*Advances in Reliability, Safety and Security, Part 6 – Kołowrocki, Magryta-Mut (eds.)*
*© 2024 Polish Safety and Reliability Association, Gdynia, ISBN 978-83-68136-18-0 (printed), ISBN 978-83-68136-05-0 (electronic)*

**Advances in Reliability, Safety and Security**

ESREL 2024
Monograph Book Series

# Decision Making For Underwater Inspection Method Selection For Floating Production, Storage And Offloading Units: Multicriteria Approach

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**Abstract**

This article addresses the selection of Underwater Inspection in Lieu of Drydocking (UWILD) methods for hull evaluation including its interface with appendages (bilge keel and fixed fender) in Floating Production, Storage, and Offloading Units (FPSOs). Periodic inspections using suitable UWILD methods are crucial to provide essential data ensuring the integrity and reliability of assets. The decision-making process, intricate and comprehensive, involves considerations such as costs, detection capability, and environmental impact. This study employs the Simple Multi-Attribute Rating Technique (SMART) for systematic evaluation and decision support. The methodology incorporates a decision diagram to optimize the inspection scope and assess the effects of failure modes, reducing alternatives for a more focused analysis. The analysis, conducted using the SMART method and Visual Interactive Sensitivity Analysis (VISA) software, engaged maintenance and reliability engineering experts in defining and prioritizing criteria. In case study, the results indicated the crawler with video recording as the recommended UWILD method for comprehensive hull inspection. The consistency of this approach is noteworthy, offering a valuable opportunity for systematic evaluation and assisted decision-making in the context of hull inspection. For future improvements, there are plans to incorporate a probabilistic approach in eliciting utility functions, with the pursuit of collaborations with underwater inspection experts and access to more comprehensive databases.

*Keywords*: underwater inspection methods, simple multi attribute rating technique, inspection, decision analysis

## 1. Introduction

The offshore industry plays a crucial role in meeting the global demand for energy, with FPSOs being fundamental assets in this context (Duggal and Minnebo, 2020). To ensure the safety and efficiency of these operations, periodic inspections are indispensable, particularly in the hull region and at the interfaces between appendages and the hull (American Bureau of Shipping, 2023). This underscores the significance of UWILD methods in maintaining the structural integrity of these platforms.

In this context, regulatory boards not only approve the use of UWILD methods but also establish standards and regulations that guide inspection practices in the offshore industry, helping to determine the appropriate timing considering the scope of inspection. The decision regarding the UWILD method to be adopted in an inspection is a critical aspect that goes beyond a technical choice. In various situations, divers are still employed for underwater inspections or cleaning activities (Nassiraei et al., 2012), a practice that involves significant risks to human life. In this regard, the use of UWILD methods with the aim of reducing human exposure to hazard represents a significant advancement in risk management.

However, the variety of available methods (Caltrans, 2018) requires a careful analysis of specific platform conditions, along with the preferences of the responsible manager to achieve the inspections method safety and effectiveness. In addition to costs, criteria such as method detection capability, geographic and environmental features (depth, location, current, etc.), and type of structure are determining factors in this choice, aiming not only to optimize resources but also to minimize downtime and maximize production. The application of advanced analysis and decision-making techniques stands out as a crucial aspect in the pursuit of inspection effectiveness. Among decision-making techniques, the group of compensatory techniques is noteworthy, using the premise that it is possible to compensate for a weak attribute of an alternative by attributes that offset this weakness (Goodwin and Wright, 2014). In this context, the Simple Multi-Attribute Rating Technique (SMART) provides a systematic and judicious approach. By using specific and measurable criteria to assess multiple attributes, SMART not only enhances the quality of inspections but also provides a robust framework for data analysis and informed decision-making (Kiker et al., 2005). This method allows for a comprehensive evaluation of different aspects involved in choosing the most appropriate UWILD method, considering variables such as effectiveness, cost, time, and environmental impact. However, one of the main challenges in directly applying the decision analysis method without considering the inspection scope is the abundance of available UWILD methods, which can make the decision analysis burdensome.

To achieve the goal of mitigating diver exposure to danger and ensuring the reliability and structural integrity of FPSOs, this article approaches the selection of the UWILD method for hull assessment and inspection of the interface between the hull and appendages (bilge keel and fixed fender) as a multicriteria decision problem. For decision analysis, the SMART method was employed using the Visual Interactive Sensitivity Analysis (VISA) software. Three reliability and maintenance engineering experts were consulted through forms for defining criteria and sub-criteria and prioritizing the criteria considered in the choice of the UWILD method. As a novelty, this article presents an approach based on scope as well as the sought mode of failure during inspection to define alternatives during the decision analysis.

## 2. Literature Review

### 2.1. Multi Criteria Decision Analysis

Multiple criteria decision making (MCDM) is a field of study that deals with decision making problems involving numerous and often conflicting criteria (Thilagavathy and Mohanaselvi, 2023). When multicriteria exist, simplistic intuitive process may not be applicable in which case a more detailed and robust process is required.

Decision experts frequently encounter situations where a single criterion is insufficient for optimal choice in real-world scenarios (da Silva et al., 2021). In this aspect, decision analysis enables decision makers to structure their thinking, explore trade-offs between attributes, and deliver a documented and defensible rationale for a given decision (Goodwin and Wright, 2014).

The MCDM analysis benefits previously mentioned are relevant to select an inspection method, as it entails complex decisions such as “which inspection method is more suitable for a specific inspection plan for a particular section of a ship hull structure?”. It is no longer a simple and technical decision, and it needs to be supported as different criteria need to be considered.

The MCDM methods are widely used for personnel selection in a broad range of fields such as information technology (Greco et al., 2005), higher education (Chen and Cheng, 2005), construction (Celik et al., 2009), professional sports (Shahhosseini and Sebt, 2011) and more. However, in the underwater inspection field, due to the use of brand new UWILD technologies the number of decision-making process applications is relatively limited (Martins et al., 2020; Yao et al., 2020), which makes pertinent to practitioners and researchers of the oil and gas field, especially for UWILD scenario, and for the theme of this paper.

In the underwater inspection field, the decision-making is guided by several criteria with attributes of qualitative, quantitative, and mixed nature, making it a complex decision process. For an assertive decision in inspections actions, which need to address what type of UWILD method should be selected and implemented, it is appropriate to apply Multiple-Criteria Decision-Making methods (MCDMs) that direct the most suitable alternative or rank the alternatives according to their respective cost and benefits of important criteria indicated.

### 2.2. SMART Decision Analysis Method

The Simple Multi Attribute Rating Technique (SMART) is a multicriteria decision-making method based on the theory that each alternative consists of a number of criteria that have values, and each criterion has a weight that describes how important one criterion is to another (Kiker et al., 2005). The performance of the alternatives under the respective criteria, evaluated via a direct-rating procedure, is expressed in grades on a numerical scale.

Some advantages of the SMART technique can be mentioned according to (Greco et al., 2005), (Chen and Cheng, 2005), (Celik et al., 2009) and (Shahhosseini and Sebt, 2011), SMART can be used quickly to obtain a weighted total score and is a very popular decision-making method, since its analysis incorporates a variety of quantitative and qualitative criteria. Moreover, SMART is a useful technique because it is simple, easy, and requires little time in making decisions that are quite important for those involved in the decision-making process and using SMART in performance measures can be a better alternative than other methods. Although, the cost of this simplicity is that the method may not capture all the details and complexities of the real problem (Watson and Buede, 1988), where the SMART approach is usually applied when uncertainty is not the central concern of the analysis (Rezaei, 2021).

Much of the inspection equipment currently used in UWILD evaluation has completely new technologies with few units available for use, which makes access to technical data on these equipment, such as performance and operational costs, very complex. To access this information, technical interviews with UWILD inspection experts can be carried out. Along with this information, interviews can be useful for capturing criteria and the weights of those criteria according to the judgment of the interviewed experts for different UWILD inspection methods. In this way, it becomes possible to implement the MCDM technique using these data.

A very similar approach considering an interview experiment with experts was performed by (Greco et al., 2005), (Murad et al., 2021) and (Marttunen and Hämäläinen, 1995) where SMART technique was applied and the questions to be asked from the experts should be well tested by the analyst. The participants found that the SMART method with direct ratio weighting was easy and fast enough to avoid the tiring of the participants.

The weighting process should also be flexible and lower time consuming than AHP (Analytic Hierarchy Process) or MAUT (Multi-Attribute Utility Theory) procedures (Goodwin and Wright, 2014; Celik and Kandakoglu, 2009; Murad et al., 2021). The motivation of the participants clearly decreased towards the end of the interview sessions. In SMART method, changing the number of alternatives will not change the decision of the original number of alternatives, and this is useful when new alternatives are added and means an advantage to other approaches, such as PROMETHEE (Preference Ranking Organization METhod for Enrichment Evaluations and ELECTRE (Elimination Et Choix Traduisant la Realite) (Rosalina et al., 2023).

This list of advantages aforementioned, quick score responses, flexibility (especially for survey approaches) and low time consuming were the major reasons why we decided to use the SMART technique in this study for UWILD inspection method evaluation.

## 3. Methodology

The employed methodology is based on the basic structure of the decision-making process, as illustrated in Figure 1. In this study, a method for generating alternatives for stage 5 is proposed, aiming to narrow down the space of available alternatives according to the scope of inspection.

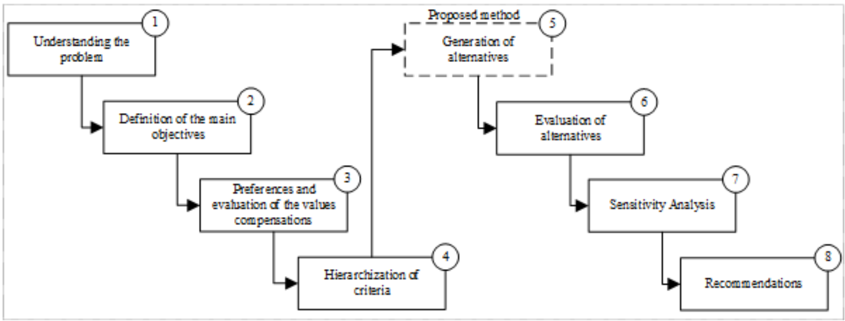


Fig 1. Stages of decision analysis. Adapted from (De La Vega et al., 2018; Goodwin and Wright, 2014).

In the first two stages, the problem to be solved is established, and the relevant criteria for the problem are defined. The definition of relevant criteria is generally assisted by a literature review. In the case of UWILD methods, regulatory standards, such as the “Guide for Risk-based Inspection for Floating Offshore Installations” (American Bureau of Shipping, 2018) and “Rules for Building and Classing Floating Production Installations” (American Bureau of Shipping, 2023), serve as the foundation for defining the necessary criteria for the selection of the UWILD method for hull inspection and its appendages (steel plates, fixed fenders, and bilge keels).

In stages 3 and 4, the preferences of decision-makers and the prioritization of criteria are assessed. Stage 3 typically employs forms or questionnaires to determine the level of preference that decision-makers accept regarding the criteria (De La Vega et al., 2018). On the other hand, in stage 4, the prioritization of criteria can be accomplished through various methods, such as the scoring method, pairwise comparison method, analytic hierarchy process, elimination and choice traditional method, among others. These two stages require significant participation and commitment from decision-makers. In this study, swing weights method was employed.

In step 5, alternatives are obtained according to the methodology proposed and described in section 3.1. The proposal begins with a literature review, aiming to identify the UWILD methods used in different regions of FPSOs and exploring inspection approaches, such as corrosion, cracks, among others. Based on the results of this review, a decision diagram was created which, aligned with the specific scope of inspection, allows the identification of suitable UWILD methods for decision analysis.

Given the alternatives, stage 6 aims to evaluate the utility or value functions of each alternative, allowing for the comparison of the aggregated values of the alternatives, facilitating the decision-making process. The aggregated value of the alternatives is determined by the sum of the product of weights and the method score for each assessed criterion, as per Eq. (1) (Goodwin and Wright, 2014).

$$AV(a) = \sum_{i=1}^{n} w_i \cdot u\big(x_i(a)\big) \tag{1}$$

Where $AV(a)$ is the aggregated value of the alternative $a$, $n$ is the number of attributes, $w_i$ is the normalized weight to attribute $i$ and $u\big(x_i(a)\big)$ is the performance of the alternative to attribute $i$.

While the assessment of aggregated value provides an initial indication of the best alternative for the problem, according to (De La Vega et al., 2018) and (Goodwin and Wright, 2014), it is usual to conduct a sensitivity analysis (stage 7). In this stage, both the criteria weights and the decision-maker's preferences are varied, assessing the effects of these changes on the aggregated values of the alternatives.

Both stages 6 and 7 depend on the outcomes of stages 3 and 4. Since stages 6 and 7 are contingent on the execution of stages 3 and 4, this work will solely discuss these activities and provide an illustrative example.

Finally, in stage 8, based on the results of stages 6 and 7, the most suitable alternative for resolving the problem is recommended.

### 3.1. Generation of alternatives proposal

In a literature review conducted from April to June 2023, nine UWILD methods were identified for inspecting hull plating and the interfaces of the bilge keel and fixed fenders with the hull. The identified UWILD methods encompass the combination of a vehicle used to reach the desired inspection area and a data collection technique, such as the Autonomous Underwater Vehicle (AUV) with video recording and the Remote Operated Vehicle (ROV) with photo registration.

The identified UWILD methods, as per the literature, have been employed to assess corrosion, the presence of cracks, the extent of biofouling, leaks, defects caused by abrasion, paint peeling, and minor ruptures in hull and appendage regions. The inspection approaches mentioned adhere to the terminology found in the literature and will continue to be used throughout the paper. However, it should be emphasized that while some designations may differ, they may represent the same effect of the failure mode cause, for example, the presence of cracks and the presence of leaks.

According to the Rules for Building and Classing Floating Production Installations (FPI) rules established by the (American Bureau of Shipping, 2023), general inspections are conducted via video streaming and are accompanied by a classification society surveyor. In cases where there is suspicion of severe degradation in the hull, the surveyor has the authority to request a detailed inspection. In this context, the proposed generation of alternatives initially employs a decision diagram with the aim of identifying the scope of the inspection. That is, whether the inspection will be comprehensive or focused on a detailed assessment of the presence of a specific failure mode effect on a particular structural element. Figure 2 illustrates the developed decision diagram.

After determining the scope of inspection, the diagram depicts the generation of available UWILD methods. To generate available alternatives, the first step involves listing the methods identified in the literature that have been employed in the inspection of a given structural element. Subsequently, the identified methods employed in evaluating the respective failure cause effects are listed. Given these two lists, the available UWILD methods stem from the intersection of the two sets. Figure 3 illustrates the procedure considering the sets of methods identified in the inspection of the steel plates of the hull and in the detection of cracks, based on literature review, disregarding the use of divers due to safety reasons.

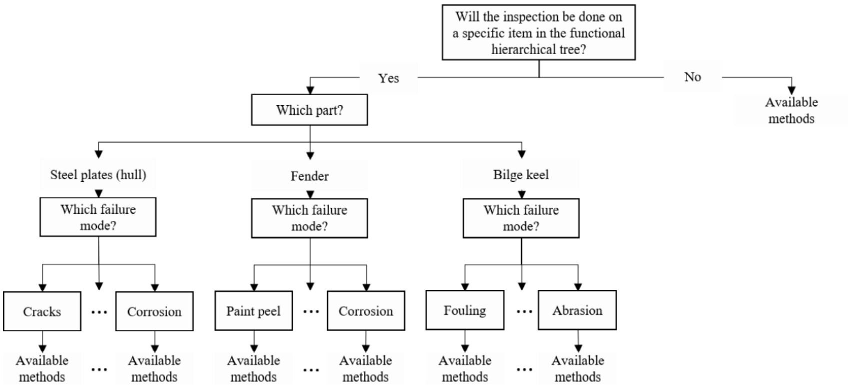


Fig 2. Decision diagram proposed.

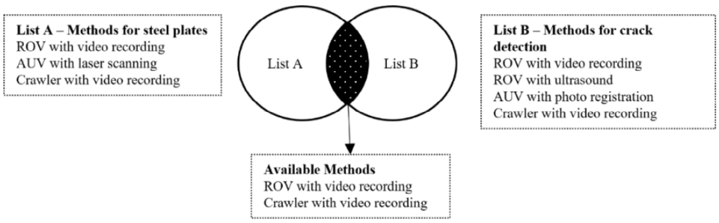


Fig 3. Methods available for inspecting cracks and FPSO steel plates.

## 4. Case study and evaluation of the proposed method

### 4.1. Understanding the problem

According to the FPI rules outlined by the (American Bureau of Shipping, 2023), operational floating units are mandated to undergo periodic inspections at five-year intervals, referred to as Special Periodical Surveys (SPS). An intermediate inspection is also required between SPS, with a primary focus on the hull region and its interfaces with appendages such as bilge keels and fixed fenders. In certain FPSOs, inspection activities are still carried out by divers, posing a risk to human lives. As an alternative to diver-based inspections, UWILD methods have emerged, gaining prominence in the offshore scenario. Despite the availability of various UWILD methods, not all possess the capability or maturity level to meet the requirements and operational procedures mandated by classification societies, such as (American Bureau of Shipping, 2023). In addition to technical considerations, the initial costs associated with implementation and the potential downtime the method may incur are criteria that must be assessed in the selection of a UWILD method.

### 4.2. Definition of the main objectives

According to the problem statement, the selection of the UWILD method must satisfy a series of criteria and sub-criteria, whether they are of a technical or economic nature. Thus, Figure 4 illustrates the value tree developed for the decision analysis process, with the support of the VISA software. It is evident that the primary objective is to define the UWILD method within a specified scope of inspection. The technical criteria and sub-criteria have been established in accordance with the requirements of the (American Bureau of Shipping, 2023), while the economic and operational criteria and sub-criteria have been developed with the support of consulted experts in reliability and maintenance engineering.

### 4.3. Preferences and evaluation of the value compensations

In this stage of the decision analysis, the evaluation structure for each criterion in the value tree was defined. Criteria can be measured either qualitatively or quantitatively. Tables 1 and 2 outline the scales for qualitative and quantitative criteria, respectively. For qualitative criteria, a 2-point linguistic scale was employed for Human Safety (0-Low, 100-High), while a 3-point linguistic scale was utilized for the remaining criteria (0-Low, 50-Medium, and 100-High). Conversely, for quantitative attributes, a linear scale between the values indicated in Table 2 was employed. It is noteworthy that for cost-related criteria, Vessel Downtime, Maintainability, and Mean Time Between Failures, the scale is decreasing. The scales used for each criterion and sub-criterion were determined through a literature review.

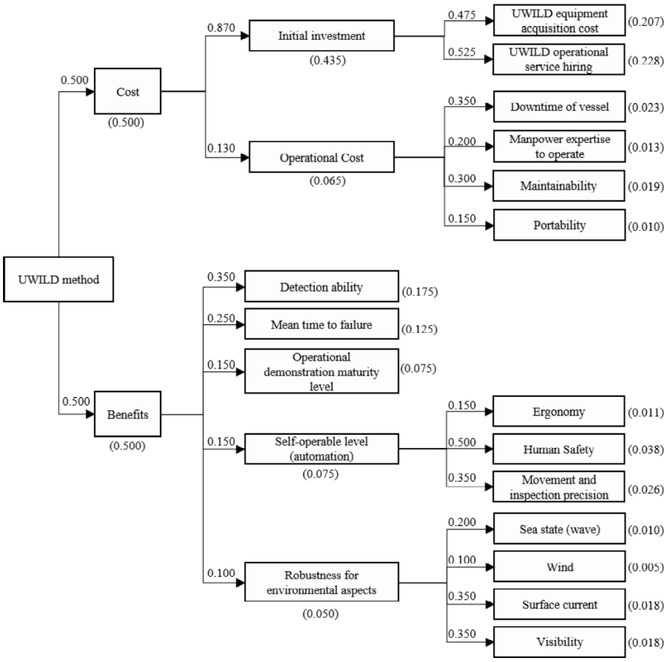


Fig 4. Value tree proposed.

Table 1. Scale for qualitative criteria.

| Manpower Expertise required to operate | Portability | Ergonomy | Human Safety |
|---|---|---|---|
| H/M/L<br>H - more than 5 years<br>M - between 1 & 5years<br>L - less than 1 years | H/M/L<br>H - Less than 15kg and length of 1m<br>M - Less than 25kg and 2m of length<br>L - More than 50kg and 5m of length | H/M/L<br>H - Full remote operated or totally autonomous<br>M - Partial Remote needs cables for commands<br>L - No remote operation - needs a human for all commands | H/L<br>H - It does not require any close human interaction<br>L - It requires some human close handling actions during operation |

Table 2. Scale for quantitative criteria.

| COST | | BENEFITS | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| UWILD Equipment Acquisition | UWILD Operation Service Hiring | Vessel Downtime | Maintainability of the equipment (h) | Detection Ability (%) | Mean Time Between Failures of the equipment (h) | Operational Demonstration Maturity Level | Movement & Inspection Precision | Sea State (Wave) Robustness | Surface Current Robustness | Visibility Robustness |
| From $50,000 to 1,200,000 | From $150,000 to $300,000 per year | from 6 to 36 hours | From 4 to 8 hours | From 60 to 95% | From 300 to 1500 hours | From 1 to 7 years | From 50 to 90% | From 1 to 3 meters | From 1 to 5 m/s | From 50 to 100 centimeters |

### 4.4. Hierarchization of criteria

For assigning weights to the criteria for the selection of the UWILD method, interviews were conducted with experts in reliability and maintenance engineering. Respondents were provided with forms where they elicited the weights of the criteria using the swing weights method (Goodwin and Wright, 2014). After compiling the weights assigned by the respondents, the arithmetic mean was calculated, resulting in a singular value for the weights of each criterion. Figure 4 presents the local weights, with values in parentheses indicating the global weights.

### 4.5. Generation of alternatives

Applying the proposed method for generating alternatives, Figures 5, 6, and 7 present the available UWILD methods for evaluating specific failure mode effects for the steel plates, bilge keel, and fixed fender, respectively.

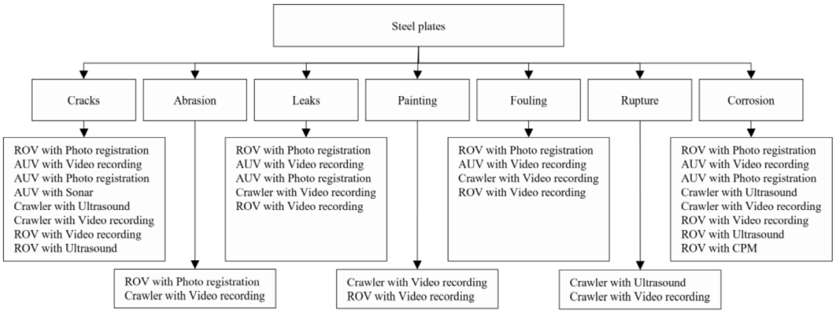


Fig 5. UWILD methods obtained to evaluate the effects of causes of failure in steel plates. Note: CPM is Cathodic Potential Measurement.

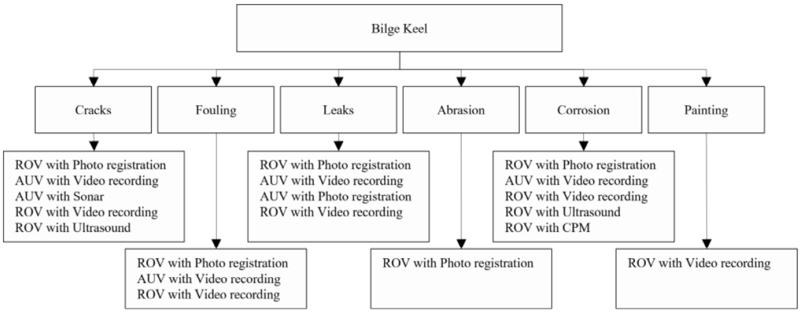


Fig 6. UWILD methods obtained to evaluate the effects of causes of failure on bilge keels. Note: CPM is Cathodic Potential Measurement.

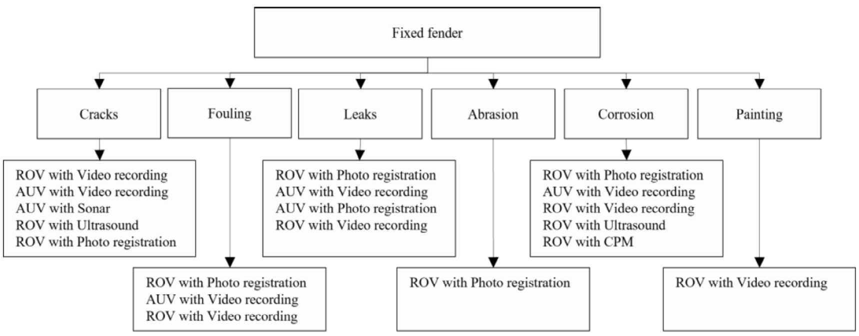


Fig 7. UWILD methods obtained to evaluate the effects of causes of failure in fixed fenders. Note: CPM is Cathodic Potential Measurement.

In the case of a general inspection, three UWILD methods were identified: AUV with video recording, ROV with video recording, and Crawler with video recording. It is noteworthy that the proposed approach significantly reduces the number of alternatives, both when aiming for a detailed inspection and a general inspection. For instance, when assessing abrasion and the paint condition of the bilge keel and fixed fender, the proposed method provides a solution without the need for additional steps in the decision analysis process.

It is also observed that, for the same items but assessing the presence of small ruptures, the method does not yield alternatives. In this situation, it is possible that the literature review conducted and utilized in this case study did not capture available methods, or as previously emphasized, the existence of distinct designations for the same failure mode effects could be one reason for the lack of alternatives. In this context, for the presented method to be applicable, it would be necessary to conduct further literature review aimed at identifying available UWILD methods for those items and failure modes for which no alternatives have been identified.

To proceed with the decision analysis process, it is assumed that the scope of inspection is general, and thus the alternatives created by the method for this purpose will be utilized.

### 4.6. Alternatives evaluation

To exemplify the application of the proposed alternative generation in the case study, it is considered that the inspection scope is general, meaning that the obtained alternatives are AUV with video recording, ROV with video recording, and Crawler with video recording. Tables 3 and 4 present the values of the alternatives for each criterion. These values were defined based on promotional materials and catalogues of the respective equipment.

Table 3. Quantified cost criteria for each alternative.

| **UWILD Method** | **COSTS** | |
|---|---|---|
| | UWILD Equipment Acquisition | UWILD Operation Service Hiring |
| AUV with Video record | $1,200,000.00 | $600,000.00 |
| ROV with Video record | $200,000.00 | $100,000.00 |
| Crawler with Video record | $50,000.00 | $25,000.00 |

Table 4. Qualitative and quantitative benefit criteria.

| **UWILD Method** | **BENEFITS** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Vessel Downtime | Manpower Expertise required to operate | Maintainability (h) | Portability H/M/L | Detection Ability (%) | Mean Time Between Failures (h) | Operational Demonstration Maturity Level | Ergonomy H/M/L | Human Safety H/M/L | Movement & Inspection Precision | Sea State (Wave) Robustness | Surface Current Robustness | Visibility Robustness |
| AUV with Video record | 7 | M | 5 | M | 70% | 1000 | 1.5 | H | H | 80% | 2 | 2.0 | 50 |
| ROV with Video record | 9 | H | 7 | L | 80% | 500 | 5 | M | H | 70% | 2 | 2.5 | 50 |
| Crawler with Video record | 13 | M | 6 | H | 75% | 800 | 3 | M | H | 75% | 3 | 5 | 100 |

Given the values of the alternatives and the weights for each attribute, the aggregated value of each alternative is calculated according to Eq. (1). According to the thermometer function of the VISA software, the obtained aggregated values were 52, 49, and 45 for crawler with video recording, AUV with video recording, and ROV with video recording, respectively. In this context, the indicated method for a general inspection is crawler with video recording.

### 4.7. Sensitivity analysis

Sensitivity analysis is employed to examine the robustness of the decision to changes in the numbers of the decision analysis. In general, both the values of the alternatives and the weights of the criteria can be altered. In this case study, the interviewed experts were asked which of all the selected criteria would exhibit the highest sensitivity in terms of varying their weights and, consequently, impact the choice of the inspection method. When questioned about which criterion would have this characteristic, all respondents identified Robustness for Environmental Aspects as the criterion.

With the assistance of the VISA software, when varying the weight of the Robustness criterion for Environmental Aspects, Figure 8 (a) illustrates the variation in the aggregated value of benefits for the UWILD methods. It is noteworthy that within the weight range of 0 to 0.07 for Robustness for Environmental Aspects, the benefits suggest that the most suitable UWILD method would be the AUV with video recording. Conversely, for weights exceeding 0.07, the method indicated by the sensitivity analysis is the crawler with video recording.

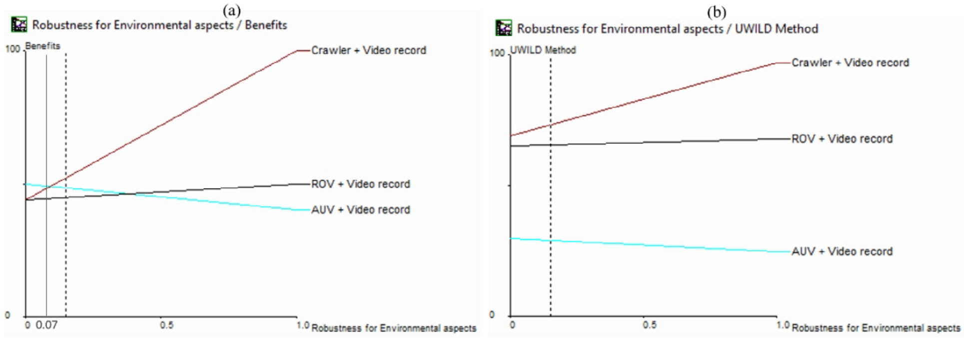


Fig 8. Aggregated value of alternatives varying the weight of Robustness for Environmental Aspects for (a) benefits (b) total.

It is worth noting that, although the benefits indicate the AUV with video recording for weights between 0 and 0.07, this method would not be the recommended by the decision-making process. This is due to the fact that the benefits branch carries the same weight as the costs branch, and within the costs branch, the aggregated values for AUV with video recording, ROV with video recording, and crawler with video recording are 10, 85, and 95, respectively. Consequently, the total aggregated value, regardless of the weight assigned to Robustness for Environmental Aspects, will always indicate crawler with video recording, as depicted in Figure 8(b).

### 4.8. Recommendations

After conducting the decision analysis process and performing sensitivity analysis, considering a general inspection scope, the recommended UWILD method is the crawler with video recording. Sensitivity analysis indicates that the suggested method has the highest aggregate value over a broad range of weights, demonstrating the robustness of the solution.

## 5. Conclusions

The present work presented the analysis of a multi-attribute decision problem of choosing a UWILD method using the SMART method, where it demonstrated a methodology for generating alternatives based on a decision diagram that aims to optimize the scope and evaluation of effects of the causes of failures. The analysis of the decision problem was constructed according to the stages proposed by (Goodwin and Wright, 2014). Three experts in maintenance and reliability engineering helped define the criteria and sub-criteria and elicit the weights.

From the value tree, it is observed that in the cost sector, there is concern on the part of specialists regarding the need for initial investment. This concern is valid, mainly, when regulatory societies require that the means for carrying out underwater inspections are safe, requiring the installation of devices in FPSOs. Therefore, concern about the initial costs for carrying out the inspection using each available technology is justified.

In the benefits sector, there is concern about the detection capacity of the method used. From an engineering point of view, the detection capacity is relevant since identifying the emergence of a degradation mechanism as soon as possible is essential for taking preventive actions to avoid human, financial and environmental losses.

Regarding the generation of alternatives, proposed in this work, it is observed that the proposed method is consistent and allows the UWILD methods to be stratified according to the scope of inspection. When inspections are targeted at specific items, there is also a reduction in the number of alternatives, that is, instead of using all available methods as alternatives, alternatives that have already been tested and documented in the literature for that purpose are used, ensuring a deeper analysis in the decision-making process.

Regarding the evaluation of alternatives, the SMART method was used, which suggested the crawler with video record method. Additionally, conducting a sensitivity analysis, given that the Robustness for Environmental Aspect criterion could significantly influence the performance of an inspection, it was observed that the crawler with video record method would still be the most recommended method for the analysis.

For future work, we aim to use a probabilistic approach in eliciting utility functions, which would require a deeper dive into the discipline of UWILD methods. This presupposes that the authors seek more partnerships with experts in underwater inspections in addition to more scientific research and, above all, greater access to databases that would be vital to provide parameters for constructing utility function scales.

## Acknowledgements

The authors gratefully acknowledge the financial support from Petróleo Brasileiro S.A. – PETROBRAS. Prof. Gilberto F. M. de Souza also wishes to acknowledge the support of the Brazilian National Council for Scientific and Technological Development/Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) by grant 303986/2022-0. Prof. José G. V. Vieira also wishes to acknowledge the support of the Brazilian National Council for Scientific and Technological Development/Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) by grant 310720/2022-2.

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