ONLINE PERCEPTION OF ARTIFICIAL REEF RISK AND SAFETY BY STAKEHOLDERS (INCLUDING RESIDENTS AND TOURISTS) VIA THE ANALYTIC HIERARCHY PROCESS

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ABSTRACT

Artificial reefs (AR) may be ignored by many people, probably because they are usually unseen structures. Even so, there are users that believe in the value of these structures even without observing them, as is the case of most fishermen and anglers. Divers usually believe in AR and are the ones effectively able to notice them. Based on the previous simple premises, the aim of this paper is to ascertain the perception coastal community people and tourists have on the risks and benefits derived from the presence of AR nearby. AR were deployed off the Algarve from 1990 to 2003. The methodological approach for sampling purposes used a search engine with key-terms following a simple 3-step protocol: identification, screening, and eligibility. The eligible documents were analysed using qualitative data analysis software. Most documents found were from AR promoters named as "institutional" and communication "media" reporting mostly AR by the supply side. Sources from companies named as "firms" and discussion "fora" were mostly on the demand side. The contents of the samples were assigned onto two different categories: risk and safety. These derived into the relevant criteria where alternatives were judged to achieve the goal stated in the analytic hierarchy process (AHP). AHP sensitivity analyses were carried out and the best choices were calculated.

Keywords: Coastal Community, Coastal Management, Multi-Criteria Analysis, Socioeconomics, Wellbeing.

JEL Classification: Q57

1. INTRODUCTION

Artificial reefs (AR) are placed on the seabed and are not visible to most people (Baine, 2001). Only a few people are aware of the existence of AR. These people are usually divers who, for reasons of tourism, leisure, or research, dive into the depths at which the AR are deployed, if these are not very deep, that is, up to a depth of approx. 30 meters (Stolk et al., 2005). For this reason, AR are known as structures perceived from the point of view of the Petrarch principle, that is, people believe in something that cannot be seen (Pitcher & Seaman, 2000).

The divers believe in the existence of the AR, because they dive in the deployment sites and can verify the real existence when seeing and touching the structures. However, fishermen generally do not dive, nor do they go to the bottom to see if the AR are there or not. But fishermen can be aware of AR even if they have not experienced these structures previously (Sreekanth et al., 2019). At first, fishermen can be incredulous or can have doubts about the

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efficiency of AR, if they have no experience with these structures. However, fishermen start to believe in the benefits derived from the existence of the AR, when they make comparisons regarding the catches of fish before and after the deployment. If they catch more fish after deployment of the AR, they believe in the structures as having a positive impact on their activities (Ramos et al., 2019).

All other people who are neither divers nor fishermen, only perceive the impacts of reef deployment if they have solid evidence about it, or if it is transmitted to them by users (Klain et al., 2018). However, there are exceptions; for instance, in AR placed near the coast, people may perceive the AR as providing some coastal protection due to the dissipation of wave energy (Mangi, 2013).

Although the Algarve is the region of Portugal with the highest number of reef structures in place, it is not very easy to gather data on their social impact, namely in terms of the perceptions of local populations. From direct observations there are no signs of change that can be immediately attributed to the AR. From the data collected in the media - whether in print or online - the signs of positive or negative changes perceived by people and which are directly attributable to reef deployment are generally not obvious (Ramos, 2007).

Most people who live in coastal locations where AR were deployed know of their existence, but do not use them. On the other hand, most tourists who visit these coastal locations with AR in their vicinity, generally use them only if there are firms providing services - either diving or sport fishing - in the areas where the AR were deployed (Jensen, 2002).

The aim of this study was to identify the risk and safety perceived by residents and tourists who have used or know about the presence of AR along the Algarve coast. For this purpose, a search engine was used to search non-scientific literature, using the terms "artificial reefs" and "Algarve". The selected texts were recorded on computer support. Subsequently, a software was used to make the qualitative analysis of the data. Finally, the perception of residents and tourists was ascertained using the hierarchical analytical process (AHP).

2. LITERATURE REVIEW

2.1 Risks Associated to AR

In the past, there have been some risks arising from reef deployment and some mistakes have already been made (Pears & Williams, 2005). The literature reports that the risks associated with reef deployment are essentially related to specific factors (Collins et al., 2002), including: the degradation of structures over time, either by natural phenomena or by human origin (Pickering et al., 1999); contamination risks when, for instance, sunken boats are used (they must be cleaned from oils and fuels before sinking) (Johnston et al., 2003); the stability of the structures themselves, i.e., if they are not well placed at the bottom (Barber et al., 2009); or in the usage of scrap tires, a use that proved disastrous in many of these situations, causing risks for some coastal areas (Becker et al., 2018). There is also the case of congestion externalities by fishermen, i.e., if the initial reef intention was fishing, leading to specific overfishing phenomena (Whitmarsh & Pickering, 2000). In the past, it was also thought that AR were a good solution for materials that were wasteful, namely civil construction, or even toxic material that could be incorporated into concrete structures (Stone, 1985).

However, it has been verified that the choice and use of suitable materials to make AR can generate promising results (Relini & Relini, 1989; Falace & Bressan, 2002). Certain structures on fossil fuel exploration platforms have also been used (Guerin et al., 2007). Structures of concrete blocks, or similar materials, vessels, other obsolete transports, or other types of vehicles have been used to make AR (Fowler & Booth, 2012). If properly

prepared after removing oils and fuels, they can be safe choices, either to be enjoyed (e.g., for diving), or because they do not pose risks to coastal populations (e.g., because they do not disintegrate or release toxic waste) (MacDonald et al., 1999). In addition, the materials and design used in AR can be risk mitigators, particularly in carbon sequestration (Callaway et al., 2017).

2.2 Safety from AR Deployment

In general, AR provide ecosystem services and they can be an asset for the improvement of habitats (Jacob et al., 2016). Thus, there are many benefits to reef deployment. In this sense, nearby coastal communities and tourists can take advantage of these services directly or indirectly (Ramos et al., 2021). Among the most important ecosystem services that AR can provide are improving fisheries (i.e., benefiting fishermen) (Methratta, 2020), providing shelter and food to colonizing organisms and habitats in the additional surfaces (Smith et al., 2017), conferring some protection to coastal areas (Jackson et al., 2007), promoting biodiversity (Tessier et al., 2015), and allowing recreational use (e.g., diving or sport fishing) (Stolk et al., 2007; Keller et al., 2017).

2.3 AR in the Algarve

The AR in the Algarve are infrastructures that were implemented between 1989 and 2003 (Santos & Monteiro, 2007). In 1989-1990, only two pilot reefs were deployed (Santos et al., 1995). Then, after positive scientific evidence on biological colonization and other ecological benefits, the reef program was carried out in a broader way (Monteiro & Santos, 2000). From 1998 to 2003, larger AR systems were implemented in other parts of the Algarve coast (Cacela, Tavira, extension of AR Faro-Ancão, Vilamoura, Oura and Alvor; see Methods).

2.4 Impacts derived from AR Deployment in the Algarve

From its completion in 2003, it was important to understand how AR were perceived by the different stakeholders, regarding the deployment of the structures (Ramos et al., 2011). A study carried out in 2002-2003 revealed that there were some negative impacts of AR perceived by several stakeholders (Ramos et al., 2007). It was noticed that there could be silting up of some reef modules due to bottom currents, and there could also be some AR modules entangled with fishing gears (Falcão et al., 2007). This was seen essentially in AR with less monitoring, as in the case of the AR in Cacela, through eyewitnesses' testimonies (pers. comm. Mike Beauchamp, 2008). Another potentially negative impact was the agglomeration of vessels, leading to a high fishing effort at certain times of the year, as was verified by another study in the AR in Oura and Vilamoura (Ramos & Santos, 2015).

In terms of security, it was found that most AR allow professional fishermen and even anglers be more certain about fishing spots, because in reef areas they are generally more likely to catch fish (Whitmarsh et al., 2008). Likewise, AR allow dive operators to diversify their locations to offer to customers (Ramos et al., 2006).

3. METHODS

3.1 Approach

For this study, we used a content analysis of documents found on the internet. This is a non-intrusive method and was used to carry out the data collection. The qualitative document analysis (QDA) was done with specific software tools (Altheide et al., 2008; Drisko, 2013).

The advantages of this methodology are: 1) to observe without being observed; 2) the data is immediately accessible/available on the internet for everyone; 3) reanalysis and replicates are easy to carry out; and 4) it is a low-cost method of obtaining information, which would otherwise have high costs, particularly if carried out with interviews or questionnaires through institutional arrangements for focus groups or group interviews.

The disadvantages of this methodology are: 1) the number of documents available is limited, and some of them are only partial, such as news pieces from newspapers; 2) the documents were written many times for purposes other than this study; 3) some distortions or other biases that may occur; and 4) the causal relationships are difficult to assess, such as whether there is any influence on the search for AR due to the influence of pre-disseminated information (Ramos et al., 2008).

3.2 Research Context

The purpose of AR can vary considerably and is highly dependent on geographical location. In the case of AR in the Algarve, with two different types of concrete modules, they had several objectives, namely, to provide fishing and protection for the smallest species that left the nursery areas of the Ria Formosa and Ria de Alvor (Santos & Monteiro, 1998). In the case of AR made with sunken ships, the objective was more related to the issue of recreative and diving tourism, and to allow biodiversity (Ramos et al., 2019). The deployment of AR implies some risks and security (i.e., benefits after maturation) that can be perceived by the stakeholders, whether they are the institutions that carry out the sinking of the structures, or their expected users, generally fishing and recreational activities (i.e., diving and angling), or in terms of education (MacDonald, 1994; Becker, 2018).

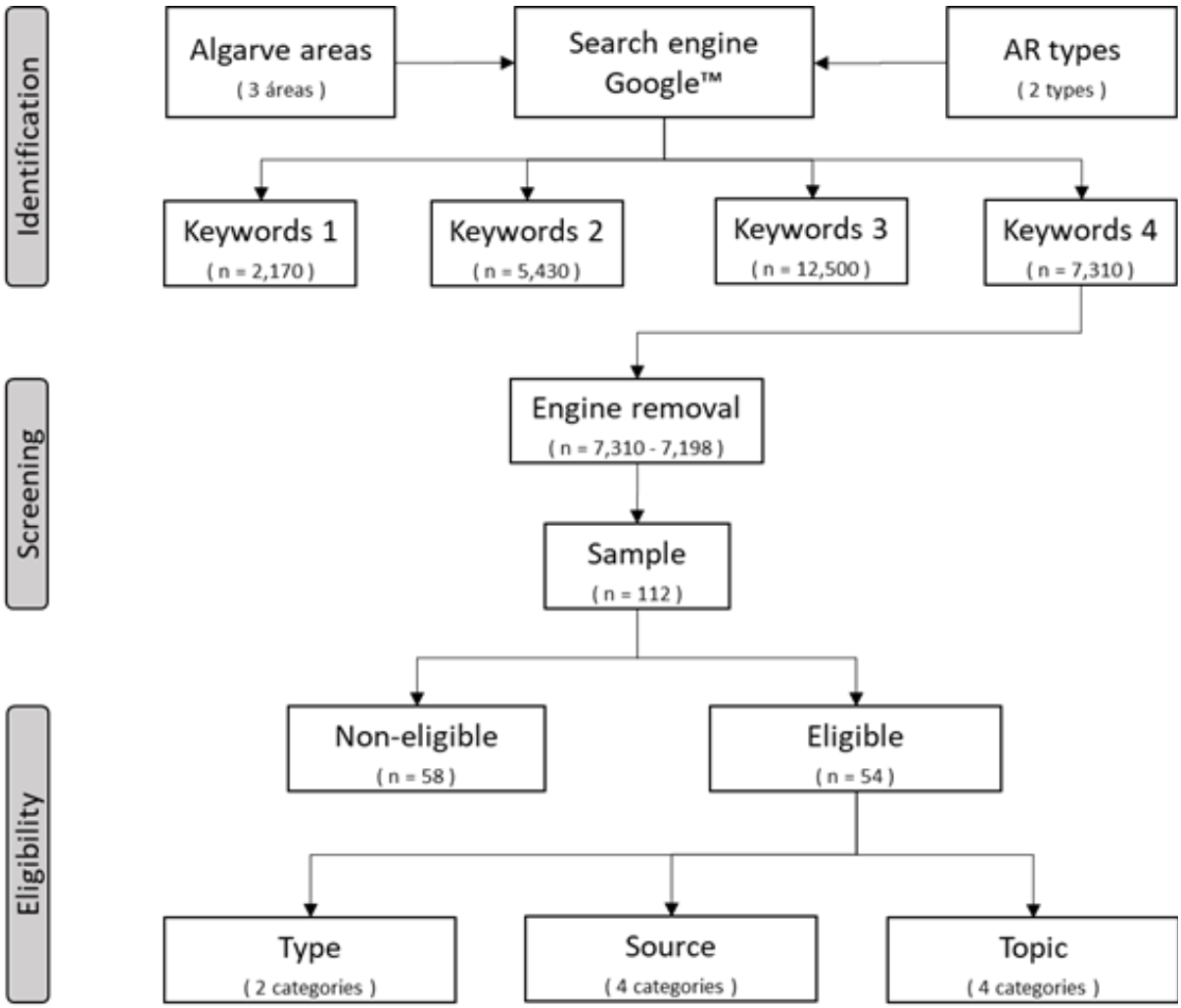
3.3 Research Questions

In the specific case of this study, it was intended to know what the perception of individuals from local communities and tourists is regarding the AR deployed off the coast. In this way, it was evaluated the social importance that the AR have had up to now, about risk and security. The main research questions were: “How have AR been perceived by stakeholders?” and “What is the relative importance attached to structures by the stakeholders, according to the different terms used in the discourse of the documents consulted?”. For this purpose, we searched documents on the internet that could be used as indicators of human use or non-use about AR deployed in the Algarve region.

3.4 Sampling Strategy

A 3-step protocol was used to search for relevant literature (Figure 1).

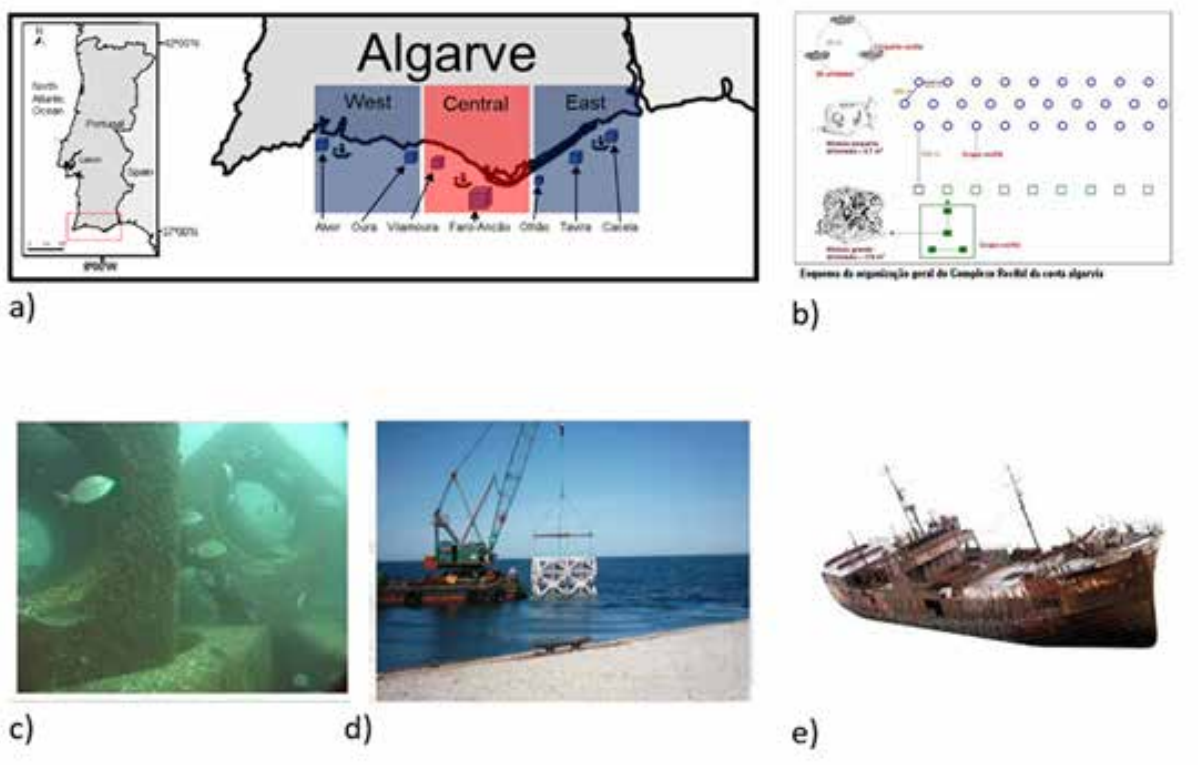
Figure 1. Literature Search with a Three-step Protocol



Source: Adapted from Lima et al. (2019)

Firstly, the "Algarve areas" refer to the places off the Algarve coast where AR were deployed. These AR were allocated into three geographic areas: West, Central and East (Figure 2a). Second, we considered two "AR types", although there are several types of AR (Thierry, 1988; Komyakova et al., 2019): the concrete AR with 2 different shapes deployed by the Portuguese Institute for Sea Research (then IPIMAR, now IPMA) in the period from 1990 to 2003 (Figure 2b, c, d); and sunken structures - essentially ex-vessels - sunk not only by the IPMA, but also by other entities. For example, in 2013, four ships were sunk off Portimão (Figure 2e).

Figure 2. a) Pictorial location of the AR deployed in the West, Central and East areas off the Algarve. The cubes represent the modular AR sites, and the silhouette ships represent the sunken vessels. b) Generalized layout of the reef arrangement with two types of modules. c) Cubic modules. d) Octagonal modules. e) Sunken ship.



Sources: a) Own Elaboration, b) and c) IPIMAR (now IPMA), d) Mota Engil website: www.mota-engil.com, and e) image for non-commercial use from website: www.clipart-library. com

Third, the Google™ search engine was used with four different keyword combinations. The most appropriate keywords were selected: "artificial reefs" and "Algarve". Then the work consisted of identifying all types of content derived from the chosen keywords. The contents found varied and included texts, figures, films, sounds, or in most cases a combination of several. However, they are all encoded as documents. From the total universe found, a sample provided by the search engine itself was selected (by default/omission of the others).

Afterwards, all contents were checked for eligibility. Eligible documents were analysed using qualitative document analysis (QDA) software. The documents were analysed according to the type of market, the source of information, and the topic. The documents were considered ineligible if: 1) the location of the AR was outside the Algarve, 2) the content was scientific, 3) there was repetition of content, 4) it was an advertisement unrelated to the AR.

3.5 Analysis with NVivo™

To carry out the qualitative data analysis, a recent version of the NVivo™ software (Release 1.0) was used. This software is used to analyse qualitative data, namely in the coding of text data, annotations, and to survey, record, and review coded data and documents (Bandara, 2006; Edhlund & McDougall, 2019). This program also allows to manage documents combining them numerically and categorically through the information that already exists. NVivo™ also allows, through a wide range of exploratory tools, to identify coding patterns

and relationships between assigned codes and other numerical and categorical properties (Bazeley & Jackson, 2013).

3.6 Recording Unit

In the context of this content analysis, the focus was on finding a set of text documents - namely with the frequency of occurrence of the relevant terms - in relation to the social dimension of AR in risk and safety contexts that these structures can be perceived by people, in particular residents and tourists. Basically, the registration unit consists of the number of times that concepts - the codes - appear and the selection of texts has been counted. By comparing the number of times and the distribution of concepts, some sensitivity is gained about the modes of discourse that different types of information sources give to the object under analysis, namely in this case study: the artificial reefs deployed off the Algarve coast.

The size of the text varied from sample to sample, as did the size of each recording unit. The validation of the registration consisted of, 1) part or all the selected sentences, and 2) complete paragraphs of the documents that corresponded to the different codes chosen a priori. To do this, it was necessary to examine the context where the registration unit was found, to match the corresponding code.

3.7 Categories for Analysis

One of the categories for analysis was to verify if the "AR market" that the document showed was on the supply or demand side. Another category had to do with the origin of the sources of information, where they were divided into four subcategories: institutional (i.e., the AR promoters), media (i.e., means of communication), firms (i.e., private companies), and discussion fora. In addition to the sources of information, it was also decided that each document could cover (or had a focus on) one of four topics, related to the objective for which AR were implemented: fishing, diving, education and/or museology, or another subject (and/or a combination of the above).

With this information in mind, the analytic hierarchic process technique was used to make a comparative categorical analysis, to understand in each source of information, i.e., institutional, media, firms, and fora, what was the intensity of each one these factors both in terms of risk and safety.

3.8 Analytic Hierarchic Process Analysis

Analytic hierarchic process (AHP) analysis is widely used in decision-making processes (Saaty, 2008). AHP is used with a wide variety of subjects, including those related to coastal zones (Teixeira et al., 2018; Sekovski et al., 2020) and AR (e.g., Tseng et al., 2001; Ramos et al., 2006).

Briefly, the AHP technique consists of a decision tree, where the goal is at the top, in the second row are the criteria and sub-criteria, and in the last row are the alternatives in the decision process (Leung et al., 1998). The analysis consists of an exhaustive process of pairwise comparisons made on a 9-point scale. For the purposes of decision, there must be consistency in the application of the method. Thus, the inconsistency rate must be low (less than 10%), and the eigenvalue must be close to the number of criteria in comparison (Alonso & Lamata, 2006).

In this study, we assume that the objective of the AR deployed off the Algarve coast was derived not only from the IPMA reef program (1989-2003) essentially using concrete modules, but also accidental sunken (barge off Cacela) or on purpose ex-vessels (trawler off Faro, and former navy ships off Portimão). The entities promoting the AR had in mind one objective aimed at people and another at species biodiversity. In other words, that

the concrete modules would be more focussed towards improving fisheries and the sunken ships directed to tourist and leisure diving; and both reef typologies to increase biodiversity (Santos & Monteiro, 2007).

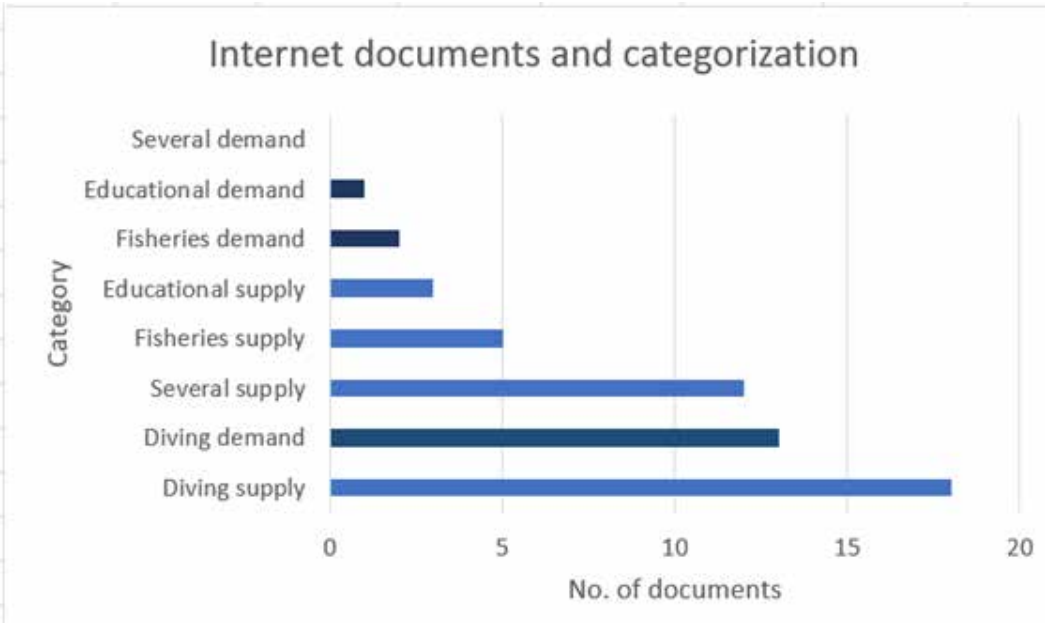
Bearing in mind the objective of the promoting entities, the AHP's goal for this study was to find out if the AR referred above, raised any risk issues (i.e., degradation of structures over time, contamination by materials or fuels not removed, instability in the positioning of structures, overfishing and loss of gear, and toxicity due to the reaction of materials). Likewise, it was aimed to find out if the AR deployed off the Algarve coast gave a perception of security (i.e., improvement in the capture of fisheries, shelter and food for marine species, protection of the coastline, increased biodiversity, additional opportunities in recreational and leisure activities).

4. RESULTS

In March and April 2021, the search engine Google™ was used with the keywords "artificial reefs" and "Algarve" and 7,310 documents were found. From this universe, a sample of 112 internet sites was selected, herein generically identified as documents regardless of their content (i.e., text, photos, illustrations, films, or several combined). From the sample, only 54 documents were considered eligible for this study.

In all 4 topics covered (i.e., fishing, diving, educational, varied), supply has always supplanted demand (Figure 3). Noteworthy are the contents related to diving, which formed the overwhelming majority (18 supply, 13 demand), being more related to AR such as sunken ships. On the supply side of AR for various purposes (12 documents), demand was not matched (zero documents). Fishing had a small number of contents in demand, mainly in the "fora" and on the part of sport fishing. At the educational level, the contents were related to museology associated with the history of former ships and their use as AR.

Figure 3. Supply and Demand (Market) for AR Sunk in the Algarve

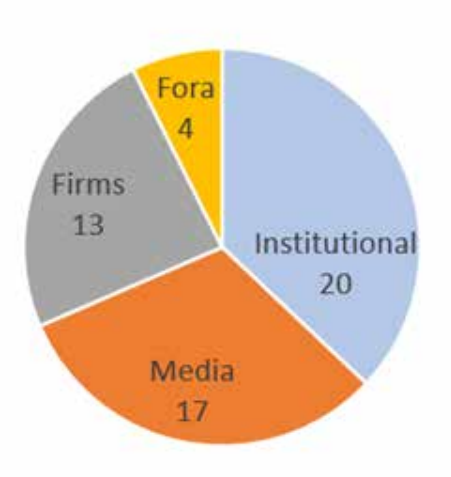


Source: Own Elaboration

Of the 54 documents eligible for the study, it was verified by content analysis that most of them were located mainly on the supply side (38 documents). It was also found

that of the 20 documents classified as coming from "institutional" sources (e.g., central government, tourism region, city councils) all were on the supply side. In the case of the 17 "media" documents (newspapers, magazines, TV), although mostly focused on supply, there was a small portion related to demand (Figure 4). On the demand side, the documents came essentially from "firms". The "fora" chatting about the AR essentially covered matters related to fishing and diving.

Figure 4. Information Sources Related to AR Content in the Algarve



Source: Own Elaboration

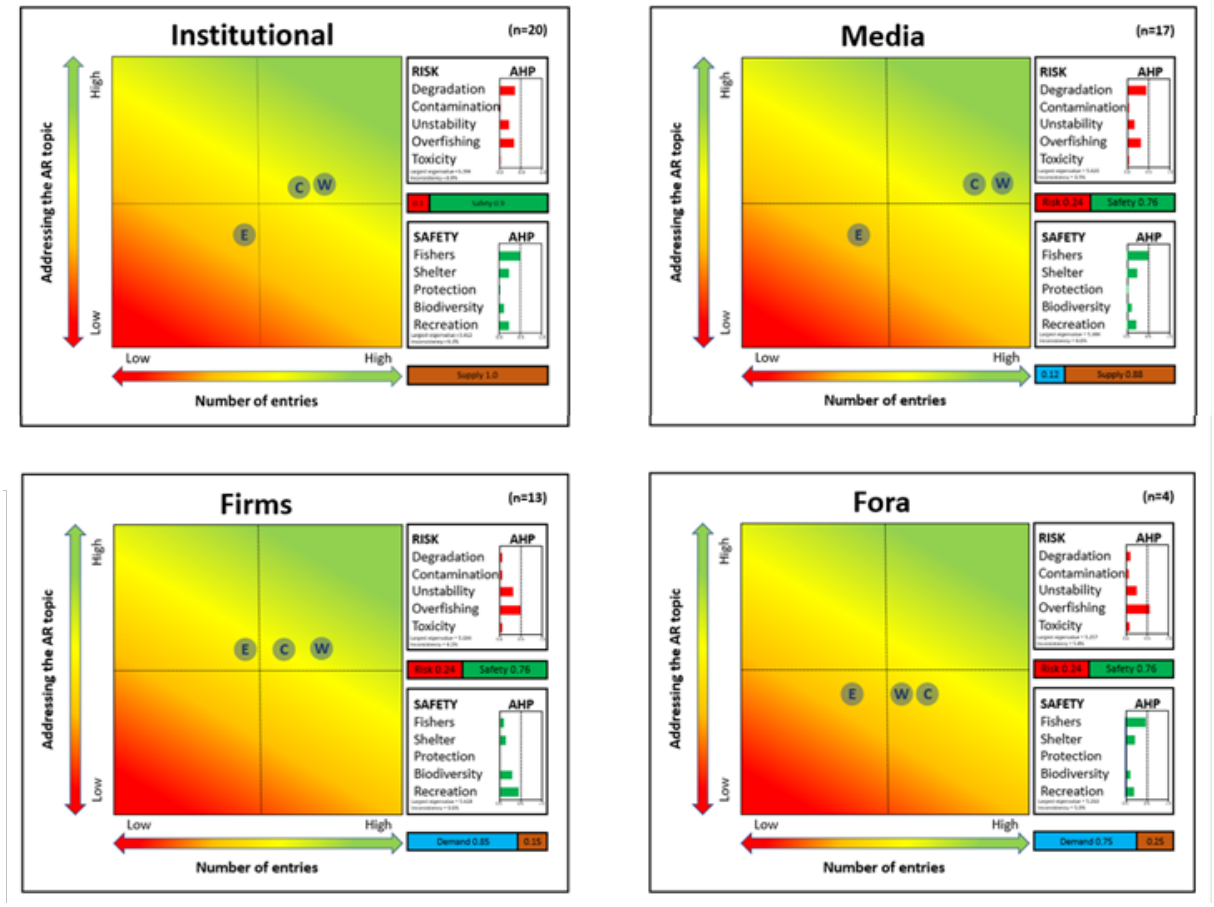
In the documentary analysis it was found that the sources of "institutional" and "media" information are those that were published in greater number (Figure 5). They have a very similar relationship in terms of the safety criteria found in the text and differ slightly more in terms of risks, as can be seen from the results of the AHP analysis. The documents from the "institutional" and "media" sources are essentially part of the supply. In the geography of the Algarve, more documents were found referring to AR in the West (most of them relatively recent and referring to former Ocean Revival ships), followed by the Central area (most of them over 10 years old and referring to the IPMA concrete modules reef program), and in a much smaller quantity to the East. In the adequacy of the topic there was a better coverage also in the part of the first two sources of the geographical areas West and Central Algarve.

The documents whose topics were related to diving, were essentially from the source "firms", originating mostly from diving companies and were generally better represented in the West of the Algarve, followed by the Central zone. In terms of coverage of the topics, they were all very similar, i.e., there were no relevant differences, and they may even be derived from research from "institutional" or "media" sources, which were then only replicated on the website of these firms. This was evident in the AHP analysis, where firms prefer to value their own activity and prefer to have a lot of biodiversity to attract customers.

In the case of "fora" there was also a lot of similarity in risk criteria compared to those of "firms". In the analysis with AHP, the criteria related to safety stand out more than those related to fishing, denoting that there were many spearfishing divers or even sport fishermen. It should be noted that for the AHP analysis the literature highlights that there are two indicators that are used for decision analysis. For example, for 5 criteria/alternatives as in this study, it is important to have an eigenvalue of less than 6 (Costa & Vansnick, 2008). The inconsistency index - regardless of the number of criteria - must be less than 10% (Kułakowski, 2015).

The sensitivity analysis using AHP showed us that the hypothetical risks derived from the implementation of AR constrains the provision of reef services (Figure 6). The best choice derived from the security provided by the AR deployed in the Algarve is most often the alternative "shelter and food" (13 out of 15) and rarely the "improvement of fisheries" (2 out of 15). All other ecosystem services do not develop. This was expected for coastal protection since most of the AR structures off the Algarve were not deployed with this function in mind.

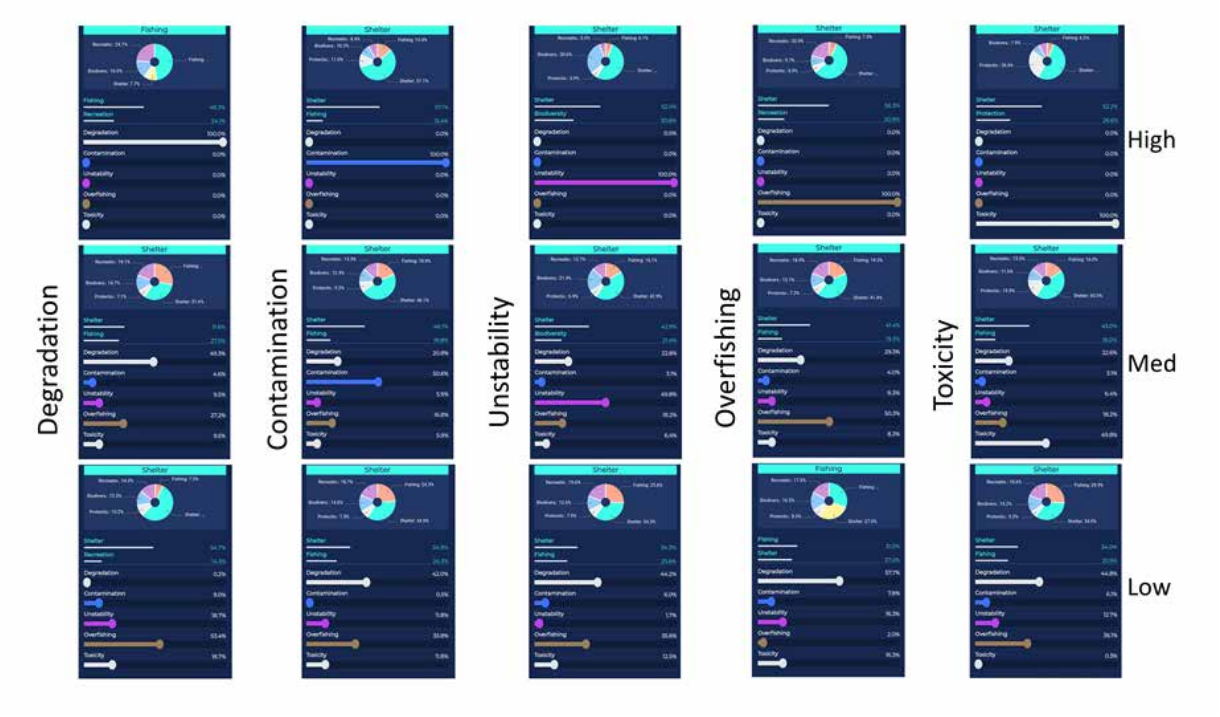
Figure 5. Documentary analysis of the sample selected on Google™ regarding AR deployed in the Algarve



Note: the perceptions were analysed qualitatively with the aid of the NVivo™ software and the prioritization made through an application using the AHP. With NVivo™: The contents were essentially textual or combined with an image; the sources of information were allocated into four groups "Institutional", "Media", Firms "and" Fora"; established the proportion of the market for each type of source (supply and demand). With AHP: Priority was given, according to each source, for both the risk and safety criteria arising from the implementation of AR in the Algarve; the proportion of safety-risk was that obtained by analysing the literature. W, C and E refer to geographical locations (Algarve: West, Central or East) and were relative to each other both in the number of documents found (xx axis) and in the addressing to the topic RA (yy axis).

Source: Own Elaboration

Figure 6. Sensitivity Analysis Carried Out in the Decision Mentor Application Version 5.1.0 (Multi-Criteria Decision Making - MCDM - Based on an AHP Algorithm) (DM, no date)



Source: Own Elaboration

5. DISCUSSION

This study consisted in the identification of online documents related to AR in the Algarve and the perception by stakeholders about the risk and safety derived from the structures. The range of stakeholders identified was not very extensive, but it was possible to perceive AR in terms of supply and demand, depending on the different types of eligible documents analysed.

The AHP allowed to verify that there was some dependence on the activities in relation to the primary objective of the AR. In other words, the institutions that gave prevalence with an objective more directed to fishermen, gave more value to the improvement of fisheries; while the entities that have sunk, for example ships, will give more value to diving activities and eventually environmental education.

The perceptions of risk or security inherent in AR depend on many factors. For example, with the AR there is greater vulnerability or, on the contrary, greater protection, for example, in the event of storms. Kaiser & Kasprzak (2008) describe the case where oil and gas structures destroyed by hurricanes were transformed into AR.

In the case of positive perceptions, it is important to understand if the existence of AR contributes to the development of more profitable economic activities. The perceptions of greater security derived from AR should be interpreted as the benefits inherent in the maturation of the structures. For example, there are undeniable benefits if, after the AR be mature, professional fishing can provide more/better fish, or if the dive operators increase the offer of places to visit for tourism or leisure purposes (Milon et al., 2000). At the security level, AR are associated with ecosystem services. Here it is important to know that AR allows the development of services for direct extractive use, such as in the case of fishing (e.g., catching fish or invertebrates) (de Oliveira Leis et al., 2019), for direct non-extractive use as in the case diving (e.g., visit of habitats with living resources) (Oliveira et al., 2015), of

indirect use (e.g., as in the case of coastal protection, through the attenuation and diversion of the impact force of the waves) (Ghiasian et al., 2021), or use or non-use options (e.g., preservation of biodiversity for future generations).

The "institutions" in a generalized way make known the AR projects or programs. In essence, the documents found reported since the late 1980s, referring to the first AR modules. In this source, the most recent documents reported essentially former military ships that, because they are obsolete, were sunk with the purpose of providing environmental services, namely by promoting biodiversity and allowing recreational diving in an essentially tourist aspect. The topics covered were always diverse (fishing, diving, educational and combined), with a little less predominance in the Eastern part of the Algarve, but always on the supply side.

In their turn, the "media" generally report what the "institutions" say through press releases in an informative way. Coverage was mostly given to the Western and Central parts of the Algarve. The "firms" found in this study were generally resident and essentially linked to diving. Hence, diving as the main activity prevails. Other issues such as biodiversity were very important, as they allow more diving activities to be developed for their clientele (residents, national and foreign tourists). The risks that "firms" posed the most were in the issue of "overfishing", often related to lost fishing gear that, if not cleaned, can damage AR biodiversity. Hence, divers were also predisposed to clean up the AR, namely remove fishing gear. There was a greater reciprocity of the "firms" essentially on the demand side. The "fora" in turn reflect a little on both sides, both residents and tourists. It should also be noted that scuba - associated with tourism and leisure - was the diving most related to spearfishing. The "fora" were also related to recreational fishing vessels that eventually went to the AR areas with the concrete blocks. In the information sources consulted, risks arising from AR in the Algarve were rarely identified. The risks were associated only with the five criteria analysed with the AHP.

6. CONCLUSION

It was possible to find online documents regarding the AR deployed off the Algarve using an internet search engine. Most of these documents referred to the supply side. Most of the documents found came from "institutional" and "media" sources (i.e., derived from press releases). On the demand side, the existing information was related to Portuguese-speaking residents and tourists, namely in documents whose sources were "firms" or "fora".

The methodology used allowed to systematize the study. The use of the NVivo™ software has made it possible to take a more comprehensive approach. The use of the AHP methodology made it possible to list the risks and safety arising from the reef deployment perceived by stakeholders. The sensitivity analysis showed that in the presence of possible risks derived from AR deployment, practically only "shelter and food" for the species that live there allow a positive impact.

From this study it can be corroborated that AR are structures that remain inaccessible to most people (whether residents or tourists). Their social perception is often only based on institutional dissemination or the media.

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