced

[6] See Bond et al. (2008)

users. These functions are listed in the main menu item "Structure and Estimate", in the submenu "Objectives".

In the **Starter variant**, solely the objective hierarchy function `IIc` is available. Detailed explanations or exemplary objective hierarchies are not provided.

5. Identification of Alternatives

Reflective decision-making requires considering the entire possible scope of action without overlooking any alternatives. Studies[7] have proven that decision-makers often think too little in decision-making situations and do not even come up with attractive possibilities themselves. For this reason, the functions implemented in the ENTSCHEIDUNGSNAVI concentrate on stimulating creativity while always drawing attention to the fundamental objectives so that particularly attractive alternatives are added. It has to be carefully ensured that the identified alternatives are all mutually exclusive because otherwise, no clear recommendation can be derived with the subsequent utility assessment.

- *Function* `IIIa`: *"Overview of alternatives"* (available in Educational, Professional & Starter)
  This function represents the basic display form for alternatives in the form of a list. For each alternative, there is an explanation section in which the alternative can be commented. In addition, the explanation section includes a list of the alternatives grouped under this alternative (see function `IIIf`). The explanation field can also be called up at other points in the ENTSCHEIDUNGSNAVI via a small orange triangle in the top right corner next to the alternative.
- *Function* `IIIb`: *"Analyzing weaknesses"* (available in Educational & Professional)
  This function indicates weak points in certain objectives of already defined alternatives. On this basis, the user is encouraged to consider modifications of the alternatives that no longer have the found weak points or only to a minor extent.
- *Function* `IIIc`: *"Objective-focused Search"* (available in Educational & Professional)
  With this function, the user is asked to first generate ideas for each of the defined fundamental objectives that achieve a good result in the respective objective. Subsequently, the task is to combine various ideas from this preliminary work and thus find new attractive alternatives.
- *Function* `IIId`: *"Ask other people"* (available in Educational)
  This function is merely an invitation to get additional possible alternatives from other people.
- *Function* `IIIe`: *"Strategy Table for Structuring the Scope of Alternatives" (*available in Educational & Professional)
  This function offers a convenient way to structure the alternatives according to certain characterizing properties. It is asked to define design parameters and associated parameter levels to assign new alternatives to matching combinations of parameters. With this function, it is easy to determine whether the scope of alternatives is covered completely or which combinations of design parameters have been overlooked. Additionally, this function simplifies checking whether the alternatives are mutually exclusive.

[7] See Siebert & Keeney (2015).

- *Function* `IIIf`**:** *"Combining Alternatives Sensibly"* (available in Educational & Professional)

  To keep the number of alternatives manageable, this functionality allows alternatives to be integrated into others by drag and drop, reducing the total number without having to delete alternatives entirely.

- *Function* `IIIg`**:** *"Establishing an Intuitive Order"* (available in Educational)

  The alternatives are to be ranked according to one's gut feeling. This function renders possible to later compare the analytically determined order of the alternatives with the intuitive ranking defined at this point and to increase the transparency of discrepancies between head and gut feeling.

Implementation in the Educational, Professional, and Starter Variant

Functions `IIIa` to `IIIg` describe the sub-steps to be run through in the same order as in the **Educational variant**. On the results page, the overview of alternatives is provided by function `IIIa` again. In addition, the assistant contains further explanations and operating instructions for the respective functions.

All functions except `IIId` and `IIIg` are available in the **Professional variant** through the menu "Structure and Estimate" and the submenu "Alternatives" as optional functions.

The Starter variant provides an overview, as in function `IIIa`. However, creativity-enhancing methods are not implemented.

6. Establishment of a Consequences Table

In the ENTSCHEIDUNGSNAVI, a consequences table is set up by filling in a matrix with alternatives in the rows and fundamental objectives in the columns. To achieve high quality, suitable measurement scales must be defined for each objective, relevant uncertainties must be reasonably integrated, and the estimates have to be given without biases on the basis of as good information sources as possible.

Definition of Measurement Scales

In the **Educational** and **Professional variants,** there are a variety of measurement options. Basically, you can choose between three types of measurement scales:

Numerical scale: A numerical scale can be created with or without units by specifying a worst and a best value. The chosen range should contain the estimates of all alternatives and not be significantly larger than necessary. Rounded numbers should be chosen as interval boundaries. Numerical scales are always continuous scales.

Verbal scale: A verbal scale is a discrete scale in which each level is explicitly named, e.g., "low", "rather low", "medium", "rather high", and "high". The maximum number of levels is seven.

Constructed scale of indicators: An indicator scale is suitable if various indicators can be operationalized well and enable a valid assessment of the fundamental objective. These indicators can be fundamental sub-aspects, instrumental objectives, or other highly correlated factors. A weight is given for each indicator with which it should be included in the overall assessment. There are two ways in which the indicators can be combined into an overall value for the objective scale:

- *Additively weighted composition when defining a desired scale range* - In this aggregation, all indicator values in the specified range are normalized to a value between 0 (worst) and 1 (best)

and weighted additively to form a score. The score is then transferred to a range in the objective scale to be specified by the user.

- *Custom Formula* - This option allows users to aggregate the indicator values in an individually defined formula. This allows complex measurement scales to be implemented in the ENTSCHEIDUNGSNAVI. The range for the objective scale resulting from this aggregation type is pre-calculated by automatically inserting the worst indicator values (assumption: this results in the worst possible objective value) and the best indicator values (assumption: this results in the best possible objective value) into the formula. However, depending on the design of the formula, it is theoretically possible that (invalid) results outside the precalculated range of the objective may result when certain constellations of indicator values are inserted into the formula. Therefore, in the case of user-defined formulas, the user can replace the pre-calculated range with a larger range. The responsibility for correctly selected ranges is thus transferred to the user in this case. Additionally, it is often useful to define global variables that can be used repeatedly in different custom formulas. This function can be accessed below the consequences table.

To increase transparency, especially in abstract scales, additional comments should be added at the different levels. Extensive options are offered in the tool for this purpose. For example, in the case of a scale of indicators, each individual numerical indicator can be divided into different levels, each of which can then be commented on. The comments should include at least short descriptions of the selected levels. However, it is also possible to provide more detailed explanations, which can refer to several dimensions at the same time. Regarding which dimensions are chosen here, elements of the already defined objective hierarchy or the design parameters can be used by clicking the button "*Suggestions*".

The higher transparency of the scales is particularly important to be able to validly determine trade-offs between objectives in a later step. Therefore, when determining a "*representative trade-off*" (see Section 7), all comments made for each indicator are automatically displayed in a simplified form. In the case of a more complex indicator scale, it may be useful to modify the comments individually instead of using the simplified design provided. For this purpose, the function "*Describe the levels of the objective scale*" is offered when defining an indicator scale. There, the comments can be imported in the simplified form using the "*Import qualitative levels*" function and then modified as desired. In addition, examples of indicator combinations can be determined and added to the comment fields, which lead to the selected objective levels.

For good project documentation, it is useful to add an explanation of the measurement scale used in the description of the respective objectives (either via the orange comment triangle at the top right corner or the list view of the objectives).

In the **Starter variant,** each objective is measured using an immutable scale from 1 (worst) to 10 (best).

Consideration of Uncertainties in Estimates

If certain estimates in the results matrix of the impact model are associated with uncertainty, this should be considered in the model. This is possible in the Educational and Professional variants via the definition of influence factors, whereby a distinction is made between two types:

- *Predefined Influence Factors* - A "worst-median-best distribution" can be used to model a probability distribution with this influencing factor by specifying the p.10, p.50, and p.90 percentile. The tool implements these specifications internally by generating a discrete distribution of 25% each for the p.10 and p.90 percentiles and 50% for the median and uses

this to perform all further evaluations. In the presence of a normal distribution, this discretization of the probability distribution provides a good approximation.

- *User-Defined Influence Factors* - The user defines possible states for an influence factor to be explicitly named (e.g., influence factor "level of sales figures" with associated states "below 1000", "between 1000 and 2000", and "above 2000"). The user must specify probabilities for all states. This can be facilitated by the optional auxiliary function "*Automatic default*". If the user finds it difficult to specify exact probabilities, the precision parameter also allows approximate input (see section "Working with imprecise precision" in Section 7).

In each matrix field, a maximum of only one influence factor can be defined, i.e., a predefined *or* a user-defined one. However, it is possible to aggregate two user-defined influencing factors into a combined influence factor. In this new influencing factor, the probabilities of the combined states are automatically calculated. Combined influence factors can also be cascaded, i.e. they can be supplemented with other influencing factors to form new combined influencing factors.

A matrix field is linked to an influence factor by clicking on the pencil icon, which appears when hovering over the matrix field and opens the input window for the respective matrix field. In the *"Data Entry"* tab and the drop-down selection bar that then appears at the top, all influence factors already defined be accessed and links created. Here, it is also possible to create a new user-defined influence factor.

An important difference between predefined and user-defined impact factors is their behavior in the overall model. A predefined worst-median-best distribution at one point in the model is always completely independent of any use elsewhere. All probability distributions of predefined impact factors are thus always considered stochastically independent. This is even true for all indicators when using a measurement scale constructed from multiple indicators. Thus, if the worst-median-best distribution is linked to an indicator scale, the uncertain expressions in all indicators are stochastically independent of each other.

If, on the other hand, two matrix fields are linked with the same user-defined influence factor, the program assumes that the respective states, incl. probabilities in the two matrix fields, are regarded as identical, i.e., are defined globally. To circumvent this dependence, different influence factors must be defined for the two matrix fields.

> *Example: The sales figures are uncertain for both alternatives A and B. In addition, the formulation of states "below 1000", "between 1000 and 2000", and "above 2000" is intended, but no connection between the associated probability distributions for A and B is to be assumed. In this case, it would be correct to define another "sales at alternative B" in addition to the influence factor "sales at alternative A".*

The menu *Influence Factors* always provides an overview of all user-defined *Influence factors.* Influence and combined influence factors can also be added and modified on this page.

To display and analyze the modeled uncertainty in a matrix field, there are two additional functions in the input menu: The creation of a risk profile and an indicator impact diagram.

In the *Risk Profile* tab, a risk profile is graphically displayed for the relevant alternative. The risk profile $R(x)$ *has* a complementary relationship to the distribution function $F(x)$, i.e., $R(x) = 1 - F(x)$. In other words, the risk profile indicates the probability by which a result x is exceeded. For a comparison with the risk profiles of the other alternatives in the considered objective, further risk profiles can be added to the graph in the "*Compare with*" menu. First-order stochastic dominances can thus be determined graphically.

The functionality in the *indicator impact* tab can be called up if an indicator scale has been linked to a user-defined or a predefined influence factor, i.e., the worst-median-best distribution. The indicator impact diagram clarifies which indicators have the greatest, second greatest, etc., influence on the result due to the respective existing uncertainty. The calculation of the influence of an indicator on the objective result can be carried out under the assumption that the median in the other indicators is included in the calculation of the respective objective result (selection: *simple variant*). Alternatively, it is also possible to select that the defined probability distribution is used in each of the other indicators and that the result is then given as the expected value (selection: *probabilistic variant*).

Consideration of Biases in All Estimates of the Consequences Table

To ensure that the estimates in the consequences table are as valid as possible and do not exhibit any bias, the ENTSCHEIDUNGSNAVI informs the user about possible sources of error and typical biases. The less knowledge of a reflective decision process is available, the higher the importance of education about these pitfalls is. In the **Educational variant,** these explanations can be found in the assistant in the consequences table under "More hints" and "*Look for typical errors and biases in impact prognosis*". In the **Professional variant,** these explanations are not available, but users can always switch between the Professional variant and the Educational variant to access the information.

Further Advice and Functionalities in Dealing With the Consequences Table

The optional colored display in green and red is intended to vividly show which alternatives have preferred results in which objectives.

In all variants, the consequences table automatically analyzes dominance relationships between alternatives. Alternatives dominated by another alternative are marked in red with an info button. Clicking on this button shows which alternative or alternatives dominate(s) the one concerned. The dominance of alternative A over B is shown if A stochastically dominates the result of B in all objectives without exception.

To facilitate data entry in more complex models, such as those that result from more elaborate indicator scales and the simultaneous use of influence factors, the contents of a matrix field can be copied to another in the same column using drag and drop. The definition of a scale can be copied from one column to another accordingly. A corresponding function becomes available when the mouse is hovered over the header in the consequences table. In the Professional version, it is also possible to duplicate alternatives using the copy function by hovering the mouse over the alternative's name.

Interface for an Excel Export and Import

An interface makes it possible to export the consequences table as an Excel file and import it back into the ENTSCHEIDUNGSNAVI later. This function is particularly useful if complex formulas or calculations are to be used as a basis for the creation of impact prognoses, which cannot be displayed in the ENTSCHEIDUNGSNAVI. These complex calculations can be performed in a separate Excel sheet and linked to cells from the exported matrix. When the Excel file is imported again, the newly calculated impact prognoses are automatically applied. A corresponding button for exporting or importing can be found at the top left of the consequences table. To ensure that the import of the Excel file into the ENTSCHEIDUNGSNAVI is successful, some rules for handling the file must be observed, which can be taken from the function and the Excel sheet itself.

7. Calculation of the Expected Utility After Determination of Utility Functions and Objective Weights

The evaluation of the alternatives is based on the multi-attribute utility theory (MAUT). This means that for each alternative A_j with $1 \leq j \leq J$ an expected utility $EU(A_j)$ is calculated, which numerically describes the attractiveness of the alternative in a relative comparison to the other alternatives. The absolute amount of $EU(A_j)$plays only a minor role here due to the normalizations made in the EU calculation. In the end, only the relative differences between the EU-values of all alternatives are decisive. Since the alternatives must be mutually exclusive, the recommendation is to carry out the alternative with the highest EU.

In the calculation of the expected utility EU of an alternative A_j in a decision model with I fundamental objectives and influence factors in each objective O_i($1 \leq i \leq I$) with K_{ij} states s_{ij}^k ($1 \leq k \leq K_{ij}$), the corresponding state probabilities $P(s_{ij}^k)$, the utility $U_i(x_{ij}^k)$ for the estimated consequence x_{ij}^k in the objectives and states, and the objective weights w_i are included. The formulas are:

$$EU(A_j) = \sum_{i=1}^{I} w_i \left[\sum_{k=1}^{K_{ij}} P(s_{ij}^k) U_i(x_{ij}^k) \right]$$

$$\sum_{i=1}^{I} w_i = 1$$

$$\sum_{k=1}^{K_{ij}} P(s_{ij}^k) = 1$$

Utilities $U_i(x_{ij}^k)$ are represented, in the case of numeric or indicator scales, by objective-specific exponential utility function:

$$U_i(x_{ij}^k) = \begin{cases} \dfrac{1 - e^{-c_i \frac{x_{ij}^k - x_i^-}{x_i^+ - x_i^-}}}{1 - e^{-c_i}} & if \quad c_i \neq 0 \\ \dfrac{x_{ij}^k - x_i^-}{x_i^+ - x_i^-} & if \quad c_i = 0 \end{cases}$$

Here, x_i^-represents the worst, and $x_i^+$the best value from the definition of the respective measurement scale. The parameter c_i represents the risk aversion parameter for objective O_i and determines the curvature of its utility function. A positive c_i leads to a right-curved function, thus modeling a decreasing marginal utility or risk-averse behavior. Conversely, a negative c_i leads to a leftward curvature, modeling increasing marginal utility or risk aversion. The larger the magnitude of c_i, the more pronounced the respective curvature. A linear valuation at $c_i = 0$ corresponds to a risk-neutral valuation (equivalent to an expected value calculation).

The utilities $U_i(x_{ij}^k)$ for objectives with verbal scales are determined using discrete utilities.

$$U_i(x_{ij}^k) = \begin{cases} 0 & if \ x_{ij}^k = x_i^- \\ \mathrm{DR}(x_{ij}^k) & if \ x_{ij}^k \in (x_i^-, x_i^+) \\ 1 & if \ x_{ij}^k = x_i^+ \end{cases}$$

The user can explicitly specify the individual utility ratings for each scale level via direct rating. Therefore, the utility for consequence x_{ij}^k is represented by the direct rating function $DR(x_{ij}^k)$. If no evaluation is made, the tool assumes an equidistant increase of the utilities from 0 (worst verbal expression) to 1 (best). Regardless of the scale, the utility for the worst value x_i^- is 0, and for the best value x_i^+ is 1. Since the objective weights are normalized to a sum of 100%, it is evident that the total value $EU(A_j)$ is also normalized in the utility interval between 0 and 1. However, these expected utilities are shown multiplied by 100 for optical reasons in the ENTSCHEIDUNGSNAVI.

Determination of Utility Functions

All utility functions are first assumed to be linear ($c_i = 0$). In many cases, this linearity is appropriate and does not need to be adjusted by the user. This is especially applicable when artificial scales such as point scores or indicator scales are used and risk preferences play a minor role. In this case, linearity is usually sufficient and useful since the defined gradations of the artificial scales usually already implicitly consider a decreasing or increasing marginal utility. In contrast, this does not apply in cases where natural numerical scales, such as physical quantities, are defined. Here, the shape of the utility function should be reflected more precisely, and attention should be paid to a suitable determination of the curvature. Likewise, if uncertainties play a major role in the objective and the person is not risk-neutral, a more detailed consideration of the correct curvature is recommended.

However, our initial studies show that in many cases the shape of the utility functions has little to no decisive influence on the resulting ranking of the alternatives. In this respect, an analysis of the correct shape of a utility function should mostly be carried out for practical reasons with reasonable effort.

In the **Starter variant,** a linear utility function is assumed. In this variant, the user does not have to question the correct shape of the functions.

In the **Educational and Professional variants,** an overview page is displayed when the utility functions are called up. In addition, a detailed view with increased functionality is available for each utility function.

- *Overview page* - The overview page is primarily used to display all utility functions for all objectives. In this view, it is also possible to alter the individual utility functions by manually changing the parameters or adjusting the curvature directly in the graphic.
- *Detailed view* - The detailed view can be reached by clicking on the header of the considered utility functions in the overview or using the box in the upper left corner. In this view, the user is supported by various verbal interpretation aids (tabs I to III) in determining the utility function. The interpretation of tab I refers exclusively to considerations of marginal utility since possible uncertainties modeled by influencing factors are masked out here. Riders II and III, on the other hand, address more the user's risk preferences. The user can choose the more appropriate preference interpretation for the situation at hand and must choose the utility function so that he or she can identify well with the given preference statements. The sliders can be used to set different intervals to which the preference statements refer. The purpose is to test whether the user can still identify with the issued preference statements in different cases. If this does not apply, a tolerance range can be set at the "*Precision interval*" parameter, which also permits less precise preference statements (see Section "Working With Imprecision").

Determination of Objective Weights

Objective weights usually have a major influence on the ranking of alternatives. Therefore, MAUT stresses the importance of a well-founded determination of objective weights and relies on a determination via trade-offs, although this is usually rather challenging for the user. If - as common in other methods - the importance w_i are merely queried generally, the user would have to take the ranges used for normalization into account already in his entries. With a larger (lower) range, a higher (lower) importance would have to be indicated very specifically. Studies[8] prove that decision-makers are usually not capable of this task. The results obtained with this methodology are, therefore, not very meaningful.

Nevertheless, this general query methodology is used in the **Starter variant** to avoid scaring users off with too challenging methodologies. However, for important decisions where the outcome strongly depends on the objective weights, one should switch to one of the other two variants.

The objective weighting in the **Educational and Professional variants** is the same. The weighting functionality starts with an overview page and offers even more advanced functionalities for determining the trade-offs concretely.

- *Overview page* - On this page, an initial, still very approximate assessment of the I objective weights is requested through a blanket statement using a bar chart. Based on this initial assessment, the tool proposes an objective as a reference against which all other $(I-1)$ objectives are to be compared in a trade-off pair comparison for validation. The user can change the reference when needed. Calling up a single trade-off comparison is done within this overview page via the "Trade-off" button beneath the bar chart. If a trade-off has been determined, the orange triangle is replaced with a blue check mark. At the same time, the objective weights shown on the overview page change to be consistent with the given trade-off statements. In the end, when all $(I-1)$ trade-offs have been determined, the displayed objective weights are consistent with all trade-offs, and prior possible biases of objective weights are corrected.

- *Trade-off determination via diagrams with indifference curves* - In this functionality, the user determines a trade-off for the selected objective compared to the objective used for reference. This determination is based on the display of indifference curves and a supporting, tabular, or verbal explanation of the indifference curve next to the chart. The user must shape the plotted trade-offs to match their preferences by changing the respective weights. To make the trade-offs as realistic as possible, a point in the diagram always refers to an alternative that has been defined. The slider "*Reference Point*" can select a different alternative. The slider "*Comparison Point*" changes the position of the second point in the diagram. The relative weighting of the two considered objectives in this diagram can be considered successfully completed when the user can identify with the indifference curve or the statements in the explanation for all combinations of the two sliders. If this does not apply, a tolerance range can be set at the "Precision Interval" parameter, which also allows more imprecise preference statements (see Section "Working With Imprecision").

- *Determination of a single representative trade-off* - This functionality is called up by the orange icon of a double slider on the trade-off determination page. Indifference curves and explanations are not shown here at all. Instead, the focus is placed on a single trade-off statement. This representation is particularly useful if the two objectives have well-documented measurement scales described at various intermediate levels. In this case, with a

[8] See von Nitzsch & Weber (1991)

good understanding of the scales, the user can focus on this single trade-off. It is possible to choose the comparison points A and B in the process, thus finding a sound trade-off between the two objectives. By clicking on *"Apply",* this trade-off is applied to the corresponding objective. As with the method explained above, the button on the trade-off page turns white once a trade-off has been set. Nevertheless, even after entering a representative trade-off, different positions of the sliders for the reference and comparison point should be tested to validate one's trade-off statement or the indifference curve determined from it.

Working With Imprecision

When specifying probabilities, the shape of the utility functions and the objective weights, generally exact specifications are demanded. However, it is possible to allow imprecise specifications by changing the required "*Precision Interval*" setting. In this case, a symmetrical interval is formed around the initially exactly specified value. The chosen interval should contain all estimations or preference statements in any case. These intervals are additionally illustrated graphically. These inaccuracies influence the evaluation within the function *"Robustness Check"* (see next Section).

8. Evaluation Options of the Results

In all three variants, the evaluation section ranks the alternatives based on the calculated expected utilities. In the **Educational** and **Professional variants**, the ENTSCHEIDUNGSNAVI offers various functionalities in the evaluation section that contribute to a better understanding of the analysis and help the user to explain possible discrepancies between head and gut feeling. Only a limited selection of these functionalities is available in the **Starter variant**.

Results Page

On the result page, a ranking is derived from the calculated expected utilities of all alternatives. Here, two additional functionalities are offered with display options:

- *"Simple" vs. "Detailed" presentation* - In the simple presentation, only the summed utilities are presented. In the detailed presentation, the expected utilities are broken down into the individual components of the objectives. In addition, by clicking on a utility component, each objective can be removed from the analysis. In this case, the ranking is presented as if this objective was neglected in all alternatives.
- *Sorting by "Utilities" vs. "Gut Feeling"* - By default, the alternatives are presented in the order of utilities. When switching to gut feeling, discrepancies between gut feeling and utility ranking are transparent. In the Educational variant, the ranking specified in the corresponding function `IIIg` is used. If a sorting according to gut feeling is selected in the Professional variant, the ranking order selected in the overview `IIIa` is used.

Sensitivity Analysis

In the sensitivity analysis, almost all of the decision model's parameters can be varied, and the effects on the resulting ranking can be observed simultaneously. For each parameter, corresponding slider boxes are available.

- *Alternatives* - Select which alternatives should be shown in the sensitivity analysis.
- *Selection of parameters* - Select which parameters the sensitivity analysis should refer to. For *weights of objectives,* a slider box always refers to all objective weights. In the case of *utility*

functions, specific objectives can be selected individually. In the case of *influence factors,* individual influence factors with the associated probabilities, and in the case of indicator weights, those objectives in which indicator scales are defined can be selected. With a selection of the parameter field *impact model,* a new selection box is generated, in which each individual field of the result matrix can be selected selectively.

If parameters were specified inaccurately by selecting a corresponding precision level, the precision interval specified by the user is marked graphically on the slider with a gray area.

Pros and Cons

Two forms of presentation are offered, with which the advantages and disadvantages of the alternatives are compared.

- *Radar Chart (absolute)* - In this representation, the partial utilities of the selected alternatives are compared in a network diagram. Markings on the outer edge represent the best achievable value in the objective scale, i.e., a utility of 1. Correspondingly, a utility of 0 applies to the worst value of the objective scale at the inner edge of the polygon. This form of representation requires a minimum of three defined objectives.

- *Bar Chart (relative)* - In this representation, relative utility differences of the respective alternatives to the average utility of the selected peer group are displayed. The alternatives to be shown are compiled in the selection box "*Alternatives",* forming the peer group. Green bars indicate that the respective alternative in this objective has an above-average utility, a red bar correspondingly marks a below-average value. The height of the bars represents the importance of the objective. A higher importance is illustrated by larger bars. This representation requires at least two selected alternatives.

Robustness Check

In this analysis, a Monte Carlo simulation is used to check how robust the result is with respect to uncertainties modeled in the defined influence factors and parameters that are not precisely specified.

- *Including uncertainty of influence factors* - The predefined influence factors for modeling uncertainty can only be included in their entirety or not at all. On the other hand, user-defined influence factors can be selected individually. In the robustness check, a state in each influence factor is randomly selected in each iteration of the Monte Carlo simulation, considering the respective probability. The totality of the drawn states forms a conditional (safe) scenario for the calculation of the expected utilities and the ranking of all alternatives.

- *Including imprecisely specified parameters* – The following three types are distinguished: non-precisely specified probabilities of user-defined influence variables, non-precisely specified utility functions, and non-precisely specified objective weights or trade-offs. Each type can be selected individually to be integrated into the analysis. In each iteration of the Monte Carlo simulation, a value is randomly drawn from the selected parameter's allowed interval in an equally distributed manner and set to calculate expected utilities and rankings. For both the probabilities and the objective weights, this drawing is still linked to a necessary normalization. The drawing is made from an interval for the parameter *c* of the utility function or, in the case of a verbal scale, directly via the intervals of the utilities of individual levels.

The Monte Carlo simulation starts automatically by clicking the "Robustness Check" button. By default, this initial robustness check is performed based on the three best-ranked alternatives. In addition, all

influence factors (system and user-defined) and not precisely specified parameters are automatically included in the calculation. The robustness check stops automatically when a "stable result" is reached. This means that it is no longer expected that the determined result will change in further simulation runs. If necessary, the calculation can be continued manually.

If it is preferred to start the robustness check with parameters different from the default, the desired or undesired parameters can simply be selected or deselected. The "Start new calculation" button performs a Monte Carlo simulation with the desired parameters.

As a result of the simulation, the range of calculated expected utilities is shown for each alternative. In addition, a tabular overview is shown of how often each individual alternative was ranked in a certain place during the simulation. If an alternative is ranked first in 100% of the cases, the result is maximally robust. The lower this percentage, the more often another alternative is better in certain constellations. A score is formed from all the frequencies determined, which reflects the weighted average of the ranks achieved. The lower the score, the more frequently an alternative was ranked at the top and the more attractive it was.

If user-defined influence factors were considered in the simulation, moving the mouse pointer over a rank position shows which states of the influence factors led to this rank position. In principle, only the states or state combinations are named that were present behind these rank positions at each simulation step.

Risk Comparison

This function compares the risks of the alternatives. In contrast to the presentation of risk profiles in the consequences table, the risk profile shown here does not refer to the scale of the objective but to the utilities of the alternatives. This means that expected utilities are not calculated as in the overall result but rather under the condition that there is no uncertainty. Like the robustness test, all possible constellations of states from all predefined and user-defined influencing factors are played out in a Monte Carlo simulation and the utility is calculated in each iteration step. The risk profiles show the probability by which the respective utilities are exceeded.

Objective Weight Analysis

The objective weight analysis can examine which objective weights must be applied for an alternative to being the best. A simulation is carried out in which different combinations of objective weights are selected algorithmically in each calculation step, and the resulting ranking of the alternatives is determined. The result is a percentage distribution of how often the alternatives were ranked first. A more detailed analysis can be carried out by using different display types. In addition to displaying the average objective weights from the simulation, medians, the maximum and minimum values, and the p.10 and p.90 quantiles of the objective weights can be displayed when choosing the display type “distribution”. In this more detailed presentation, the p.25 and p.75 quantiles can also be considered.

Cost-utility Analysis

The cost-utility analysis is useful if objectives revolve around costs or similar dimensions. The corresponding diagram shows which gains or losses arise in all objectives (aggregated) if the costs increase or decrease. The indifference curves visualize the constant expected utilities of the alternatives. Increasing costs are thus offset by gains in other objectives without changing the expected utility.

Tornado Diagram

With the help of the tornado diagram, it can be examined more closely how uncertainties from the defined influence factors affect the evaluation of the alternatives. On the one hand, the diagram shows which utility valuations result depending on the possible states of the relevant uncertainties. In addition, alternatives can be compared with each other. It is visualized in color which alternative is superior for certain states of the defined influence factors. The influence factors that have the greatest influence on the result are shown as the longest bars at the top. The remaining influence factors are arranged below in descending order of relevance. This results in the shape of a tornado, which gives the diagram its name.

9. Evaluating the Decision Quality

In management consulting focusing on decision theory, reference is often made to the concept of "decision quality", as described in the book "Decision Quality" by Carl Spetzler[9]. Decision quality is defined in this concept based on six criteria. Five criteria (Appropriate Frame; Clear Values; Creative, Doable Alternatives; Meaningful, Reliable Information; Logically Correct Reasoning) correspond to the five steps in the ENTSCHEIDUNGSNAVI. The sixth criterion, "Commitment to Action," which is not explicitly addressed in the ENTSCHEIDUNGSNAVI, concerns the question of the extent to which the decision maker is seriously prepared to put the identified best alternative into practice and to remove possible obstacles.

The decision quality concept follows the idea that the quality of a decision is only as good as the qualitatively weakest of these six criteria. To achieve high decision quality, (1) the decision statement must be formulated proactively, (2) the fundamental objectives must be sufficiently reflected, (3) all alternatives must be considered creatively, (4) assessments must be made with profound information and without bias, (5) the decision must be justified with a considered and comprehensible evaluation, and (6) there must be a serious willingness to implement the decision even in the face of possible obstacles. As soon as one of these points is not fulfilled, high quality has not yet been achieved.

In the **Educational variant,** the "Evaluate quality" function is found at the end of each step, with which a self-assessment can be made in relation to the respective criterion. In the *Final Review* at the end of the process, the sixth criterion mentioned above is added, and an overall assessment of the quality of the decision is made. The result corresponds to the minimum of the six criteria.

In the **Professional variant,** the assessment of the decision quality can be accessed in the orange question marks on the two overview pages. If the quality is indicated as insufficient (less than 8 on a scale from 0 to 10), it is recommended to switch to the Educational variant to revise the step and to be able to take into account the explanations and notes there.

In both variants, the overall assessment of the *decision quality* can always be called up and adjusted to the progress by accessing the "i" information field in the header and the *Decision Quality* tab.

In the **Starter variant,** an assessment of the decision quality is not implemented.

[9] See Spetzler et al. (2016).

10. Managing Projects: Saving, Exporting, Sharing

To work with the ENTSCHEIDUNGSNAVI, it is always recommended to log in through the header in the top right or to register if this has not yet been done. Although most of the functionalities are accessible without registration, certain restrictions exist. For example, it is not possible to participate in a team project. Also, the "*Share*" function (see below) cannot be used, and saving is less convenient. The data saved in the case of registration is not used commercially in any way. Rather, registration only asks whether the data may be used for scientific purposes and to improve the tool. For corresponding studies, the data is also anonymized and only stored on a server at RWTH Aachen University.

Saving Without Login

Without logging in, saving a project is only possible via the "*Export project"* function in the project management. The project file is saved locally as a *.json file in the download area of the private computer. This file can be imported through "*Import project*" or moved to the project management via drag and drop. **Note:** Simply opening the *.json file by double-clicking is insufficient to reopen the project!

Saving to a Logged-In Account

After logging in, new projects can be saved with "*Save project*" in the project management to the personal account. However, it is even faster with the save icon in the header. Once a project has been saved in the account, it is automatically saved again. The header contains an icon that can be used to access a history of all saved versions of the project. This makes it possible to view older versions of the project at any time and to edit them again if necessary.

When working on larger projects, it is recommended to frequently export a *.json file as a backup copy to the personal computer (see “Saving Without Login”).

Exporting as an Excel File or PDF

Another way of exporting projects is as an Excel file using the "*Export as Excel Chart*" function in the project management. The output is the data displayed in the "*Consequences Table*" tab behind the "*i*" in the header. However, it is not possible to re-import the data from this Excel sheet. Another possibility for export is the function "*Create PDF Report*". A PDF file is created that contains the essential elements of the project in a text-based manner at a selectable level of detail.

Sharing

Logged-in users can share a project saved in their personal account with other users. This can be achieved by accessing the project management under *“My projects”* and then clicking on the three dots on the right and selecting *“Share”*. A link is generated, which can be copied and sent to the desired person. This person can use the link to call up the last saved version of the project but cannot change this project. Collaborative working on the project is impossible here; the team functions (see Section 12) should be used for this purpose.

11. Using Issue Raising

The Issue Raising is a function with which thoughts about the project can be entered at any time and in an unstructured way. It is called up via the corresponding icon in the header. Unstructured means it is unnecessary to consider at which point of the project this idea could be relevant. All ideas entered

initially end up in the "Not assigned" area. Within the Issue Raising, however, it is possible to assign each idea to one of the four areas mentioned above: "Decision statement", "Objectives", "Alternatives", or "Influence factors". Following such an assignment, the respective idea can be inserted into the project in further steps. Within the "Decision statement" area, you can also choose between "New decision statement", "Assumption", or "Later decision", and within the "Objectives" area, between "Fundamental objective" or "Brainstorming aspect".

The function is offered in both the **Educational** and **Professional Variant**. While the user is guided successively through the four areas in the Educational variant and has sufficient similar brainstorming functions, the idea pool is particularly suitable for the Professional variant. When setting up a new project, the thoughts can be ordered initially to be assigned to the four areas mentioned afterward.

12. Working in Team Projects

A team project is a project that supports the participation of several people. To create a team project, the option "create as team project" must be selected when creating a new project. Alternatively, any project saved in an ENTSCHEIDUNGSNAVI account can still be converted into a team project later. This is possible in the project management under "*My projects*" via clicking on the three dots on the right and selecting *“Create a team project from template”.*

When a team project is created, the creator automatically becomes the **moderator** of the team project. The moderator can invite other people, coordinate teamwork, make certain settings and assign rights, and perform additional evaluations. **Co-moderators** have similar competences with the difference that they cannot delete the project and cannot transfer ownership of the project to others. In addition to the role of the moderator, there is also the role of the **editor**. An editor, like a moderator, has the right to make independent changes to the project. Without the editor role, no changes can be made. In a team project, however, several editors can't make changes to the project simultaneously. This would inevitably lead to data conflicts. Each editor can only change the project if he has temporarily taken a so-called "*editing right*". On the other hand, all team members can view the project at any time without making any changes.

Team Dashboard

When opening a team project, the overview page of the team dashboard appears first. The elements displayed on the dashboard depend on the own role in the team. The dashboard of the moderator is significantly more extensive than that of the other team members due to the additional options. However, the following elements are included on the cards of the dashboard overview page in any case:

- **Editing Right:** This card shows whether the editing right is currently assigned and, if so, who owns it. At this point, the editing right can also be assigned or relinquished.
- **Your Tasks:** Here it is shown which tasks the moderator has assigned. Tasks can refer to brainstorming aspects of the objectives, to the definition of objective scales or personal assessments. Personal assessments can relate, for example, to the specification of objective weights or to expressing one’s opinion of alternatives by using the “*veto label*” (red thumbs down) or "*support label*" (green thumbs up).
- **Editing Right Logbook:** The logbook informs all members about who had the editing right in the past.
- **Whiteboard:** The whiteboard is a central communication medium for the team members. The moderator and all editors can enter various information or agreements related to the project,

which are always visible to everyone. However, members cannot write on the whiteboard at the same time. If the editing mode is called for the whiteboard, no entry of other members is possible during this time.

- **Forum:** The forum is open to all members. Even non-editors can post a comment here at any time, which is visible to all. All comments are sorted by topicality.

Exclusive Features of the Moderator

In addition to the functions above, the moderator has sole access to the following additional features in other tabs.

- **Members:** This tab allows the moderator to add new members to the team via email invitation, assigning them the role of editor. Each member will receive an email with a link to join the team. An invitation remains displayed in the tab until the team member accepts it. Each team member must have an account with the appropriate mail address in the ENTSCHEIDUNGSNAVI to join the team. It is also possible for the moderator to accept so-called *"virtual members"* without their account into the team. However, these members do not have access to the project and can only work on the project together with the moderator via his account. The moderator can also transfer their rights to another team member.
- **Task Management:** Here, tasks are defined for team members, and inquiries about personal assessments of team members are created. Tasks concern, e.g., brainstorming aspects for the objectives or defining measurement scales for the consequences table. Personal assessments concern, for example, the specification of objective weights. This tab also shows which tasks have already been completed and which are still pending.
- **Weights of Objectives:** The objective weights of the members, given as personal assessments, are displayed here. In addition, weights can be derived based on the entries in the "Importance" column to determine how strongly the objective weights of the respective members should be included in a weighted average value. In addition to the importance, further dimensions can be defined, which can be used for weighting. Two different graphical representations can be used to analyze how the objective weights of the members differ and whether there are particularly striking deviations in the assessments of individual members from a possible consensus.
- **Evaluation:** In a tabular and graphical overview, the overall evaluation of the alternatives is presented based on the weighted average of the objective weights. This result is compared with the evaluations of the individual team members. The vetoes and supports are also listed.
- **Settings:** The following design options for controlling teamwork are available to the moderator:
  - activation of the automatic return of an editing right that is no longer used after 15 minutes
  - determination of who can take over the editing right, even if it has already been assigned
  - deleting the team

13. Working in the " ENTSCHEIDUNGSNAVI -Nightly" Pre-release Version

A preliminary version of the ENTSCHEIDUNGSNAVI can be accessed at the address https://nightly.enavi.app. This version already includes the next functional extensions and other improvements. As this version has not yet been thoroughly tested, individual errors cannot be

completely ruled out. Our development team will be pleased if such errors are reported at kontakt@entscheidungsnavi.de to be corrected.

However, it should be noted that the Nightly version is not linked to the accounts in the official version but requires its Nightly accounts. To access all functionalities, a new registration is required. Because of this clear separation of the two versions, projects saved in the Nightly version are only saved there and not in the account of the official version. When wanting to move projects from the Nightly version to the official version, you have to export the projects as *.json files from the Nightly version and import them into the official version again.

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