What-If Scenario Analysis and Decision Support Algorithm for Offshore Wind Farm Installation

Solution Proposal

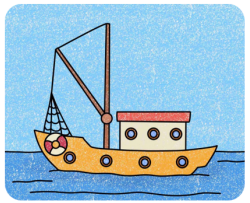
Aneta Kartali

Task overview

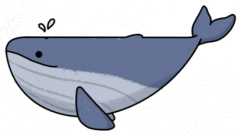
Offshore wind farm location assessment

Deciding criteria

Socio-economic conditions

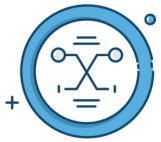


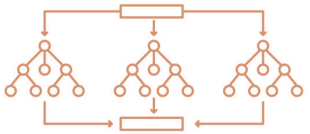
Effect on local fisheries



Environmental conditions

MCDA algorithm





Informed decision making

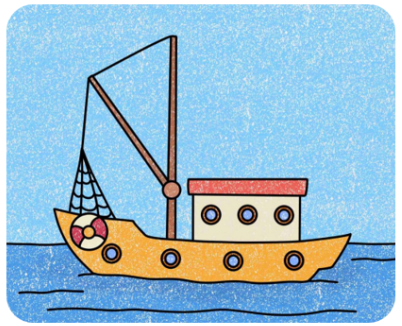
- **Problem definition**: Site selection
- **Objective**: Identifying the best location for offshore wind farm installation from a given set of potential (feasible) sites

Offshore wind farm location assessment

- **Measures of success:**
  - Socio-economic conditions
    - Fishing dependency
    - Tourism revenue
    - Changes in average income
    - Unemployment rate
  - Effects on local fisheries
    - Fish stock health
    - Marine habitat restoration
  - Environmental conditions
    - Marine biodiversity
    - Carbon sequestration rate

Deciding criteria

Socio-economic conditions



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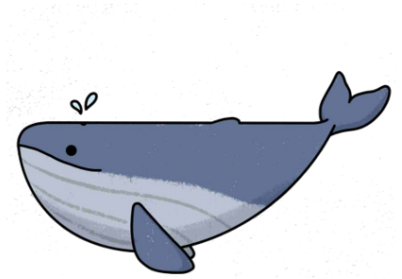
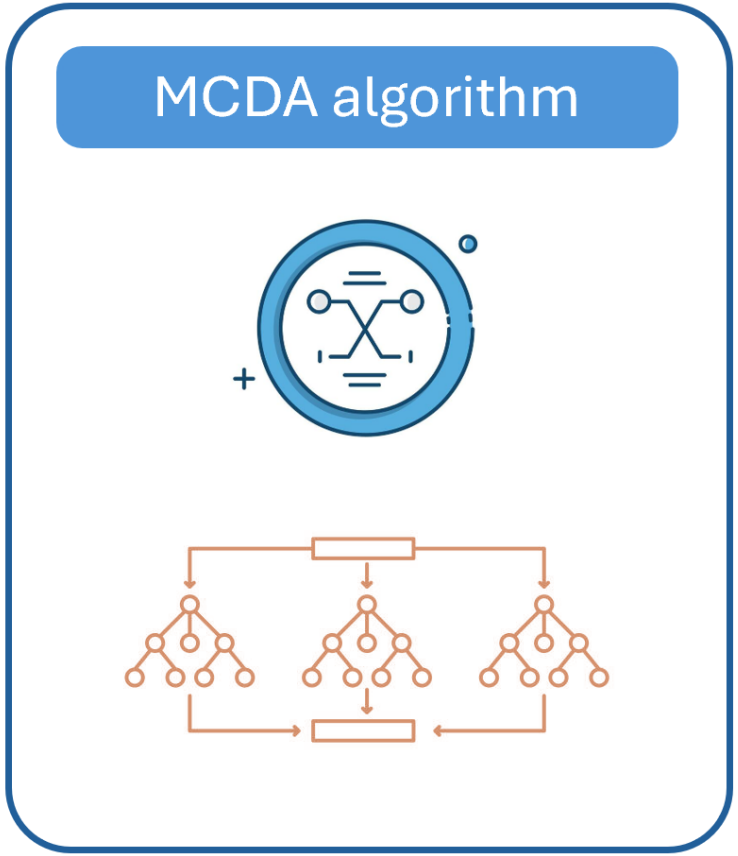
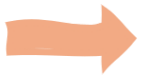


Environmental conditions

- **Criteria weighting**: Analytical Hierarchy Process (AHP)
- **Multi Criteria Decision Analysis**: Building a model based on available simulated data



- **Decision making**: Inferring the optimal location for offshore wind farm
- **Sensitivity analysis**: Testing model stability under different scenarios

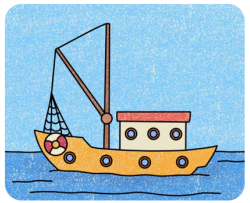


Informed decision making

Offshore wind farm location assessment

Deciding criteria

Socio-economic conditions



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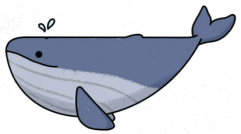

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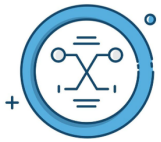
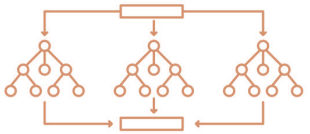




Informed decision making

Site search algorithm

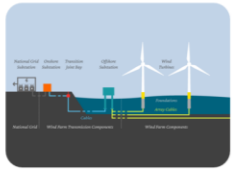
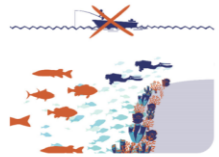
Identifying decision alternatives and criteria for offshore wind farm location assessment

Analytic Hierarchy Process (AHP) and Fuzzy AHP for criteria weighting

MCDA algorithm for scoring and ranking the alternatives

Optimal offshore wind farm site selection

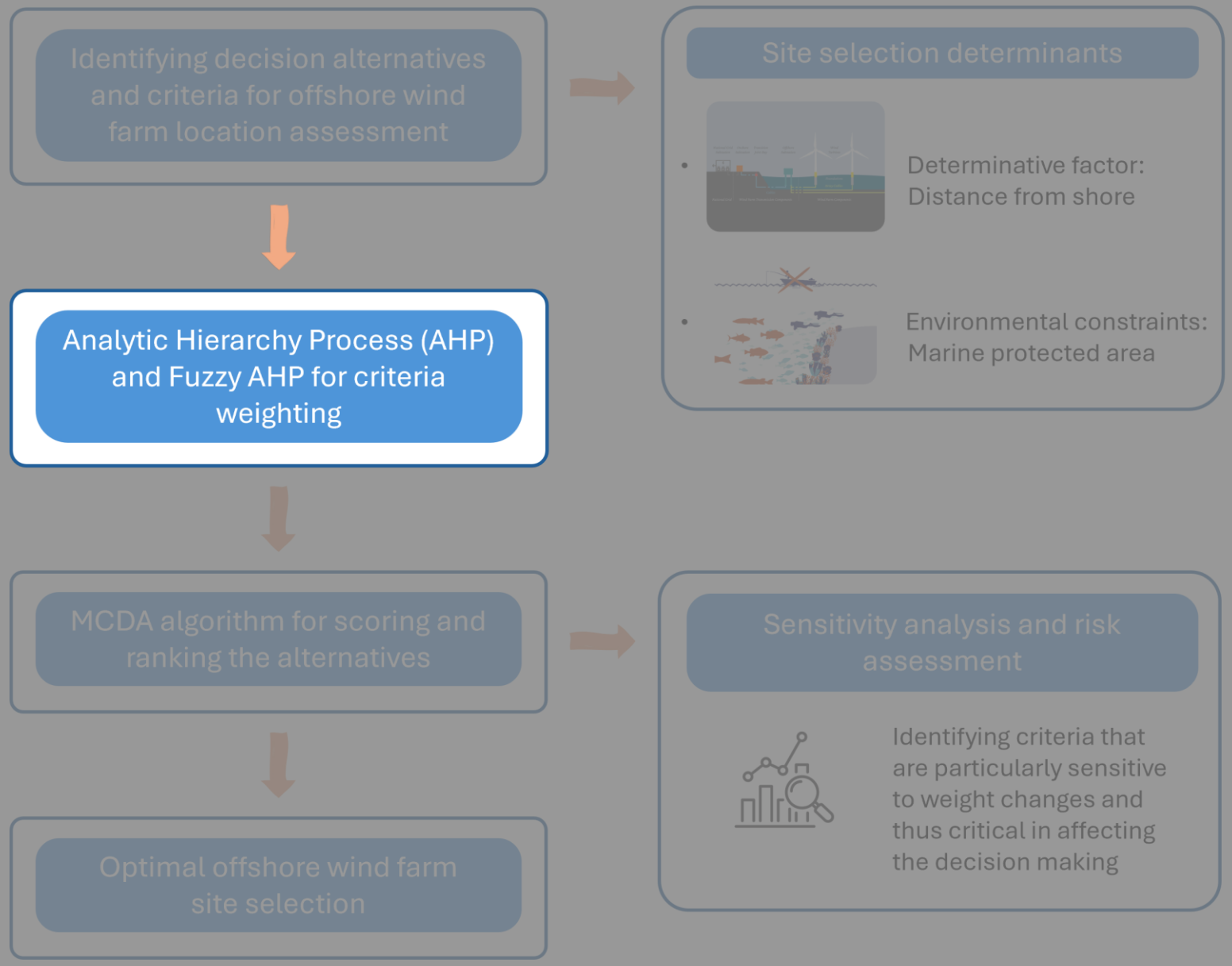
Site selection determinants

- 
  Determinative factor: Distance from shore
- 
  Environmental constraints: Marine protected area

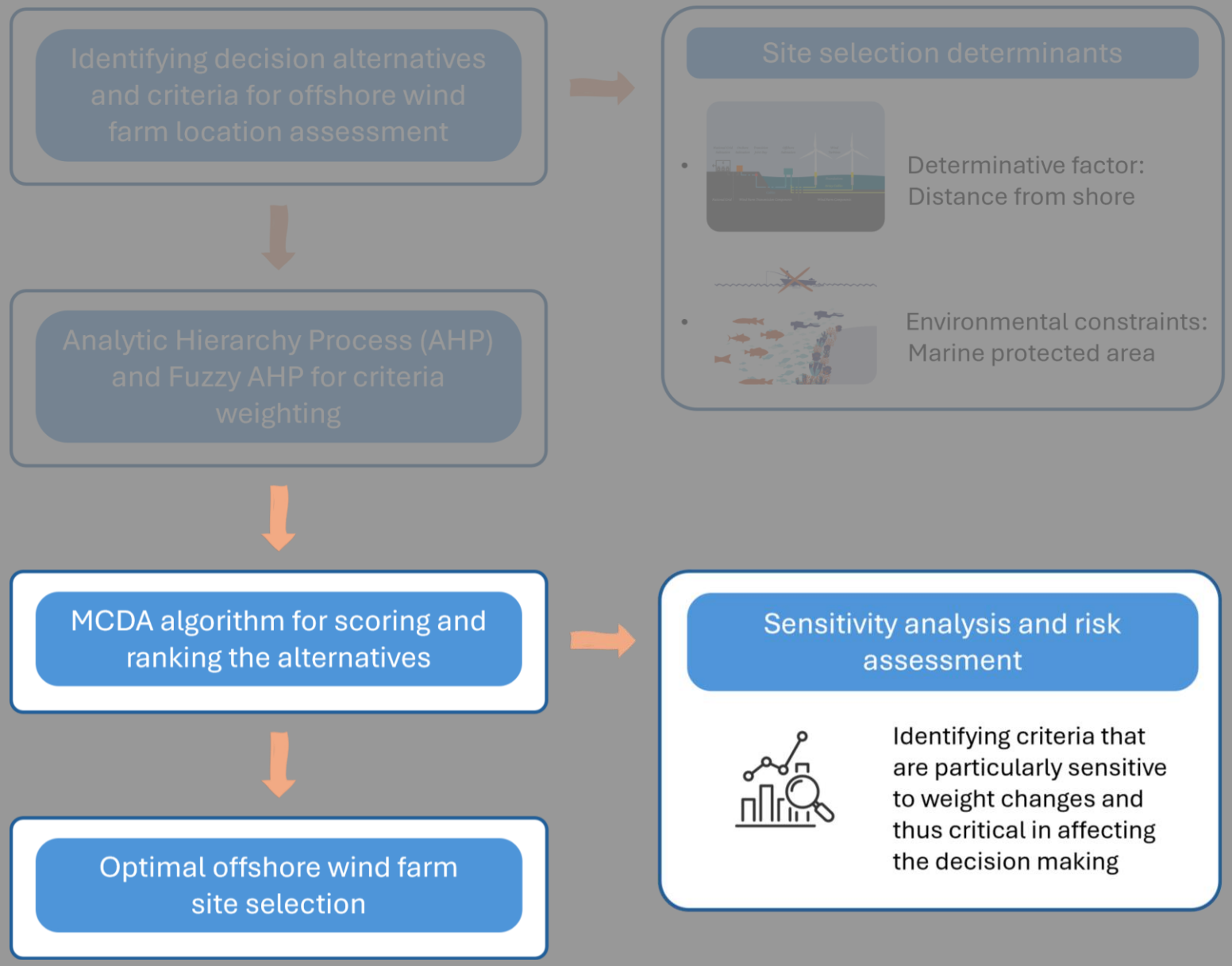
Sensitivity analysis and risk assessment

Identifying criteria that are particularly sensitive to weight changes and thus critical in affecting the decision making

- **Available data**: Synthetic socio-ecological dataset
- A total of 100 evaluated locations
- Eliminated alternatives entirely located in restricted areas where turbines are not allowed



- Best known weight evaluation method: AHP
- Stochastic alternative: uncertainty estimation using Fuzzy AHP
- Ensuring balanced decision making for all stakeholders



- **What-if scenario analysis**: determining the responsiveness of the conclusions to changes in parameter values

Implementation

ASSESSMENT CRITERIA

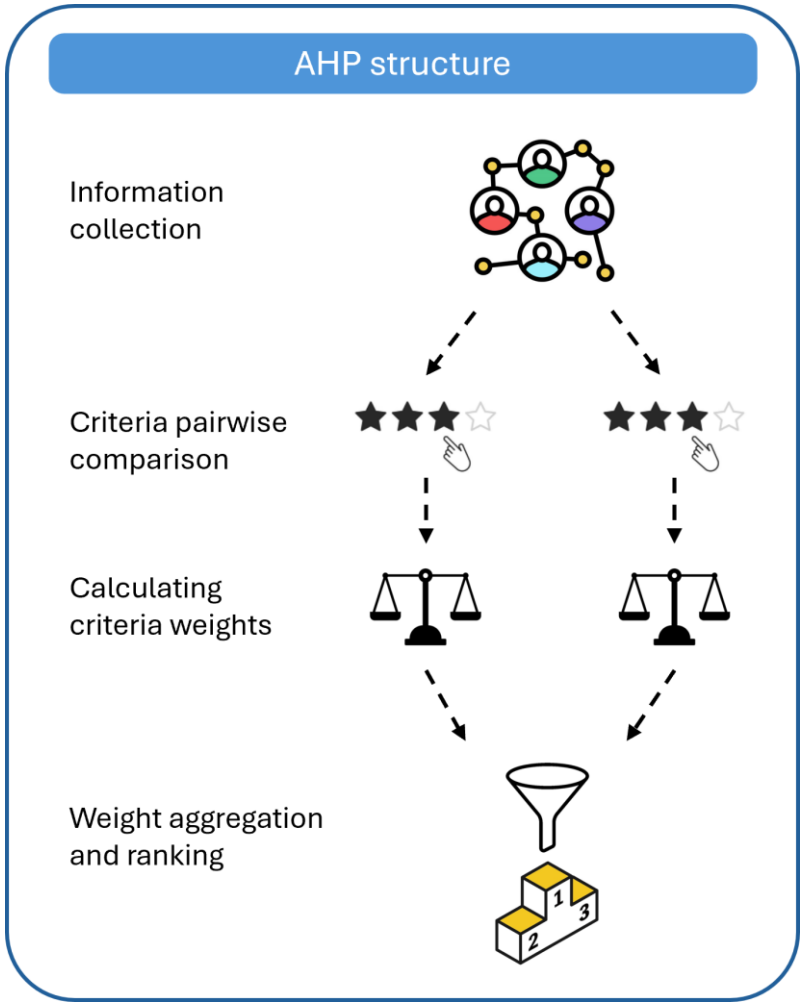
USED IN THE STUDY

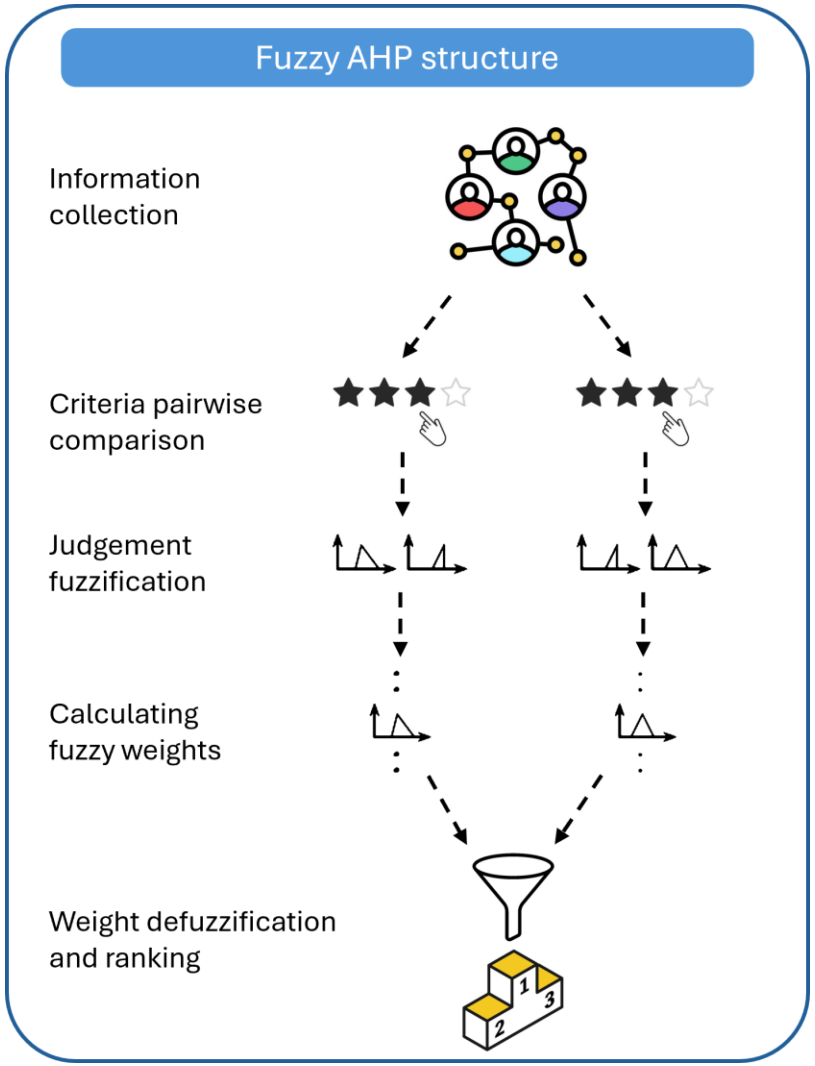
No.	Criterion	Group of criteria	Description	Preference direction
C1	Average income	Socio-economic	Average income of the community [USD]	Max
C2	Fishing dependency		Proportion of the community dependent on fisheries [%]	Min
C3	Unemployment rate		Unemployment rate of the community [%]	Min
C4	Tourism revenue		Annual tourism revenue [USD]	Max
C5	Fish stock health	Spatial/Economic	Health of local fish stocks [%]	Max
C6	Marine habitat restoration		The potential for habitat restoration in the area [%]	Max
C7	Marine biodiversity	Environmental	A biodiversity index for the marine environment (0-100)	Max
C8	Carbon sequestration potential		Estimated potential for carbon sequestration in the area [T]	Max
C9	Current offshore wind farms	Technical/Spatial	Number of existing offshore wind farms in the area [#]	Min
C10	Distance from shore		Distance of wind farm from shore [km]	Min
C11	Wind farm capacity		Potential capacity of wind farms in the area [MW]	Max

POTENTIAL ADDITION

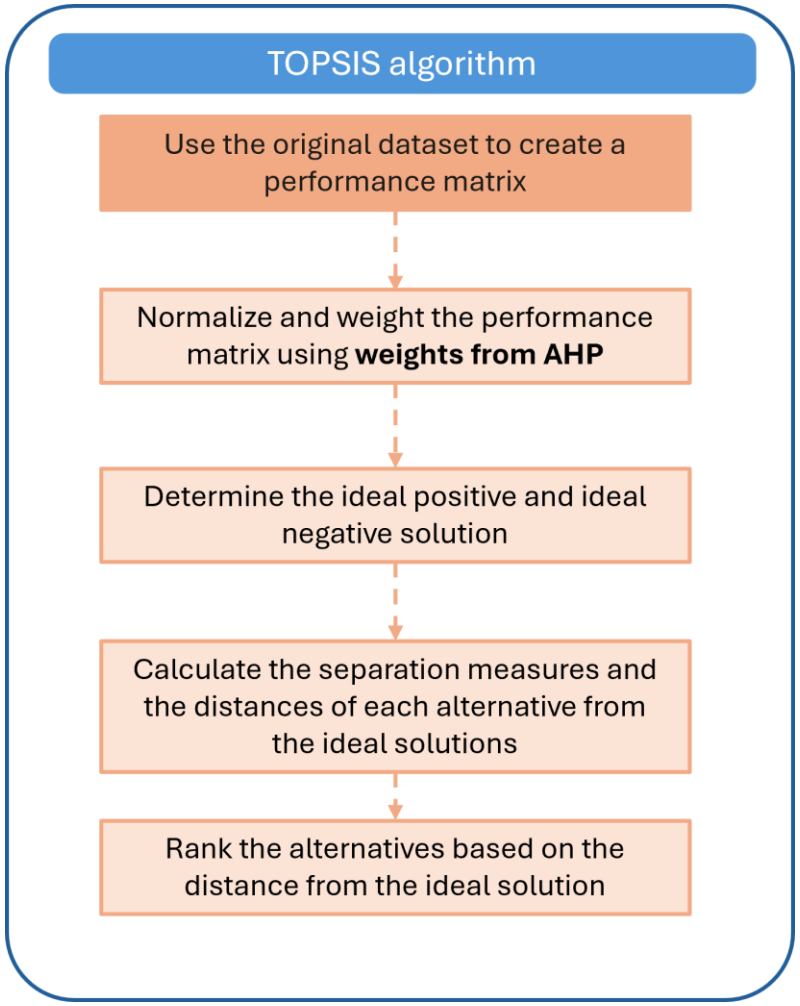
No.	Criterion	Group of criteria	Description	Preference direction
C12	Maritime traffic	Socio-economic	Distance from maritime routes [m]	Max
C15	Distance from protected areas	Environmental	Distance from marine protected areas [m]	Max
C16	Distance to grid	Infrastructure	Distance to existing onshore grid infrastructure [m]	Min
C17	Cable routing feasibility	Technical	The feasibility of underwater cable routing [%]	Max
C18	Weather conditions		Average annual air temperature [°C]	Min
C19	Wind potential		Wind potential in the area [h/year]	Max
C20	Water depth		Water depth in the area [m]	Max
C21	Wave conditions		Wave height in the area [m]	Min

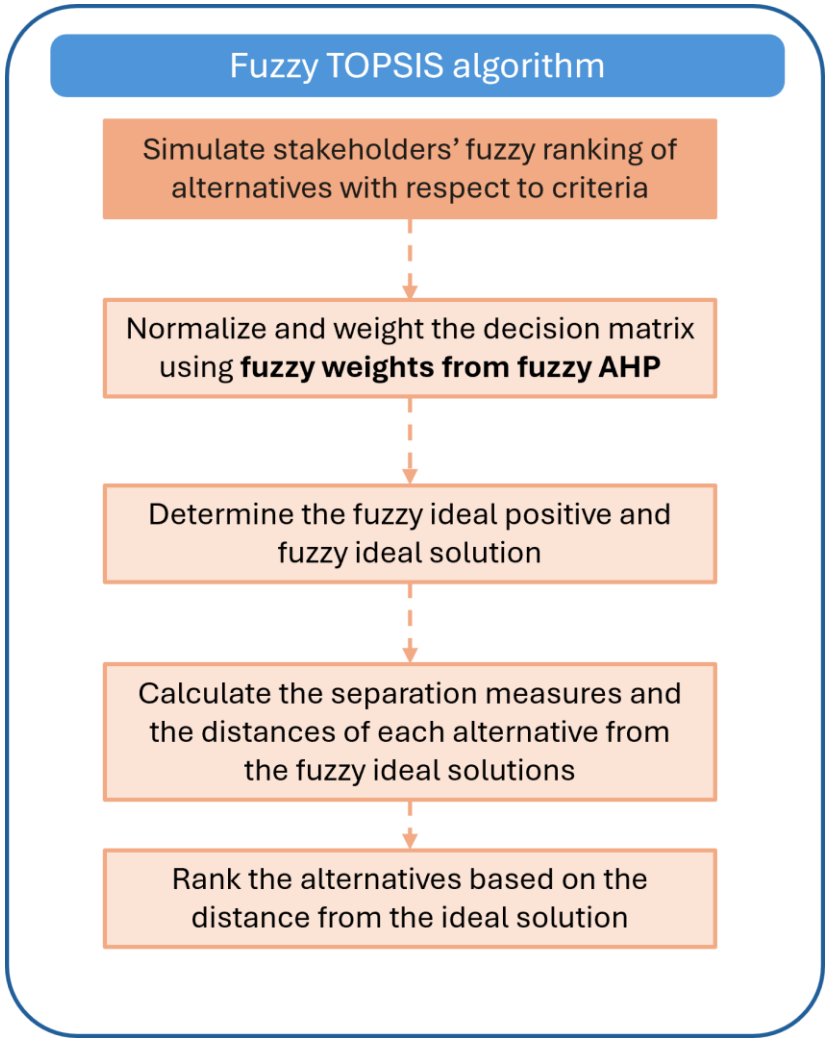
ANALYTIC HIERARCHY PROCESS





MCDA WITH TOPSIS ALGORITHM





Offshore Wind Farm Location Assessment

Decision Support for Offshore Wind Farm Installation
Solution Proposal

FUNCTIONALITIES

- Offshore wind farm location assessment that ensures balanced decision making

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- Multi-criteria decision analysis with interpretable rules

CONSOLE BASED APPLICATION

FUNCTIONALITIES

- Offshore wind farm location assessment that ensures balanced decision making
- Multi-criteria decision analysis with interpretable rules
- Interactive evaluation of alternative locations based on specified criteria

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- Interactive evaluation of alternative locations based on specified criteria
- Simulation of different stakeholder decisions and preferences with an option to consider only certain groups of stakeholders

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- Simulation of uncertain input from expert representatives of different stakeholder groups

FUNCTIONALITIES

- Offshore wind farm location assessment that ensures balanced decision making
- Multi-criteria decision analysis with interpretable rules
- Interactive evaluation of alternative locations based on specified criteria
- Simulation of different stakeholder decisions and preferences with an option to consider only certain groups of stakeholders
- Simulation of uncertain input from expert representatives of different stakeholder groups
- Sensitivity analysis provides insights into how sensitive different locations are to criteria changes