Development of software solution tool based on data acquired from latest Information technologies like advanced sensors in Subsea, Marine, Oil and Gas exploration field with the goal to highlight different factors which influence purpose of utilising offshore/Marine assets to a useful and self-sustained asset.

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ABSTRACT

In this research exercise, we developed Decision Tool by using software with the aim to show how suitable is proposed options (Various types of floating ships such as Windfarm, Seafarms , Hydrogen plant etc.) to install and operate safely & cost effectively at various sea locations against some important categories .In this paper we focussed on one important category Environment. We want to check if proposed solutions can be affected by Weather (Environment data collected from various sensors) and to check "quantity of affectedness" of each solution. To establish quantities, we took data of Marine assets and met ocean data on location .Data acquisition and use of the same data accurately in Marine ,Subsea, Oil & gas exploration field is very critical and we need to implement latest Information technologies like Wireless sensor Networks to get the accurate data information for better design and use of offshore facilities. We required site specific metocean data for 1-year,10 -year ,100- year , 1000 -year return period at a location / region of a sea/ocean .This can be achieved by design and installation of sophisticated metocean buoy with sensors. The same data can be referred for evaluating reuse and installing of offshore assets at those locations. In continuation to the initial review of our research on how to utilize the important data collected from wireless sensor networks in present ongoing oil & gas low prices environment, we developed a tool for reuse of existing assets. To brief on our earlier research study / paper, we have discussed about Decision Matrix, in a nutshell, is a tool developed with the aim to show how suitable is proposed usage option for real Marine & offshore assets and its locations.

Decision Matrix used to compare several options, based on real asset and real location. In such case, "weight factors" are introduced - some with values in the range from 1 to 3 and some with the values in range 1 to 5. In *both cases, the lowest weight factor is the best. The best option is the option with the lowest sum of weight factors. Our weight factors are based on several test cases, our experience in design, maintenance and operations of Marine& offshore assets and probabilistic methods.*

In order to use offshore/marine assets cost effectively and safely in any sea location, we proposed several options. We identified approx. 60 factors, divided into 8 categories, which may affect the success of proposed solution. To judge the suitability of the solution and to perform a comparative analysis between possibilities, if required, we have developed weight factors. In this document, our intention is to demonstrate to the potential client how weight factors are assigned in final matrix.

To assist the clients/investors to choose the most appropriate solution for real problem (offshore/marine assets) in hands, we developed "Decision Matrix" - tool developed with the aim to show how suitable is proposed use option for real offshore/marine asset and its location. This paper provides a comprehensive explanation of how our tool may be used, by introducing weight factors, for comparative analysis of several reuse options.

The tool consists of over 100 criteria/variables, divided into 8 categories: Criteria, used to measure "fitness for the purpose" of proposed solution are divided into several categories such as Existing Structure, Location Regulations, Environment, Societal, Liabilities, Conversion Operation & Risks, New Asset But for this paper we have considered Environment category for the better under standing

Keywords: Decision Tool ; WSN ; Analytica ; Environment ; Software Tools ; Mid Value ; Mean Value ; Decision Matrix ; data monitoring ; Sea Farm ; Hydrogen Plant ; Wind Farm.

I.INTRODUCTION

We proposed several options for use of offshore and marine assets. We identified approx. 60 factors, divided into 8 categories, which may affect the success of proposed solution. To judge the suitability of the solution and to perform a comparative analysis between possibilities. We have developed weight factors. In this document, our intention is to demonstrate to the potential clients/investors how weight factors are assigned in final matrix.We have developed Decision Tool, a multi-attribute analysis tool, to "measure" proposed solution against real structure in hands. Decision Tool can be used for comparative analysis of several solutions, based on the real asset on real location or for analysis of only one option. We have used a powerful tool Analytica for real-world modelling and analysis. We draw nodes and arrows to depict the relationships between model components. This approach allows describing the essential qualitative nature of the problem without getting lost in the details. As the model develops and understanding of the problem becomes clear, can define the exact quantitative details of the model. A key feature of Analytica is its ability to create hierarchies of models. By grouping related components of a problem into separate sub models, you can impose a multi-level organization to your model. This helps to manage complex relationships and allows other users to more easily grasp important concepts. For acquiring required data to for making the Decision Tool to re use assets in Marine, offshore, Subsea and Oil &gas exploration field, A Wireless sensor networks (WSN) plays major role.A site specific metocean buoy consist of a number of sensor nodes need to design and fabricate robustly to monitor an accurate / periodic data at particular location / region of a ocean.

Our developed tool consists of over 100 criteria/variables, divided into 8 categories. But for this paper we have considered Environment category for the better understanding:

Existing Structure , Location, Regulations , Environment, Societal, Liabilities , Conversion Operation & Risks, New Asset.

2.1CRITERIA CATEGORIES

It is important to understand that categories of criteria are not fully independent of each other - in many cases they are interconnected and influence each other. For example, mean of the conversion operation, covered in "Conversion operation & Risks" will lead to CO2 emission, covered by "Environment" category. **Figure 1.** Illustrates various categories considered by author for his full research and "Environment" is our focus category for this research paper.

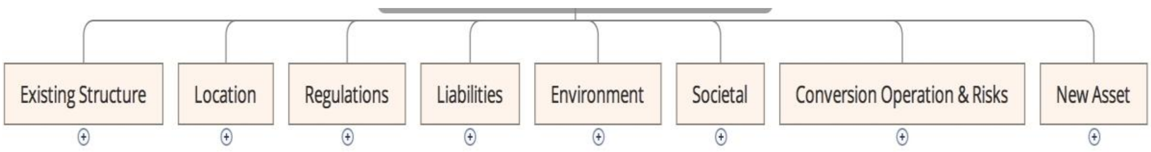

Figure 1. Illustration of Various categories

2.2 DESCRIPTION OF THE EXAMPLE

In this document, we'll compare three options:

1. Sea Farm – Author's proprietary solution for farming of aquatic and non-aquatic cultures on the Ocean Surface;
2. Hydrogen plant - solution to generate, collect and prepare for transport Hydrogen, as a energy source, to be used elsewhere;
3. Wind farm - utilizing renewable energy source (wind) for electrical power production, by means of Vertical Axis Wind Turbines (VAWT). Reasons for recommending VAWT over more common HAWT are not subject to this document.

All Marine and offshore assets are designed as per the Rules&Guidelines of any IACS society [1]

All Marine and Offshore assets should be installed/operated/decommissioned in accordance with requirements of "regulatory" bodies (laws and conventions) and aligned with an expectation of different "interest" groups (stakeholders). Note that there are four main categories of regulations:

International regulations , Regional regulations , National regulations, Local Regulations

Let us try to make a list of regulations in reference list [2,3,4,5,6,7,8], conventions, and guides which should be followed across the world by assets operators.

Proposed solutions are subject to probability calculation against "Met ocean data", which is one of the members of "Location" category.

2.3SOFTWARE TOOLS

For comparison of three proposed solutions against "Met ocean" (Weather) criteria, we're using Lumina's "Analytica 101" - visual software environment for building, exploring, and sharing Quantitative decision models. Analytica software is well established in almost every sector of The economy and is used worldwide.

Analytica Software [3] Licensed to Author “Shaik Baba” and **Figure 2.** Describes Analytica software’s release version and authenticity.

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Figure 2. Analytica software’s release version and authenticity

2.4OBJECTIVE OF ANALYSIS

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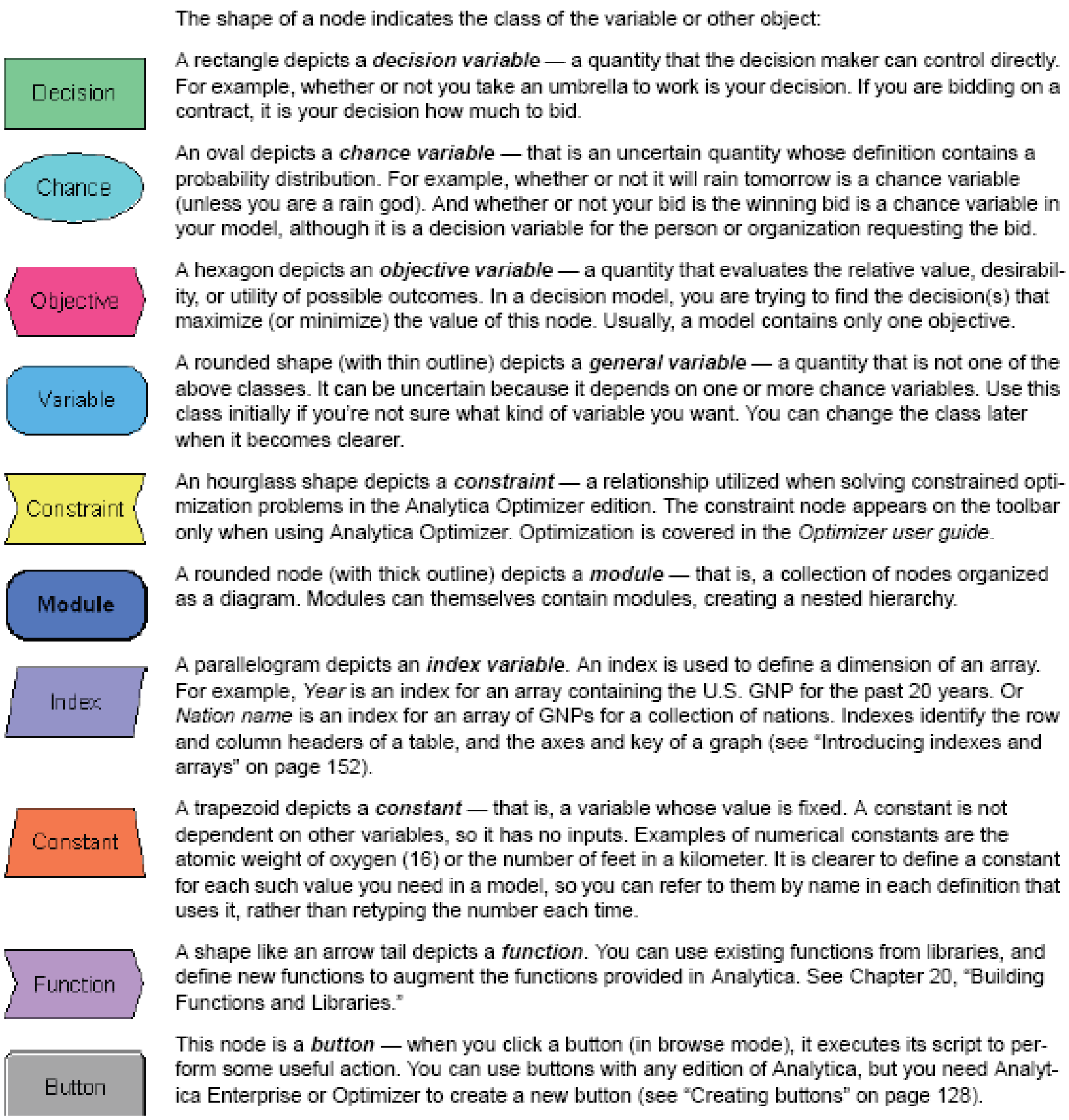
In this research exercise, we want to check if proposed solutions can be affected by weather condition (met ocean data collected from WSN networks) and to check "quantity of affectedness" of each solution.

2.5SYMBOLS USED IN THE MODEL

We used following symbols for the nodes. **Figure 3.** Describes symbols used for nodes.



The shape of a node indicates the class of the variable or other object:

A rectangle depicts a ***decision variable*** — a quantity that the decision maker can control directly. For example, whether or not you take an umbrella to work is your decision. If you are bidding on a contract, it is your decision how much to bid.

An oval depicts a ***chance variable*** — that is an uncertain quantity whose definition contains a probability distribution. For example, whether or not it will rain tomorrow is a chance variable (unless you are a rain god). And whether or not your bid is the winning bid is a chance variable in your model, although it is a decision variable for the person or organization requesting the bid.

A hexagon depicts an ***objective variable*** — a quantity that evaluates the relative value, desirability, or utility of possible outcomes. In a decision model, you are trying to find the decision(s) that maximize (or minimize) the value of this node. Usually, a model contains only one objective.

A rounded shape (with thin outline) depicts a ***general variable*** — a quantity that is not one of the above classes. It can be uncertain because it depends on one or more chance variables. Use this class initially if you're not sure what kind of variable you want. You can change the class later when it becomes clearer.

An hourglass shape depicts a ***constraint*** — a relationship utilized when solving constrained optimization problems in the Analytica Optimizer edition. The constraint node appears on the toolbar only when using Analytica Optimizer. Optimization is covered in the *Optimizer user guide*.

A rounded node (with thick outline) depicts a ***module*** — that is, a collection of nodes organized as a diagram. Modules can themselves contain modules, creating a nested hierarchy.

A parallelogram depicts an ***index variable***. An index is used to define a dimension of an array. For example, *Year* is an index for an array containing the U.S. GNP for the past 20 years. Or *Nation name* is an index for an array of GNPs for a collection of nations. Indexes identify the row and column headers of a table, and the axes and key of a graph (see "Introducing indexes and arrays" on page 152).

A trapezoid depicts a ***constant*** — that is, a variable whose value is fixed. A constant is not dependent on other variables, so it has no inputs. Examples of numerical constants are the atomic weight of oxygen (16) or the number of feet in a kilometer. It is clearer to define a constant for each such value you need in a model, so you can refer to them by name in each definition that uses it, rather than retyping the number each time.

A shape like an arrow tail depicts a ***function***. You can use existing functions from libraries, and define new functions to augment the functions provided in Analytica. See Chapter 20, "Building Functions and Libraries."

This node is a ***button*** — when you click a button (in browse mode), it executes its script to perform some useful action. You can use buttons with any edition of Analytica, but you need Analytica Enterprise or Optimizer to create a new button (see "Creating buttons" on page 128).

Figure 3. symbols used for nodes

Links and dependencies between nodes are presented with arrows, with an arrowhead pointing

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towards the node which is dependent on the connected node.

III.INFLUENCE DIAGRAM

We thought of explaining influence diagram to give better understanding to the readers of this article. An influence diagram is an intuitive visual display of a decision problem. It depicts the key elements, including decisions, uncertainties, and objectives as nodes of various shape and colors. It shows influences among them as arrows. **Figure 4.** Illustrates the influence diagram.

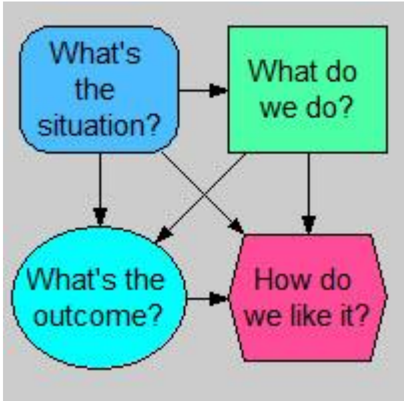

Figure 4. Illustration of Influence Diagram

This simple influence diagram depicts a variable describing the situation:

- **a decision -** What do we do?
- **a chance variable -** What's the outcome?
- **a final valuation -** How do we like it?

These four node types are the building blocks of decision problems. The influence diagram gives a high-level conceptual view on which you may build a detailed, quantitative model.

A *decision* is a variable that you (or your organization), as the decision maker, have the power to modify directly. It could be whether to invest in a new project, how much to invest, how much to bid, where to locate a new site, or, in this example, what budget to allocate for marketing.

A *chance variable* is an uncertain quantity, whose value you don't (yet) know, because you don't have complete information - maybe it's in the future - and which, (unlike a decision), you cannot control directly.

An *objective* is a measure of your satisfaction with possible outcomes. It might be net present value, lives saved, or EBITDA, or more generally, *utility*. Usually, the decision maker is trying to find decisions to maximize (or minimize) the objective. Often, an objective combines multiple sub-objectives or attributes, which may be in conflict - such as energy costs, and environmental and health risks. Usually, when the objective is uncertain, decision analysts suggest maximizing the expected value, or more generally, expected utility, based on risk preference.

A **general variable** is a deterministic function of the quantities it depends on.

The author is having prior experience in designing and deployment of a various marine / offshore assets, met ocean buoys with sensors.

This paper provides a comprehensive work of Tools development in Marine, Subsea, Oil & gas exploration field, discusses major technical challenges, and identifies future research directions and need of sensors usage in effective manner. The rest of the paper is organized as follows: **Section 2** briefly describes Model, Proposed solutions and Model Diagram. **Section 3** discusses about Results of the analysis. **Section 4** highlights conclusion and most favorable solution.

IV.MODEL

This section provides an overview on the Decision tool.

3.1UNITS

To establish "measure of impact" of weather on each of proposed solutions, we're using Dollar
[$] unit - expressing performance of the solution as a "gain" or "loss" in Dollars. To make it
Clearer: under same weather and sea state (wind), the wind farm can produce more electricity than on "normal" (moderate) weather.

However same conditions may have unfavorable influence on Sea Farm by affecting loading and transportation operation of perishable goods, while Hydrogen generation plant can be slightly affected or unaffected as hydrogen is not the perishable product. To capture those differences "gains and losses" are expressed in $.

3.2PROPOSED SOLUTIONS

Three proposals are subject to analysis and comparison - see paragraph 1.2:

1. Sea Farm
2. Hydrogen plant
3. Wind farm.

In the analytical diagram, those three possibilities are modeled as "Decision node", labeled as "Conversion". In **Figure 5.** We have shown a decision node is modeled as a "list of labels"

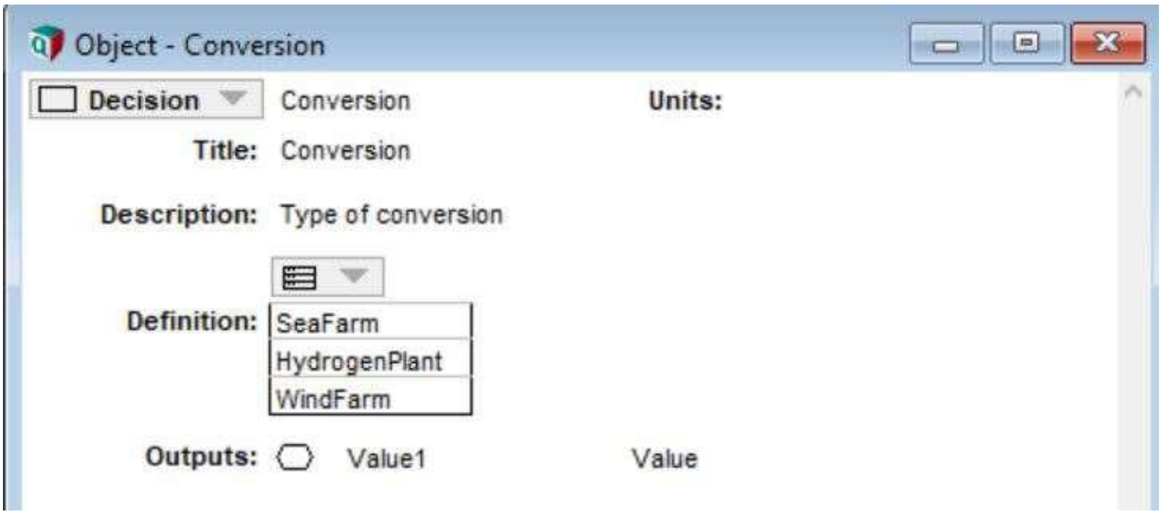

Figure 5. Decision node is modeled as a "list of labels"

3.3WEATHER

Weather is modeled as "chance node":

Mathematically, the weather is defined as "probabilistic table", which is Analytica's function for describing discrete probabilities. In this exercises weather is having following probabilistic outcomes (weather patterns):

1. Storm 2. Swell 3. No Wind 4. Moderate (& fair) 5. Severe Storm

In **Figure 7.** We described Probabilities of possible outcomes of weather. For weather (Environment category) storm, swell, No wind, Moderate and severe storm place major role. Accurate data for these can get from sensors and useful for deployment of marine and offshore assets at particular sea location for the safe and economical operation.

Probability Table - Weather

Probability Table of Weather

Domain of Weather

Storm	0.04
Swell	0.7
No wind	0.15
Moderate	0.1
SevereStorm	0.01

Figure 7. Probability Table-Weather

Note that sum of probabilities should be 1.

In real life calculation, weather outcomes and probabilities should be extracted from Met Ocean data (collected from sensor data) for given location.

IV.VALUE

Value or result of the analysis is modeled as "objective node": The "Value" is defined as a deterministic table (or determtable), using "weather" and 'conversion' as inputs. The deterministic table is a table, where at least one index must be discrete probabilistic. In this case, it is probabilistic table "weather". We have shown Deterministic table (or Determ Table) in **Figure 8.**

Determ Table - Value

Determ Table of Value ($)

Domain of Weather / Conversion

	SeaFarm	HydrogenPlant	WindFarm
Storm	-30K	0	10K
Swell	-5000	0	0
No wind	0	0	-30K
Moderate	0	0	0
SevereStorm	-30K	-30K	-30K

Figure 8. Deterministic Table (or Determ Table)

In a table shown above, values marked as "+ - xx K" corresponds to expected gains (+) and

Losses (-), where "xx" is actual amount and K stands for thousands (1000). For this exercise, those values are given randomly. In real life "gain" and "loss" values should be extracted from the ROI analysis and related documents for given time period (1-10 years?).

4.1MODEL DIAGRAM

The model diagram is given in the following **Figure 9.**

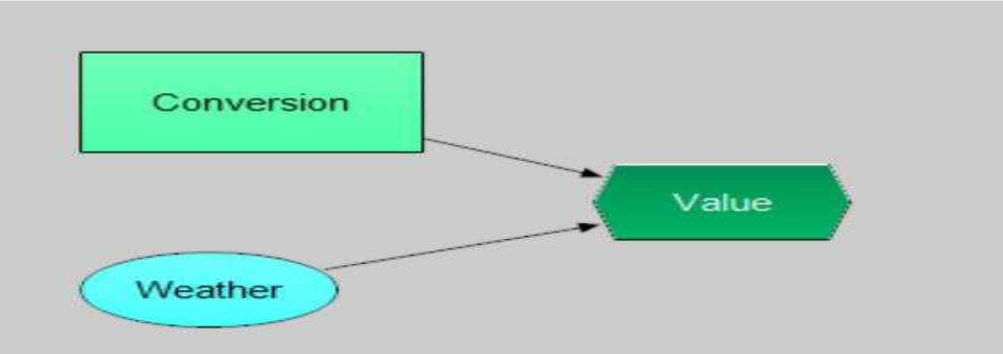

Figure 9. Model Diagram

4.2RESULTS OF THE FULL ANALYSIS

Results of the analysis discussed in detailed in this section:

4.3MID VALUE

Midvalue Results for the analyzed assets (Seafarm, HydrogenPlant &Wind Farm) shown in **Figure 10.**

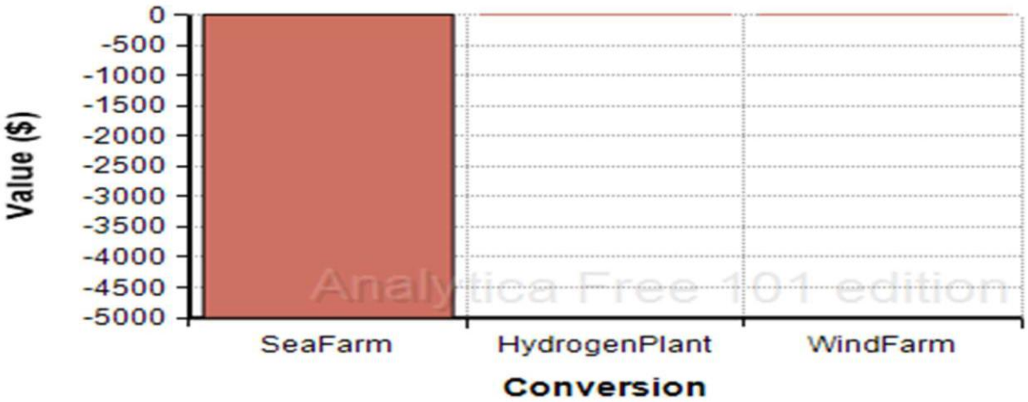

Figure 10. Mid Value Results

It is clear from above graph that SeaFarm is "sensitive" on weather conditions, as it is producing perishable goods, which transport to the market, can be heavily affected. Hydrogen Plant and Wind Farm appears like independent on weather (Value = $0):

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SeaFarm	HydrogenPlant	WindFarm
-5000	0	0

V.MEAN VALUE

Midvalue Results for the analyzed assets (Seafarm, HydrogenPlant &Wind Farm) shown in **Figure 11.**

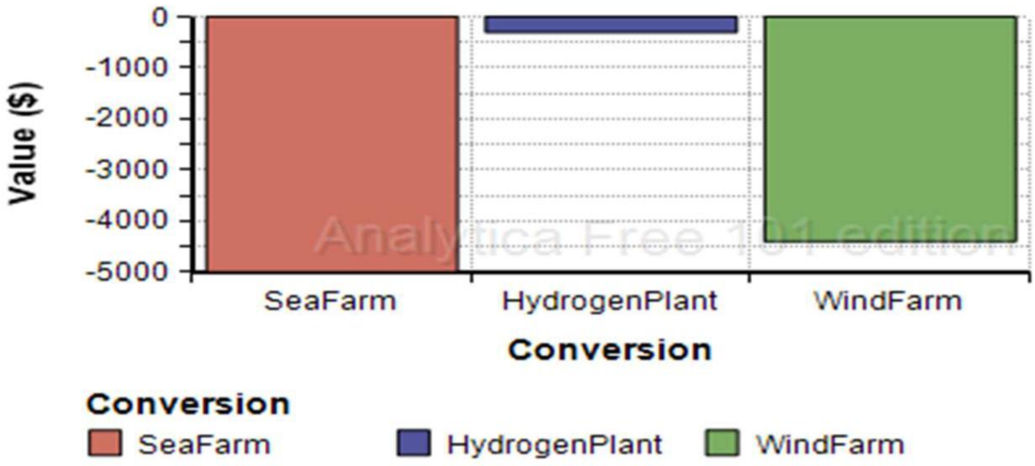

Figure 11. Mean Value Results

Mean value is giving better comparison between Wind Farm and Hydrogen Plant: higher wind Means more electricity production, but up to some degree, when over speed protection of the turbine is activated by shutting down production:

SeaFarm	HydrogenPlant	WindFarm
-5000	-300	-4400

Above results are partly expected as dominant weather is swell, which may affect transport of the goods to the shore.

Figure 12. Is graph shown for Probability (Vs) Weather? These Storm, swell, No wind, and Severe Storm values can be acquired by various sensors which are deployed in oceans.

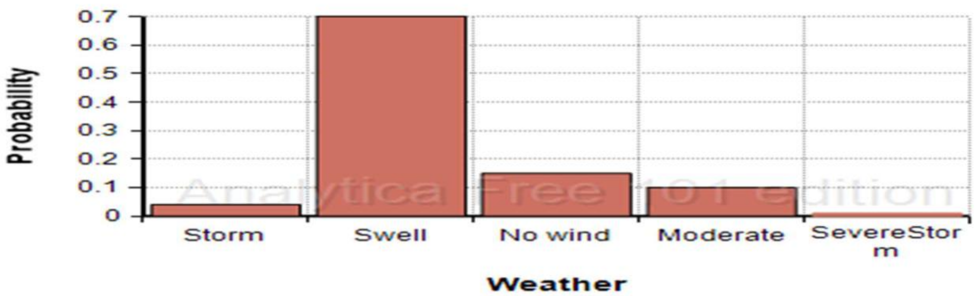

Figure 12. Probability graphs against Weather

VI.CONCLUSION

Guided by above results discussed in **Section 3**, one should conclude that most favorable solution is "Hydrogen plant", followed by "Wind Farm"; "SeaFarm" looks as the worst proposal. However, weather (Met Ocean) is only one of the inputs to the "Location" category of Reuse Matrix. Note that Reuse Matrix has over 60 criteria to rank different solutions, divided into 8

Categories. In this case, input for Met ocean data criteria in Reuse Matrix should be:

Hydrogen Plant - 1 (the best) , Wind Farm – 2 , SeaFarm - 3 (the worst)

Probability (mathematical) of Value is given in following graph which is shown as **Figure 13**.

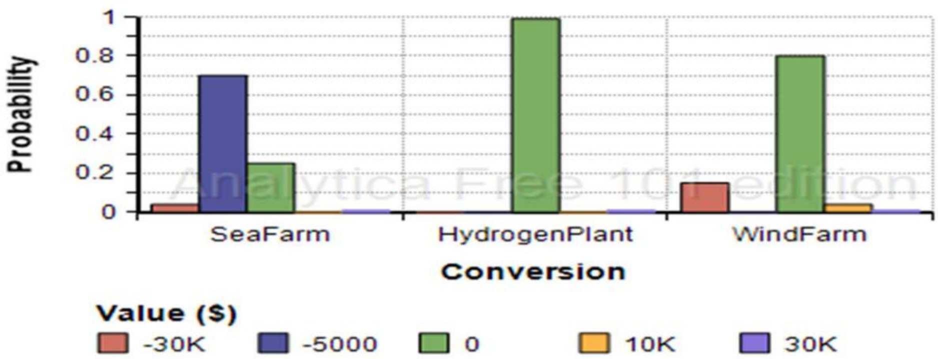

Figure 13. Probability (mathematical) of Value Graph

Exact expected "worth" of each proposed solution can be calculated by multiplying probability of the "Weather" with "Value":

SeaFarm = -30,000*0.04 + (-5,000)*0.7+0*0.15+0*0.1+(-30,000)*0.001 = - $ 5,000.00.

Exact values are given in the table format in **Figure 14 .** (Negative values are given in the brackets, in red):

		Value [$]		
Weather	Probability	SeaFarm	Hydrogen Plant	Wind Farm
Storm	0.04	($30,000.00)	$0.00	$10,000.00
Swell	0.7	($5,000.00)	$0.00	$0.00
No wind	0.15	$0.00	$0.00	($30,000.00)
Moderate	0.1	$0.00	$0.00	$0.00
SevereStorm	0.01	($30,000.00)	($30,000.00)	($30,000.00)
Exact Value [$]	**N/A**	**($5,000.00)**	**($300.00)**	**($4,400.00)**

Figure 14. Value Table for SeaFarm, HydrogenPlant & WindFram

Results shown in the above table just strengthen conclusion that the best option, for considered criteria, is Hydrogen Plant, while the worst one is SeaFarm. Decision Tool can analyze any kind of the solutions, it is a good time to mention software tool we used - it is, at the moment, Analytica 101, which is available from Lumina website. Python, Excel, Octave and other programming languages can be used as well. The tool consists of over 100 criteria/variables, divided into 8 categories: Criteria, used to measure "fitness for the purpose" of proposed solution are divided into several categories such as Existing Structure, Location Regulations, Environment, Societal, Liabilities, Conversion Operation & Risks, New Asset But for this paper we have considered critical Environment category (out of 8 categories) for the better understanding and detailed explanation.

VII.ACKNOWLEDGMENTS

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VIII.CONFLICT OF INTEREST

The authors declare no conflict of interest.

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[11.] Analytica is a **visual software environment** for building, exploring, and sharing quantitative decision models. This was developed by LUMINA Decision Systems.